Environment Agency

Evidence

Hazards from landspreading wastes

Methodology for Rapid Evidence Assessment

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This report is the result of research commissioned and funded by the Environment Agency.

Published by:
Environment Agency, Horizon House, Deanery Road, Bristol, BS1 5AH

www.gov.uk/government/organisations/environment-agency

ISBN: 978-1-84911-374-8

Further copies of this report are available from our publications catalogue:
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Dissemination Status:
Publicly available

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- **Carrying out research**, either by contracting it out to research organisations and consultancies or by doing it ourselves;
- **Delivering information, advice, tools and techniques**, by making appropriate products available.

Miranda Kavanagh

Director of Evidence

Executive summary

The Environment Agency regulates the spreading of waste to land in England under the Environmental Permitting Regulations (EPR) 2010. Under EPR the operator is required to obtain a standard rules or bespoke permit, and to make a separate deployment application for waste to be spread on a specific area of land.

As part of the deployment application, the operator is required to provide receiving soil and waste chemical analysis data, and to demonstrate that any site-specific risks from spreading the wastes are intrinsically low or will be effectively managed during deployment. For a deployment to be approved, the operator must demonstrate that the activity will not endanger human health or harm the environment in the following ways:

- risk to water, air, soil, plants or animals
- causing nuisance through noise or odours
- adversely affecting the countryside or places of special interest

On receiving the deployment application, staff at the Environment Agency's National Permitting Service consider the potential adverse impacts on human health and the environment based on the information provided by the operator in the application.

The first step in assessing and managing the risks is the identification of hazards. This requires a clear understanding of the physical, biological and chemical properties presented by a specific waste type and the intrinsic hazards it may pose in an agricultural context. However, it is recognised that the present level of knowledge possessed by operators and Environment Agency staff of the hazards associated with certain waste streams can be limited and that more evidence may need to be collected to support decisions on bespoke permits and site-specific deployment applications.

To assist in the identification of hazards associated with specific waste streams, the Environment Agency commissioned consultants to prepare a methodology for undertaking a Rapid Evidence Assessment (REA). An REA can produce a systematic and comprehensive overview of evidence under tight timescales, enabling the collation and appraisal of information to address specific questions. An REA facilitates the collection and objective evaluation of information about a topic from a wide range of different sources, and presents it in an open and reliable way. In this case, an REA can be used to help to identify the hazards presented by spreading specific waste materials to land, so informing subsequent decisions on risk management and the suitability of such materials for bespoke permits and individual deployments.

This report presents an efficient methodology for obtaining evidence and information to help assess the potential adverse effects from the landspreading of wastes. It is intended to be useful to those assessing the suitability of a waste stream for spreading to agricultural land including:

- operators and their advisers considering the suitability of new waste streams for inclusion on a new bespoke permit
- operators and their advisers considering the site-specific risks associated with a landspreading deployment under an existing permit
- Environment Agency permitting and Area staff conducting a review of submitted applications for either a bespoke permit or deployment
- Environment Agency staff developing guidance and tools to support the assessment of risks

The report explains the most important regulatory controls for the landspreading of waste, as well as other parameters that influence the scope of any assessment of hazards and risks.

Two types of assessment are identified: waste stream and deployment. The waste stream assessment takes into account how the waste was produced, its composition and any potential variability. The deployment assessment takes into account site-specific factors, which can influence the likelihood and severity of a hazard resulting in an adverse impact on receptors.

The REA methodology proposed is an adapted version of the UK Civil Service REA toolkit. It focuses on the production processes identified in the waste stream assessment so as to obtain a better upstream understanding. This information can then be used, along with that from processes identified in the deployment assessment, to inform subsequent generic or site-specific risk assessment for a deployment application or review.

The REA methodology aims to address the overarching primary question:

> What key hazards are associated with [insert waste type/code or description] which could present a risk to critical receptors during or after landspreading on agricultural land?

This is supported by a series of secondary questions (presented in Appendix A), which provide structure to the REA and contribute to the build-up of evidence surrounding the primary question.

This methodology sets out the scope and objectives for the REA, detailing the conceptual understanding that will help the reviewer identify hazards and factors that can influence such hazards, such as differing waste compositions.

Guidance on the approach used for the data search strategy and subsequent evidence synthesis, extraction and reporting is presented, with examples and watch points provided, where necessary. The REA report should present a comprehensive record of the work undertaken, including a summary of the Master List and Principal List of hazards for the waste type and, wherever possible, typical composition ranges for these hazards. As the REA forms a baseline for subsequent deployment applications, the REA work needed to support an application is determined in part by whether the proposed waste stream falls within typical composition ranges.

Contents

1 Introduction

This report describes an efficient methodology for obtaining evidence and information to assist the assessment of the potential adverse effects from the landspreading of wastes. It is intended to be useful to those assessing the suitability of a waste stream for spreading to agricultural land including:

- operators and their advisers considering the suitability of new waste streams for inclusion in a new bespoke permit
- operators and their advisers considering the site-specific risks associated with a landspreading deployment under an existing permit
- Environment Agency permitting and Area staff reviewing submitted applications for either a bespoke permit or a deployment
- Environment Agency staff developing guidance and tools to support the assessment of risks

The methodology has been written for a technical audience and specific terms are defined in the glossary at the end of the report.

1.1 Background and purpose

The Environment Agency regulates the spreading of waste to land in England under the Environmental Permitting Regulations (EPR) 2010. Under EPR the operator is required to obtain a standard rules or bespoke permit, and to make a separate deployment application for waste to be spread on a specific area of land.

As part of the deployment application, the operator is required to:

- provide chemical analysis data for the receiving soil and wastes
- demonstrate that any site-specific risks from spreading the wastes are intrinsically low or will be effectively managed during deployment

To meet regulatory requirements (see Section 2), the operator is responsible for ensuring that all potential risks from the landspreading of materials are considered in the deployment application.

For a deployment to be approved, the operator must demonstrate that the activity will not endanger human health or harm the environment by:

- posing a risk to water, air, soil, plants or animals
- causing nuisance through noise or odours
- adversely affecting the countryside or places of special interest

On receipt of the deployment application, staff at the Environment Agency's National Permitting Service (NPS) must consider the potential adverse impacts on human health and the environment based on the information provided.

The operator must also demonstrate – and permitting staff must evaluate – the agricultural benefit from applying the wastes under a specific deployment. However, this is not the focus of the REA methodology set out in this report.

The first step in assessing and managing the risks is the identification of hazards (Defra and Cranfield University 2011). This requires a clear understanding of the

physical, biological and chemical properties presented by a specific waste type and the intrinsic hazards it may pose in an agricultural context. However, it is recognised that:

- the level of knowledge of operators and Environment Agency staff of the hazards associated with certain waste streams can be limited
- more evidence may need to be collected to support decisions on bespoke permits and site-specific deployment applications

To assist in the identification of hazards associated with specific waste streams, the Environment Agency commissioned Amec Foster Wheeler to prepare a methodology for carrying out a Rapid Evidence Assessment (REA).

An REA can provide a systematic and comprehensive overview of evidence under tight timescales, enabling the collation and appraisal of information to address specific questions. An REA facilitates the collection and objective evaluation of information about a topic from a wide range of different sources, and presents it in an open and robust way.

In this case, an REA can be used to help identify the hazards presented by spreading specific materials to land, so informing subsequent decisions on risk management and the suitability of such materials for bespoke permits and individual deployments. The relationship between the REA and deployment processes is set out in Figure 1.1.

Three worked examples of REAs were produced by the authors of this report (Amec Foster Wheeler) using earlier drafts of the methodology. These worked examples, which are provided as separate reports, describe the search strategy approach and evidence extraction and screening processes in more detail for three scenarios:

- where a lot of published evidence can be readily identified for the waste type (paper sludge ash)
- where there is limited evidence for the waste type (sludge from the on-site treatment of effluent from the soft drinks production)
- where unpublished evidence is collected through liaison with upstream waste producers

1.2 Terms of Reference

This report has been prepared in accordance with the Agency instruction (reference. HOEV121302/66) dated 2 December 2013, under Contract RM830. The revised report takes into account additional material prepared by Amec Foster Wheeler Environment & Infrastructure UK Limited (Amec Foster Wheeler) in accordance with the Department for Environment, Food and Rural Affairs (Defra) instruction (reference LM0107) dated 11 December 2014, under Contract RM830.

1.3 Structure of this report

This report presents the proposed methodology for undertaking an REA to identify hazards associated with wastes intended to be spread to land.

Section 2 summarises the most important regulatory controls for the landspreading of waste, as well as other parameters that influence the scope of any assessment of hazards and risks.

Section 3 sets out the scope and objectives for the REA, detailing the conceptual understanding that help the reviewer identify hazards and the factors that can influence

them, such as differing waste compositions. The primary question for the REA is presented, together with a summary of supporting secondary questions. A full list is given in Appendix A, along with the underlying rationale and watch points to be aware of during evidence synthesis and extraction.

Section 4 provides specific guidance and describes the methodology for undertaking an REA for landspreading, with potential watch points and examples.

Appendix B presents a template for evidence extraction as a Microsoft® Excel spreadsheet. This identifies the information that should be recorded during the search strategy and evidence synthesis and extraction. It also provides a centralised record of the evidence sources and data used to inform the REA.

