Commentary report: The potential health impacts of extending the frequency of non-recyclable waste collections

Zero Waste Scotland

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Contents

Zero Waste Scotland works with businesses, individuals, communities and local authorities to help them reduce waste, recycle more and use resources sustainably.

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1. Introduction

1.1 History of household waste collections

Twenty years ago, household waste collection in the UK was simple: waste was typically collected once a week in black refuse sacks and for the most part dumped unsorted in a landfill site. Since then we have come to understand the economic and resource value of the material that we throw away, and the negative environmental impact of disposing of waste in landfills.

By 2009 a large proportion of local authorities across the UK had already, or were considering, a change from weekly to fortnightly "non-recyclable waste"[1] collections, often coinciding with the expansion of recycling collection services. At this time there was a small number of local authorities across the UK trialling separate food waste collections, and a number that accepted fruit and vegetable peelings in garden waste collections[2]. The majority of collection systems required residents to dispose of food waste through their non-recyclable waste collections.

In some local authority areas the change from weekly to fortnightly non-recyclable waste collections was met by public concern related to the potential risk to human health. Specific concerns raised at that time were:

- Potential for unpleasant odours or airborne disease due to decomposing waste; in particular food waste and absorbent hygiene products (including nappies), and particularly in warm summer months; and
- Potential for increased presence of flies and vermin attracted by the decomposing waste.

These concerns prompted the Waste and Resources Action Programme (WRAP) to undertake a study into the potential health effects of fortnightly non-recyclable (residual) waste collections.

WRAP (2009). Scoping study of potential health effects of fortnightly residual waste collection and related changes to domestic waste systems.

In 2009 WRAP, in partnership with the Chartered Institute of Wastes Management (CIWM), published its review into the available scientific evidence of the potential risks to householders and operatives due to fortnightly, rather than weekly, collections of non-recyclable waste.

The literature review examined over 150 published papers and documents dealing with a range of potential health impacts linked to waste management and found that there was no documented evidence of a direct link between the frequency of waste collection and any actual health impacts on householders or waste collectors.

The literature review did confirm some issues that could be affected by collection frequency: the incidence of maggots and flies; manual handling issues related to the weight of the waste containers; and the risk of exposure to bacteria, moulds (and their spores), and bioaerosols (airborne microorganisms) from both food and garden waste materials. Although both householders and waste collectors could theoretically be affected by these factors, the conclusion was that the lower exposure of

[1] For the purposes of this report the term "non-recyclable" waste is used to describe waste that is collected for disposal or energy recovery, rather than recycling or re-use. A proportion of this waste will in fact be recyclable, however the resident chooses not to recycle them or it is not targeted for recycling by the local authority.

[2] This practice was brought to an end through the enforcement of the Animal By-Products Regulations which aim to prevent the spread of animal diseases, such as foot and mouth or BSE, by limiting open windrow composting to garden waste materials only. Hence animal by-products and other kitchen food waste that may have come into contact with animal by-products (e.g. such as cooking oil, meats or plate scrapings) can no longer be composted in this way.

householders and the availability of simple precautions mean the risk for them is little changed from that experienced with weekly collections. However, the repetitive nature of the occupational exposure to waste collectors suggests that the issues could be more significant for operatives albeit if properly controlled and a precautionary approach adopted, these issues need not become a real risk.

In 2012/13 WRAP and Zero Waste Scotland undertook a survey of the primary[3] non-recyclable waste collection service frequency operated by local authorities across the UK. As shown in Table 1.1 at this time approximately 72% of Scottish local authorities' primary non-recyclable waste collection was fortnightly, similar to the UK average of 68%.

Table 1.1 Primary frequency of non-recyclable waste collections provided by local authorities across the UK in 2012/13

Nation	More than weekly	Weekly	Fortnightly
England	1%	35%	64%
Wales	0%	9%	91%
Scotland	0%	28%	72%
Northern Ireland	0%	4%	96%
UK Total	**1%**	**31%**	**68%**

Since 2012/13 a further three Scottish councils have changed their primary non-recyclable waste collection service to fortnightly (East Dunbartonshire, Orkney Islands and City of Edinburgh) with a further two (Dundee and Dumfries and Galloway) announcing plans to implement fortnightly collections in 2014/15. This will mean that 88% of Scottish local authorities' primary non-recyclable waste collection frequency will be fortnightly by the end of 2015.

2014 has seen the implementation by Falkirk Council of a three-weekly non-recyclable waste trial collection from approximately 18,000 properties. The trend of increasing recycling provision, whilst reducing capacity for non-recyclable waste, could continue as local authorities seek to maximise capture of materials for reuse and recycling. As the quality of dry recycling, food and garden waste collection services improves and non-recyclable waste volumes decline, local authorities are starting to consider the feasibility of further reducing non-recyclable waste collections in order to support high levels of recycling.

