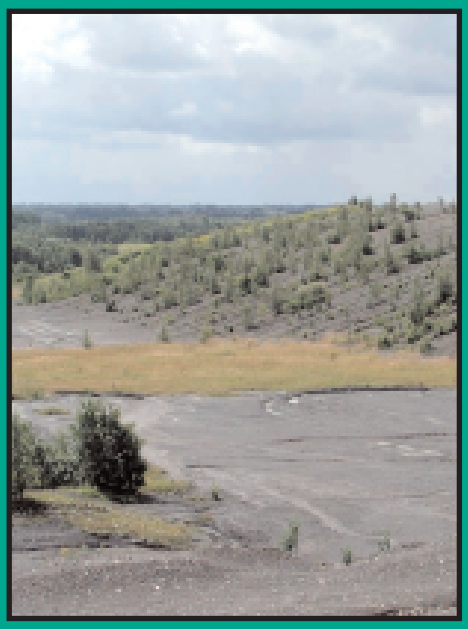


Code of Practice

for the use of sludge, compost and other organic materials for land reclamation

SNIFFER
SCOTLAND & NORTHERN IRELAND FORUM FOR ENVIRONMENTAL RESEARCH

Contents

This Code of Practice was produced by SNIFFER as part of project ER11 with the support of the Department of the Environment (Northern Ireland), the Environment Agency, Scottish Water, Sepa and WRAP.

1 Introduction

1. This Code of Good Practice addresses the use of recycled organic materials in projects involving restoration and improvement of land on which there is a need to establish sustainable vegetation. It is aimed at those who have a practical involvement in land restoration and reclamation, such as land owners, restoration managers, civil engineers, waste management companies and regulators, as well as those who may be required to give advice and recommendations to others, such as environmental consultants, trade associations and Regional Development Agencies.

2. Organic matter is a vital component of a healthy soil, contributing to its structure, moisture retention capacity, nutrient content and stability. Recycled organic material is a collective term used to describe materials rich in organic matter that are either a by-product of an existing process, such as biosolids (sewage sludge), or materials that have been produced as a result of some form of recycling process, such as compost.

3. Recycled organic materials of appropriate quality may be used to restore land that has been used for some purpose in the past and is no longer used for that purpose. Such land may or may not include buildings in various states and may include contaminated land, although in most cases it is not likely to be seriously contaminated. However, most land of this type is degraded in comparison with agricultural land and additions of recycled organic matter may be required to bring it back into productive use.

4. While Codes of Practice to protect human health and the environment exist for agricultural land, and advisory documents exist for certain types of recycled organic materials, notably sewage sludge, such guidance is either not specific to degraded land or is no longer up to date. This Code of Practice provides a source of guidance and information to ensure the appropriate use of **RECYCLED ORGANIC MATERIALS** in **LAND RESTORATION AND RECLAMATION**. It provides up to date information on the suitable application of a range of materials that could be used to improve soil quality in various non-agricultural applications. The Code is intended to be concise, easy to read and informative for a wide range of end users. It has been produced as a stand-alone document, with an accompanying Technical Document that provides detailed information to support the Code itself, along with a full bibliography. The Code is available either in hard copy or electronic download: the Technical Document is available as an electronic download only. Both can be downloaded from http://www.sniffer.org.uk search code ER11.

Degraded former industrial land

1 Introduction

5. The Code itself is not a legal document, but it highlights the legal requirements for land management and the use of recycled organic materials. It does not replace any equivalent Codes of Practice for specific materials, nor does it replace any Codes of Practice for agricultural land. It gives guidance above and beyond the minimum legal requirements to ensure the best level of environmental and human health protection, whilst permitting the greatest opportunity for the improvement of degraded land for a range of end uses.

6. A full list of the materials covered by the Code is shown in the box below: these materials will be discussed in more detail in Section 2. Inorganic materials that may be applied to soils to improve their quality, such as ash from co-combusted poultry litter are not considered. Livestock manures have also not been considered, as they are typically used on agricultural land where they are produced: this is not to say that such materials cannot be used as a soil improver in land reclamation projects.

MATERIAL INCLUDED IN THIS CODE OF GOOD PRACTICE

- Composts produced from green waste and green/food waste
- Compost-Like Output (CLO) produced via a Mechanical Biological Treatment (MBT) process
- Anaerobic digestate derived from source segregated feedstock
- Biosolids from the sewage sludge industry, including liquid sludge, sludge cake, limed sludge, thermally dried sludge and composted sludge
- Water treatment sludges from drinking water production
- Paper crumble produced from by-products of the paper processing industry
- Organic industrial wastes and sludges

7. The Code covers the use of these materials in the activities listed in the box on page 5. The use will be on non-agricultural land producewith the intention of producing an ecological improvement in the quality of the land or bringing it into productive use for non-agricultural activity. In some cases the reclamation of land may ultimately result in it returning to agricultural production. However, this Code does not cover good practice on agricultural land, for which the relevant Code of Good Agricultural Practice applicable in England, Ireland, Scotland or Wales is recommended. These can be found at www.defra.gov.uk, www.dardni.gov.uk and www.scotland.gov.uk respectively.