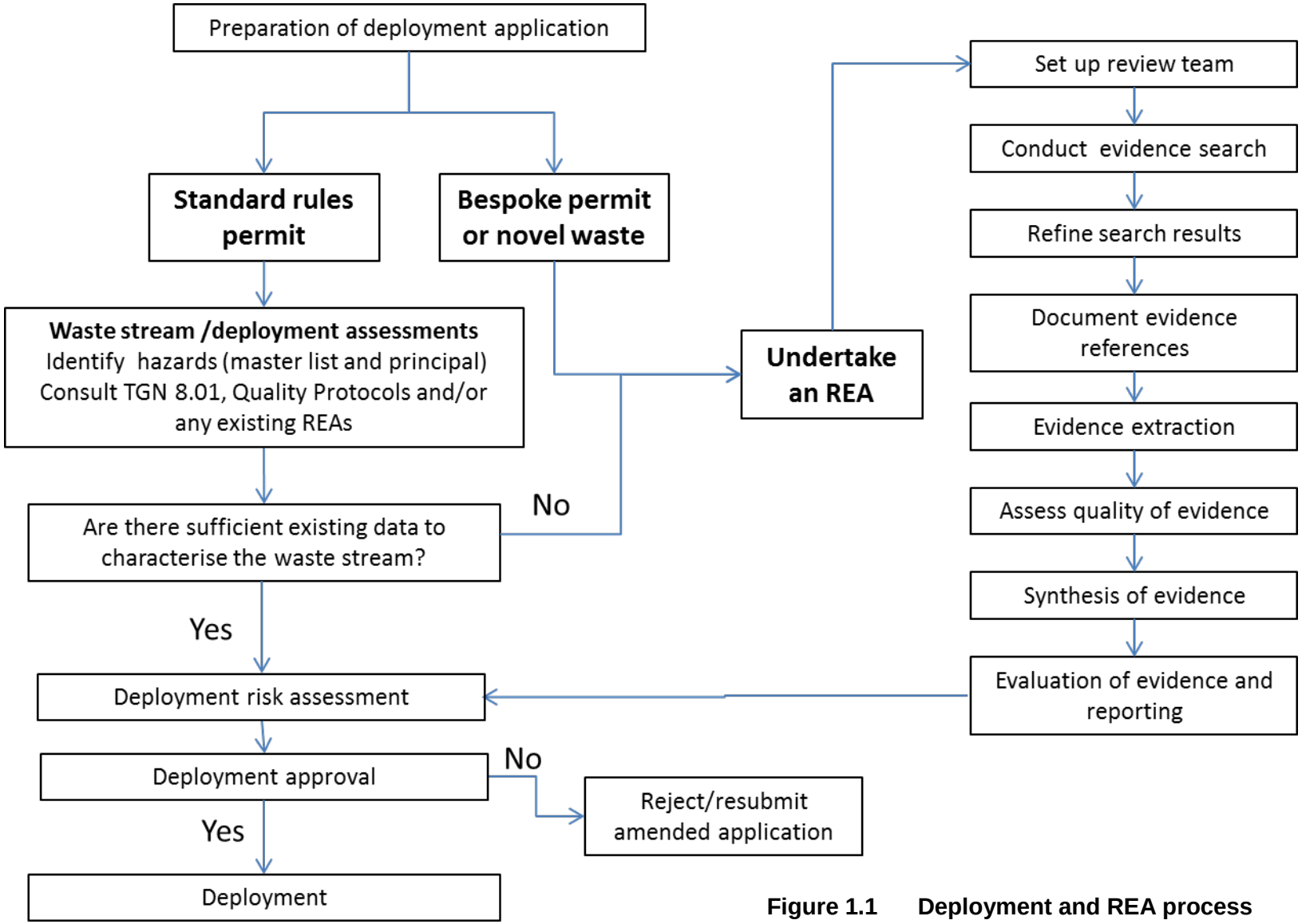


Figure 1.1 Deployment and REA process

2 Regulatory context

Any REA methodology requires clearly established boundaries to ensure that the correct evidence is assessed and evaluated in the correct context (see Section 3 for further information on the REA methodology).

This section summarises the most important regulatory controls and other parameters that influence the scope of any assessment.

2.1 Standard Rules Permit (SR2010) No. 4

EPR 2010 allows certain landspreading activities to be carried out under a standard rules (SR) permit. Standard rules permit (SR2010) No. 4 (SR2010No4) allows an operator to operate mobile plant for land treatment activities on notified agricultural or non-agricultural land in England and Wales which results in a benefit to agriculture or ecological improvement. For the purpose of this REA methodology, only the hazards presented by the waste when spread to agricultural land are considered in detail.

Though a risk-based approach to the controls on activities is inherent in modern environmental permitting, it must comply with the requirements of European and national legislation. For current and proposed activities, this legislation seeks to prevent pollution and the creation of new land contamination, following the polluter pays principle. This is precautionary and more restrictive than the approach to historic land contamination where the activity that gave rise to the contamination has long ceased.

For landspreading under a standard rules permit, it must be clear that no pollution and significant long term build-up of land contamination can arise.

To carry out any landspreading activities under an SR2010No4, an operator must comply with **all** the following criteria.

- The wastes spread must be suitable for landspreading and specified in the standard rules.
- No more than 3,000 tonnes of waste must be stored at any one time per deployment.
- Waste must not be stored for more than 12 months.
- The activity must not be carried out:
  - within 50 metres of any spring or well, or any borehole used to supply water for domestic or food production purposes
  - within 10 metres of any watercourse
  - within a Groundwater Source Protection Zone 1

The standard rules permit is only applicable for a specific list of waste codes and types as detailed in Tables 2.2A and 2.2B of SR2010No4 (Environment Agency 2010). The permit states that:

- the quantity of waste applied per hectare must not exceed that in the agreed deployment form
- in any case, no more than the following quantities of waste must be spread on the land in any period of 12 months:
  - 5,000 tonnes per hectare of dredging spoil from inland waters (17 05 06)

- 1,500 tonnes per hectare of soil from washing and cleaning sugar beet (02 04 01)
- 250 tonnes per hectare of any other waste

Important note

The criteria and requirements set out in this section were correct over the timescale of this project (December 2013 to March 2015) but may be subject to change. Always check the latest version of the relevant guidance.

Following successful receipt of an SR2010 permit, the operator is required to submit a deployment application to the Environment Agency for each proposed landspreading activity under the permit, before this commences.

As discussed in Section 1.1, it is the operator's responsibility to:

- provide evidence identifying all potential hazards
- assess the risks posed by these hazards to receptors on site
- record the findings of the assessment in the deployment application

Given the range of waste types covered under SR2010No4, it is not a valid assumption that the particular waste, which may have been considered previously for another site, is low risk under all deployment situations or that all wastes encompassed by a single waste code have a similar composition and/or hazardous properties.

On receiving the deployment application, the permitting officer is responsible for assessing and reviewing the hazards identified by the operator and associated risk assessment for the requested deployment.

For many waste types, the hazard characterisation is currently limited. Only general hazard information, easily available to both contractors and permitting officers, is provided in:

- Technical Guidance Note (TGN) EPR 8.01 (Environment Agency 2013)
- various Quality Protocols (for example, compost, anaerobic digestate and poultry litter ash)

This general information is available for only a small number of waste types. For some waste codes and types, such information is absent, increasing the need for proper hazard characterisation by individual operators.

One of the aims of this project is to improve the quality of hazard characterisation to support applications for bespoke permits and individual deployments and over time to improve the general information available about hazards associated with various waste types.

2.2 Assessment framework

In addition to the main regulatory controls, there are a range of other factors which strongly influence the identification and management of hazards associated with landspreading and hence form part of the boundaries to the REA – see Section 3 for more about the REA process and Figure 1.1 for the relationship with deployment applications.

These factors are set out in Table 2.1, which gives a conceptual overview of the landspreading of wastes using the source–pathway–receptor model commonly used in environmental risk assessment (see Section 3.2). The table shows that the boundaries are influenced by a number of processes dependent upon both upstream producers and site factors.

2.2.1 Categories of assessment

For the purpose of identifying the potential associated hazards in this REA methodology, two main categories of REA assessment can be defined:

- waste stream assessment
- deployment assessment

The waste stream assessment takes into consideration the production process for the waste, potential variability, waste composition and so on. Understanding how these factors can influence the hazards realised on a site requires a good understanding of upstream conditions. The hazards are waste-specific rather than being strongly influenced by the proposed deployment site in question.

In contrast, the deployment assessment involves consideration of site-specific factors. These can influence the likelihood and severity of a hazard resulting in an adverse impact on receptors and is often difficult to separate from the first steps of risk screening.

The REA methodology set out in Section 3 focuses on those processes identified in the waste stream assessment, providing a better upstream understanding for the waste under consideration. This information can then be used, along with consideration of those processes identified in the deployment assessment, to inform subsequent generic or site-specific risk assessment for a deployment application and/or review.

Table 2.1 Landspreading conceptual overview for SR2010No4 wastes

	Process	Source factors	Pathway/receptor factors	Management controls	Regulatory controls		Comments
					Non-statutory	Statutory	
Waste stream assessment	Waste production	Initial composition, variability	N/A	Operator EMS		Categorisation of waste stream	
	Mixing and treatment	Treatment additives, changes in composition	N/A			(ABPR)	Includes conditioning (for example, addition of water) to facilitate handling and disposal
	Storage and transport to site	Time, storage conditions	N/A			Duty of Care Waste transfer note (must specify waste)	
Deployment assessment, including generic and case- specific risk assessment	Waste as received at site	Composition, homogeneity, stability. Variability of waste stream through time	N/A	Certification of operator and operator EMS (landspreading permit condition), including management plan, general management measures, contingency plan, TCM/NCP requirements		Landspreading SR permit; agreed deployment form	No treatment allowed under permit; specified waste codes; representative samples.
	Storage	Design and integrity of storage, time	Location restrictions		Guidance on storage (for example, COGAP)	SR Permit; deployment form, SSAFO, pollution control legislation	No significant change during storage
	Selection of land	General suitability	Surface suitability (for example, slope)		EPR guidance, including TGN 8.01 and COGAP	SR permit; deployment form (ABPR)	
		Receptor identification	Set off distances, prohibitions (for example, SPZ1)				
	Benefit assessment	Must improve land					
	Selection of	Surface application or	Consider liquidity,				Emission limits

	Process	Source factors	Pathway/receptor factors	Management controls	Regulatory controls		Comments
	application method	injection	odour, dust, pests, noise, vibration				on deployment forms
	Landspreading	Volume, rate, timing, weather	Inherent and time dependent ground conditions	Dynamic risk assessment, EMS			Volume limits on deployment forms
	Reporting/records			EMS			

Key: ABPR = Animals By-Products Regulations 2005

COGAP = Code of Good Agricultural Practice

EMS = Environmental Management System

EPR = Environmental Permitting Regulations 2010

TCM = Technically Competent Manager

NCP = Nominated Competent Person

SPZ = groundwater Source Protection Zone

SSAFO – Silage Slurry and Fuel Oil Regulations 2010

3 REA scope and objectives

3.1 What is an REA?

There is a recognised need for an evidence-based approach when assessing the risks presented by the landspreading of waste, particularly as current generic information for several waste types is absent or sparse.