1.2 This report

In 2012/13 the Scottish Waste Management Officers Network approached Zero Waste Scotland to request support to appraise options for extended frequency non-recyclable waste collections from householders. Consultancy support to appraise the potential resource and financial impacts of a number of three or four weekly non-recyclable waste collection options was provided. In addition further work streams were agreed, namely to:

- Undertake laboratory testing to determine if there is a potential risk to human health linked to extended frequency collections; and

[3] Statistics shown represent the primary frequency of non-recyclable waste collection provided by each local authority. Often there will be a number of properties where storage space for containers/wheeled bins is constrained and therefore a more frequent collection is provided.

- Design messages and communication templates, tested with members of the public, to communicate extended frequency service changes.

This report provides an overview of the health impacts study that was undertaken, and includes commentary on the results and an interpretation of what these mean in the context of potential health impacts for householders, collection staff and waste site staff. Furthermore, this report gives recommendations for councils considering extended frequency (beyond two weekly) collections of non-recyclable waste and outlines the factors that should be included in risk assessments for such a service.

This report is intended for use by Scottish local authorities and it is written with them in mind. Other UK local authorities and industry partners may find our research of interest, however it should be noted that the policy landscape in Scotland varies from elsewhere in the UK.

2. Laboratory analysis methodology

An initial short-term pilot study was undertaken to determine the most suitable approach for the laboratory analysis to provide accurate results and to inform the scope of testing. The aim of the study was to understand the behaviour of non-recyclable waste and the potential for impact to human health. The pilot study identified that the analysis should focus on decomposition, microorganism growth and gaseous emissions, during storage in wheeled bins, in both warm and cold conditions.

The pilot study was used to inform the main phase of the study, which commenced in August 2013. Bins were monitored over an eight week period to better understand the nature and level of odour/gas and bioaerosol emissions experienced by householders over extended frequency collections. Tipping the bins in week four and eight, whilst agitating the material inside, was undertaken with the intention of replicating the potential for emissions experienced by waste collectors as they lift and move the bins around during collection.

The sections below describe how the non-recyclable waste was analysed in the laboratory during the eight week testing period:

2.1 Waste composition

Testing was undertaken over a period of eight weeks from a 'zero baseline[4]'. It was important to ensure that waste was 'fresh', meaning that sourcing waste from normal household collections was not feasible. This meant that a waste had to be created by collecting materials from different sources and mixing to represent an average composition[5].

Although the tested non-recyclable waste represented an average waste composition it is recognised that extended frequency collections are most likely to be introduced by the higher performing local authorities who have separate kerbside collections for dry recycling and food waste. This means that any risks highlighted by the testing are likely to be overstated[6] and will represent non-recyclable waste at those properties where capture of material for recycling is relatively low.

2.2 Conditions tested

The laboratory testing was designed to create conditions that mimicked typical householder behaviour by adding waste to the non-recyclable waste bin at least once per week. This practice was carried out over a four-week period as it is assumed that if local authorities were to extend the frequency of non-recyclable waste collections, collections would be every three or four weeks. Testing was also carried out over a further four weeks in order to mimic missed collections, albeit it was not possible to continue to add waste to the sample as the wheeled bins were largely full. It was therefore assumed that any additional waste generated by households would be stored separately, either in black bags beside the bin or taken to the local recycling centre.

Four conditions were tested through this study:

- warm bagged bins: bins were stored at over 21°C with waste contained in bags within the bins;

[4] Testing from a zero baseline ensured that the sample was fresh, and therefore the residence time in the non-recyclable waste sampled could be managed and emissions measured over time from one week after the material was deposited in the non-recyclable waste container.

[5] Non-recyclable waste composition was based on the study '*Parfitt, J.P., Bridgewater, E. (2010) Waste 2010: municipal waste composition: what is still in the residual bin and what can we get out?* This is largely similar to the '*Zero Waste Scotland (2010) The composition of municipal solid waste in Scotland* study findings.

[6] From an initial literature review it was clear that some materials commonly found in non-recyclable waste bins are much less likely to impact on human health due to extended frequency collections than others, for example glass and most plastics are chemically inert and therefore will not change properties due to increased storage time. Other materials including food waste and garden waste will decompose over time.

- warm loose bins: bins were stored at over 21°C with waste loose within the bins;
- cold bagged bins: bins were stored at under 8°C with waste contained in bags within the bins; and
- cold loose bins: bins were stored at under 8°C with waste loose within the bins.

Six bins were tested for each of the four conditions described above. This involved monitoring the bins in-situ for bioaerosols, microorganisms and odour on a weekly basis. After eight weeks the bins were tipped and the agitated material monitored.

Six additional warm loose bins were also filled with non-recyclable waste in weeks one to four. At four weeks they were tipped to determine the potential emissions at the point of collection from four-week-old material.

3. What did the study find?

This section of the report provides an overview of the findings from the laboratory analysis. The findings are split into three categories:

- Microorganisms and bioaerosols;
- Gas emissions; and
- Other observations.

Risks and mitigation measures are discussed in Section 4.

3.1 Microorganism and bioaerosol results

Table 3.1 describes the findings from the laboratory analysis into bioaerosol components fungi, β-glucan, bacteria and endotoxin which dependent on dose can lead to respiratory and other health issues.