Earthworks being undertaken at Lambton cokeworks

Sludge cake being delivered to site

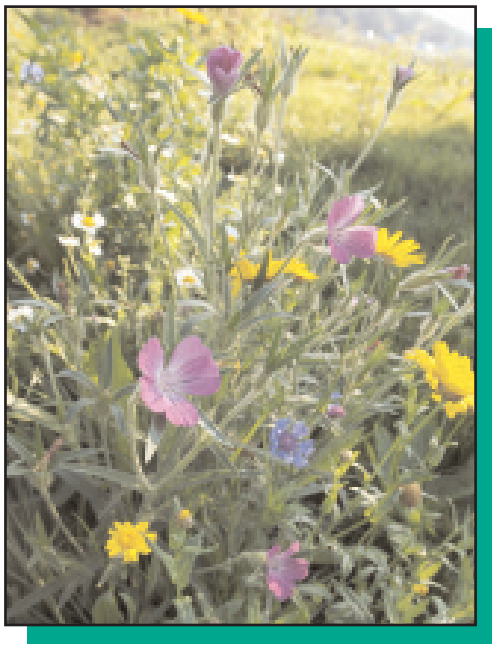
1 Introduction

ACTIVITIES COVERED IN THIS CODE OF GOOD PRACTICE

- Restoration or improvement of non-agricultural land, through soil formation and soil improvement, including the application of recycled organic matter via incorporation or mulch
- The preparation of non-agricultural land for non-agricultural end uses:
  - **Non-food crop production**
  - **Forestry**
  - **Habitat development**
  - **Recreational activity**
  - **Public open space**
- Reclamation of waste management facilities through the improvement of the surface layer of a landfill capping system
- Recovery for subsequent conversion to agricultural land

8. The Code is divided into five main sections:.

- A detailed description of the organic materials covered.
- A brief description of the potential benefits and risks involved in using these materials in reclamation projects.
- A section outlining the legal framework in which applications of recycled organic materials to land must operate.
- A series of case-studies from around the UK, which illustrate how recycled organic materials have been used in a range of restoration activities using a range of types of organic matter.
- The Code of Practice itself, which describes the steps that should be followed to ensure appropriate reclamation of non-agricultural land. The Code covers site selection, site testing, application of recycled organic materials, and monitoring and aftercare. It describes what should be done in order to go beyond the minimum legal requirements for land reclamation and into good practice.



Wildflowers established on former landfill, Cross Lane

9. This Code of Good Practice is a stand-alone document. It contains sufficient advice and information to enable the user to undertake a successful land reclamation project using recycled organic matter in the most environmentally appropriate manner, with consideration to the intended end use of the reclaimed land, the protection and enhancement of the surrounding environment and the protection of human health. It is intended to be a short, easily accessible document that provides the core information that is likely to be required by the majority of users in the majority of situations. If more detailed information is required we recommend that you read the accompanying Technical Document, which is cross referenced to the Code by means of the paragraph numbers that lead directly to a more detailed description of the information as well as the sources of that information. For specific enquiries, please email SNIFFER at info@sniffer.org.uk.

2 Types of organic matter

10. Organic matter is a vital component of all soils; it provides stability and structure to the soil, as well as the macronutrients nitrogen, phosphorus and potassium (N, P and K), organic carbon and other trace elements, such as boron, copper, manganese, molybdenum and zinc. Organic matter is a dynamic feature of the soil. Organic matter can be applied to soil from a variety of sources, of which livestock manures are the largest in quantity, followed by biosolids (sewage sludge) and composts.

Green and green/food composts

11. Green waste materials collected independently from other waste streams from sources such as domestic gardens, municipal parks and recreational areas may be treated using a composting process. Composting is a term used to describe the aerobic biodegradation of organic materials under controlled conditions of temperature and moisture. Compost may be produced in open windrows or in enclosed in-vessel systems. Food waste must be composted in an in-vessel system and must be compliant with Animal By-Products Regulations (ABPR) as well as the relevant waste legislation. The end result of the composting process is a stable organic residue with high organic matter content and potentially significant quantities of nutrients. The breakdown of the organic material in the feedstock occurs as the compost heats up to its maximum temperature (>50°C) as a result of biological activity. This temperature must be reached to ensure the destruction of pathogens, after which the material must be allowed to mature for a period of several weeks. The final organic matter content of the compost depends largely on the length of this period of maturation; the longer the maturation, the lower the organic matter content. The feedstock must be turned regularly during this process to ensure that the treatment applies evenly throughout the windrow. In 2007-2008, 2.7 million tonnes of compost were produced in the UK; it is likely that this level of production will increase further in the future.

Matured compost (Scottish Water)

Aerial view of a typical composting facility (Scottish Water)

Compost-like outputs

12. Compost-like output (CLO) is a generic term used to describe organic-rich materials which have been derived from mixed municipal solid waste (MSW) feedstocks through some form of Mechanical Biological Treatment (MBT) to produce an organic-rich material. MBT is a very broad term encompassing many processes, or combinations of processes. These might include biological treatments such as composting, anaerobic digestion and autoclaving, as well as some form of mechanical processing to remove dry recyclables from the original feedstock, such as metals, as well as fragments of unwanted material such as glass and plastics.

2 Types of organic matter

13. The term CLO has come into common use specifically in reference to material derived from mixed waste feedstocks that have been treated biologically and is used to distinguish it from green compost derived from source segregated green waste materials. While some CLOs may be of reasonably high quality and contain useful quantities of organic matter and nutrients, the quality of CLOs varies considerably between processing plants and during the year. This is the result of variation in feedstock, seasonal variations in waste composition, differences between urban and rural waste streams and differences in the design of CLO plants.

14. Estimated production of CLO in the UK by 2010 is 583,500 tonnes (fresh weight) per year. However, since the exact scale of production is difficult to estimate due to differences between processes at different sites, feedstock composition and the ongoing development of new MBT plants, this figure should be regarded as approximate.

Digestate

15. Anaerobic digestion is a process whereby organic material is broken down by bacteria in a sealed environment without oxygen. There are two end products. Biogas may subsequently be used to generate electricity, for heating, transport fuel and fuel cells. Digestate is a nutrient-rich material that can be provided as separated fibre, separated liquor or whole digestate, which is a combination of the two; all forms of digestate can be applied to land. Green waste, food waste and mixed waste can be treated using anaerobic digestion but, for the purposes of this Code, we only consider digestate that has been produced from source segregated materials.

16. The scale of production of digestate in the UK is relatively low at present; in 2006-2007, 86,700 tonnes of digestate were produced. In 2007-2008 no survey data were available. More facilities are being planned, or are under construction, therefore this figure is likely to increase in future.