There is a growing interest in the use of more systematic approaches to assessing evidence in the UK. However, this presents a number of challenges in terms of identifying information sources, collating and synthesising data, and analysing and reporting it in a clear and unbiased way. The problem of interpreting the results of a multitude of separate but similar studies led to the 'science of reviewing', which has been transformed by notable developments in the past 30 years (UK Civil Service 2012).

Evidence reviews in their various forms represent ways of searching for, reviewing and summarising evidence to help policymakers and practitioners answer specific questions. They range in cost, time and complexity from a literature review to the formal Systematic Review that has been used to assess health impacts (UK Civil Service 2014).

Despite being the most comprehensive, the time and cost of a formal Systematic Review is often a major drawback. The alternative is to undertake a more rapid and less costly assessment of evidence so as to answer a specific primary question. A Rapid Evidence Assessment (REA) aims to provide an overview of the volume and types of evidence and knowledge available to address the primary question or topic. An REA provides a comprehensive search, which aims to be thorough and transparent under identified constraints. This is accompanied by a critical evaluation of evidence, using a formal weighting system (Collins et al. 2014).

The UK government has developed a toolkit to assist those undertaking an REA (UK Civil Service 2014), although most of the procedures and examples are based on the effectiveness of interventions in areas such as healthcare, education, and law and order. The Joint Water Evidence Group (JWEG) expanded on the high level guidance provided by the toolkit to produce a 'how to' guide for the production of REAs that can be applied across the Defra network to environmental questions (Collins et al. 2014). Readers looking for further information on planning and undertaking evidence reviews are referred to these resources.

The REA primary question is commonly supported by a series of secondary questions, which provide structure to the REA and contribute to the build-up of evidence surrounding the primary question. The questions can be impact or non-impact, depending on the topic of interest and format of the evidence available. Impact questions tend to be narrow, defining the particular intervention, topic or issue of interest, such as 'Does the application of compost increase the rate of crop productivity?'. In contrast, non-impact questions tend to address less quantifiable or defined effects, covering a broader issue, for example 'How does the application of compost to land affect soil quality and crop production?'.

In developing the primary and secondary questions, it is important to consider the question or issue that needs to be answered or addressed. One way of doing this is through the consideration of PICO elements (Population, Intervention, Comparison and Outcome). PICO elements help to break down the concepts in the question, allowing different aspects of the information required to be considered when developing the primary and secondary questions.

The guidance provided by UK Civil Service (2012) and Collins et al. (2014) for undertaking an REA has been adapted in Sections 3 and 4 to make the methodology or protocol more specific for identifying hazards from the landspreading of wastes.

- Section 3 sets out the scope and objectives for the REA. It also details the conceptual understanding that will help the reviewer identify hazards and influencing factors such as differing waste compositions.
- Section 4 provides specific guidance and describes the methodology and approach for undertaking an REA for landspreading.

3.2 Conceptual understanding

To define the scope and objectives of the REA, it is essential to understand the conceptual model for the landspreading process and the prospective agricultural site and setting.

The conceptual model is a simple representation of the relationships between sources, pathways and receptors, where:

- a **source** is a hazard which is associated with the waste and has the potential to cause an adverse impact or harm
- a **receptor** is something which could be adversely affected by the hazard
- a **pathway** is a route or means by which a receptor could be exposed to, or affected by, a hazard

The source–pathway–receptor model is commonly used to assess environmental risk; all three components need to be present for a risk to be realised.

In the context of landspreading, the composition and form of the source term (the waste to be spread) can be influenced by a number of factors as follows:

- the production process or processes involved in creating the waste
- any primary waste or input materials into the production process
- any treatment or cleaning applications carried out before, during and after the production process
- any screening or pre-treatment of waste prior to its application to land (for example, conditioning dusty wastes with water)

These factors can occur either upstream or as part of any pre-treatment prior to spreading to land. They can also result in variability between batches of waste from the same producer and variability between similar wastes from different producers. This potential variability is an important consideration when assessing the potential hazards associated with a waste type.

As noted previously, for a potential risk to exist from a specific spreading activity, all three of the source–pathway–receptor elements must be present to form a viable linkage. The potential risk associated with a linkage can be assessed by considering:

- the nature of the source (for example, the level of hazardous chemical contaminants)
- the degree of potential exposure of a receptor to the source (for example, the inhalation or ingestion of chemicals)
- the sensitivity of the receptor to the hazard and the level of exposure

The detail of such a risk assessment is beyond the scope of this REA methodology. But by identifying potential hazards that are associated with particular waste types, the REA can provide a preliminary indication of which of these hazards potentially present a greater risk to receptors and thus allow them to be prioritised. Information obtained from the REA can also be used to inform and refine the Environment Agency's generic risk assessment for landspreading activities.[1]

As part of a deployment application, the operator needs to perform a risk assessment (see Figure 1.1). Environment Agency guidance TGN EPR 8.01 states that:

> 'Deployment applications in lower risk locations many be able to use the generic risk assessment to support their deployment application and then undertake a dynamic risk assessment whilst operating [under that deployment]' (Environment Agency 2013, p. 35).

Lower and higher risk locations are defined in the Environment Agency's Form Guidance LPD1 (Environment Agency 2011).

The operator should review the Environment Agency's generic risk assessment for SR2010No4 to ascertain if a site-specific risk assessment is more appropriate for a particular deployment.

For those deployment applications in higher risk locations or for bespoke permits, the operator is required to submit a site-specific risk assessment with the deployment application. The REA can therefore be an important tool in drawing the operator's attention to particular primary or principal hazards which are relevant for that specific waste type. Furthermore, an understanding of the potential variability of waste compositions between batches and producers can help the operator to decide whether a generic assessment is suitably robust for the deployment application or whether a site-specific assessment is more appropriate.

The potential sources and hazards associated with a particular waste will vary depending on a number of factors, including the production process, waste composition and characteristics (see Table 3.1). The REA is used to:

- identify all potential hazards associated with a specific waste type
- prioritise which hazards present the greatest risk to identified receptors based on the conceptual model

The potential importance of pathways for exposure and receptors will be influenced by the individual site location and setting. These need to be considered for each deployment application. However, this more detailed part of risk estimation is outside of the scope of this REA methodology.

A summary of the potential hazards for a waste source, the important pathways and the most commonly considered receptors for a landspreading activity to agricultural land are presented in Table 3.1. This conceptual model is used as the basis to inform the objectives of the REA and questions to be answered.

[1] http://webarchive.nationalarchives.gov.uk/20140328084622/http://publications.environment-agency.gov.uk/pdf/GEHO0612BWQM-E-X.xls

Table 3.1 Summary generic conceptual model for landspreading to agricultural land

Source	Pathway	Receptor	Potential effect
Chemical contamination	Direct contact, ingestion and inhalation (dust and vapour)	Livestock	Toxic, hazardous to health
	Uptake via plants and ingestion		
	Direct contact, ingestion and inhalation (dust and vapour)	Humans (operator)	Toxic, carcinogenic, hazardous to health
	Inhalation (dust and vapours)	Humans (bystanders)	
	Uptake via plants and ingestion of produce	Humans (consumers)	
	Uptake via livestock and ingestion of produce		
	Plant uptake	Crops	Reduction in crop yield and quality due to phytotoxicity, plant die-back, detrimental conditions to plant growth and so on
	Leaching from soil to groundwater and vertical migration through the unsaturated zone	Groundwater	Groundwater contamination – deterioration of quality, impact on potable water resource requiring treatment or closure of source of supply (borehole, well or spring)
	Surface run off and lateral migration within groundwater	Surface Water	Surface water contamination – deterioration of water quality, sediment loading
	Direct application to land	Soils	Deterioration of soil quality, damage to soil structure, toxicity and other adverse changes to soil micro-organisms impacting soil functions, or increased contaminant loading in site soils affecting amenity and use
	Direct application to land, direct contact and uptake via soil vertebrate and invertebrate followed by transmission through the ecological food web	Ecological designation/ wildlife	Harm to protected sites and species through toxic contamination or habitat interference (nutrient enrichment, loss, disturbance and so on)

Source	Pathway	Receptor	Potential effect
	Migration of dusts and leachate to adjacent sites, direct contact and uptake via soil vertebrate and invertebrate followed by transmission through the ecological food web	Ecological designation/ wildlife	Harm to protected sites and species through indirect contamination of sites adjacent to spreading area
Plant pathogens	Direct application to land	Crops on site	Reduced crop yield and quality, deterioration of soil quality
	Wind-blown migration	Crops on adjacent land	Reduced crop yield and quality, deterioration of soil quality
Animal pathogens	Ingestion of soil	Livestock	Toxic, hazardous to health
	Uptake via livestock and ingestion of produce	Humans (consumers)	Toxic, hazardous to health
Toxic or injurious plants	Ingestion of plants	Livestock	Toxic, hazardous to health
Invasive weeds	Direct application to land	Crops on site	Reduced crop yield and quality due to additional competition and potential deterioration of soil quality
	Seed dispersal (by animals or wind)	Crops on adjacent land	Reduced crop yield and quality due to additional competition and potential deterioration of soil quality
Physical contamination, including glass, plastic, metal and so on	Direct application to land	Soil	Deterioration of soil quality
Release of vapour and dust	Airborne transport	Air quality	Deterioration of local air quality
Release of odours	Airborne transport and inhalation (odours)	Humans (bystanders)	Nuisance, impact on quality of life and loss of amenity
Release of dust	Airborne transport and inhalation (dust)	Humans (operator and bystanders)	Hazardous to health, nuisance, impact on quality of life and loss of amenity
Attraction of pests and scavenging animals	Airborne transport	Humans (by-standers)	Nuisance, impact on quality of life and loss of amenity

For some waste types the generic hazards listed in Table 3.1 may not exist and the Environment Agency's generic risk assessment may be refined for that particular waste type, enabling the permitting officer to prioritise their attention on certain hazards.