Table 3.1 Microorganisms & bioaerosols

Indicator	Description	Findings
Bacteria	A group of microorganisms[7] with a primitive cellular structure, in which genetic material is not retained within an internal membrane. Bacterial food spoilage microorganisms such as salmonella can have a harmful effect by causing digestive problems. When bacteria are suspended in air (bioaerosols) increased exposure has been linked to respiratory problems, headaches, nausea and fatigue.	The laboratory analysis showed that microorganisms (including bacteria and colonies on gram-negative selective agar[8]) were significantly higher at week four than week two under all tested conditions and that loose bins had significantly higher concentrations of bacteria than bagged bins[9]. Microorganism levels above the suggested precautionary occupational exposure limit[10] were not exceeded during the weekly sampling, but they were exceeded when the bins were tipped at weeks four and eight, particularly in the loose bins. Mitigating measures to reduce the likelihood and impact of exposure are described in Section 4. Also, Salmonella could be a hand-to-mouth health issue for residents and collectors (regardless of existing or extended collection frequencies), albeit it did not become dispersed in air when the bins were tipped and therefore is not expected to be a respiratory health issue. Weekly testing for Listeria (a food pathogen) was inconclusive, albeit when the bins were tipped in weeks four and eight airborne Listeria was not detected.
Endotoxin	Endotoxin is a compound found in the walls of gram negative bacteria. Endotoxin is a known respiratory sensitiser[11] and is linked to toxic pneumonitis (acute inflammation of the lungs) and airway inflammation.	Concentrations of endotoxin increased from week four until week seven, most likely due to the death and breakdown of bacteria. From week five onwards, it is possible that lower oxygen levels, in addition to the lack of fresh waste input, contributed to aerobic microorganisms dying out and increased concentrations of endotoxin. Peak concentrations were in week seven (week eight for the cold bagged bins). Concentrations measured (particularly after week four) were in excess of the precautionary occupational exposure standard seen elsewhere[12], and were also exceeded when the warm loose bins were tipped in week eight. Mitigating measures to reduce the likelihood and impact of exposure are described in Section 4. The results suggest that older waste (for example where individual collections are missed) and particularly where waste is kept loose in the bin may lead to increased endotoxin concentrations albeit it should be recognised that natural dispersion was prevented in the laboratory meaning that levels are likely to be higher than would be experienced by residents or crews.

[7] Microscopic organisms that are capable of living on their own. Often simply called 'microbes'.
[8] An agar plate is used to provide a growth medium using a mix of agar and other nutrients in which microorganisms, including bacteria and fungi can be cultured and observed under the microscope. Agar is indigestible for many organisms so that microbial growth does not affect the gel used and it remains stable. Selective media are used for the growth of only selected microorganisms, in this instance gram-negative bacteria.
[9] In warm loose bins microorganism levels peak in week four, remain elevated in week five and then decline to undetectable concentrations. In cold loose bins microorganism levels peak in week three, remain elevated in week four and then decline to undetectable concentrations.
[10] Suggested precautionary occupational exposure limit of 10^5 cfu/m^3. Eduard W., Heedrick D., Duchaine C., Green B.J. (2012) Bioaerosol exposure assessment in the workplace: the past, present and recent advances. Journal of Environmental Monitoring, 14, 334–339.
[11] A substance that causes an allergic reaction in the lungs and airways following exposure. Once a person has become sensitised to a particular substance, further exposure can cause an allergic reaction.
[12] There is not an occupational exposure standard in the UK, hence the results are compared with the proposed occupational exposure standard within The Netherlands of 90 EU/m^3 (90 Endotoxin Units per cubic metre).

Table 3.1 Microorganisms & bioaerosols (continued)

Indicator	Description	Findings
β -glucan	β -glucan is a soluble fibre derived from the cell walls of algae, bacteria, fungi, yeasts, and plants. (1-3)-β-D-glucan may affect the immune system and acts in synergy with endotoxin to produce an inflammatory response.	(1-3)-β-D-glucan fluctuated throughout the eight weeks of testing, indicating that fungi must have been present even though viable counts were erratic. This is likely to be due to a variety of spores, and extinct cells being out-competed by the bacteria, or because temperatures were not favourable to support growth among certain species. Warm loose material generally shows higher readings, although all conditions had some data points within this range. No current standards are available for (1-3)-β –D-glucan exposure levels. There were no significant findings from the weekly testing or tipping to suggest that concentrations of (1-3)-β-D-glucan would be higher/lower if non-recyclable waste is collected every three or four weeks, rather than fortnightly.
Fungi	A group of microorganisms with a more complicated cellular structure than bacteria, in which the hereditary genetic material is retained within an internal membrane, forming a nucleus. Fungi release allergens during germination.	Fungi were very difficult to detect throughout the weekly testing. The initial literature review predicted that fungi would 'take over' after 20 days and become predominant, which did not happen. When fungi did appear it was mainly in small concentrations and during weeks three to four (in the warm bins and the cold loose bins). However when bins were tipped the movement of the material caused the fungi to become dispersed; and therefore easier to detect. The internal bin temperature did not increase in either the warm or cold bins, which means that conditions which might have enabled certain species of thermophillic fungi to thrive did not occur. That said, if temperatures rise considerably (e.g. if bins are stored in direct sunlight on very sunny days) increased concentrations of fungi could be expected.

