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LFE6 - Guidance on using landfill cover materials

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Introduction

Issues

This document is not prescriptive. It aims to provide guidance to both landfill operators and Environment Agency staff on four issues associated with using landfill cover for landfill sites. The four issues are:

- The environmental reasons why daily covering of waste may be necessary.
- The range of materials that may be available for this purpose.
- Their effectiveness as daily cover.
- The advantages or disadvantages of their use.

The issue of cover is a complex one. Using low permeability materials as cover has created perched leachate problems and has enabled lateral migration of landfill gas. It may also slow down the degradation process and therefore delay site completion.

In addition, many operators are looking at ways of husbanding scarce void space and are looking towards alternative materials to use as landfill cover.

Manufacturers of substitute landfill cover materials often claim there are benefits of using their product over alternative or more traditional cover techniques. However, none of the substitute materials on the market are ideal under all circumstances, though some do have useful attributes such as being biodegradable or easy to apply. In many cases, combining cover techniques is required to deal with the range of weather conditions, waste types and the degree of exposure encountered during a sites life.

We recommend a move away from fixed landfill cover conditions to objective led requirements. This document provides a framework to assess a wide range of cover materials. Before using alternative techniques, you will need to demonstrate that you're proposal can achieve the environmental benefits of using landfill cover. We'll expect you to use evidence from substantial research programmes to demonstrate these benefits. You must have a presumption in favour of using covering materials unless you've achieved the objectives of applying cover by other means. Only if site specific circumstances clearly demonstrate that cover is unnecessary will we agree to any proposal not to provide a landfill cover.

The detail in this document supports our general approach to landfill engineering which is contained in our policy [LFE1 – Our approach to landfill engineering](#).

Objectives of landfill cover

Applying a cover to a landfill surface is just one part of a complex range of overlapping environmental control processes that must occur on landfill sites. Covers have the potential to solve some environmental problems but also a capacity to create others. Your selection of an appropriate cover material will need consider the properties of the cover material, the waste types and your objectives for applying a cover.

The relevant objectives for applying a landfill cover are to:

- prevent wind blown litter
- prevent odours causing a problem off site
- avoid attracting scavenging birds to the site or the air space above it
- deter other forms of scavenging
- prevent vermin from being attracted to or infesting the site
- prevent flies from infesting the site
- minimise the risk of fire on or within the site
- ensure the visual appearance of the site is not seriously detrimental to the amenity of the locality.

There may be circumstances where cover is required to stay in place for an extended period of time. In these situations, you should consider whether the materials being used have characteristics which ensure it will continue to meet its environmental objectives. Operators must appreciate that covers are not designed or installed to achieve engineering objectives such as the exclusion of water. For such objectives, you will need to lay temporary capping to a specific design agreed with us in advance.

It is essential your choice of cover materials does not in itself create an environmental nuisance such as dust, litter or odour.

Each landfill cover objective is discussed in greater detail in Section 6 of this document.

History

The requirement for daily cover was first contained in the Sumner Report. Guidance on its requirements were included in the first edition of Waste Management Paper No.4 and further extended in WMP 26 and WMP 26B. Historically, this required a layer of non-putrescible, non-combustible material (typically soils), being progressively placed over the putrescible wastes so the working face and flanks were covered to a depth of 150mm by the end of each working day.

Alternative covering materials have been used, generally on a trial basis. However, very little published data detailing thorough investigation of the advantages and disadvantages has been available to determine the overall effectiveness of any particular material or its impact.

Specific considerations

Undoubtedly, the type of cover you use, the location and topography of your site, and the types of waste deposited will play a major part in determining what form of landfill cover, if any, you require.

We have assessed and weighted the most important issues relating to the objectives for using cover materials in their relative order of importance. The issues shown in Table 1 are for two types of landfill, in three sets of circumstances. The greater the number of ticks, the more important we consider that issue in the specified circumstances. A low rating does not mean the objective does not require you to apply control measures, but does indicate that it is less important when compared to an objective with a higher rating. These weightings will be important when you are considering the type of cover or alternative measures you need to achieve the objectives relevant in your particular circumstances. In some cases, other issues may be of similar importance to those shown in Table 1 and you will also need to assess these issues.

The weighting shown in Table 1 relates to landfills that accept slowly degradable wastes such as paper and timber and rapidly degradable wastes such as food wastes. These weightings also consider whether the site is close to sensitive receptors. They also take into account whether the current working area is situated below, at or above the surrounding ground level.

You can identify sensitive receptors through risk assessment, forming a link between your site and who or what is affected by it, and including a measure of the significance of the effect. You will need to agree during your pre-application discussions who or what constitutes a sensitive receptor, you must subsequently detail them in your management plan. Where you don't provide sufficient detail in your management plan, we may need to impose further conditions in your environmental permit.

We recommend that the presence of a sensitive receptor should be the overriding factor when you are assessing any individual site.

From Table 1 you can clearly see that the requirement for cover is not the same for different types of site and even for the same site at different stages in its development. Provided the same objectives apply for all sites and you assess them consistently, we will not require operating standards in excess of the minimum to avoid pollution of the environment, harm to health or serious detriment to the amenity of the locality.

Table 1 Indicative assessment of environmental issues for daily cover

Issue	Slowly degradable waste			Rapidly degradable waste		
	Below ground	Above ground	Sensitive receptors	Below ground	Above ground	Sensitive receptors
Vermin	✓	✓✓	✓✓✓	✓✓✓	✓✓✓✓	✓✓✓✓✓
Litter	✓	✓✓✓✓	✓✓✓✓✓	✓	✓✓✓✓	✓✓✓✓✓
Amenity	✓	✓✓✓✓	✓✓✓✓✓	✓	✓✓✓✓	✓✓✓✓✓
Odour	✓	✓✓	✓✓	✓✓✓	✓✓✓✓✓	✓✓✓✓✓
Flies	✓✓	✓✓	✓✓	✓✓✓✓✓	✓✓✓✓✓	✓✓✓✓✓

Note: It should be understood that the ticks shown are indicative only and give a guide to the assessment of the anticipated importance of an issue in the circumstances specified. Any

type of cover proposed for such a site should primarily address the criteria with the greatest number of ticks, but also be capable of addressing the other issues if circumstances require.

Please note there are additional environmental benefits associated with using local waste arisings, (provided the environmental objectives of the landfill site are met), which you need to offset against the environmental disadvantages of transporting alternatives a large distance.

Landfill cover

Daily cover is generally applied to the working surface, flanks and working face of an active site to minimise the potential of the site to pollute the environment, harm human health or detrimentally affect the amenity of the locality. Application of cover may be continuous as filling takes place; at the end of the each working day; or occasionally in the case of a tipping face, at the end of the working week or operating phase. The particular circumstances will dictate how covers should be applied to achieve the desired objectives.

Public health may be affected by spread of disease, vermin or other infestations if a site is not properly controlled. It can also be affected by the spread of odours from the waste or its decomposition products.