3.3 Objectives

3.3.1 PICO

As introduced in Section 3.1, a PICO strategy can be used to inform the objectives and questions to be answered as part of an REA (UK Civil Service 2012, Collins et al. 2014). The PICO elements for a landspreading REA (Table 3.2) are influenced by understanding of the conceptual model and the assessment framework underpinning the landspreading process to agricultural land.

Table 3.2 PICO elements for a landspreading REA

PICO element/definition	Description
Population (P)	Waste type, code or description under consideration
Intervention (I)	Landspreading of waste under SR2010No4 and associated deployment application to agricultural land Assessment of hazards associated with a particular waste type/code or description which could potentially present a significant risk to relevant critical receptors[1] – to be undertaken either at deployment application stage for wastes under SR2010No4 or an existing bespoke permit, or at the permit application stage for a novel waste under a bespoke permit
Comparison (C)	Landspreading of other types of materials to agricultural land such as fertilisers, manures and soil improvers which do not require an environmental permit
Outcome (O)	Accurate identification of hazards leading to appropriate risk assessment and acceptance or rejection of deployment or bespoke permit application Mitigation of unacceptable hazards associated with the population of concern can be incorporated where necessary in resubmitted deployment applications.

Notes: 'Critical receptors' is the collective term for humans, controlled waters and dependant ecosystems, wildlife, soil (quality), air quality and property in the form of livestock and crops. They depend on the type of waste and site-specific information for each deployment application.

3.3.2 Primary question

The REA methodology proposed here addresses the overarching primary question:

> What key hazards are associated with [insert waste type/code or description] which could present a risk to critical receptors during or after landspreading on agricultural land?

This is a non-impact question (see Section 3.1), which defines the topic of investigation that is subject to review.

Secondary questions (see Section 3.3.3) are used to guide the reviewer step-by-step through the identification of a range of different hazards, building up the evidence to address the primary question.

3.3.3 Secondary questions

A series of secondary questions are asked in the REA under the defined headings presented in Table 3.3. These allow the reviewer to work efficiently through the REA process, identifying all potential hazards associated with the waste under consideration. The responses to the secondary questions will inform subsequent risk assessment and ultimately a decision on whether a particular deployment or permit application should be approved.

The secondary questions are based on the conceptual understanding presented in Table 3.1, providing more detailed evidence to identify relevant pathways and receptors for particular waste streams and the identification of key hazards which may impact on them.

An example set of secondary questions and associated justification are presented in Appendix A. It is recommended that these are tailored for the specific waste stream or materials being reviewed. In particular, it is important to reflect the specialist and technical language relevant to operators and upstream waste producers to put the questions into a clearer context.

Table 3.3 Defined headings for secondary questions, with examples

Defined heading	Example(s) of secondary question
Waste production and form	Are there different production processes for this waste and how long have they been in place? How variable is the waste between batches and what factors influence this variability?
Chemical hazards	Does the waste contain potentially toxic elements (PTEs) or other contaminants? Are pesticides, herbicides or fungicides likely to be present in the waste?
Plant and animal pathogens and toxic compounds	Are plant pathogens, fungus and/or soil-borne diseases likely to be present in the waste, post spreading?
Invasive weeds	Is there potential for invasive weeds to be present in the waste, post spreading?
Physical contaminants that is, glass, plastic, metal and so on	Is non-biodegradable material such as plastics, metal, brick, concrete and/or glass and so on likely to be present in the waste, post spreading?
Nuisance (that is, odour and dust)	Are unpleasant odours likely to be associated with the waste?
Other environmental hazards	Does the waste have a high fat or oil content (that is, >4%)?

3.4 Defined limits of the REA

The REA focuses on potential hazards and associated receptors as identified in the conceptual model (see Table 3.1) from waste materials that could potentially be spread to agricultural land. It is not confined to those waste codes and types currently listed in

SR2010No4, but can also be extended to those considered under bespoke permits or added to the waste codes listed under SR2010No4 in the future.

This REA methodology is intended to be used to inform the evidence base and review for deployment and permit applications under the EPR 2010. Although developed by the Environment Agency to support applications in England, its principles are generic.

As part of the data search strategy and evidence extraction, only English language documents are reviewed.

Given that for some waste types there is the potential for limited evidence to be available, there is no defined limit of the date of documents to be considered and/or reviewed as part of the REA. However, more recent documents, with a date from 2010 onwards, take a higher priority for review and are given a higher weighting in the evaluation of evidence.

Similarly a wide range of different publication sources may be used including material produced by industry, trade associations, academic institutes, government bodies and agencies, and international organisations such as the European Commission or World Health Organization.

For individual deployment and bespoke permit applications, the operator should liaise and obtain information relating to the waste composition, production processes and so on from the waste provider/producer(s). As a minimum, the operator should obtain and review the Material Safety Data Sheets for the key raw materials and products from the waste producing processes as well as those for the wastes themselves.

However, when undertaking the REA as part of a general review of evidence of a particular waste type to provide upstream information for defining the source, it is recommended that only waste producers based in the UK or known to import wastes into the UK should be consulted.

3.5 Constraints

The constraints of undertaking an REA should be taken into account when collecting, reviewing and evaluating the evidence collected.

Compared with a systematic literature review, an REA relies on a limited range of search terms rather than an extensive search of all variants, and information collected from a reduced number of potential evidence sources. This means that the REA can be performed in a much shorter timescale than for a systematic literature review, although it could result in evidence being missed, which may introduce bias and gaps into the evidence collected.

There are varying levels of sophistication possible for an REA, with time and cost constraints associated with each approach.

The time spent carrying out an REA can range from a week to several months and can depend on the budget and quantity of evidence anticipated to be available. Collins et al. (2014) indicate that the cost of an evidence review depends on a number of factors. Those relevant to this REA methodology include:

- the volume of relevant literature
- how dispersed the evidence is
- how easy the evidence is to locate
- how far back the search needs to go

- how quickly the review needs to be done
- how much input is needed from experienced or qualified personnel
- how much knowledge and experience the reviewer has on the subject area and in conducting evidence reviews

As with any review, there is the potential risk of generating inconclusive findings that provide a weak answer to the primary question (UK Civil Service 2012). This is an issue for REAs for the landspreading of waste, as published information may not be available or easily obtained for a particular waste type. In the absence of generic information, emphasis should be placed on the operator and associated waste producer(s) to provide such information in the deployment application. For example, more detailed chemical analysis and sampling might be expected to demonstrate the presence or absence of potentially toxic elements or persistent organic pollutants.

In addition to the potential lack of information, the tight timescales involved in an REA mean that if the findings are inconclusive, there is less time to go back and revise the question and/or inclusion criteria and to search for new evidence from additional sources.

In identifying the need for an REA it is important to consider the costs and benefits that this can provide. For example, where an operator is proposing to spread a novel or potentially hazardous waste to land on one or two occasions, the operator's costs associated with undertaking an REA may outweigh the commercial and agricultural benefits obtained, particularly if limited evidence is identified resulting in an inconclusive or weak answer to the primary question. In such cases, the landspreading of these wastes may not make commercial sense.

This methodology provides a clear structure for carrying out an REA in an attempt to minimise any potential bias and gaps in evidence collection. The time and cost associated with undertaking this REA need to be assessed on an individual basis by the operator and the review team making the assessment.

4 REA approach

4.1 Review team

The reviewer(s) carrying out the REA should ideally have experience in reviewing evidence and some technical knowledge of the landspreading process and the hazards associated with this. The reviewer(s) should also be familiar with the regulatory context and practical issues surrounding the activity (Collins et al. 2014).

The review team should have access to the relevant electronic evidence databases and collated hazard database (where one exists) and be able to actively engage with experts in the field.

If the REA involves collecting and using data from upstream waste producers, it is essential that the reviewer(s) understand the industry and industrial processes involved.

Experience gained from the worked examples demonstrated the importance of early engagement with industry, which proved to be important to helping the review team collect and interpret industry data within a tight timescale. Effective early engagement with industry enables the review team to work with their contacts to:

- scope out the amount of industrial data available through understanding factors such as the number of companies in the sector, the types and volumes of wastes produced, and the location and differences between facility processes
- explain the context of the study, and through dialogue, ensure that terminology is not a barrier to understanding
- identify and resolve issues around confidentiality
- engage contacts as soon as possible in the collecting and collation of data, which can be a significant obstacle for reviews over a short timescale

4.2 Search strategy

4.2.1 Initial evidence search

Identifying relevant evidence sources

The following three main evidence categories can be used to inform the REA:

- peer-reviewed evidence
- grey literature
- unpublished evidence, including expert opinion

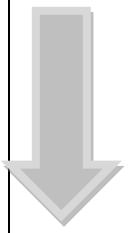
Using multiple databases and searching for different resource types ensures that a wide variety of peer-reviewed evidence is identified, minimising the potential for bias and also allowing the discovery of grey literature and useful unpublished evidence (Collins et al. 2014).

Table 4.1 lists a number of potential evidence sources for this REA for landspreading. These are presented in the order of preference in terms of informing the hazards' identification. Note that this list is not exhaustive, but provides the reader with a good starting point for evidence collection.

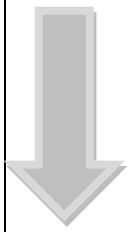
The list of potential methods for obtaining evidence should be refined and developed as the review progresses. Ideally this should also be fed back into the REA methodology to provide a more comprehensive list of potential data sources and methods for any subsequent REAs made in the future.

When searching the internet, it is a good idea to restrict the number of hits reviewed to avoid getting overloaded with information. It is recommended that at least 25 and up to 50 hits from each search are reviewed against the inclusion/exclusion criteria (see Section 4.2.2). The reviewer may consider looking at a reduced number of hits as the REA progresses, if the initial searches consistently identify a lower number of relevant hits per keyword search.