Risks and mitigation measures for microorganisms and bioaerosols are discussed in Section 4.

3.2 Gas emission results

Gas emissions were tested to identify if extended frequency non-recyclable waste collections would result in an increased risk of unpleasant or harmful odours. Odours from waste decomposition come from many compounds, each typically contributing a small proportion to the total odour. It is therefore not easy to correlate characteristic odour with particular compounds unlike, for example, odours from sewage treatment caused by hydrogen sulphide.

Table 3.2 describes the findings from the laboratory analysis into gases and odour.

Table 3.2 Gases & odour

Indicator	Description	Findings
Inorganic gases: methane, ammonia and carbon dioxide	Carbon dioxide and methane are produced during decomposition of organic materials. Ammonia is produced during the decay of nitrogenous animal and vegetable matter. Methane and ammonia emissions are associated with unpleasant odour and can be harmful in high concentrations.	The warm condition bins (loose and bagged) showed increased carbon dioxide emissions, peaking in weeks two and three[13]. These increases suggest active waste decomposition during the first four weeks when waste was added to the bins. Carbon dioxide emissions from the cold condition bins increased gradually over the eight-week period (with maximum concentration of approximately 1% between weeks five to eight), indicating a reduced decomposition rate compared with the warm conditions. Methane emissions from bins in all four conditions indicated anaerobic environments, with oxygen levels decreasing towards the end of the test, especially for the warm bagged bins. Ammonia levels in the warm bins increased during weeks five to eight. The findings demonstrate that decomposition occurs at a faster rate in warm temperatures and that older waste, where conditions are more anaerobic, is likely to have a stronger odour; albeit it should be recognised that natural dispersion was prevented in the laboratory meaning that levels are likely to be higher than would be experienced by residents or crews in real life.
Mixed odour emissions	Odours from decomposing waste can be unpleasant and a key concern for local residents.	The odour compound levels were relatively low over the eight weeks of testing and significantly lower than odour emissions from other common activities (e.g. home composting of organic waste). For the warm and cold bins, aromatic levels (e.g. methyl sulphide levels) for the bagged waste samples were slightly lower than loose waste samples, with the lowest levels for the cold bins. The findings suggest that there is likely to be increased levels of selected mixed odours in warm bins compared to cold bins. This is in keeping with the increased carbon dioxide emissions recorded from the warm bins, which suggest heightened decomposition rates. But mixed odour emission was relatively low for all conditions, and differences between conditions and age of waste were marginal.

Risks and mitigation measures for gases and odours are discussed in Section 4.

[13] Carbon dioxide concentrations peaked at approximately 2-3%. The concentration of carbon dioxide in air is typically 0.04%.

3.3 Other observations

Table 3.3 describes other observations from the laboratory analysis.

Table 3.3 Other observations

Indicator	Description	Findings
Internal bin temperature	Increasing temperatures during waste decomposition are often associated with increased emissions of Volatile Organic Compounds, while reduced sulphur compounds are generally emitted during warmer growth conditions.	Internal bin temperatures were measured weekly and shown to be stable over the eight week period. This confirms that here was no evidence of hot composting[14] of biodegradable waste in the bins.
Bin weight	The weight of the bin and its contents was monitored to determine if the weight of waste decreased over time.	Approximately 4.5kg of waste was added to the bins each week in weeks one to four and bin weights measured over the eight week period. By week four the weight of material had reduced by approximately 4kg (c. 20%), with the weight remaining approximately constant until week eight (scales were accurate to 0.5kg).
Bin headspace	The distance between the top of the bin and the top of the waste's surface. The bin headspace was monitored to determine if the volume of waste decreased over time, potentially resulting in capacity for new waste.	Headspace measurements decreased in weeks one to four as waste was added to the bins. In weeks four to eight measurements remained constant. The results demonstrate that there is some breakdown of waste and moisture loss in the first couple of weeks suggesting the start of decomposition.
Leachate production	A liquid that usually contain both dissolved and suspended material which percolates through the waste materials.	The sampling protocol was designed to allow leachate to be sampled in order to understand the potential impact it may have on human health. However over the eight week analysis period insufficient amounts were produced and therefore no testing could be undertaken. It is expected that leachate was dispersed into drier material such as card and paper.
Presence of flies	Flies are scavengers, and their main food source is decaying material. Flies can carry disease-causing germs from food source to food source.	Flies, maggots and mites became apparent in the warm loose bins by week four. However by week eight, although still present, their numbers were reduced. This may be due to fresh waste no longer being added to the bins after week four.

Risks and mitigation measures for these observations are discussed in Section 4.

[14] Hot composting is where microbes rapidly breakdown organic matter in aerobic conditions at high temperatures (usually 50-60^{o}C). If the conditions become anaerobic strong odours may be produced.