Even if not a health hazard, odours, wind blown litter, vermin and insects can be a nuisance to nearby sensitive receptors. An unsightly landfill site can be a visual nuisance in what might otherwise be an attractive landscape.

You may need to consider a range of cover materials to deal with all foreseeable site conditions

Landfill covers, unlike temporary caps and final restoration capping, don't minimise rainfall ingress to a site, though some cover materials are more effective than others in this respect. You will need to further investigate the materials used for landfill cover to determine their specific ability to minimise rainfall ingress. Where you need to minimise water ingress into a site, you should consider using a temporary cap also.

Applying suitable cover materials must mitigate all of these criteria and others, to ensure the site causes minimum disruption to the surrounding area. However, applying cover materials is not the only way to address the criteria. For your site to operate in an environmentally acceptable way, you will need to examine all possible ways of minimising the sites impact and to predict and mitigate problems before they occur. You must detail your contingency plans and your review procedures for such problems in your management plan.

You should regard using a landfill cover as one part of a control system to prevent environmental pollution rather than a panacea for all possible pollution sources.

Intermediate cover

An intermediate cover is a landfill cover that is expected to remain effective by over an extended period of time. Where your site requires an intermediate cover, the sensitivity and type of issues in Table 1 will change and the durability of the cover material becomes a more crucial element. Not all materials used as daily cover are suitable as intermediate covers. In most cases, the working surface of a landfill will be covered with the next layer of waste after a short period of time either incorporating the daily cover material or after you remove it for use elsewhere.

Some types of cover material are more suitable for intermediate covers than others. The material's ability to continue containing the waste, including any generated odour

and to prevent vermin access becomes more important. A fly's breeding cycle is approximately ten days, so where flies are an important factor in applying an intermediate cover or over-tipping with waste should occur well within this time-scale. You should not ignore your site's ability to create its own microclimate when assessing the likelihood of fly infestation during cold spells.

The ability of an intermediate cover to shed surface water to drainage ditches is more critical for covers which will be exposed for a few months before over-tipping or capping occurs.

Details to be addressed in your management plan

What is required in a management plan when considering landfill cover is a flexible relationship between the working plan and the site permit, allowing operators maximum freedom to select a method to achieve the objectives of the environmental permit. The details covering landfill cover within your management plan must provide us with sufficient confidence that you will comply with the overall objectives of the permit.

Through your management plan, you should detail the measures and procedures you will use to ensure your site operates without causing pollution of the environment, harm to human health or serious detriment to the amenities of the locality. You must include what measures you will be take to satisfy the objectives of applying a cover.

To demonstrate that a material will fulfil the relevant objectives, you must carry out a source/pathway/receptor risk assessment. This should demonstrate that the risks associated with any particular cover material are minimal.

The way you achieve the objectives of applying landfill cover will change on a seasonal or even more frequent basis during the life of a site. To accommodate this, your management plan must be flexible, its contents allowing you to vary your procedures as circumstances change, while the objectives and standards contained within your permit remain the same. You must actually carry out anything you include in your management plan as a statement of intent. However, provided we agree to the changes in advance, you can periodically review and update your plan.

Your permit conditions will state the objectives and standards you have to achieve and how you can demonstrate that you've achieved them. Where your site requires default conditions, they will need to be much more prescriptive detailing how we require you to deal with a particular problem.

You must submit sufficient detail in your management plan to allow us to be sure you will achieve the objectives and standards required. If you don't include enough information, we will have to specifically detail in your permit conditions how, where and what type of cover you must apply.

Requirements of daily and intermediate cover

A summary of the effectiveness of various types of cover material at addressing each identified environmental criterion is shown in Tables 1 and 2 of Appendix 1. Each of the criteria is further detailed below.

Wind blown litter

Cover is applied to a landfill site to prevent litter from blowing away from the surface of the site. This process is different from other sources of litter generation of greater potential, such as the actual act of tipping and emplacing waste.

The problems facing each site will differ due to the prevailing winds, aspect and elevation of the site, the type of waste accepted, the equipment used and the proximity of the site to sensitive receptors. Providing litter control is adequately addressed through litter prevention and control procedures, daily cover may not be required for litter control purposes.

Your management plan should identify how you will prevent and control surface derived wind blown litter. Any cover material you apply to a surface must be of sufficient thickness or mesh size to prevent wind blown litter. Pay particular attention to how face and flanks are compacted and/or covered. Areas of waste left uncovered may be re-compacted to anchor waste within the uppermost surface layer.

Uncontrolled release of material from your site's surface must not occur, regardless of whether the site litter fencing will contain it.

Odours

Odours at landfill sites are associated with landfill gas, leachate, malodorous wastes and incoming and newly deposited refuse. Malodorous waste includes re-excavated refuse produced when excavating previous deposits.

Applying a cover will not reduce the impact of odours associated with landfill gas from passive venting trenches, stacks or open leachate wells. Daily covers will have only a marginal effect on landfill gas from the sites surface. A daily cover is unlikely to offer significantly more than the natural protection provided by recent layers of waste. Close-packed cover materials are more likely to be successful than those with an open lattice. Soil-based cover materials containing micro-organisms may promote oxidation of trace organic chemicals diffusing through it, thereby reducing the odour potential of a site.

Landfill cover will have no effect on odours from leachate storage lagoons, ditches and sumps on site. It may even have a detrimental effect where low permeability materials cause perched leachate. Perched leachate can lead to leachate on the surface of the site, rather than allowing it to be absorbed into the body of the waste.

Malodorous waste must be buried immediately once received and covered with non-odorous waste. Once effectively buried, the material should not cause a problem due to the natural scrubbing effect of the waste. You should not need to treat the site surface differently as a result of burying odorous waste. You must not deposit malodorous waste in liquid trenches unless you plan to immediately fill them. You must include your procedures for dealing with liquid trenches in your management plan.

General refuse may have an odour depending on its composition. Waste containing a significant proportion of food wastes will be odorous, and can cause a nuisance if not managed appropriately. Some collection authorities have changed to fortnightly collection of household waste, which may be significantly more odorous than fresh refuse as a result. Selecting suitable cover materials will need to consider a materials ability to control odour.

The type of cover you need to apply as daily cover to contain general refuse odours will depend on many factors. These include the nature and age of the waste, the climatic conditions including surface temperature, the proximity of sensitive receptors and the rate of site filling. Independent research into odour complaints at sites has found that each site investigated had a critical windspeed above which odour release did not generate complaints. Odour control requirements may vary seasonally or more frequently. Some materials used for daily cover are more effective at containing

odours than others. Choose the right material or combination of materials for the prevailing conditions at your site.

You must not leave untreated waste (especially re-excavated wastes) on the surface of your site if you can't contain the odours from it within the site. Using perfumes and other masking agents may reduce the effect of odours, but in some cases they are as unpleasant as the waste odour they're masking.

Using a cover on a site will not necessarily solve all odour problems. You will need to identify and solve any remaining odour issues on your site. Unless you can demonstrate the site surface will not be odorous at the end of the working day, we'll require you to apply a cover capable of containing odour. Landfill odours are a common form of nuisance outside the generating site, as well as the Environment Agency, local environmental health departments may take action on these grounds.