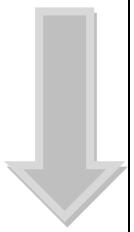
Table 4.1 Hierarchy of potential relevant sources of evidence

	Evidence type	Evidence category	Possible evidence	Source of evidence[1]
Most preferred 	Producer-specific waste stream data	Unpublished	Chemical data for waste type or similar Classification labelling and/or material safety data sheets for relevant waste or primary product Information on the production processes, feedstocks, products, by-products, wastes from cleaning of processing equipment and any treatment processes performed by the producer and/or operator prior to land spreading	Evidence should be requested from the producer supplying the waste for deployment or other known producers of this waste stream. Liaison with experts within or outside the Environment Agency may provide a list of useful contacts for this waste stream.
	Representative case-specific/ compliance data	Unpublished	Internal Environment Agency data obtained during a previous deployment application for this waste type or any compliance testing by operator post-spreading	This kind of evidence is unlikely to be available for the majority of waste types, but reviewers should liaise with the Environment Agency's national permitting staff and relevant operators/producers to seek such information.
	Environment Agency or Defra database	Peer reviewed	Published or archived reviews/reports	Quality Protocols for waste stream or similar waste stream Liaise with Environment Agency permitting team or internal experts to identify any key evidence sources Search for reviews/documents relating to the waste under consideration on GOV.UK (Environment Agency and Defra pages) Search for research and generic guidance for the waste under consideration on the WRAP website (www.wrap.org.uk)
	Environment Agency/Defra database	Unpublished	Internal unpublished or draft reviews/reports	As above and liaison with permitting team or internal experts in the field

	Evidence type	Evidence category	Possible evidence	Source of evidence[1]

	European Commission database	Peer reviewed	Published reviews/reports	Searches of the following websites:
				• European Commission
				  - Agriculture and rural development pages (http://ec.europa.eu/dgs/agriculture/index_en.htm)
				  - Waste pages (http://ec.europa.eu/environment/waste/index.htm)
				• European Chemicals Agency (ECHA) (http://echa.europa.eu/information-on-chemicals)
				• European Food Safety Authority (EFSA) (http://www.efsa.europa.eu/en/topics.htm)

	Generic producer data (UK based)	Unpublished/ published	Chemical data for waste type or similar Classification labelling and/or material safety data sheets for relevant waste or primary product	Liaison with experts within or outside the Environment Agency may provide a list of useful contacts. Request information from any identified producers in the UK.

	Evidence type	Evidence category	Possible evidence	Source of evidence[1]
	UK published literature Grey literature Expert knowledge and UK academic research	Peer reviewed	Reports Reviews Journal articles	Liaison with experts within or outside the Environment Agency to identify any key evidence Review of bibliography or reference list from key reports, reviews or journal articles Keyword searches on: • online databases such as Web of Science, Science Direct and Scopus • Google Scholar • library sources – preferably electronic – university, scientific establishments, local authority or British Library Keyword search and links on websites/databases of other organisations such as: • National Resources Wales (http://naturalresourceswales.gov.uk) • Scottish Environmental Protection Agency (www.sepa.org.uk) • Northern Ireland Environment Agency (www.doeni.gov.uk/niea) • WRAP (www.wrap.org.uk) • Food Standards Agency (www.food.gov.uk) • Public Health England (www.gov.uk/government/organisations/public-health-england) • Irish Agriculture and Food Development Authority (www.teagasc.ie) • ADAS (www.adas.co.uk) • Chemicals Regulation Directorate (www.pesticides.gov.uk/guidance/industries/pesticides) • Food and Environment Research Agency (http://fera.co.uk) • Organics Recycling Group (www.organics-recycling.org.uk)

	Evidence type	Evidence category	Possible evidence	Source of evidence[1]
 **Least preferred**	UK published literature Grey literature Expert knowledge and UK academic research	Grey literature	Reports Reviews Articles Books Conference proceedings	Review of bibliography or reference list from key reports, reviews or journal articles Keyword searches on: • search engines such as Google and Bing • library sources – university, scientific establishments, local authority or British Library Keyword search and links on websites/databases of other organisations: • see above for list • OpenSIGLE (www.greynet.org/opensiglerepository.html)
		Expert knowledge	Interview	Liaison with major experts for the waste type under consideration
		Academic research	PhD theses Other academic works	Keyword searches on academic research databases
	European and overseas data	Peer reviewed	Reports Reviews Journal articles	Keyword searches on the following websites: • search engines such as Google and Bing • US Department of Agriculture National Agricultural Library (www.nal.usda.gov and http://agricola.nal.usda.gov) • Food and Agriculture Organisation of United Nations – (http://agris.fao.org/agris-search/index.do) • World WideScience.org (http://worldwidescience.org) • Foundation of Water Research (www.fwr.org) • Sustainable Organic Resource Partnership (www.sorp.org) • BioOne (www.bioone.org)
		Grey literature	Reports Reviews Articles	
		Unpublished	Organisation reports – only distributed internally	

Notes: [1]Sources of possible evidence identified during this project and informed by those listed by Collins et al. (2014), Newman et al. (2007) and Waterson and Randall (2013).

Keywords

The keywords used in the search strategy will depend on the waste type. They may vary between evidence sources, with different keywords being applied for organisation databases and general internet searches.

The identification of keywords can be developed with reference to the PICO elements and the primary and secondary questions which need to be answered. People with technical knowledge of the particular waste type and people with specific knowledge of searching online databases can also provide valuable assistance.

Keywords can be combined using 'strings' of search terminology such as 'AND' and 'OR'. If a particular search turns out to be too broad and results in a substantial number of irrelevant hits, the 'NOT' term can be used to exclude inappropriate or irrelevant terms. The truncation symbol * can be used for words that have multiple possible endings (for example, contam* can be used for contaminant, contaminants, contamination and so on).

The list of keywords may need to be refined or developed further as the evidence search proceeds in response to limited or substantial data hits. Further relevant keywords may also come to light following the reviewer's scan of abstracts and relevant executive summaries.

Table 4.2 shows an example of the range of keywords which can be used in an REA data search for paper sludge ash.

Table 4.2 Example of keywords to identify potential hazards associated with landspreading paper sludge ash

Waste type	Activity	Hazard identification
Paper sludge ash	UK	Material data sheet
Waste paper sludge ash	Producers	Environmental risks
Paper by products	Agriculture	Hazards
Ash	Landspreading	Human health
Paper mill ash	Incineration	Groundwater
Paper mill sludge ash	Fertiliser	
Paper mill fly ash		
Waste code 10 01 01		

All keywords used for the REA data search should be recorded, with an indication of the number and quality of evidence obtained from each search. This information will not only provide background to how the evidence was obtained, but can also be used to inform future REAs for similar subjects.

The evidence extraction spreadsheet in Appendix B shows the type of information that should be recorded.

4.2.2 Refining the search results

The initial evidence search is refined using inclusion and exclusion criteria. This refinement of the search results is achieved by:

- scanning the title and the abstract or executive summary (or both if present) for the evidence in question
- identifying where the associated keywords appear in the document and the context of their use

In addition to the defined limits of the REA stated in Section 3.4, the evidence selected for review as part of the REA should focus on the particular waste type under consideration. Specific information for some waste types may not exist or be very limited. In such cases, evidence for a sufficiently similar waste type can be used as the basis for the assessment, though this should be clearly recorded in the evidence extraction spreadsheet.

In addition to the above, at least one of the following **inclusion criteria** must apply.

- The evidence provides information on the upstream production processes and any pre-treatment that the waste goes through prior to landspreading.
- The evidence provides qualitative or quantitative information about the waste's chemical composition.
- The evidence provides information on the potential microbiological or physical hazards associated with the waste.
- The evidence considers the spreading of the waste to agricultural land.
- The evidence provides a comparison between waste types and/or application to different land types.

Exclusion criteria are as follows.

- The evidence is not published in English.
- A full text version of evidence is not available.
- The evidence does not focus on the waste type (or similar waste type) under consideration.

These criteria should be reviewed and amended as appropriate for the specific waste stream under consideration. Examples of appropriate criteria are given in the three worked examples.

If the full text is not freely available on the internet or through the organisation's subscriptions, a further round of screening may be required if the evidence cannot be sourced in a reasonable timeframe or proves prohibitively expensive. If this occurs, this item should be omitted from the review and this recorded in the evidence documentation.

Depending on the volume of evidence obtained from the REA data search, it may be appropriate to amend the inclusion and exclusion criteria given above to provide a sufficient evidence base to offer a reasonable outcome for the REA.

The screening of evidence against the inclusion and exclusion criteria occurs at the time of the search. Only that evidence that passes the inclusion and exclusion criteria needs to be documented fully and saved for review. The documenting of information is discussed in Section 4.2.4.

Evidence can also be removed from the review if it becomes apparent that the document is not as relevant as initially thought from reviewing the title or abstract or executive summary.

4.2.3 Working with upstream waste producers

In many cases, the most important evidence on the biological, chemical and physical characteristics of a particular waste is obtained by talking to upstream waste producers.

As noted in Section 4.1, early engagement with industry is vital to plan and obtain evidence for review in a timely manner. Waste producers may need time to pull relevant data together. In addition, the review team needs to find out early on what restrictions, if any, there are on the use and reporting of data. Any limitations on data use and reporting should be stated clearly in the review.

Issues of confidentiality should be resolved as early as possible. In some cases, industry may request that data are anonymised through a third party such as a trade association, or collated and reported so that a single batch or facility cannot be identified. In such cases, the review team should ensure it understands how this will impact on the review and document it as an uncertainty in the overall assessment. Time also needs to be allowed for the data to be collated and anonymised by the third party.

Strategy for collecting evidence from waste producers

The review team should develop and agree a strategy for collecting evidence with waste producers. Such a strategy might include one or more of the following methods:

- questionnaires
- site visits
- face-to-face expert meetings or interviews

Questionnaires

Questionnaires are useful to structure initial requests for information and are usually based around the secondary questions set out in Appendix A.