3.4 Study limitations

Limitations that were identified throughout the study are described below:

- **Validity/ number of bins analysed:** Evidence of high variability in gas emissions was predicted and seen in recorded values between some bin replicates, especially for the warm bins. Budget limitations restricted the analysis to six bins for each tested condition which was deemed sufficient, albeit future studies of this nature may wish to consider increased replication.
- **Non-recyclable waste composition:** The composition of the tested non-recyclable waste represents an average waste composition. It is recognised that extended frequency collections are most likely to be introduced by the higher performing local authorities who have separate kerbside collections for dry recycling and food waste. This means that any risks highlighted by the testing are likely to be overstated and will represent non-recyclable waste at those properties where capture of material for recycling is relatively low.
- **Missed collections[15]:** Testing was carried out over an eight week period in order to evaluate the impact of missed collections. In weeks one to four, fresh waste was added to the bins to replicate typical householder behaviour. After week four it was not possible to continue to add waste to the sample as the wheeled bins were largely full. It was therefore assumed that any additional waste generated by households would be stored separately, either in black bags beside the bin or taken to the local recycling centre.
- **Addition of waste:** Both the bioaerosol and gas data showed active decomposition within all bins during the first four weeks when fresh waste was being added. However this pattern changed after week four, likely to be because fresh waste was no longer added. It is expected that had fresh waste been added during this period, active decomposition would have occurred throughout the eight weeks. There is some indication that, for the warm bagged waste bins, low oxygen levels became more pronounced towards the end of the eight weeks. This supports the conclusion put forward in previous research[16], that waste can become anaerobic during breakdown, which may have odour implications. It is also speculated that levels of ammonia could increase in longer-term waste storage, and in this study it was found to be higher in during the last four weeks of warmer treatment when waste was no longer being added.
- **Gas emissions:** Natural dissipation of gases was not allowed to occur. In real life when bin lids are opened it is likely that gases and odours will naturally disperse, meaning that levels experienced by residents, collection crews and staff at facilities could be less concentrated than the laboratory findings suggest.

[15] The term "missed collections" is used to broadly describe where waste is not collected on the scheduled collection day. This may be because the container is not presented by the resident at the collection point on time, or because it is not collected by the collection crew.

[16] Frederickson, J., Boardman, C.P., Gladding, T.L., Simpson, A.E., Howell, G., Sgouridis, F. (2013) Critical review of biofilter performance and operation. Environment Agency Research Report, https://publications.environment-agency.gov.uk/skeleton/publications/ViewPublication.aspx?id=137618da-4f12-4325-8b93-81b4b3b434a0

4. Risk assessments and mitigation measures

Employers, such as local authorities, are responsible for taking effective measures to control exposure and protect the health of their employees and others. Guidance, such as the extract below, is available from the Health and Safety Executive.

HSE (2012) Health and Hazardous substances in waste and recycling. Waste 27.

The Control of Substances Hazardous to Health Regulations (COSHH Regulations 2002) requires organisations to assess the risk from harmful substances and prevent or control exposure to them. This means that employers should consider how employees (and others) may be exposed to harmful substances or microorganisms and decide whether they are doing enough to prevent this happening.

The priority should be to try to prevent exposure at source, and if exposure can't be prevented, put suitable measures in place to control it adequately. Employers need to make sure control measures are used and kept in good order by monitoring and reviewing the risk regularly, or if there is significant change.

In this section example risk assessments are provided which identify sensible controls, precautions and mitigation measures to reduce public and occupational risks.

4.1 Risks to householders

In Table 4.1 an assessment of the risks to householders has been undertaken. Likelihood and impact is scored one to three, one being low and three being high. The scores are then multiplied to give the risk factor. Risk factors of three or less are classed as low, scores between four and six are medium and scores of seven or more are classed as high. Mitigation measures to prevent and control exposure are provided for all of the perceived hazards, even where the risk rating is low. Table 4.2 provides more detail on the control and mitigation measures identified and good practice examples.

Table 4.3 identifies risks to collectors, and Table 4.4 identifies risks to staff at tipping facilities. Further detail on occupational control and mitigation measures for collectors and staff at tipping facilities is provided in Table 4.5.