Your management plan must detail what action you'll take in the event that odours from your site surface are not being contained by the cover material you've used. Your management plan must specify what constitutes good operational practice and how to contain odours released from deposited waste. The plan must also detail your procedures to identify and deal with odorous waste and, to mitigate the effects of adverse climatic conditions. Your plan must also cover the availability use of stockpiled cover materials.

It is often difficult to identify precisely which operation within a site is generating an odour, especially when it is only detected from a distance.

Birds

Applying a landfill cover can be a deterrent to birds, particularly scavenging birds. Larger birds are a nuisance, especially near an airfield or in a landing or takeoff corridor due to the increased risk of causing a bird-strike.

Birds are primarily drawn to sites where they can gather food scraps. Numerous techniques for scaring or excluding birds have been developed, including loud bangs, flying birds of prey, bird kites and the use of nets. Varying the scaring techniques or the use of nets is the most effective strategy in the long term, but is not a complete solution.

Daily covering has a role to play in deterring birds from landfill sites, especially outside working hours and when other methods are not being used. Total cover of the waste is essential. While some birds are initially very cautious to some types of cover such as foams, they become accustomed and overcome their apprehension, easily breaking through the surface. Where sites are in close proximity to each other simultaneous controls will need to be exercised on both sites.

Gulls are a particular problem as they are opportunist feeders and large enough to remove and drop large pieces of food waste. Their droppings can also annoy and could present a potential health risk outside the site, a matter often underplayed.

Your management plan must detail the type and frequency of bird scaring techniques to be used. Forming a hierarchy of measures to be adopted as site conditions change is a useful addition to a management plan. It could also specify, through daily monitoring of bird numbers, when to apply alternative techniques for waste covering.

The standard of bird control required depends on the particular details of a site. At some it is important to deter birds at all times while at others there may be scope for less than full deployment of deterrent measures for some types or numbers of birds. Maintaining a comprehensive record of bird types and numbers on and above your

site along with the bird deterrence actions you took must be kept for auditing purposes.

Deterring scavengers

Using a landfill cover can reduce the attractiveness of a site to scavengers, who may be humans or animals.

Unauthorised scavenging and the associated activities are potential risks to the people involved and to your sites integrity. While ideally only non-recyclable residues would be landfilled, there may be materials that may prove useful to someone. Landfill sites are potentially dangerous locations and you must prevent all unauthorised access. Compacting and covering the waste will make it less visible and attractive as an income source.

Scavenging by animals is more prevalent in remote rural sites, partly because of the lower standard of site security than would be required in a more urban location and also the likelihood of greater numbers. You should assess your site for the implications of scavenging and the potential risk this may have on the environment. You can assess the scale of the problem by observing site activity and complaint levels.

Your management plan must specify what constitutes good landfill practice and how you will control animal and human access.

Vermin

Vermin are attracted to sites because of the potential supply of food. Daily cover is unlikely to affect the nesting habits of vermin, which will enter the site from the surrounding fields or build up colonies in undisturbed areas such as long term storage heaps or soil banks. Rats tend to colonise manmade tunnels such as sewers and culverts, resulting in you needing to inspect them regularly. It is not unusual for vermin to arrive on site within a waste delivery.

It is unlikely that daily cover will prevent the presence of vermin on site, although certain types of material are more likely to keep them away from their food source. You will need to regularly monitor your site for evidence of vermin, eradicating them before they colonise provides the defence against vermin problems. Areas of landfill that are complete but not yet restored have a greater potential for infestation. The standard of intermediate cover is more critical in these circumstances as a result.

Rabbits are known to be a problem because of their numbers, their attractiveness as preys and for the damage they do to restored surfaces. It's unlikely landfill cover will have any effect on their presence.

You must be able to demonstrate there is effective vermin control on your site. At the first sign of vermin on site, you should begin to apply a suitable daily covering material. You should work closely with your surrounding landowners to ensure vermin are kept under control.

Your management plan must specify how you will reduce the attractiveness of your site to vermin. Your plan should specify the inspection and baiting programme you'll use detailing where appropriate, that a specialised contractor will be employed. It should also specify in detail the "what, where and when" criteria you will use. You will need to keep detailed records of the work your vermin control contractor has carried out for payment purposes. You should make these records available to us for auditing.

Flies

Flies are a major source of nuisance and health risk, and require close control on landfills. The life cycle of a housefly in summer is as short as ten days. Flies can infest an area very quickly, so you'll need to ensure your site has a supply of a suitable, non-polluting insecticide to control them. Over-applying insecticides can cause problems by introducing potentially harmful and polluting substances into the environment.

Applying adequate daily cover is a major contributor to controlling fly infestation. To be effective, all putrescible waste including the flanks of cells, must be covered with non-putrescible and non-fly attracting cover materials. Flies can be attracted to waste even with no obvious contamination of vegetable or animal matter. Waste stored for long periods or even short periods in high temperatures can become infested. Once compacted, you'll need to compact or treat waste very quickly during hot weather to prevent infestation. During cold weather, flies are not such a serious problem though they may still develop in microclimate conditions, although these are less likely to result in an infestation.

Certain cover materials are unlikely to have any significant effect on fly infestation and you should not use them where flies are a potential problem. You should only regard barrier cover materials as part of your armoury against fly infestation; use them alongside other, more direct methods of insect control. Good landfill management is the most effective control for this problem, including recognising the conditions that might allow fly infestation and by taking preventative action in sufficient time.

Inspectors investigating complaints will need to be aware of fly types, wind direction and distance from the site as not all complaints of fly infestation are automatically related to the landfills. Infestation of a site can be determined by observation, and measured by using fly attractant strips and boards at strategic locations around the site.

Your management plan must specify what actions you will take to identify and control fly populations on the site. It must also detail site-specific standards and emergency procedures that will be triggered in the event of an infestation.

Fires

Applying a daily cover provides a barrier between the landfill's surface and the waste. Certain types of cover material better protect against the promotion and spread of fire. A soil-based cover is least likely to allow fires on the landfill's surface to spread to the waste beneath. However, some types of cover materials are both flammable and may lead to the creation of underdraughts that draw surface fires into the body of the waste.

The risks will be different for each site depending on the nature of the wastes, their flammability and the risk of external fire sources being present on site, particularly in urban areas. Daily cover is unlikely to have any immediate effect on the potential for deep-seated fires though you may reduce or slow their progress by dividing the refuse with inert bund walls. Degradable covering materials will have no such effect and can allow rapid spread of deep-seated fires throughout a waste body.

You should strongly consider using soil-based covers where there is a significant risk of fires on the landfill's surface.

Your management plan must assess the risk associated with a surface or deep-seated fire, and how cover materials can minimise their effect. It must specify what you will do in the event of either type of fire.