It is essential to tailor the questions, language and terminology to the target audience. While a pro forma style is efficient, industry may prefer to supply data in their own formats and the review team should take this into account when resourcing data management. For example, data may be provided as spreadsheets, PDFs or as hard copies, and this may need to be retyped into a useable format by the review team. Issues of confidentiality permitting, it is better to obtain the raw data from industry and spend the time consolidating it to give a deeper understanding of the data sources, gaps and uncertainties.

Site visits

Site visits enable the review team to see how the waste is produced and managed in practice and can provide invaluable insight into operations.

A site visit can often be integrated with face-to-face expert meetings and interviews.

Ideally, site visits should be arranged after an initial review of the published evidence and to follow up data received via a questionnaire. This allows the review team to work with industry to improve understanding and identify or resolve gaps in knowledge. Using the questionnaire can also provide structure to discussions.

The review team should:

- make a transcript of any expert discussions that take place during the site visit
- ensure that they are seen and approved by all parties so that they can be added to the evidence record

Expert opinions

Expert opinion is subject to bias and this should be taken into account when drawing conclusions from the evidence provided. Ideally, multiple expert interviews should be conducted to avoid over-reliance on a single viewpoint.

4.2.4 Documenting the data search

To justify that a strong and reliable REA has been undertaken, the search strategy should be documented in the evidence extraction spreadsheet (see Appendix B) or similar database. The information provided should be clear and transparent, allowing the data research to be repeated in the future, if required. Table 4.3 lists the information that should be documented:

Table 4.3 Information to be documented

Type	Description and comments
Details of any discussions with experts or producers	Including: • dates of interviews • name and location • form of interview or discussion (face-to-face, over the telephone and so on)
Record for each search	Including: • date of evidence search • database or evidence source name • keyword search used • number of hits (if provided) • number of hits reviewed An indication of the quality of information provided for each keyword search and evidence source is also be useful to inform future REAs.
Details of evidence which meets the inclusion criteria	Including: • reference • date of review • evidence source and type • brief description of information provided Where possible, the evidence should be saved or a hyperlink recorded for internet resources.

4.2.5 Applying the search strategy

To summarise the above, the application of the search strategy involves the following steps:

1. Identify relevant sources of evidence.
2. Run the keyword search across sources identified.
3. Refine the keyword search depending on the results from step 2.
4. Document the volume of evidence identified.
5. Apply the inclusion and exclusion criteria as search results are read at the title and abstract/executive summary level.
6. Document the evidence reference reviewed as part of the REA.

4.3 Evidence extraction and evaluation

4.3.1 Quality assessment

When considering multiple lines of evidence, it is important to assess the quality of the data collected (Defra and Cranfield University 2011). The evidence reviewed as part of the REA should be assessed to:

- ascertain the robustness and overall quality of the information
- provide an indication of any bias or uncertainty for each secondary question response

The results of this assessment should be recorded in the evidence extraction spreadsheet (see Appendix B) and discussed in the REA report.

Quality indicators (see Table 4.4) should be used to determine the quality rank for the evidence collected for a particular secondary question.

The reviewer should assess the quality of the evidence for each category (robustness, evidence type and objectivity), with the final quality score being given based on the lowest quality ranking for each of the three indicators.

For example, a document produced by an operator, which has a strong evidence base and has been peer reviewed will score highly on the quality ranking for the robustness of evidence and primary evidence category, but given the source of the information, there could be some inherent bias in the document resulting in a medium rating overall.

Assuming that sufficient evidence has been obtained, this quality assessment should be made for each secondary question response.

Table 4.4 Quality indicators for an REA

Quality ranking	Robustness of evidence	Primary evidence category	Objectivity
High	Strong evidence with multiple references Most authors and experts come to the same opinion or conclusion Supporting quantitative data	Peer reviewed	No discernible bias
Medium	Evidence provided in a small number of references Authors and experts vary in their opinion or conclusion Limited supporting quantitative data	Grey literature	Weak to moderate bias
Low	Scarce or no evidence Authors/experts opinions/conclusions very considerably No supporting quantitative evidence	Unpublished	Strong bias

4.3.2 Synthesis of evidence

Once a list of relevant evidence is identified, the next step is to extract the relevant information to be able to answer the primary and secondary questions. This is likely to require the synthesis of evidence from multiple sources to answer the key questions identified for the REA.

Qualitative evidence

For any qualitative evidence collected, the reviewer should take into account:

- keywords identified in the evidence
- objectives of the evidence
- methods for assessment or review
- key findings and main conclusions
- any limitations of the evidence
- quality of evidence (see Section 4.3.1)

Quantitative evidence

For the majority of waste types, it is unlikely that sufficient quantitative information will be obtained to warrant formal quantitative synthesis (for example, meta-analysis). However, there may be sufficient information to allow basic statistics to be applied to the dataset, such as the calculation of median values, averages, ranges and standard deviations. Usually, a minimum sample size of around 10 is necessary but the exact number will depend on sample variability.

If chemical data are aggregated from multiple evidence sources, the reviewer should note and take into account:

- the quality of the data (that is, use of accredited methods, sufficiently low laboratory limit of detection, age of analysis and so on)
- potential for bias in any chemical datasets collected

The potential for temporal or spatial bias in the datasets obtained should also be considered. For example, results may vary due to changes in raw materials or fuels, or fluctuate seasonally.

Another important issue is whether the units are comparable (for example, mg/kg versus µg/kg, and fresh and dry weight measurements). These should be standardised, where possible, to allow clearer comparisons to be made.

Care should also be taken when comparing or combining average values from one study with individual data points from another study. This is because the average values could potentially be skewed by individual results which lie outside the main dataset (that is, statistical outliers).

4.3.3 Hazard assessment and screening

For a particular waste stream or waste code, a list of potential hazards should be compiled of all the hazards that may be present. Defra guidance ('Green Leaves III') refers to this as a 'Master List' (Defra and Cranfield University 2011, p. 36).

Using a screening process, this master list can be refined down to a 'Principal List' of hazards. These hazards are those that are likely to be present **and** whose presence may be significant in terms of potential impact on receptors.

Factors to consider during the screening process

Where relevant, the following factors should be considered during the screening process.

The evidence and opinion in the literature on the likely risks presented by a particular hazard to a given receptor in a landspreading context should be examined.

The prevalence, frequency and level of a hazard in the characterised materials should be noted. While worst-case levels often drive perceptions of hazard and risk, a measure of central tendency such as an average or median value is a stronger measure of a hazard.

Comparison of hazard levels, such as chemical concentrations, with existing soil levels and in comparable non-wastes such as fertilisers, manures, and soil substitutes (taking application rates into account) can provide a useful indicator and context for potential impacts.

Long-term multiple applications can be screened using a simple soil enrichment model with default assumptions for material application rate, soil density (1,300 kg/m^3) and incorporation thickness (5–25 cm depending on agricultural use). Predicted soil concentrations can be compared with current concentrations to assess enrichment potential or with existing environmental benchmarks (see below).

Environmental benchmarks for soil and other media are available in the literature and are potentially useful when screening or prioritising hazards. Benchmarks are usually set to be protective of human health, livestock, crops, soil quality, wildlife or controlled waters. The review team need to fully document the basis of benchmarks used and ensure that they are appropriate for the context of the REA (an agricultural end-use). Often advisory benchmarks are compared with predicted or measured soil

concentrations and are used to ‘screen out’ hazards and risks. Exceeding a benchmark during screening does not automatically imply a significant hazard or risk.

The potential likelihood of a hazard occurring under generic conditions, with controlled application rates and the risk criteria specified in SR2010No4 should be considered.

Any underlying requirements for management practices or mitigation to be implemented to minimise the risk (for example, standard permit conditions and good practice under statutory codes) should be noted.

Example of the process of hazard screening

The process of hazard screening is demonstrated in the three worked examples, which are presented in separate reports.

For example, the REA for paper sludge ash (PSA) identified the potential presence of dioxins and furans on the Master List of hazards for this waste type. Limited quantitative data identified during the REA showed that the concentrations of dioxins and furans tended to be very low and one source noted that the concentrations of dioxins were at similar or lower concentrations to those found in urban soils. Furthermore, there was an apparent consensus in the literature that, under normal conditions, the incineration process is an effective method for removing such contaminants.

With these factors in mind, the review team concluded that, although there was the potential for dioxins and furans to be present in PSA, in reality the presence of concentrations of these contaminants sufficient to present a significant risk to receptors was low. As a result, dioxins and furans were not included on the Principal List of hazards for PSA.

In contrast, dust was identified on the Master List of hazards for PSA. Although, one evidence source suggested that dust was unlikely to present a significant health risk to bystanders, the hazard was deemed to warrant further consideration in the form of a dust management plan in any deployment application for this material. This was to ensure that dust did not present a risk to air quality in the area and cause an adverse impact on nearby residents through nuisance. As a result, dust was identified on the Principal List of hazards for PSA.

Using the Master and Principal Lists of hazards

The REA process applied generically for a waste code or waste stream should produce both Master and Principal Lists of hazards. These are then used as a starting point during the bespoke permit or deployment application process.

In the absence of site or case specific data, the Principal List of hazards is normally used for risk assessment purposes to make it a more manageable process. For any specific deployment, however, there is a risk that a waste stream may contain outliers not included on the Principal List of hazards. Typical risk factors to consider in this context include:

- waste is from a new operator
- changes to the waste production process
- high expected variability due to variable feedstock

Depending on its scope and quality, any data from a case-specific waste analysis accompanying the deployment application may provide a further opportunity to refine

the Principal List of hazards. In some cases, such an analysis may be useful to provide evidence that hazards are not present in a waste material.

The purpose of the secondary questions presented in Appendix A is to identify all the potential hazards which could be associated with the specific waste type, that is, to provide a Master List of hazards with supporting information that can be used to screen down to a Principal List. This screening and determination of hazards on the Principal List also allows refinement of the conceptual model (see Section 3.2) for subsequent risk assessment.

Further sampling and analysis may be required, before the deployment can be approved, if the analytical data provided in the application do not include data for all the hazards identified on the Principal List for the waste type.