Biosolids (sewage sludge)

17. Biosolids is a generic term used to describe the various forms of treated sewage sludge. Raw sewage derived largely from human waste undergoes sedimentation and treatment at wastewater treatments plants, producing a final effluent that is discharged safely back into the environment, and a liquid sludge of approximately 2-5% dry solids. This liquid sludge undergoes a number of additional treatment processes such as dewatering, composting, lime pasteurisation, or thermal drying, to produce a raw sludge cake or a conventional or enhanced biosolids product depending on the level of pathogen destruction during the treatment process. These materials have different characteristics: dewatered sludge cake has a dry matter content of 25%; limed sludge cake has a dry matter content of 40% and a higher pH than the other products, which are typically more or less neutral; sludge compost has a dry matter content of 60% and thermally dried granules or pellets have a dry matter content of 95%. These materials can be further designated as “conventionally treated” and “enhanced treated” products depending on the level of pathogen destruction. Most biosolids have an organic matter content of more than 50% by dry weight. Levels of nitrogen and phosphorus are variable but usually significant. Dewatered sludge cake is the most common form of biosolid used for land restoration in the UK, but sludge compost is important in some regions. Dewatered sludge that is co-composted with other material is considered as compost rather than as biosolids and is subject to the regulatory controls for compost. Although granules/pellets are the easiest form of sludge to transport and apply, they are expensive to produce and are currently not widely used in land reclamation. In 2007 approximately 1.4 million tonnes of biosolids (on a dry solids basis) were recycled to land, of which 53,000 tonnes (4%) was used directly in land reclamation. In 2008 the equivalent figures were 1.36 million tonnes and 34,000 tonnes (3%) respectively. Most biosolids (70-75%) are used in the agricultural sector.

Water treatment cake

18. Water treatment sludge cakes are the by-product of potable water production in water treatment works (WTW). Approximately 50% of WTW sludges are discharged to sewer for further treatment at wastewater treatment works. The alternative is to dewater the sludge on-site to form a cake produced of approximately 25% dry solids, which can be recycled to land. Typical processes include centrifuging, coagulation, filtration, dewatering and thickening. Approximately 71% of cake from freshwater treatment was recycled in the UK in 2003-2004; separate data on the quantity of water treatment cake produced in the UK are not available as they are usually combined with data for sewage sludge.

2 Types of organic matter

Paper crumble

19. Paper crumble is a by-product of the paper manufacturing industry and consists mostly of short wood fibres such as cellulose, lignin and hemicellulose. A big advantage of paper crumble is its ability to hold moisture. It can also have a very high carbon content and therefore has a high carbon to nitrogen (C:N) ratio, potentially exceeding 150:1, although it is more typically 70:1. This can lead to N immobilisation if paper crumble is applied directly to land untreated unless a nitrogen-rich material is applied at the same time. Paper crumble can also be pre-treated prior to land application by composting, which reduces the C:N ratio, as well as the volume and moisture content of the material. The typical moisture content of paper crumble is around 60%. Organic matter content ranges from 30-70% on a dry solids basis. Nitrogen content typically ranges from <1 to 11 kg t^{-1} (mean = 2.5 kg t^{-1}) and phosphate content has been recorded between 0.2 and 3 kg t^{-1} (mean = 0.6 kg t^{-1}) on a fresh weight basis.

20. Estimated production of paper crumble from recycling operations in the UK was around one million tonnes (fresh weight) in 2005; with increased rates of recycling this figure may increase in the future. Further crumble is produced from the processing of new paper but no estimate of the quantity produced is available.

Other non-hazardous recycled organic materials

21. A range of other organic materials and by products from industrial processes may have a value in land restoration. Examples include residues from the brewing process, sawdust and other wood remains from sawmills and timber processing plants[1], as well as seaweed and by-products from the mushroom growing industry. Depending on their physical and chemical nature and provided that they have been source segregated these materials may be applied directly to land or may be treated prior to application, for example by composting or digestion. This may be undertaken on the organic residue alone or in conjunction with other organic materials such as manure or green waste. However, we have not considered their use specifically in this code. If you intend to use these or other organic materials in land reclamation, we recommend the general guidance in this Code of Practice as a source of information, along with consultation with the regulatory authorities at a local level to ensure that appropriate good practice is maintained.

Whole anaerobic digestate in a storage tank.

Sludge cake (M Reeve)

[1] Any wood residues must be free from paints, preservatives and other sources of contaminants.

3 Benefits and risks

22. Using recycled organic matter in land reclamation projects can bring significant benefits to a degraded site; the nature and extent of the benefit varies according to the physical and chemical properties of the material. However, the potential environmental and human health risks must be assessed and minimised.

Benefits

23. All organic matter, regardless of the source, can make a significant contribution to the physical structure of the soil to which it is applied. This can include the lowering of soil bulk density, an increase in soil moisture available to plant roots, an improvement in aggregate stability (and by implication greater resistance to erosion) and an increase in porosity, and consequently aeration, infiltration and drainage. From a biological perspective the addition of organic materials stimulates soil biological activity, which improves nutrient cycling and soil fertility. The organic matter content of materials varies considerably. Biosolids and paper mill crumble tend to have the highest organic matter content (around 50% dry weight) while others, such as compost and CLO have an organic matter content of between 20% and 50%.

24. The chemical benefits of most recycled organic materials are largely the result of their nitrogen and phosphate content, although levels of potash may be beneficial in some situations. Recycled organic matter may also contain useful levels of vital trace elements. The average ecosystem in a temperate climate needs about 100 kg N ha^{-1} $year^{-1}$ to maintain good growth. The nutrient content of recycled organic materials varies considerably, as does the availability of the nutrients. The availability of nitrogen in particular may be a more relevant criterion than total nitrogen for determining application rates. Most recycled organic materials tend to have neutral or slightly alkaline pH which is a positive asset when soils on many degraded sites tend to be acidic. Lime-treated biosolids have a higher pH and a greater liming benefit. Benefits of an elevation in pH include an improvement in the buffering capacity of the soil and reduced bioavailability of certain contaminants, such as nickel and zinc.