Visual appearance

The setting of a site, especially during its operational phase form part of the amenity issues the relevant planning authority will consider during their determination of the planning consent. It is unrealistic for a site to be invisible during its operational phase, but operators can take steps, such as the carefully selecting cover materials to reduce its visual impact on the surrounding environment. The cover types you select must complement the setting of the site any impact it may have on views from sensitive locations.

The appearance of an active landfill site can be a problem particularly those above ground level or visible from high vantage points. Depending on the relative landscape the exposure of uncovered refuse may reduce visual amenity. You may need daily cover to reduce the visual impact of your site even if there are no other reasons for its use. Certain types of cover are better suited for visual-amenity use than others. Soils are an obvious choice, though other types of cover may be equally effective provided the variability of surface is minimal and colours blend into surroundings, especially when large areas are left for long periods.

Your management plan must detail how you will blend the worked surface of the site with the surrounding landscape. It should also detail how you will achieve waste homogeneity and how you will deal with specific coloured waste streams.

Surface water ingress

You will need to consider surface water ingress to ensure your sites water balance is not compromised. Some forms of landfill cover do provide an absorptive medium that holds some rainfall close to the surface. Under the right atmospheric conditions, these materials allow it to return to the atmosphere rather than be absorbed into the waste.

Landfill cover consisting absorbent materials may be effective to varying degrees in warm conditions with low relative humidity in reducing surface water ingress. Most permeable synthetic materials will provide little or no beneficial properties in this respect. Landfill cover can shed water in circumstances such as heavy storms, but this water is usually contaminated. Solid films and plastic sheets allow much more water shedding, though you'll need to provide ditches and lagoons to allow this water to be channelled away without being absorbed elsewhere on the site. Your water balance calculations for the site need to reflect this feature if you propose to use it

Your management plan must detail where surface water ingress needs to be minimised. Site design and temporary capping selection will significantly affect water ingress and the subsequent leachate build-up.

Default minimum standard

If your management plan fails to clearly detail how you will meet the required environmental objectives of landfill cover, we will use a site specific permit conditions on landfill cover requirements.

Types of cover material available

Materials proposed for landfill covers generally fall into the categories of mineral and processed waste materials, or manmade products.

The range of materials this document considers is contained in Appendix 1 along with a summary of their advantages and disadvantages. This list of materials is not exhaustive.

Waste materials

Quarry minerals are often available on site, but must be transported to the working face. Waste soils don't have the excavation and transportation costs and can provide some income, though they are not always readily available. They do take up void space (up to 10%) that might otherwise have been used for higher value wastes. Operators must exercise great care to ensure soils are not contaminated to such an extent that they need to be buried within the site.

Using waste that would otherwise have been buried is cost effective, unless the cost of pre-treatment to render it suitable for use as a cover outweighs the advantages gained. Materials such as shredded green waste, pulped paper or pulverised refuse fall into this group. You must exercise caution if using these types of material, ensuring that at all times they meet the environmental objectives of landfill cover and don't hinder effective operation of the site. For example, they may not provide adequate traction for the vehicles using the site.

Other forms of waste that have been used include fragmentised waste, foundry sand, and contaminated soil.

Fragmentiser waste has been used on landfill sites as a cover material. However, it can contain elevated concentrations of substances including polychlorinated biphenyl (PCB) and heavy metals including lead and cadmium. Dust emissions from such a site which could reach sensitive receptors are therefore of great concern if the material is dry.

The foam element of some fragmentiser waste has resulted in surface fires spreading further than expected. It has also resulted in the release of toxic smoke.

Given the above, we recommend you only use fragmentiser waste containing shredded foam if it will itself be covered with waste the next working day. You must not use it for intermediate cover.

You should only use fragmentiser waste as daily cover where you can demonstrate the PCB content is below the limit for landfilling, as recommended in Waste Management Paper No 6. Your permit conditions must specify that PCB is permitted on your site if you plan to use fragmentiser waste.

You must quantify the concentration of heavy metals around your site, and carry out regular dust monitoring to demonstrate that your site is not causing pollution of the environment or harm to human health. Your management plan must clearly state the monitoring protocol, trigger levels and remedial actions if the trigger levels are exceeded. Your determinand list must include heavy metals and PCBs.

We will review sites already using fragmentiser waste as a cover material to determine what impact the waste is having at that site with the aim of following the recommendations above. Where an operator proposes to use fragmentiser waste at any sites where it isn't currently used, they must carry out a thorough, quantified risk assessment. This must include background monitoring, review of existing waste

types, source material to be used and appropriate receptors, including the potential to contaminate surrounding soil and crops.

Foundry sand is only likely to be available for sites close to major foundries. You must exercise caution when using foundry sands because of the possible presence of phenols and other agents in the uncured sand. As with fragmentiser waste, the chemical composition will depend upon the manufacturing process the sand has undergone.

The sand can be delivered hot, and therefore poses a fire risk.

Foundry sands may contain elevated levels of metals. When dry, they can be very dusty, especially when traversed by vehicles. You may need dust monitoring if your site is near any sensitive receptors. As with fragmentiser waste, you must state your monitoring protocols and trigger levels in your management plan.

There is a ready source of contaminated soil from sites throughout the country, some of which will receive landfill tax advantages, assisting its disposal. However, the most highly contaminated soils won't be suitable for use as cover because of the contaminants. Some slightly contaminated material may be acceptable for use, provided it fulfils the criteria stated above.

Paper pulp may be available in useful quantities if your site is close to paper mills. Pulp has significant disadvantages because of its odour and potential clay content.

Man made products

Man-made materials generally fall into the categories of films, geotextiles and foams. They are generally designed for a specific purpose and can frequently be used in ways other forms of cover cannot. Each has advantages and disadvantages which you'll need to against your site-specific requirements.

Foams have the benefit of being capable of application to near vertical surfaces and that they totally degrade within the site. However, you can only use them on poorly compacted surfaces, you must therefore treat them with care. They tend to be relatively expensive in use to achieve a level of cover that meets the relevant objectives. They also require specialised spraying equipment and mixing facilities, making their use very site specific.

Films include plastic and Hessian sheets as well as geotextile membranes. The ability to lay and remove them quickly provides opportunities for some sites. Some degrade within the site once they are incorporated within the filling material and cause virtually no void space. They are susceptible to high winds, you may need to anchor them with soils, rubber tyres or anchoring pegs.

Geotextile matting has found specific use for covering near vertical faces on baled waste. Applying the cover is labour intensive, but provided the material is not mishandled it, can last a long time. It is less likely to biodegrade within the body of the waste when finally disposed of and may block over time impeding leachate movement.

Environmental aspects of landfill cover material

Assessment

You must only select a particular type of landfill cover material after assessing the risk to the environment, human health and amenity regarding the waste types and site specific factors that will exist throughout the site's operational life.

A summary of the advantages and disadvantages of different cover materials is shown in Appendix 1.

When selecting using a material for landfill cover, consider the following criteria:

- availability
- permeability
- combustibility
- dust
- chemical contamination
- ease of application
- traction needs of vehicles

Availability

For some cover materials, you will need to be able to satisfy us that sufficient material will always be available for use on the site. For materials derived from waste, you need to satisfy us that the source is sustainable for the periods of the year you propose to use it. Where you propose more than one type of cover material, you will need to specify each separately.