Table 4.1 Householder risk assessment examples

Perceived hazard	Laboratory analysis findings	Likelihood	Impact	Risk	Mitigating measure	Likelihood	Impact	Residual risk
Potential for unpleasant/ harmful odours due to decomposing waste	Odour emission was relatively low for all conditions, especially where waste was bagged rather than loose. Differences between conditions and ages of waste were marginal. Emissions are not expected to exceed those experienced with home composting, and are not expected to be harmful to health.	1	1	1	• Provide a separate, frequent food waste collection to reduce biodegradable content & odours produced during decomposition. • Increase amount of food waste captured via a separate, frequent food waste collection e.g. through communications with residents. • Communicate good practice measures for storage of particularly odorous waste (e.g. wrapping nappies in scented nappy sacks; wrapping food waste in liners).	1	1	1
Potential for harm to human health due to decomposing waste	Bacteria: The precautionary exposure limit for microorganisms is not likely to be exceeded when residents are depositing waste in their bins. Bioaerosols: Unlikely to be an issue for healthy adults albeit emissions are expected to be higher if loose waste is placed in the bin. Food pathogens: Listeria and Salmonella are not expected to become airborne during tipping. Microbial contact (hand-to-mouth) is a concern (regardless of collection frequency). β –glucan & fungi: There were no findings from the weekly testing to suggest that concentrations of β-glucan increased over time. Fungi concentrations are expected to be low except where bins are stored in direct sunlight in warm weather.	1	2	2	• Undertake compositional analysis to understand the biodegradable content of non-recyclable waste. • Provide a separate, frequent food waste collection and/or collection of nappies (and other absorbent hygiene products) to reduce biodegradable content in the non-recyclable waste. • Increase amount of food waste captured via a separate, frequent food waste collections. • Encourage residents to bag waste, rather than placing it loose in bin and communicate good practice measures for storage of waste (e.g. food waste and nappies). • Encourage residents to wash their hands and work surfaces after handling waste.	1	1	1
Potential for increased flies/ vermin attracted by decomposing waste	Flies, maggots and mites became apparent in the warm loose bins by week four, with fewer occurrences in the cold and bagged bins. There is no increased risk of vermin if waste is properly contained.	2	1	2	• Increase capture of biodegradable waste. • Communicate good practice measures for storage of waste.	1	1	1
Potential for risks above to be amplified if collections are missed	Exposure to endotoxins is likely to increase beyond four weeks, particularly where loose waste is placed in the bin. That said, instances of exposure will be infrequent, rather than over a sustained period of time and therefore the impact is expected to be low.	2	1	2	• Follow earlier measures and: ○ Develop policies for missed collections to limit collection delays, particularly when the service is bedding in and residents may have difficulty remembering their collection schedule.	1	1	1
Potential for risks above to be amplified in warmer weather	Fungi concentrations are expected to be low except where bins are stored in direct sunlight in warm weather. Flies, maggots and mites may become more apparent in warmer weather.	1	1	1	• Follow earlier measures and consider: ○ Residents may wish to wash their wheeled bins to clean out residues and maintain good hygiene practices.	1	1	1

Table 4.2 Measures to reduce risks to householders

Mitigating measure	Example
Undertake compositional analysis to understand the biodegradable content of non-recyclable waste.	Support is available from Zero Waste Scotland to understand the composition of waste arisings. This information can assist local authorities to understand the availablility of materials for capture for recycling and plan new or improved services.
Provide a separate, frequent food waste collection to reduce biodegradable content in the non-recyclable waste. This will reduce the potential for bacteria and odour; and will lessen attraction from vermin.	 Guidance and support is available from Zero Waste Scotland to design, communicate and increase performance of separte food waste collections. Recycle for Scotland communication templates are available from our Partners site.
Increase the capture of biodegradable waste through communications with residents to explain how to use the services and which materials are collected for recycling. The purpose of this mitigation measure is to reduce biodegradable content in the non-recyclable waste. This will reduce the potential for bacteria and odour; and will lessen attraction from vermin.	 Extended frequency collections communication templates have been consumer tested and developed by Zero Waste Scotland which can be used by local authorities adopting the Recycle for Scotland brand.
Communicate good practice measures for storage to keep waste contained. The purpose of this mitigation measure is to contain bacteria, odours and flies, and reduce the likelihood of hand-to-mouth contact with pathogens. For example: • Store containers outdoors and, if possible, out of direct sunlight; • Ensure waste is properly contained by closing the bin lid and preventing access for flies or rodents; • Wrap waste, particularly food waste e.g. use a liner or place paper within the bin to soak up wet residues (leachate); • Where food waste is temporarily stored in the home for home composting or separate collection, empty the container regularly.	 The example shown is an extract from a food waste service change leaflet template developed by Zero Waste Scotland using the Recycle for Scotland brand.
Develop and implement a policy for missed collections to avoid the potential for risks above to be amplified if collections are missed[17].	All councils contacted through this study have developed policies for responding to complaints, including the collection of missed bins. An example policy describes that the Council aims to collect missed bins the next working day, and no later than two working days after the

[17] It is not uncommon for councils to have excess waste policies whereby if excess is presented by residents (either as side waste or 'top-hatted' overflowing bins) it is not collected for health and safety reasons and the bin is stickered. Councils may wish to revise these policies if extended frequency collections are implemented to reduce the number of missed bins.

missed collection was reported.

Table 4.2 Measures to reduce risks to householders (continued)

Mitigating measure	Example
Communicate the need to wash hands and work surfaces after handling waste to prevent the spread of bacteria (especially hand-to-mouth).	**Q Is it hygienic to collect, sort and move waste materials in the home?** A You can ensure your materials are kept in a hygienic manner by rinsing materials before they are recycled, using lids on recycling containers and using the lockable handle on food waste caddies. Washing your hands and wiping down surfaces after sorting and handling your waste materials and containers will ensure good hygiene practices. The example shown is an extract from a set of example FAQs developed by Zero Waste Scotland using the Recycle for Scotland brand.
Residents may wish to wash their wheelie bins to avoid build-up of residues and potential for odour. Private bin washing companies operate across a large proportion of Scotland.	

4.2 Risks to occupational health: collectors & staff at tipping facilities

Table 4.3 provides an example assessment of the occupational health risks for collection crews. The risk assessment looks only at the health impacts from being exposed to non-recyclable waste collected on an extended frequency. Manual handling is not considered, albeit should be considered by local authorities prior to service implementation.