Risks

25. Recycled organic materials, regardless of whether or not the feedstock is source segregated, may contain a range of substances that could potentially be harmful to the environment and human health. The severity of any potential impact is related to the composition of the organic matter added, the scale of the application, the way in which it is applied and site-specific circumstances relating to topography, the soil, the receiving substrate and proximity to surface and groundwater.

26. Biological risks are principally related to plant pathogens in the case of plant derived materials such as compost. There may also be a risk from human pathogens such as E. coli and Salmonella in compost, CLO and conventionally treated biosolids. If the biological treatment process used was undertaken correctly, the pathogen presence should be very low. Good management of the material and appropriate personal protection equipment should minimise the impact any pathogens may have during application and levels of pathogens should drop to near background within a few months of application.

27. Chemical risks are mostly related to contaminants such as arsenic, boron, cadmium, copper, lead, mercury, nickel, selenium and zinc, which tend to be elevated in comparison to their concentration in soils. Other contaminants that may be present include a range of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), dioxins, furans, biocides and pesticides. These contaminants may be persistent and may bioaccumulate: they could affect plant growth, interfere with plant and soil processes and adversely influence human health. If any contaminants present are not contained within the zone of application they may also be a threat to the wider environment.

28. Plant nutrients can also have short-term negative as well as beneficial impacts. Nitrogen released from large additions of organic materials might be several times greater than plant requirements during the first season after application and has the potential to leach into drainage water. Small quantities of phosphate might be leachable, but movement of phosphate off-site is mainly through association with eroded sediment. Low nutrient levels are appropriate for certain vegetated after-uses, such as species-rich grassland, which thrives in soils poor in phosphate and potash.

3 Benefits and risks

29. Adverse physical impacts of recycled organic matter include the content of inert material that may be present such as stones, glass, rubble, plastic and metal. The impact of such material is largely visual: fragments of glass and small fractions of plastic are highly visible at a distance. There is also the potential for harm to animals via the ingestion of larger fragments of plastic. In the case of certain recycled organic materials dust may have a significant physical impact, particularly during application and possibly afterwards if the material has not been effectively incorporated.

30. It is important to emphasise that, depending on the nature of the source material and the treatment process used, the substances discussed above may not be present, or their concentrations, if they are present, may be within acceptable limits. It is also highly unlikely that any one batch of material would contain all possible contaminants in significant concentrations. It should also be emphasised that land reclamation brings about many environmental, social and economic benefits to a site and the surrounding area, and that any risks should also be considered in this context and weighed against the benefits.

4 Regulatory requirements

31. Waste policy is now dealt with by the devolved administrations: at present these policies are broadly similar and are summarised in waste strategies, available for each country in the UK at the weblinks listed below. The strategies follow the principles of the waste hierarchy, which places reduction in waste, reuse of materials, recycling and composting, energy recovery, and disposal in order of priority.

- **Defra Waste Strategy 2007:**
  http://www.defra.gov.uk/environment/waste/strategy/stategy07/documents/waste07-strategy.pdf
- **Scottish National Waste Plan 2003:**
  http://www.scotland.gov.uk/Publications/2003/02/16445/18571
- **Welsh Government information on waste and recycling, including the National Waste Strategy for Wales:**
  http://wales.gov.uk/topics/environmentcountryside/epq/waste_recycling/?lang=en
- **Northern Ireland Waste Management Strategy 2006 – 2020:**
  http://www.doeni.gov.uk/towards_resource_management.pdf

32. The production of some organic materials is subject to particular specifications, standards and protocols. The most significant specifications for organic materials used in land reclamation are PAS100 (compost) and PAS110 (digestate from source segregated feedstock). Further information can be downloaded from the following Weblinks:

- **WRAP PAS 100 homepage:**
  http://www.wrap.org.uk/composting/compost_specifications/bsi_pas_100/index.html
- **AfOR PAS110 information downloads page:**
  http://www.organics-recycling.org.uk/index.php?option=com_docman&task=cat_view&gid=64&Itemid=86

33. In Scotland, materials that comply with PAS100 are considered to be fully recovered and are no longer regarded as a waste material provided that there is a secure market for the compost or digestate and it is not merely being discarded. For material compliant with PAS110 different rules will apply and have yet to be finalised by SEPA. Currently in Northern Ireland PAS100 compost is considered to be fully recovered, but as of 2009 Northern Ireland has joined the Quality Protocols scheme so this position will be reviewed. In order to be fully recovered within England and Wales (and Northern Ireland as of 2009), compost and digestate must also comply with the relevant Quality Protocol. A Quality Protocol gives guidance on how waste should be recovered and removed from the regulatory regime. Materials that comply may be used more flexibly and may therefore be sold more readily. Further information on the Quality Protocols for compost and digestate can be found at the **WRAP Quality Protocol information page**, which is available at the following weblink:

- http://www.wrap.org.uk/recycling_industry/quality_protocols/index.html

Currently In Northern Ireland PAS 100 compost is considered to be fully recovered but, Northern Ireland has now joined the Quality Protocols Project so this position will be reviewed.

34. The Waste Management Licensing Regulations (WMLR) are the main form of waste legislation in Scotland and Northern Ireland. Applications of materials classified as waste maybe undertaken on non-agricultural land through an exemption via either Paragraph 7 (forests, parks etc.) or 9 (reclamation or restoration). It must be demonstrated that the application will result in agricultural benefit or ecological improvement. The material used for restoration must also be fit for purpose. More details can be found at the links below.