You must be able to provide us details of your alternative arrangements if circumstances reduce the availability of your preferred cover material. You must also maintain a stockpile of material on site to cover your ongoing daily needs. If your management plan doesn't adequately address storing a waste derived cover material, we may need to add a specific condition to your permit to ensure it does not create an environmental problem.

Your management plan should specify the type and source of material you plan to use when your preferred material is not readily available. It should detail the rate at which you will use it and the stockpile size you'll need to maintain. Where the cover material is a product such as plastic sheeting, your management plan should specify the anticipated delivery time from the supplier and the trigger level of stored material for a further order to be placed. It should detail an emergency plan you would use in the event of a breakdown in specialised equipment, the site running out of the cover material or additional need through vandalism of existing cover. You must specify the specific properties of the cover material in your plan, along with the measures you will take to ensure it doesn't cause pollution of the environment or harm to human health.

Permeability

You will need to consider the permeability of your chosen landfill cover material. Unless the material is known to degrade rapidly once buried, you must avoid a build-up of layers of impermeable material which may impede the movement of landfill gas and leachate within the waste body. This is to prevent perched leachate within the site and impeded removal of landfill gas or leachate.

You must remove any low permeability materials you've used for landfill cover before applying the next layer. Material stripped in this way may be contaminated with waste materials, and so have limited further use as landfill cover and may increase odour release. Some forms of low permeability cover can be reused as lateral bunds to help contain the waste. Low permeability sheeting can be reused frequently before it will require replacing.

Other materials such as paper pulps may have sufficient clay content to produce a low permeability layer.

Your management plan must detail how you will ensure significant perching of leachate does not occur.

Combustibility

You must exercise care when using cover materials capable of ignition, such as rubber, plastic or plant materials. You must establish the presence of an ignition source before using this type of cover material. If an ignition risk is present, you must detail how you will use the material in a way that will not allow it to ignite. Using combustible materials only during periods of rainfall or after prior wetting may be possible, preferably using suitable leachate. You will need to be careful to prevent the material drying out. Storing dry wood shavings on site will also require you to undertake a fire risk assessment and to adopt any necessary measures to prevent ignition.

Your management plan must detail the risk associated with storing and using any cover material that can easily catch fire. Where appropriate you should also include an emergency plan for use in the event of a fire. It should detail how you will use the material will to minimise fire risk.

Dust

Many forms of cover material become dusty if left to dry. This is exacerbated if vehicles drive across the material to reach the working face. Many forms of fine dust are known to be harmful to human health, so you'll need to consider the safety of site users. You, your visitors and the local population may be put at risk by the presence of harmful dusts.

Prolonged exposure to many dusts can cause harmful health effects. Your site's personnel will be most regularly affected. Their health is your responsibility of and is regulated by the Health & Safety Executive. You must also consider the potential health effect on the public before agreeing to use any waste as cover, this includes using foundry sands and fragmented residues (see above).

You must assess materials in their likely condition rather than how it they are generated. You must be satisfied that a proposed cover material use doesn't contain any harmful substance that could be spread in its dust. Such substances may include asbestos fibres and chemical contamination. Excessive quantities of dust can also significantly affect plant growth, can block site vehicle air filters and can contribute to fires in site plant. You will need to demonstrate within your management plan how you will contain any dust that is produced. You will also need to demonstrate how you will reduce dust from using a cover material to below acceptable levels.

Chemical contamination

You must take great care to ensure the materials you use as landfill cover are not contaminated with potentially hazardous substances to such an extent they cause problems. Soils classified as contaminated are readily available, and have some beneficial properties as a cover material. However, you should only consider using soils where the contamination level is low. We have produced a paper called 'Interim guidance on the disposal of contaminated soils'. Your site must be specifically permitted to accept contaminated soil as waste before you consider using it as a cover material.

No two circumstances are the same, therefore you will need to make site specific decisions. Contaminated soils that are odorous; attractive to insects or vermin; dusty (especially if asbestos fibres are present); or brightly coloured are not suitable for use as cover materials.

Your management plan must detail how you will ensure your choice of cover materials will not include levels of contamination that might pose a threat of pollution of the environment or harm to human health. Where you specifically propose contaminated soils, you should assess the risks the level of contamination may have on human health or the environment.

Ease of application

Where landfill cover is required, it often has to be applied before the end of each working day. You should consider your ability to use different types of cover material in all weather conditions. You must be satisfied with the effectiveness of applying foams and sheets in wet or windy conditions, or alternatively have a stockpile of a more effective material on site.

Specialised landfill cover applying equipment can fail. Unless spare equipment is available on site, you must deploy agreed alternative methods in the case of equipment breakdown.

Using foams requires a water source, in freezing temperatures this may not be available. You should implement agreed alternative methods in these circumstances.

The removal of sheeting used for daily cover can be required throughout the year. Certain types will become much more difficult to handle when wet and could affect the way you use the material and how much it costs you.

Your management plan must detail what methods you will use to apply and remove the materials you use as landfill cover. If you use specialised equipment, you should provide contingency plans in case of breakdown which should include a stockpile of alternative cover material that can be spread using regular site equipment.

Vehicle traction

The ability for site vehicles to cross the covered waste to access a working face may be necessary. Materials such as plastic cover sheets don't allow vehicles to easily pass over them. You will need to make arrangements to remove such materials if vehicles do need to traverse covered areas. This will have both time and cost implications for you. Other forms of cover such as foams will be destroyed by vehicles and as a result you will need to recover the areas affected.

Some sheet materials are capable of being used several times before becoming damaged or contaminated. The quality of a covered surface will show gradual decline towards this replacement point. You must specify the criteria you will use to

decide when to replace used sheeting. Damaged cover must still meet the environmental objectives for us to consider it acceptable.

You will also need to be careful to avoid cover materials which have stuck to the wheels or bodies of vehicles from being dropped on public highways. You must provide sufficient wheel and vehicle cleaning to ensure this does occur.

Some cover materials, especially those from processed waste contain wire residues and can be difficult to pass on foot. Hazards to pedestrian also include materials that won't support the weight of humans or site equipment, you must ensure such areas are clearly identified on the ground. Extreme care needs to be exercised when walking near these areas.

Your management plan must detail how vehicles will access the tipping area and working face. Where you use reusable cover materials, your plan must detail how you will achieve this without damaging the cover material. It should also specify the criteria you will use to replace the covers with fresh ones. It should specify how vehicles and pedestrians will be directed away from covered areas where damage to the integrity of the cover or risk of harm to human health will occur if crossed.

In many cases there will be a conflict between your use of cover and vehicle access. By selecting appropriate cover materials there should be few occasions where site access is only possible by not applying cover. If your assessment of the site-specific circumstances requires using cover, you must not allow uncovered routes across the waste to the tipping face.