Table 4.4 provides an example assessment of the occupational health risks for staff at tipping facilities. Operatives at waste treatment sites and transfer stations are more likely to be exposed to high volumes of non-recyclable waste over a longer period of time. In the laboratory testing bins were tipped in order to replicate the expected emissions when non-recyclable waste is emptied into the collection vehicle and then when the vehicle tips at the facility (typically at a landfill site, treatment facility or transfer station). For this study it was decided not to undertake testing at a facility (rather than a laboratory) due to the impracticalities of natural dissipation of odour, gases and bioaerosols. Local authorities implementing extended frequency collections are advised to undertake/review COSHH assessments which may identify the need to undertake environmental monitoring at facilities, particularly where non-recyclable waste is bulked (rather than being tipped directly on the landfill face in the open air).

Table 4.5 provides more detail on occupational mitigation measures identified and good practice examples related to collectors and operatives at tipping facilities.

Table 4.3 Occupational health risk assessment: Collectors

Perceived hazard	Laboratory analysis findings	Likelihood	Impact	Risk	Mitigating measure	Likelihood	Impact	Residual risk
Potential for unpleasant /harmful odours due to decomposing waste	Odour emission was relatively low for all conditions. Emissions are not expected to exceed those experienced with garden waste collections.	2	1	2	• See measures described in Table 4.1 to capture biodegradable waste. • Implement health screening and monitoring to identify respiratory illness or sensitiveness.	1	1	1
Potential for harm to human health due to decomposing waste	Bacteria: Extended frequency collections may lead to an increase in bacterial levels when the bin is collected. Bioaerosols: Unlikely to present an issue to healthy adults albeit emissions were higher where loose waste is placed in the bin. Food pathogens: Microbial contact (hand-to-mouth) is a concern (regardless of collection frequency). β –glucan & fungi: There were no findings from the weekly testing to suggest that concentrations of β-glucan increased over time. Fungi concentrations are expected to be low except where bins are stored in direct sunlight in warm weather.	2	2	4	• See measures described in Table 4.1 and above to capture biodegradable waste. • Provide induction, refresher training and checks to ensure collection crews adopt good hygiene practices e.g. ○ Wear gloves when collecting; ○ Avoid reaching into bins to collect waste; ○ Maintain good hygiene in the vehicle cab; ○ Regularly wash hands, particularly before eating; ○ Avoid leaving waste on-board the vehicle overnight; ○ Clean up split waste using equipment provided; ○ Collection crews should stay in the vehicle cab or in a designated area away from the vehicle when non-recyclable waste is being tipped. • Risk assess and train staff on best practice approaches for washing out vehicles. • Provide adequate personal protective equipment.	1	2	2
Potential for increased flies/ vermin attracted by decomposing waste	Flies, maggots and mites became apparent in the warm loose bins by week four, with fewer occurrences in the cold and bagged bins. There is no increased risk of vermin if waste is contained.	2	1	2	• Provide induction, refresher training and checks to ensure collection crews adopt good hygiene practices.	1	1	1
Potential for risks above to be amplified if collections are missed	Exposure to Endotoxins is likely to increase beyond four weeks, particularly where loose waste is placed in the bin.	2	2	4	• A small number of missed bin collections is unlikely to affect crews (some residents may currently choose to use their collection services on a less frequent basis) however if multiple properties are missed (e.g. due to breakdowns) then the collection crew should feed back to the office to allow an alternative collection to be arranged. (Also see measures described in Table 4.1).	1	2	2
Potential for risks above to be amplified in warmer weather	Fungi concentrations are expected to be low except where bins are stored in direct sunlight in warm weather. Flies, maggots and mites may become more apparent in warmer weather.	2	2	4	• Follow measures described above. • Ensure crews wear gloves, even in warm weather to ensure contact with waste is avoided.	1	2	2

Table 4.4 Occupational health risk assessment: Operatives at tipping facilities

Perceived hazard	Laboratory analysis findings	Likelihood	Impact	Risk	Mitigating measure	Likelihood	Impact	Residual risk
Potential for unpleasant /harmful odours due to decomposing waste	Odour emissions are expected to increase for older wastes. Emissions are not expected to exceed those experienced with organic wastes.	2	2	4	• Undertake occupational and environmental monitoring at tipping facilities, particularly where non-recyclable waste is bulked (rather than being tipped directly on the landfill face in the open air). • COSHH assessments should also be undertaken or updated. • Identify further controls at tipping facilities to reduce emissions, e.g. improved ventilation and odour control.	1	1	1