- **Waste Management Licensing Amendment (Scotland) Regulations, 2003:**
  http://www.opsi.gov.uk/legislation/scotland/ssi2003/20030171.htm
- **Activities exempt from waste management licensing in Scotland:**
  http://www.sepa.org.uk/waste/waste_regulation/application_forms/exempt_activities.aspx
- **Waste Management Licensing Regulations (Northern Ireland) 2003:**
  http://www.opsi.gov.uk/sr/sr2003/20030493.htm
- **Activities exempt from waste management licensing in Northern Ireland:**
  http://www.ni-environment.gov.uk/waste-home/authorisation/exemption.htm

4 Regulatory requirements

35. Since April 2008 waste management activities in England and Wales have been regulated through the Environmental Permitting (EP) regime, which combines waste management and Pollution Prevention and Control (PPC) regulations. EP covers activities including waste management and the application of waste-derived products to land as part of the recovery process. The application of organic materials to degraded land as part of a land reclamation programme would be considered as a waste operation within the EP regulations, and would require an environmental permit for the activity to go ahead. However, during the transition period between the new and old systems, the spreading of the majority of organic materials for land restoration purposes in England and Wales is being undertaken under a paragraph 9 exemption from EP regulations. This allows for the landspreading of the following (relevant) organic materials, provided they are not classed as hazardous waste: paper and cardboard processing wastes, composts, water treatment sludges, wastewater treatment sludges, and sludges from soil remediation. The new system of Standard Permits will include updated lists of applicable waste streams. Of the sixteen new Standard Rule Permits developed to date, Standard Rule SR2009No10 (Use of mobile plant for treatment of land for land reclamation, restoration or improvement) is the most direct replacement to the current Paragraph 9 exemption. A copy can be found at:

- **EP Standard Rule for Mobile Treatment Plant:**
  http://www.environmentagency.gov.uk/static/documents/Research/SR2009No10_Mobile_Plant_for_treatment_of_land_for_land_reclamation_restoration_or_improvement.pdf

36. The new table of wastes included within the Standard Permit may still be subject to amendment. It is anticipated that the Environmental Permitting system will be fully operational by April 2010. A copy of the draft regulations, including the dates and transitional provisions can be found at:

- **Draft Environmental Permitting Regulations:**
  http://www.opsi.gov.uk/si/si2009/draft/ukdsi_9780111487112_en_1

37. The principal environmental protection legislation for the water environment in Europe is the Water Framework Directive (2000/60/EC) and associated Groundwater (daughter) Directive (2006/118/EC). These Directives require the protection of good quality waters and the improvement of poor quality waters across the scale of river basin districts, which are large basins covering several hundreds of square kilometres. The application of recycled organic matter as part of a reclamation project should be undertaken in such a way as to cause minimal impact on the aquatic environment. Good practice is a fundamental part of ensuring that the environmental impact of organic matter application is controlled. Further information on the Water Framework Directive can be found at the following link:

- **Water Framework Directive Information Site:**
  http://www.euwfd.com

The goal of the EU Nitrates Directive is to reduce the impact of diffuse nitrate pollution and either improve or maintain the ecological status of surface water in line with the Water Framework Directive. On agricultural land within designated Nitrate Vulnerable Zones (NVZ, covering 70% of England, 14% of Scotland, 100% of Northern Ireland and 4% of Wales) the maximum amount of nitrogen that can be applied annually from livestock (including field deposited and handled manures) is 170 kg N per hectare averaged over the whole farm area. Farmers wishing to apply for higher nitrogen loading rates (up to 250 kg per hectare total N) must apply for a derogation. There are currently no restrictions on nitrogen application on non-agricultural land as part of a land reclamation project, as long as it is within its aftercare period following restoration and is being managed according to planning agreements. If the land is still within the aftercare period it is not classed as agricultural land even though it may be put to an agricultural use during this time. For example, the growth of non-food crops may be considered as an agricultural activity, even when it occurs on non-agricultural land. Sites which are no longer in the aftercare period, may potentially be considered as agricultural land, so the NVZ rules would apply in designated areas.

- **EU Nitrates Directive:**
  http://ec.europa.eu/environment/water/water-nitrates/directiv.html?lang=_e

38. As well as the weblinks provided within this Code, further information on regulatory issues is also available in the accompanying Technical Document. A summary of how different standards and regulations are applied in the different countries of the UK is shown in Table 4.1

4 Regulatory requirements

Table 4.1 Summary of variations in regulatory requirements between UK countries

	Material			Applications		Protection	
	PAS100	**PAS110**	**Quality Protocol**	**WMLR**	**Environmental Permitting**	**WFD**	**NVZ**
England	PAS100 material can be applied to land for reclamation but is still considered as a waste in England.	PAS110 material can be applied to land for reclamation but is still considered as a waste in England.	Material must be of PAS100/110 quality to be considered for the relevant Protocol. Material in England that passes the Quality Protocol is no longer considered as a waste.	WMLR were superseded in England by the Environmental Permitting scheme in April 2008.	Biosolids, CLO and composts etc. that do not comply with a Quality Protocol should be applied to non-agricultural land in England under an Environmental Permit. The Permit can be standard or bespoke depending on the nature of the activity and the organic material.	The maintenance or improvement of ecological status in surface and groundwater may influence land reclamation practice within a river basin district. River basin districts cover the whole of the UK but their management is undertaken by different competent authorities in each case.	NVZ legislation does **not** apply to non-agricultural land. Applications of organic material in land reclamation should be sensitive to the prevention of nitrate pollution through good practice but are not restricted by the targets set for agricultural land.
N. Ireland	Material that reaches the criteria for PAS100 is no longer considered as a waste in Northern Ireland.	No position taken on PAS110.	Northern Ireland has joined the Quality Protocol programme as of 2009.	Material classified as waste may be applied to land for reclamation purposes. This activity must be registered via a Paragraph 11 exemption.	Environmental Permitting does not apply in Northern Ireland.		
Scotland	Material that reaches the criteria for PAS100 is no longer considered as a waste in Scotland provided it has a secure market.	SEPA is still considering the status of PAS110 in terms of "end of waste".	Quality Protocols are not required in Scotland. However, operators are free to register and comply with the requirements of protocols if they so wish.	Scotland still uses the WMLR to regulate applications of organic materials to land. Waste organic matter is applied to non-agricultural land under a Paragraph 7 or 9 exemption depending on the type of operation.	Environmental Permitting does not apply in Scotland.		
Wales	PAS100 material can be applied to land for reclamation but is still considered as a waste in Wales.	PAS110 material can be applied to land for reclamation but is still considered as a waste in Wales.	Material must be of PAS100/110 quality to be considered for the Protocol. Material in Wales that passes the Quality Protocol is no longer considered as a waste.	WMLR were superseded in Wales by the Environmental Permitting scheme in April 2008.	See information for England.		