4.4 Reporting

The 'Communicating findings' section of the Civil Service toolkit states that the evidence should be communicated in a way that:

> 'seeks to balance the need to present the findings of the research in a form that is quick and accessible to read, with a requirement to demonstrate that the research has been conducted in a robust and reliable manner' (UK Civil Service 2011).

The evidence extraction spreadsheet (see Appendix B) can be used as a supporting tool to:

- identify where there is sufficient evidence to give a response to the secondary question or where evidence is lacking
- to indicate which evidence provided key information for a particular question

The spreadsheet offers a template for presenting the detail of the search strategy, as well as the information extracted from the evidence and literature identified during the REA. This can be used to inform a written report that summarises the main findings, data gaps and implications of the REA, as well as providing valuable feedback for the refinement of subsequent assessments.

The REA report should contain the following:

- executive summary
- background and rationale for REA
- primary and secondary questions and scope of REA
- details of reviewer or review team
- outline of the data strategy utilised for the REA
- evaluation of the evidence including:
  - answers to secondary questions under the defined headings in Table 3.3
  - a summary of biological, chemical and physical characteristics on the hazards on the Master List associated with the particular waste type (that is, answer the primary question) and, where possible, typical ranges in the composition of these hazards

- an evaluation of Master List hazards to derive a Principal List including the substance concentrations in the waste compared with soils and non-waste comparators, soil enrichment from multiple long-term applications and the use of environmental benchmarks
- a summary table of the final Master List and Principal List of hazards with clear reasons for their inclusion and exclusion
- a consideration of those hazards and, if sufficient information is available, those pathways and receptors which may not be relevant for this particular waste type

- a discussion of the limitations of the REA – where information was identified but could not be obtained during the time period, no response to producer information requests, and so on
- details of any potential conflicts of interest or bias in the data, for example, where all chemical evidence obtained is provided by the prospective operator or producer who has an interest in a successful deployment application
- Identified data gaps and recommendations for future work – data gaps should be clearly evident if insufficient information has been found to answer a particular question or questions (will feed into the provision of any recommendations for future work)
- any regulatory or practice implications based on the REA's findings
- reference list and sources of information

An REA report can be regarded as part of a continuing process of acquiring knowledge about a particular waste type. The effort expended in collating, assessing and recording the evidence is normally significantly greater the first time an REA is carried out for a waste stream or waste type than on subsequent occasions.

Ideally, a typical range of physicochemical properties should be defined for a waste stream during an initial REA, which can then be assessed as being acceptable in principle for landspreading – subject to deployment assessment for site-specific factors. On subsequent deployments, the existing REA can form a base from which to work. Providing the composition of the waste stream at the deployment stage lies in the typical range defined previously, then relatively little additional work may be needed with respect to REA. If the composition lies outside the typical range, then this should be a trigger for review of the REA and potentially more data collection. In both cases, any additional data obtained should be used to amend or refine the existing REA report so that, with time, thorough assessment and reporting improves the evidence base for the landspreading of that particular waste stream.

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List of abbreviations

ABR	Animal By-Products Regulations 2005
COGAP	Code of Good Agricultural Practice
DEFRA	Department of Environment, Food and Rural Affairs
EMS	environmental management system
EPR	Environmental Permitting Regulations 2010
NCP	Nominated Competent Person
NPS	National Permitting Service
PCB	polychlorinated biphenyl
PSA	paper sludge ash
PICO	Population, Intervention, Comparison, Outcome
REA	Rapid Evidence Assessment
SPZ	Groundwater Source Protection Zone
SR	Standard Rules [Permit]
SSAFO	Silage Slurry and Fuel Oil Regulations 2010
TCM	Technically Competent Manager
TGN	Technical Guidance Note

Glossary

Agricultural land	Meaning given by Section 109 of the Agriculture Act 1974. Includes land for the production of timber and non-food agricultural crops.
Anoxic soil conditions	Soil depleted in oxygen.
Bioaccumulation	Accumulation of substances such as pesticides or other organic chemicals in an organism at levels higher than ambient.
Breakdown products or metabolites	A chemical compound produced as a result of metabolism or a metabolic reaction by living organisms such as soil microbes.
Cumulative or additive effects	A series of repeated actions, contaminants, hazards and so on which have a greater effect than the sum of their individual effects.
Deployment form	The Environment Agency form (LPD1) which requires site-specific information and control measures to be provided and agreed prior to use of any mobile plant under the standard rules.
Emerging contaminants	Chemicals that have recently been either shown to occur or suspected of occurring widely in wastes and the wider environment, and are identified as being a potential environmental or public health risk. However, there is often inadequate data to determine their risk.
Endocrine disrupting	Chemicals that at certain doses can interfere with the endocrine (hormone system) in mammals.
Environmental benchmark	Collective term to describe chemical, microbiological or radiological standards, environmental limits, tolerable or acceptable intakes, and other similar quantitative criteria which are used to evaluate the significance of an observed or estimated exposure or environmental emission as part of a generic or more detailed risk assessment.
Exotic species	Non-native plants (to the UK) which can spread and establish themselves quickly presenting a threat to indigenous species and problems for farming.
Hazard	A property of a waste that poses a threat to identified receptors.
Hazardous substances	Substances which are considered to be highly persistent, highly bioaccumulative and highly toxic in accordance with the Groundwater Daughter Directive (2006/118/EC) or a substance which gives rise to an equivalent level of concern to that previously classified under 1980 Groundwater Directive (80/68/EEC).

Impact question	Aims to assess the effectiveness of a policy driven intervention, for example, 'Does this intervention have the desired outcome?'
Invasive weeds	Weeds which are native to the UK but can spread and establish themselves quickly, presenting a problem for farming.
Master List	A list of all potential hazards associated with a waste type which can impact upon identified receptors.
Non-hazardous substances	Any potential pollutant other than a hazardous substance.
Non-impact question	Aims to address less quantifiable or defined effects such as 'How does it work?', 'What is required to make it work?', and so on.
Pathway	A route or means by which a receptor could be exposed to, or affected by, a hazard.
Potentially toxic elements (PTEs)	An element which is potentially toxic for human beings, plants or animals.
Primary question	Defines the topic and scope of the review.
Principal List	A list of primary potential hazards which are considered to have the potential to present a significant risk to identified receptors.
Priority Hazardous Substances	Substance of concern to surface water identified in Directive 2008/105/EC (as amended). Compliance with Environmental Quality Standards for Priority and Priority Hazardous Substances provides the basis for 'good chemical status' classification.
Rapid Evidence Assessment	A tool for getting obtaining information and available research evidence on a specific topic, as comprehensively as possible, within the constraints of a given timetable.
Receptor	Something which could be adversely affected by the hazard. This can be a collective term for humans, controlled waters and dependant ecosystems, wildlife, soil (quality), air quality and property in the form of livestock and crops. The relevant receptors will depend on the type of waste and site-specific information for each deployment application.
Risk assessment	The formal process of identifying, assessing and evaluating the risks to health and the environment that may be posed by the waste and associated activity.
Secondary questions	Questions which contribute to the build-up of evidence surrounding the primary question. These are generally more open questions than the primary question.
Site	The place where mobile plant is to be deployed as detailed in the agreed deployment form(s).

Soil quality	The capacity of a specific kind of soil to function and sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation by soil microbiology, invertebrates and vertebrates.
Source	Properties of the waste including biological, chemical and physical contaminants, which have the potential to cause an adverse impact or harm.
Specific Pollutants	Those contaminants identified in the UK to support the aim of achieving 'good status' by 2015 under the Water Framework Directive. Specific polluting substances are part of the classification of 'good ecological status' in the UK.
Toxic or injurious plants	Five weeds are classified under the Weeds Act 1959: common ragwort (*Senecio jacobaea*), spear thistle (*Cirsium vulgare*), creeping or field thistle (*Cirsium arvense*), broad-leaved dock (*Rumex obtusifolius*) and curled dock (*Rumex crispus*).
Waste code	The six digit code referable to a type of waste in accordance with the List of Wastes (England) Regulations 2005.
Waste stream	Single waste, generated from a single site.

Appendix A: Secondary questions

Note: all potential hazards for a waste stream should be recorded in the Master List of hazards for that waste stream. However, the secondary questions are primarily focused on providing the base data for a screened list of principal hazards that can be taken forward for risk assessment (see Section 4.3.3).

Table A.1 Secondary questions and rationale

Question no.	Question	Rationale
WASTE PRODUCTION AND FORM		
1	How many producers of this waste are there in the UK?	To allow an informed assessment of the potential variability of the waste stream, in general or between different batches. The aim is to determine how representative the chemical data in the deployment application are of the waste type and allow the reviewer to decide whether a subsequent generic or site specific risk assessment is needed. **Watch point:** Many of the answers from this section (particularly Q3, Q5, Q6 and Q7) will require input from upstream producers of the waste. The reviewer should liaise with producers at an early stage in the REA and focus on obtaining information relating to the production process(es) involved in generating the waste, any relevant material safety sheets or classification labelling information and, if possible, any representative chemical data for the waste. Note that obtaining this information may be time-consuming and some producers may be reluctant to get involved in the REA.
2	Is the waste from a single producer or as a result of a collection of waste from a number of producers?	
3	Are there different production processes for this waste and how long have these been followed?	
4	Is the waste produced as part of a treatment process (for example, effluent treatment)?	
5	If yes, please provide details of the primary treatment process, particularly whether this has the potential to introduce contaminants such as disinfectants and so on.	
6	Is there any information on the primary product for this waste (for example, from material safety data sheets or similar)?	
7	How variable is the waste between batches and what factors influence this variability?	
8	How variable is the waste between producers and what factors influence this variability?	
9	Is the waste to be applied as a solid, sludge or liquid?	To provide background information on the physical nature of the waste. The aim is to determine whether the method of application is appropriate and what risks to