Conclusion

The permutations of site situation, waste types, weather patterns, environmental issues, cover types and differentiating the effect of cover from other site activities makes specifying standards difficult. However, both the landfill industry and the Environment Agency generally agree that provided the objectives for applying cover can be fully met elsewhere, there may be no need to specify a definitive cover standard requirement, other than as a default permit condition.

The landfill industry has indicated that providing the objectives we apply for all sites are identical, achieving those objectives in different ways is not contrary to their ability to compete fairly.

Assessing some criteria can be nothing other than subjective. However, this document aims to set out best practice for using landfill cover.

Appendix 1 - types of cover materials

The following list of materials that have been used, or proposed for use as landfill cover is not exhaustive. We will consider novel materials but they should first be assessed by the prospective user for their specific properties and effectiveness. We will need to agree to the assessment before you begin. Not all types of cover material are readily available in all parts of the country, but some may have use in the area around their source. Transporting large volumes of cover material by road over long distances must be avoided wherever possible.

Soils (draining and non-draining)

Soils have been traditionally used as a daily cover material and may be of a free draining type such as sand, or non-draining such as clay. Our experience has highlighted inherent problems with using soils in a modern sustainable landfill, particularly the non-draining types. The main problems arise from the clay and silt content forming low permeability layers within the waste when subsequent layers of waste are compacted. This results in difficulties in leachate and landfill gas control. Leachate may become perched within a site and preferential lateral pathways may form for landfill gas, increasing the risk of off-site migration.

Soils can be scraped off the waste surface or ripped prior to the next lift of waste being applied, however this is unlikely to remove all of the impermeable material. This method also produces large quantities of litter contaminated soil that may render it unsuitable for further use.

Waste soils remain readily available but sites are less able to attract sufficient quantities for use as cover as a result of the financial impact of the landfill tax.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Ease and availability▪ Visual appearance▪ Non-combustible▪ Can be temporarily seeded▪ May be used to reduce water infiltration▪ May utilise a waste stream	<ul style="list-style-type: none">▪ Impermeability of clay type soils▪ Poor traction▪ Consumes valuable void space▪ Wheel cleaning requirements▪ Wind loss from sandy material

Contaminated soils

Careful consideration of the implications for the health and safety of site users and neighbours should be taken before using of soils removed during the clean up of chemically contaminated industrial sites.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Ease and availability▪ Non-combustible▪ Utilises a waste stream.	<ul style="list-style-type: none">▪ Potentially impermeable▪ Poor traction qualities▪ Chemical contamination▪ Possible odour problems▪ Wheel cleaning requirements▪ Possible health risk.

De-inked paper sludge

This is frequently a grey odorous sludge. It arises as a waste product from paper recycling at paper mills. Experiments using it as a daily cover material have been carried out, but in the main have been unsuccessful due to its poor traction qualities and its low permeability as a result of a high kaolinite clay content.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Utilises a waste stream▪ Good visual appearance when uniformly coloured	<ul style="list-style-type: none">▪ Traffic movements over it are difficult▪ Odorous▪ Water content will contribute to leachate▪ Clay content may cause problems with perched leachate▪ Will slowly degrade if spread thickly possibly contributing to odour in the long term

Pulped paper

This is formed by separating and pulping paper from the general waste stream and adding water or leachate and polymer as a binder. Mixing can take place in a large volume blender at the working face with the material being applied using a high-pressure cannon or spray gun. Applying leachate based cover may provide a means of leachate recirculation in a controlled manner and therefore assist in waste stabilisation. To date, no practical application of this cover material is known in the UK, it having been tested on a laboratory scale only. In the USA its manufacture is a proprietary process and it has been used as cover on a number of landfill sites.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Utilises a waste stream▪ Water could be replaced by suitable leachate.	<ul style="list-style-type: none">▪ Traffic movements over it may be difficult▪ Water content may contribute to leachate▪ Clay content may cause problems with perched leachate▪ Specialised equipment required▪ May be prone to wind blow when dry.

Foams

Foams consist of a weak structured material sprayed onto the waste either manually or by automated self-propelled equipment. The foam commonly used in the UK is urea formaldehyde based, although other foams have been produced in the USA. Both hardening and non-hardening foams are available, which will retain their structural integrity for hours, or up to weeks, depending upon the product and the effect of climatic conditions. The foam structure collapses when the next lift of waste is placed and therefore remains permeable to leachate and landfill gas. Foam application requires using specialised equipment that continues to be refined to minimise the disadvantages listed below. The availability and cost of the equipment required may prohibit using this technique.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Adheres to waste surface allowing its use on vertical or near vertical waste surfaces such as baled waste or covering the heading ▪ Non-combustible ▪ Permeable to gas and leachate ▪ Saves void space. 	<ul style="list-style-type: none"> ▪ Damaged by traffic movements across it ▪ Colour of some products ▪ Time taken to cover working area ▪ Mixing of material to make foam prior to use ▪ Water content ▪ Specialised equipment required ▪ Hides poorly compacted waste ▪ May suffer long term damage from birds ▪ Difficult to apply in windy and adverse weather conditions ▪ Usefulness due to short lifespan.

Geotextile matting

Comprises a geosynthetic material either specifically developed or adapted for use as a cover material. They are normally manufactured as a robust, reusable sheet of varying weight and construction depending on their specific application and derivation. The textile is used until physical damage sustained during placement renders it ineffective. Sheets can be manufactured in a range of colours.

If the material is incorporated into the waste body its potential for biological clogging should be considered, as this process can lead to reduced permeability. There are two main types of geotextile, woven and non-woven. Each has slightly different advantages and disadvantages when used as cover.

The sheet can be applied manually or mechanically and removed prior to placing the next lift of waste.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Useful on inclined surfaces ▪ Depending upon the type of geotextile used, rapid deployment and ease of relocation by landfill equipment or manual labour when dry ▪ Reusable ▪ Saves void space ▪ Can be made from recycled material and can be recycled. 	<ul style="list-style-type: none"> ▪ Relocation can be a problem during wet periods due to the extra weight of absorbed water ▪ Susceptible to damage in high winds if not adequately weighted down ▪ Not suitable for heavy traffic movements ▪ Requires manual handling ▪ Colours limited at present time ▪ Difficult to secure to ground ▪ Fly and odour problem especially when moved ▪ May require weighting down ▪ May form low permeability layer when incorporated within waste

Plastic film

A degradable film placed mechanically over the waste using modified landfill equipment. The cover is trailed out and weighted down automatically with small amounts of sand, gravel or screened soil. It remains in-situ and is left to biodegrade with subsequent lifts of waste deposited over it. Different grades of material can be manufactured which are designed to last for a specified life. Films are now available for use as daily cover or with a life span of up to 18 months for intermediate cover.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Rapid deployment using existing site plant▪ Degrades over time to become permeable to gas and leachate▪ Saves void space▪ May be reusable▪ Elevated temperatures below surface suppress fly infestation▪ Can be made from recycled material▪ Thicker grades can be used for intermediate cover▪ Can be blended in with surrounding surfaces.	<ul style="list-style-type: none">▪ Not suitable for areas which are trafficked▪ Potential risk of damage from rough or sharp surfaces▪ Requires sand, gravel or screened soil to anchor it down▪ Susceptible to wind damage▪ Birds may cause damage to thinner grades▪ Fly and odour problem if moved

Shredded wood (excluding sawdust)

This is a cover material which has proven effective and provides reasonable traction in all weather conditions. It is routinely disposed of at landfill sites in bulk loads and can also be manufactured by shredding specific waste streams entering the site. It can be applied using equipment readily available at the site and can be left in-situ when a further lift of waste is deposited, as it will remain permeable to leachate and gas. While some biodegradation will take place lignin is not anaerobically biodegradable.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Permeable and can therefore be left in-situ prior to next lift of waste▪ Utilises a waste stream.	<ul style="list-style-type: none">▪ Difficulty may be experienced in gaining sufficient quantity▪ Investment may be required to provide an on-site shredder▪ Fire risk▪ Hazards of dust from hardwoods.