5 Case Studies

39. The case studies highlighted in this section demonstrate the range of former uses, end goals and geographical coverage of such projects and cover a range of scales, from the relatively small to the very large. They also reflect the usage of organic materials; many have used PAS100 compost, but other materials have also been used.

Lambton cokeworks

40. This project involved the restoration of a former industrial site on the fringe of urban development in County Durham. The 66 ha site had been used for a variety of industrial activities, the last of which was a substantial cokeworks that was closed in 1984. The legacy of this activity was a severely degraded soil profile with poor physical characteristics. The site was redeveloped over the period 2007-2008 to include a large area of open space (20 ha recreational woodland, 20 ha grassland) plus housing development. A major requirement was the creation of soils suitable for the intended applications. New topsoil and subsoil were manufactured using soil-forming material found on-site, prepared to BS3882 for topsoil and combined with PAS100 compost, paper crumble and colliery shale in order to provide a suitable soil for planting. Two different soil profiles were produced; forest soil of 2 m depth with three horizons and grassland soil of 0.25 m depth. Details of the soil profiles are shown in Table 5.1. All applications of organic material were fully compliant with relevant waste management legislation at the time.

Table 5.1 Details of soil profiles created at Lambton

Forest soil	**Horizon depth (m)**	**Description**	**Volume (m3)**
Topsoil	0.1	Topsoil found on-site prepared to BS3882	20079
Upper subsoil	0.9	Paper crumble, green compost and colliery shale in the ratio 1:1:5	186370
Lower subsoil	1	Colliery shale and paper crumble in the ratio 5:2	200790
Grassland soil			
Topsoil A	0.25	Topsoil found on-site prepared to BS3882	20079
Topsoil B*	0.1	Topsoil found on site	-
	0.25	Colliery shale and paper crumble in the ratio 5:1	-

*This soil profile only to be used if and when Topsoil A is exhausted

41. The profiles were created with and without the use of a bulldozer to assess the impact of soil compaction through the use of machinery. The woodland areas were subsequently planted with alder, oak and spinosa. Plant performance was good in both cases, particularly given the dry conditions following establishment; however the loosely tipped soil showed a distinctly better performance.

Stockley Park

42. Stockley Park, west of London, was a gravel quarry that had been filled with refuse since the 1940s. Before reclamation work started in the 1980s it was derelict and a source of groundwater pollution. It was redeveloped as a business park and golf course, including lakes and footpaths for recreational users. It is an example of the use of digested biosolids from a drying bed process to build topsoil to a defined specification and to help reclaim a derelict and polluting site. Approximately 4.6M m^3 of fill was excavated to develop a 10 ha area on which the business park was built. The excavated material was also contoured over the remaining 100 ha of the site which was opened as a golf course in 1993. The redevelopment would have needed more than 300,000 m3 of topsoil, of which there was none available on-site. Topsoil was manufactured at the site using mineral material from the excavations and 100,000 m^3 of air-dried biosolids from old sludge-drying lagoons. More than 140,000 indigenous trees and shrubs were planted, of which less than 5% failed.

5 Case Studies

Trees newly planted into 2m of manufactured soil, Lambton

Stockley Park (M Reeve)

Cross Lane site entrance

St Ninian's colliery

43. The St Ninians opencast coal site in Fife, Scotland, illustrates the use of organic materials to restore land for biomass production; this is an onward use of reclaimed sites that is of particular interest for many site owners as it provides an opportunity to generate income. The site is close to a planned biofuel combined heat and power (CHP) plant at Glenrothes so there will be a guaranteed local outlet for any material produced. This is significant, as transport costs are an important consideration in the economics of such projects. The aim is to cultivate short rotation coppice to produce biomass for the plant.

44. As is the case at almost all former industrial sites, the soils were of very low quality and incapable of supporting economic production. The project has established trial plots, incorporating PAS100 compost with the on-site soil to form material on which growth trials of the planned biomass crop have been undertaken. These trials have compared plant performance in plots with and without added PAS100 material and had to comply with waste management regulations in force at the time and conform with waste management licence exemptions where applicable. This project is ongoing and more information can be found at http://www.wrap.org.uk/composting/brownfield/ summary_page_st.html

45. The results to date indicate that the nutrient content of the organic materials was not as important to initial survival as the potential for water retention. Within 18 months, soil quality properties in the organic-amended treatment were similar to those of nearby semi-natural woodland soil. The compost treatment resulted in soil microbial biomass and respiration rates comparable to those in natural systems.

Cross Lane landfill

46. The Cross Lane landfill site, to the west of Liverpool, is an example of the use of organic materials to restore land that had been previously restored to a lower specification. When the 14.4 hectare landfill facility was closed in 1978 it was restored using a thin layer of subsoil, which failed to provide an adequate environment for vegetation establishment. Over the intervening 25 years, landfill design and restoration techniques have developed and improved substantially, and the site underwent reinvigoration as part of the Forestry Commission's Newlands project, which was launched in 2003 as a vehicle for the reclamation of derelict, underused, and neglected land in north-west England for the establishment of community woodland.