Potential for harm to human health due to decomposing waste	Bacteria: Extended frequency collections may to lead to an increase in bacterial levels when waste is transferred.
	Bioaerosols: Unlikely to present an issue to healthy adults albeit emissions were higher where loose waste is placed in the bin or where bags are split at the tipping site.
	Food pathogens: Microbial contact is a concern (regardless of collection frequency).
	β –glucan & fungi: There were no findings from the weekly testing to suggest that concentrations of β-glucan increased over time. Fungi levels are expected to be low.
		2	2	4	• Undertake occupational and environmental monitoring.
					• COSHH assessments should also be undertaken or updated.
					• Provide induction and refresher training to remind operatives to adopt good hygiene practices e.g.
					  ○ Wear gloves when transferring waste;
					  ○ Maintain good hygiene in the welfare facilities;
					  ○ Regularly wash hands, particularly before eating;
					  ○ Clean up split waste using equipment provided;
					  ○ Regularly wash vehicles and waste containers;
					  ○ Avoid unnecessary contact with waste.
					• Provide adequate personal protective equipment.
					• Advise contractors of extended frequency collections to allow risk assessments to be updated.
						1	2	2

Potential for increased flies/ vermin attracted by waste	Flies, maggots and mites became apparent in the warm loose bins by week four, with fewer occurrences in the cold and bagged bins. There is no increased risk of vermin if waste is properly contained.	2	1	2	• Good hygiene practices and site management will reduce the likelihood of increased flies/vermin.	1	1	1
Potential for risks above to be amplified if collections are missed	Exposure to Endotoxins is likely to increase beyond four weeks, particularly where loose waste is placed in the bin.	2	2	4	• Follow measures described above. • Undertake occupational and environmental monitoring. Monitor number of missed bin collections. • COSHH assessments should also be undertaken or updated.	1	2	2
Potential for risks above to be amplified in warmer weather	Fungi concentrations are expected to be low except where waste is stored in direct sunlight in warm weather. Flies, maggots and mites may become more apparent in warmer conditions.	2	2	4	• Follow measures described above. • Ensure operatives wear gloves, even in warm weather.	1	2	2

Table 4.5 Measures to reduce occupational health risk for collectors & staff at tipping facilities

Mitigating measure	Example
Undertake COSHH assessments	Councils should undertake/review their COSHH assessments to identify the need for health screening and/or environmental monitoring.
Undertake occupational and environmental monitoring	If required following a COSHH assessment, personal exposure to airborne particles and bioaerosols can be tested. Lung function tests can be used to identify respiratory conditions, albeit it is not possible to differentiate between occupational impacts and underlying personal health conditions (e.g. due to smoking). Environmental monitoring to identify levels of airborne particles and bioaerosols may also be required and necessary controls identified.
Hygiene training	Councils should provide induction and refresher training to remind operatives to adopt good hygiene practices.  Extended use of face masks/ visors is unlikely to be appropriate as a control as this is likely to increase fatigue.
Feedback from crews	In addition to the measures outlined in Table 4.2 to reduce missed bins and to promote good practice measure for residents to store their waste, councils may also wish to ask collection crews to provide feedback from the collection rounds. Examples include recording any addresses where excess waste is presented and monitoring and recording where residents place waste loose in their bins. This monitoring may be short-term or, if in-cab systems allow, may be on-going. This information will help council officers to work with residents to reduce the likelihood of potential health impacts of extended frequency collections for collectors and staff at tipping facilities.
Personal protective equipment	Adequate personal protective equipment should be provided to crews. Councils may wish to provide crews with light-weight gloves for warm weather.  Particular care should be taken to ensure correct PPE is identified and worn when washing vehicles.

5. Summary

The laboratory analysis findings demonstrate that certain characteristics of non-recyclable waste are affected by collection frequency. Although householders, collectors and staff at tipping facilities could theoretically be affected by these factors, the conclusion is that the lower exposure of householders and the availability of simple precautions mean the risk for them is little changed from that experienced with existing weekly and fortnightly collections. The repetitive nature of the occupational exposure to waste collectors and staff at tipping facilities suggests that the risk could be more significant for operatives albeit if properly controlled and a precautionary approach adopted, these issues are unlikely.

The priority for local authorities planning extended frequency collections should be to try to prevent exposure at source by reducing concentrations of microorganisms and gases. Examples discussed in this report include:

- Capturing biodegradable waste (e.g. absorbent hygiene products (including nappies) and food waste) through separate, frequent collections.
- Promoting good practice measures for storage of waste. Encourage residents to bag waste, rather than placing it loose in bin.

If exposure can't be prevented, local authorities should put suitable measures in place to control it adequately; ensuring that control measures are used and regularly updated. Examples discussed in this report include:

- Undertake occupational and environmental monitoring and if necessary identify further controls at tipping facilities to reduce emissions, e.g. improved ventilation and odour control.
- Promote good hygiene practices and provide health and safety training to staff. Ensure that adequate welfare facilities are provided (e.g. hand wash facilities on the vehicle) and that personal protective equipment is provided and used.
- Implement health screening and monitoring to identify staff with respiratory illness or sensitiveness.
- Develop and implement working practices to control exposure e.g. collectors should stay in the vehicle cab or in a designated area away from the vehicle when non-recyclable waste is tipped.
- Develop policies for missed collections to limit collection delays, particularly when the service is bedding in and residents may have difficulty remembering their collection schedule.
- Advise contractors of extended frequency collections to allow risk assessments to be updated.

Further guidance of waste and recycling collections is provided by the Health and Safety Executive http://www.hse.gov.uk/waste/

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