Shredded tyres

This consists of pieces of shredded tyres, the size of which depend upon the shredder used. Tyres are widely available and can be shredded on site and applied using conventional landfill equipment. Problems have arisen from reinforcing wires in the tyres being exposed during shredding causing difficulties in placement and subsequent reuse.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Can be left in-situ prior to next lift of waste or reused ▪ Tyres widely available ▪ Utilises a waste stream ▪ Could be used to provide a high permeability layer between waste lifts and therefore encourage more even percolation of leachate and extraction of landfill gas. 	<ul style="list-style-type: none"> ▪ On-site shredder may be required ▪ Known fire hazard ▪ Difficult to place if not shredded correctly ▪ Difficult to traverse ▪ Contaminated surfaces attract flies

Fragmentised waste (Light fraction cyclone waste ‘fluff’)

Waste from the shredding process of cars and white goods, prior to recycling the metals recovered, falls into two main categories. Light fraction material commonly known as ‘fluff’ derived from passing the shredded waste through a cyclone and the heavy fraction containing the non-ferrous metals together with dense, heavy non-metallic compounds such as hard plastics, rubbers and concrete. The fluff predominantly comprises foam, light plastics and rubbers, dusts and other contaminants account for approximately 25% of the feedstock. Heavy media plant further separate the feed by aqueous density baths recovering floated hard plastics and rubbers from non-ferrous metals and account for approximately 2-3% of the initial feedstock.

The light fraction fluff waste, which may also be mixed with heavy fraction material, is applied using conventional landfill equipment. It produces a visually acceptable and permeable cover that provides good traction in all weather conditions. While the benefits of permeability aid leachate and landfill gas transmission, as with other permeable cover types, it doesn’t provide a barrier to surface water ingress.

The waste has been found to be variable in its contaminant levels and has been found to contain the metals lead and cadmium, PCB and in some cases asbestos fibres, albeit mainly within the fines fraction. The possible concentration of the contaminant in specific waste fractions and the route that the contaminant is spread into the environment should be considered. It is recommended that without further processing of the waste to reduce or exclude these contaminants to acceptable levels consideration must be given to its suitability as intermediate cover material. As with other cover materials the level of any contaminant will be determined by the original material and the processes that it has been subjected to.

Heavy fraction waste may have some potential for use as a landfill cover but insufficient information is available to consider it separately. It may have similar properties to shredded tyres.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Utilises an existing waste stream that is widely available ▪ Good tractive surface ▪ Remains permeable and can therefore be left in-situ prior to next lift of waste ▪ Generally uniformly coloured. 	<ul style="list-style-type: none"> ▪ Dusty during dry weather ▪ High level of toxic metals, PCB and some asbestos may be present ▪ Foams are a known fire hazard ▪ Subject to wind damage, exposing waste ▪ In warm, moist conditions provides an ideal breeding ground for flies

Shredded green waste

Defined as waste that has previously been growing and ranging from grass clippings to trees. The waste is readily available and could be separated from the incoming waste stream and shredded on site. In some instances it may be composted before use. It will form a biodegradable and permeable cover that can be left in place prior to the next lift of waste. Given the importance of reusing as much waste as possible it may have a more appropriate use as a soil conditioner.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Utilises widely available waste stream▪ Remains permeable and can therefore be left in-situ prior to next lift of waste▪ Degradable and promotes waste stabilisation.	<ul style="list-style-type: none">▪ May give rise to some odour▪ On site shredder may be required▪ Seasonal availability.

Pulverised domestic waste

Biodegradable waste arising from treatment of domestic refuse at 'Dano' plants or similar. The pulverisation process can be variable which may give rise to increased odours. The waste appears as a brownish 'fluff like' product which has been applied as cover material. Although visually acceptable, considerable problems can be experienced with odour due to the early onset of degradation. Birds are also attracted to the waste, and due to its moisture content and physical properties it has poor traction capabilities.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Utilises a plentiful waste stream▪ Remains permeable and can therefore be left in-situ prior to next lift of waste▪ Degradable and promotes waste stabilisation.	<ul style="list-style-type: none">▪ Potentially odorous▪ May attract birds and vermin▪ Poor traction qualities▪ Needs to be applied directly▪ Odorous if stored▪ Prone to generate litter▪ Does not prevent fly infestation.

Synthetic mesh

A plastic mesh of varying mesh size adapted from other uses. It is rolled out over the waste and can be reused until physical damage renders it ineffective. As the material requires manual handling there will be an inherent risk to the health of manual workers laying and moving the material that will require a thorough risk assessment to be carried out before its use.

Advantages	Disadvantages
<ul style="list-style-type: none">▪ Relatively simple placement and ease of relocation by adapted landfill equipment	<ul style="list-style-type: none">▪ Requires manual application▪ Does not contain odour▪ Does not prevent fly infestation

<ul style="list-style-type: none"> ▪ Permeable to gas and leachate ▪ Saves void space. 	<ul style="list-style-type: none"> ▪ Does not prevent bird or vermin attack ▪ Material not fire retardant ▪ Requires weighting down ▪ Birds can damage thinner grades.
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Hessian sheet

A natural woven fibre manufactured into a sheet of different grades that can be rolled out over the waste surface and either removed or left in-situ prior to the next lift of waste. The sheet is permeable and will undergo degradation within the waste mass. As the material requires manual handling there will be an inherent risk to the health of manual workers laying and moving the material that will require a thorough risk assessment to be carried out before its use.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Permeable and biodegradable and can be left in place or reused ▪ Relatively simple placement ▪ Useful on inclined surfaces ▪ Good visual appearance ▪ Utilises on-site machinery ▪ Saves void space. 	<ul style="list-style-type: none"> ▪ Not suitable for trafficked areas ▪ Requires weighting down ▪ Requires manual input if sewn ▪ Relocation difficult when wet ▪ Does not prevent fly infestation ▪ Limited to daily cover ▪ Material not fire retardant ▪ Thinner grades subject to bird damage.