47. Renovation of the restored site used a combination of locally sourced soil forming materials (silt from a nearby lake restoration project and sandy subsoil from a local redevelopment project) and PAS100 compost to create a new topsoil to support newly established woodland and native wildflower meadows. As a WRAP trailblazer site the application of material was fully compliant with the relevant waste management exemptions. Further information can be found at http://www.wrap.org.uk/composting/brownfield/summary_page_ cross.html

5 Case Studies

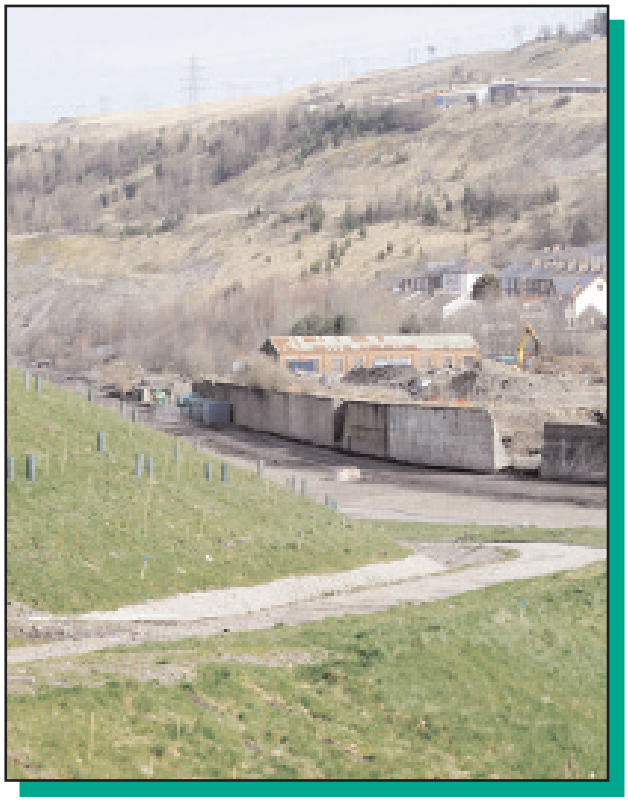
Athersley memorial park

48. The park was based on a former colliery spoil tip near Barnsley, which presented a particularly difficult substrate due to the high proportion of pyrites in the spoil, which led to the production of sulphuric acid in the leachate and very low pH values on site. This in turn led to difficulties in establishing vegetation on the site and several attempts to do so resulted in failure, despite the addition of lime to counteract the acidity. Eventually the site was remediated successfully using digested sludge cake co-composted with straw. This material was supplied by a local water company, who were responsible for communicating with the regulator with regard to the quality of the material and its application to the site under a waste management exemption. The organic matter was applied across the site at a depth of 100mm and subsequently incorporated with the shale to a depth of 100mm, resulting in a new soil profile of 200mm. To minimise risk of contamination of watercourses furrows and rips were incorporated into the lower slopes of the site near to drainage ditches at the request of the regulator. The site was planted with woodland across 30% of the area, with the remaining 70% being grassland. Vegetation establishment was successful and has not required additional treatment or fertilisation.

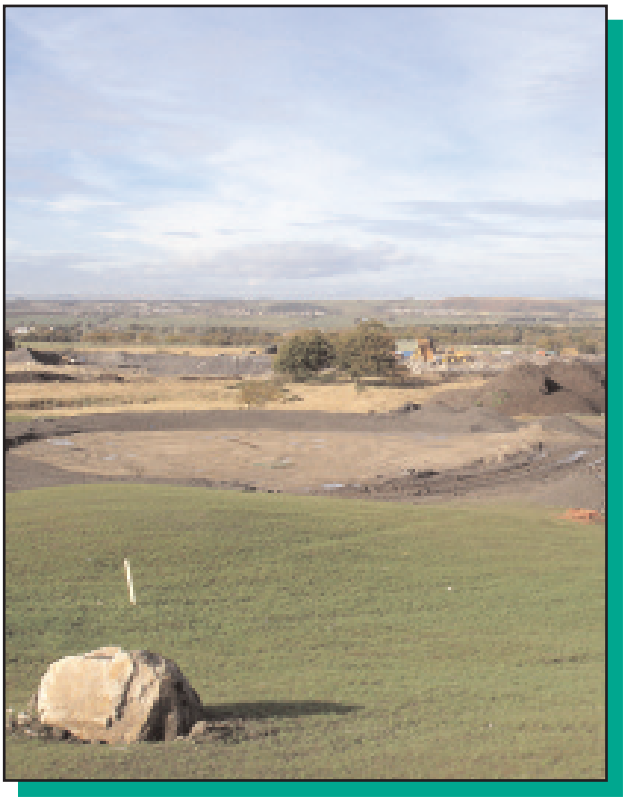
Ebbw Vale steelworks

49. This ongoing project aims to establish new grassland and woodland areas in a landscape made of manufactured topsoil on the site of a former tinplate works at Ebbw Vale in South Wales. The industrial facilities were decommissioned in 2004, after which demolition, site clearance, remediation and re-engineering were undertaken to clean up and stabilise the site prior to establishing a new use for the area.

50. Following the remediation process the site contained no natural topsoil. In order to re-establish a functioning soil at the site, locally available quantities of industrial spoils were combined with PAS100 compost and biosolids. Different combinations of spoil and organic materials were tested in pot trials at the site before large scale manufacturing of soils and planting was undertaken over the site in autumn 2007. Further details of the project can be found at http://www.wrap.org.uk/composting/brownfield/summary_page_ebbw.html



Ebbw Vale after vegetation establishment



Emerging Polkemmet golf course

5 Case Studies

Polkemmet opencast site

51. The Polkemmet opencast site, near Whitburn, West Lothian, is the largest of the case studies selected, covering 470 hectares. Unlike many of the other projects it has a very specific end goal of producing two golf courses, as well as other leisure facilities and housing. The quality of the manufactured soil had to be suitable to support the good quality turf needed for its end use. The trial also had to comply with waste management regulations in force at the time and conform with relevant waste management licence exemptions. A series of experiments to combine the large volume (>4 million tonnes) of colliery waste on the site, with PAS100 compost sourced from the area, showed that a ratio of shale to compost of 70:30 was the optimum to provide strong growth and good nutrient availability. Large scale plot experiments (2000 m^3, to which 750 m^3 of PAS100 compost was added) using six different combinations of golf course grass mixtures were assessed to identify the most suitable combination. Further details of this project can be found at http://wrap.org.uk/downloads/Case_study_Polkemmet.ba9d2f44.5524.pdf