Question no.	Question	Rationale
10	What is the method of application of this waste to land?	receptors are posed by the physical nature of the waste. Inconsistencies between the typical method of application and those specified in a deployment application should be highlighted and assessed in terms of good practice. **Watch point:** The spreading or incorporation method(s) is an important factor to consider, along with the requirement for any pre-treatment such as the potential conditioning of the waste before spreading (that is, adding water), the amounts typically spread (5–15 tonnes/ha) and how often they are spread (for example, annually or once every 2–3 years).
11	Why is this material to be spread to land?	To confirm that there is an intended beneficial use and purpose of the application. **Watch point:** The operator will need to demonstrate in the deployment application that the waste type has a beneficial use when spread to land.
CHEMICAL HAZARDS		
12	Are there any analytical data available for this waste?	To support any qualitative assessment on the presence or absence of potential hazards. Where feasible, operator or producer data should be compared with data from independent sources and any inconsistencies highlighted. **Watch point:** Analytical data supplied by an operator or producer may be biased and should be used with caution in the absence of any comparable independent data.
Groundwater assessment		
13	Does the waste contain any hazardous substances (as defined by JAGDAG)?	To identify the presence of any chemical hazards in the waste that could impact on groundwater. The reviewer should identify all contaminants at significant concentrations in the waste to ensure that appropriate assessment and testing is carried out at the deployment stage. Note: the significance for hazardous substances can be judged in terms of exceedance of laboratory limit of quantification (LOQ) and for non-hazardous substances as indicated. **Watch point:** Care should be taken when using data for a solid waste to assess the potential hazards for water resources. Ideally, leachate data should be used to inform this assessment.
14	Does the waste contain any non-hazardous pollutants in concentrations substantially above (greater than twice) typical natural background for shallow groundwater or drinking water standards?	

Question no.	Question	Rationale
Surface water assessment		
15	Does the waste contain any Priority or Priority Hazardous Substances?	To identify the presence of any chemical hazards in the waste which could impact upon surface water. **Watch point:** The reviewer should determine the presence of all significant contaminants in the waste to ensure that appropriate assessment and testing is performed at the deployment stage.
16	Does the waste contain any Specific Pollutants?	
Soil etc. assessment		
17	Does the waste contain potentially toxic elements (PTEs) or other contaminants?	To identify the presence of any contaminants that could present a risk to soil quality, livestock, human health and crops. The substances of interest will be those which have previously been identified as potentially presenting a risk to soils and the agricultural food chain and many include PTEs, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins and furans, veterinary medicines and pesticides. **Watch point:** The reviewer should determine the presence of all significant contaminants in the waste to ensure that appropriate testing is carried out at the deployment stage.
18	What substances does the waste contain that could benefit the soil?	To identify the benefits (chemically) to the receiving soil (supporting Q11).
General assessment		
19	Does the waste contain any contaminants which are considered to be toxic to human health (that is, have proven or suspected carcinogenic, mutagenic, reproductive toxic effects and so on)?	To assess to the PBT (persistence, bioaccumulation and toxicity) for contaminants present. **Watch point:** These questions may already have been answered in Q13 and Q15.
20	Does the waste contain any contaminants with a high bioaccumulation potential?	
21	Are there any contaminants present in the waste that are proven or suspected to be persistent in the environment?	

Question no.	Question	Rationale
22	Does the waste contain any contaminants which are proven or suspected of being endocrine disrupting?	To identify any endocrine-disrupting contaminants. **Watch point:** These are not necessarily considered in the determination process for hazardous or priority substances.
23	Describe any speciation or the form of contaminants identified in the waste which could influence the hazards associated with these.	To support the assessment of the potential severity and likelihood of risk – a contaminant may be present in a more or less toxic or mobile form. **Watch point:** Be aware of relying on prior knowledge with respect to the interactions of certain contaminants with factors such as pH and organic matter. For example, metals are generally available at acidic pH and the use of lime or similar should encourage contaminant lock-up. Under certain conditions, however, the introduction of organic matter to an alkaline environment can result in the mobilisation of metals.
24	Are pesticides, herbicides or fungicides likely to be present in the waste?	There is the potential for pesticides, herbicides and fungicides to be present in certain waste codes applicable under SR2010No4. The response to this question will provide an indication of whether there is the potential for these contaminants to be present to allow an informed assessment of the risks of these to crops, livestock and human health, and consideration of any potential risks from metabolites (see Q25). **Watch point**: Any contaminants identified as potentially being present should be included in the testing schedule and analysis results provided by the operator at the deployment stage.
25	Are there any breakdown products or metabolites associated with these contaminants, which could present a significant hazard?	Some contaminants can have common breakdown products or metabolites which can also present a risk to receptors and will therefore need to be considered. Note that this is also covered in Q30 under emerging contaminants.
26	Does the waste contain any contaminants which could potentially have cumulative/additive effects?	This is an important consideration for contaminants which could present a risk to human health or livestock. Tends to be associated with organic contaminants such as total petroleum hydrocarbons (TPH) and PCBs.
27	Does the waste contain any contaminants which could present a significant hazard due to their volatility?	To indicate whether the waste presents a vapour risk to livestock and/or human health.
28	Does the waste have a biological oxygen demand (BOD) of >6 mg/l?	To determine the potential risks to surface water from high BOD wastes.

Question no.	Question	Rationale
29	Does the waste have a pH of <5.0?	Waste spread to land can be acidic. This can impact on soil quality and plant growth, and present an indirect risk to groundwater and surface water through the mobilisation of certain contaminants under more acidic conditions.
30	Does the waste have the potential to contain any emerging contaminants of concern?	To identify contaminants where existing knowledge is limited, but are likely to be significant. The Organisation for Economic Co-operation and Development (OECD) has produced a list of emerging contaminants, with varying importance to agriculture (OECD 2012). The OECD's importance rating for each emerging contaminant group is provided in brackets in the list below. This rates the potential for these contaminants to be present in agricultural land as low or high: • natural toxins (high) • veterinary medicines (high) • hormones (high from animals, low from humans) • transformation products (high from veterinary medicines and low from pharmaceuticals and personal care products) • nanomaterials (low) • human personal care products (low) • emerging persistent organic pollutants for example, flame retardants (low) • human medicines (low) In addition, perfluorinated compounds such as perfluoro-octanesulphonic acid (PFOS) and nanomaterials have been identified in sludges and thus may also be an important consideration. There is increasing concern over the potential persistence and mobility of these contaminants. The reviewer should identify the presence of high risk contaminants in the waste to ensure appropriate assessment and testing at the deployment stage.

Question no.	Question	Rationale
PLANT AND ANIMAL PATHOGENS AND TOXIC COMPOUNDS		
31	Are *Salmonella*, *Listeria monocytogenes*, *Escherichia coli, Clostridium botulinum* or *Bacillus cereus*, or other bacteria or pathogens, or diseases such as bovine spongiform encephalopathy (BSE) and scrapie likely to be present in the waste, post spreading?	To identify the presence of animal pathogens to inform both the testing requirements at the deployment stage and the risk assessment for livestock and human health. **Watch point:** This is an important consideration when identifying potential hazards associated with waste that is currently managed under the Animal By-products Regulations 2005.
32	Are plant pathogens, fungus and/or soil-borne diseases likely to be present in the waste, post spreading?	To identify the presence of plant pathogens to inform both the testing requirements at the deployment stage and the risk assessment for soil quality and crops.
33	Are toxic or injurious plants likely to be present in the waste, post spreading?	To identify the presence of toxic or injurious plants and inform the risk assessment for livestock.
INVASIVE WEEDS		
34	Is there potential for invasive weeds to be present in the waste, post spreading?	Under the Weeds Act 1959, it is an offence to allow the spread of the five weeds listed below to agricultural land, particularly grazing areas or land which is used to produce conserved forage: • common ragwort (*Senecio jacobaea*) • spear thistle (*Cirsium vulgare*) • creeping or field thistle (*Cirsium arvense*) • broad-leaved dock (*Rumex obtusifolius*) • curled dock (*Rumex Crispus*) The presence of invasive weeds should be identified to inform the risk assessment for soil quality and crops.
35	Is there potential for exotic species to be present in the waste, post spreading?	It is an offence under section 14(2) of the Wildlife and Countryside Act 1981 to 'plant or otherwise cause to grow in the wild' any plant listed in Schedule 9, Part II to the Act. See list available the UKWildlife website (www.ukwildlife.com/index.php/wildlife-countryside-act-1981/schedule-9/schedule-9-part-2/). The potential presence of exotic species should be identified to inform the risk assessment for soil quality and crops.

PHYSICAL CONTAMINANTS		
36	Is non-biodegradable material such as plastics, metal, brick, concrete or glass likely to be present in the waste, post spreading?	Non-biodegradable material present can result in nuisance to nearby residents, reduce the quality of the receiving soil or present a risk of harm to livestock or humans using or accessing the field(s).
NUISANCE		
37	Are unpleasant odours likely to be associated with the waste?	To assess the potential for landspreading to result in nuisance. The identification of a potential nuisance issue at deployment stage will inform the permit officer of whether appropriate mitigation measures are required to make a deployment application acceptable (that is, the provision and implementation of an emissions, odour and/or noise management plan).
38	Is dust likely to arise from this waste?	
39	Is the waste likely to attract pests such as flies or scavenging animals?	
OTHER ENVIRONMENTAL HAZARDS		
40	Does the waste have a high fat or oil content (that is, >4% by weight)?	A high fat content in some wastes can impact the soil quality and growth of crops.
41	Is the waste likely to cause anoxic soil conditions?	Some wastes, such as those with a high fat content, or the over-application of wastes in sludge or liquid form, can result in anoxic soil conditions which can have an adverse impact on the microbiology of the soil environment and crop growth.
42	Is there the potential for the stability of the waste to come into question?	Certain wastes, such as biotreated wastes should be stable before being applied to land.
43	Provide any further details on hazards identified in this waste which are not covered in the questions above.	This is an open question to allow the reviewer to list or detail any additional potential hazards which have been identified in the REA and are not covered in the secondary questions above.

Notes: JAGDAG = Joint Agencies Groundwater Directive Advisory Group (www.wfduk.org/stakeholders/jagdag-work-area-0)

Appendix B: Evidence extraction template

Available as Excel spreadsheet

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