Ash

A greyish black ash from domestic/commercial waste incinerators that can be spread out over the waste surface by conventional landfill equipment. The ash contains visible metal fragments and tins resulting from incomplete combustion, it will also contain toxic metals and the poor combustion may also produce significant dioxin levels. Ash from clinical waste incinerators and fly ash is not a suitable cover material. Chemical analysis of contaminant levels is required to ensure they fall within licensed limits. The use of contaminated material as cover may result in increased exposure of the workforce to dusts that may require lower limits to be set than for direct burial.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Good traction qualities ▪ Utilises an existing waste stream ▪ Permeable to gas and leachate and can therefore be left in-situ prior to the next lift of waste. 	<ul style="list-style-type: none"> ▪ Dusty during dry weather ▪ May contain significant levels of toxic metal and dioxins ▪ Not always consistent material ▪ Can be odorous.

Colliery shale

Waste arising from the deep mining of coal. Its composition will differ as a result of the mines geological setting.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Utilises a waste source ▪ Can be applied using conventional plant. 	<ul style="list-style-type: none"> ▪ Traffic movements can be difficult ▪ Pyrite content and presence of residual coal can lead to self combustion ▪ Oxidation of pyrites can lead to acidic iron rich leachate ▪ Clay content may lead to impermeable barriers. ▪ Wheel cleaning required

Quarry waste

The waste arising from the processing of hard rock quarry stone. It usually comprises of oversize and fines, its composition will vary depending on the geological setting.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Utilises a waste stream ▪ Good traction qualities ▪ Can be applied using conventional plant. 	<ul style="list-style-type: none"> ▪ Potentially dusty ▪ Permeability problems may occur depending on particle size distribution and compaction levels ▪ Some materials too fine to use ▪ Inconsistent unless single source.

Foundry sand

Used sand from a metal casting process. The sand has a binding agent added to it to maintain its form. The binder may be varied depending upon the casting process and some forms may be phenolic.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Permeable to gas and leachate ▪ Utilises a waste stream ▪ Non-combustible ▪ Provides good site traction. 	<ul style="list-style-type: none"> ▪ May contain chemical binders ▪ Wind loss ▪ Inconsistency of material may require frequent sampling ▪ Dusty in the extreme in dry conditions.

Shredded commercial waste

Slowly biodegradable waste comprising mainly finely shredded paper, cardboard, wood and plastic excluding 'food type' components. It appears as a buff coloured fluff like product. The waste can be shredded on site or obtained directly from waste transfer stations taking predominantly commercial waste. It has been successfully used to cover flanks of waste lifts.

Advantages	Disadvantages
<ul style="list-style-type: none"> ▪ Utilises a plentiful waste stream 	<ul style="list-style-type: none"> ▪ Potentially poor traction qualities

<ul style="list-style-type: none">▪ Remains permeable and can therefore be left in-situ prior to next lift of waste.	<p>depending on mix</p> <ul style="list-style-type: none">▪ On-site shredder may be required▪ Light colour▪ May liberate odour with extended use▪ Prone to wind blow.▪ Quality only as good as the selected feed stock▪ Does not prevent fly infestation.
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Table 1 Summary of effectiveness as daily cover

	Litter	Odour	Bird attraction	Scavenging	Vermin ¹	Flies ¹	Fire risk ⁶	Visual appearance	Water ingress
No cover ²	8	8	8	8	8	8	8	8	8
Soils (Free draining)	4	4	4	4	*	*	4	4	8
Soils (Non-draining)	4	4	4	4	*	*	4	4	4
Contaminated soil	4	4	4	4	*	*	?	?	4
De-inked paper sludge	4	8	4	4	*	*	8	8 ³	8
Pulped paper	4	8	4	4	*	*	8	8 ³	8
Foams	4	4	4	4	*	*	4	8	8
Geotextile matting	4	8	4	4	*	*	4	4	8
Plastic film	4	4	4	4	*	*	8	4	4
Shredded wood	4	4	4	4	*	*	8	4	8
Shredded tyres	4	8	4	4	*	*	8	8	8
Fragmentised waste	8 ⁴	4	4	4	*	*	8	4	4
Shredded green waste	4	8	4	4	*	*	8	4	8
Pulverised domestic waste	4	8	8	8	*	*	8	4	8
Synthetic mesh	4	8	8	4	*	*	8	8	8
Hessian sheet	4	8	4	4	*	*	8	4	8
Ash	4	4	4	4	*	*	4	4	8
Colliery waste	4	4	4	4	*	*	?	4	?
Quarry waste	4	4	4	4	*	*	?	4	?
Foundry sand	4	4	4	4	*	*	4	4	8
Shredded commercial waste	8	8	8	8	*	*	8	4	8

Table 2 Summary effectiveness of intermediate cover types

	Litter	Odour	Bird attraction	Scavenging	Vermin ¹	Flies ¹	Fire risk ⁶	Visual appearance	Water ingress
No cover ⁵	8	8	8	8	8	8	8	8	8
Soils (Free draining)	4	4	4	4	4	4	4	4	8
Soils (Non-draining)	4	4	4	4	4	4	4	4	4
Contaminated soil	4	?	4	4	4	?	?	?	4
De-inked paper sludge	4	8	4	4	4	4	8	8 ³	8
Pulped paper	4	8	4	4	4	4	8	8 ³	8
Foams (on degradation)	8	8	8	8	8	8	8	8	8
Geotextile matting	4	8	4	4	4	4	4	4	8
Plastic film (Thicker grades)	4	4	4	4	4	4	8	4	4
Shredded wood	4	4	4	4	4	4	8	4	8
Shredded tyres	4	8	4	4	8	8	8	8	8
Fragmentised waste	8 ⁴	4	4	4	4	8	8	4	8
Shredded green waste	4	8	4	4	8	8	8	4	8
Pulverised domestic waste	4	8	8	8	8	8	8	4	8
Synthetic mesh	4	8	8	4	8	8	8	8	8
Hessian sheet	4	8	4	4	8	8	8	4	8
Ash	4	4	4	4	4	4	4	4	8
Colliery waste	4	4	4	4	4	4	?	4	?
Quarry waste	4	4	4	4	4	4	?	4	?
Foundry sand	4	4	4	4	4	4	4	4	8
Shredded commercial waste	8	8	8	8	8	8	8	8	8

Key and notes to tables 1 and 2	
Key	
✓	Effective
X	Not effective
?	Effective under certain circumstances depending on the precise nature of the material.
*	Not considered an objective that can be addressed by the use of daily cover alone.
Notes:	
1	Relates to infestation by flies or vermin rather than just their presence on site.
2	In the absence of cover the environmental criteria can only be achieved by using alternative operational techniques.
3	Could be acceptable depending on the colour of the material used.
4	A layer of this material will prevent litter derived from the waste it covers but may itself fail the litter objective.
5	The approach taken when using no cover to achieve the daily cover objectives is not considered sustainable for intermediate cover requirements.
6	The suitability of use of a cover material that is considered not to be effective will depend on the specific circumstances of the site it is to be used at.