Machair sand dunes

52. The Western Isles of Scotland contain a wide range of rare and unique habitats supporting a highly diverse range of flora and fauna. The group of islands is also host to a small and widely distributed population, for whom wastewater treatment was provided in 2001 in line with the Urban Wastewater Treatment Directive. This resulted in the production of sewage sludge in the islands for the first time and as a result a logistical problem of treating and disposing of the material, either via transport to the mainland or local use, if possible. The 'Machair' sand dunes in the coastal fringes of the islands are a highly valued habitat that are established on calcareous soils that are subject to constant wind and water erosion, which in extreme cases can cause significant damage to the habitat. The local water company, in conjunction with Scottish Natural Heritage developed a scheme for the productive reuse of enhanced lime treated sludge on the dunes to prevent erosion and help stabilise vulnerable areas. The dunes were landscaped to reduce wind channelling and biosolids incorporated to a maximum rate of 50 tonnes per hectare.

53. The above projects have been chosen from those for which comprehensive information is available in the public domain. However a range of organic materials has been used in a variety of land restoration applications, some of which are listed in Table 5.2 below:

Table 5.2 Other case studies showing further uses of organic materials and types of land restoration

Case study	Former use	End goal	Organic material(s) used
Lee Moor Pit, Cornwall	China clay spoil	Moorland, grassland	Biosolids, woodchip, compost and harbour dredgings
Collyweston Quarry, Northamptonshire	Limestone quarry	Grassland and woodland	MSW digestate
New Park Springs Tip, South Yorkshire	Coal washing plant	Grassland, woodland and wildflowers	Paper crumble and biosolids
Cromwell Quarry, West Yorkshire	Flagstone quarry	Restoration to grassland	Paper crumble
Park Pit, Cornwall	China clay spoil	Heathland and acid grassland	WTW sludge
Glynneath Colliery, West Glamorgan	Colliery spoil	Grassland restoration	Biosolids

6 Code of practice for using recycled organic materials in land reclamation

54. The Code of Practice described in this section is divided into four parts:

1. General appraisal of potential for using organic materials on a site

2. Site-specific investigation and sampling, and assessment of appropriate soil amelioration methods

3. Application of recycled organic matter as part of the restoration process

4. Monitoring and aftercare of a site once reclaimed

It is assumed that the Code will be followed sequentially but this is not essential. For example, a user may wish to consult the code for advice on aftercare: using the Code. Alternatively, some procedures (such as assessing site suitability and in-depth site investigation) may occur concurrently.

55. As well as following the advice provided in this Code, it is recommended that an open and ongoing dialogue is maintained with local planning authorities and environmental regulators, as well as any relevant local stakeholders. Keeping the relevant groups informed about what is being undertaken is the most effective way of making a project run smoothly and effectively. The number of stakeholders, the extent of their involvement and the complexity of the task will increase with the scale of the project; local planning and environmental regulatory authorities will be able to provide advice on any obligations regarding stakeholder interaction.

General appraisal of potential for using organic materials on a site

56. Estimates of the extent of degraded land across the UK vary, with the available land at any one time being highly variable in terms of its location, quality, size, form and its suitability for recovery. The first stage of the Code provides generic guidance to assess a site for its suitability for reclamation. There are two types of selection criteria in this process; the first are elimination criteria, which will mean that site is deemed appropriate or not depending on the response; the second are restriction criteria, which may limit the space within a site that is suitable for organic matter application or the type of organic matter that may be applied. The end goals of this assessment are as follows:

- To establish whether the site is suitable for further investigation
- To broadly identify broadly the areas within the site that are suitable for organic matter application
- To identify areas that may be suitable for organic matter application if they are amended appropriately

57. This assessment is likely to be a desk-based survey, requiring only readily available published information about the site and maps of the area to be completed. The decision tree shown in Figure 6.1 is a summary of the process. Further information on the criteria is discussed below.

58. It is possible that a site, or part of a site to be improved by the application of organic material may be part of a designated environmental protection area, such as a Site of Special Scientific Interest or a National Nature Reserve (for example see the Machair Dunes project in Section 5) It is more likely that a designated environmental protection area might be adjacent to the planned reclamation site, in which case care should be undertaken to ensure that organic matter application does not have any negative impact on the designated site. If a designated area is part of, or adjacent to, the site to be reclaimed, there should be consultation with Scottish Natural Heritage, Natural England or the Northern Ireland Environment Agency (depending on the location of the site) to establish the most appropriate way to use recycled organic materials in the area.

59. If at this initial stage any part of the site is known to be classified as contaminated land, specialist advice should be sought as to the nature of the contamination, the potential impact it could have on the reclamation and the time and cost implications of cleaning up the contamination. If the contamination can be managed appropriately within the reclamation project, the assessment may proceed.

60. The potential for groundwater pollution from contaminants within and applied to the site means that sites with shallow (<1m) permanent groundwater immediately below the site should not be considered. Where the site is within 20 metres of a surface water course a buffer zone should be established within which organic materials are not applied. Similarly, a buffer zone of 50 metres should apply in the vicinity of a water abstraction point (either surface water or a borehole). Although it is unlikely that a drinking water abstraction point would exist on degraded land the possibility should be considered. A further issue is the potential for flooding; contamination, if present, can be transferred from the site to surface water very effectively if the site is frequently inundated. It is recommended that no organic matter application is undertaken in areas of the site that are prone to regular flooding. If such an area forms a large part of the site, measures to reduce the risk of flooding may be considered as an alternative.

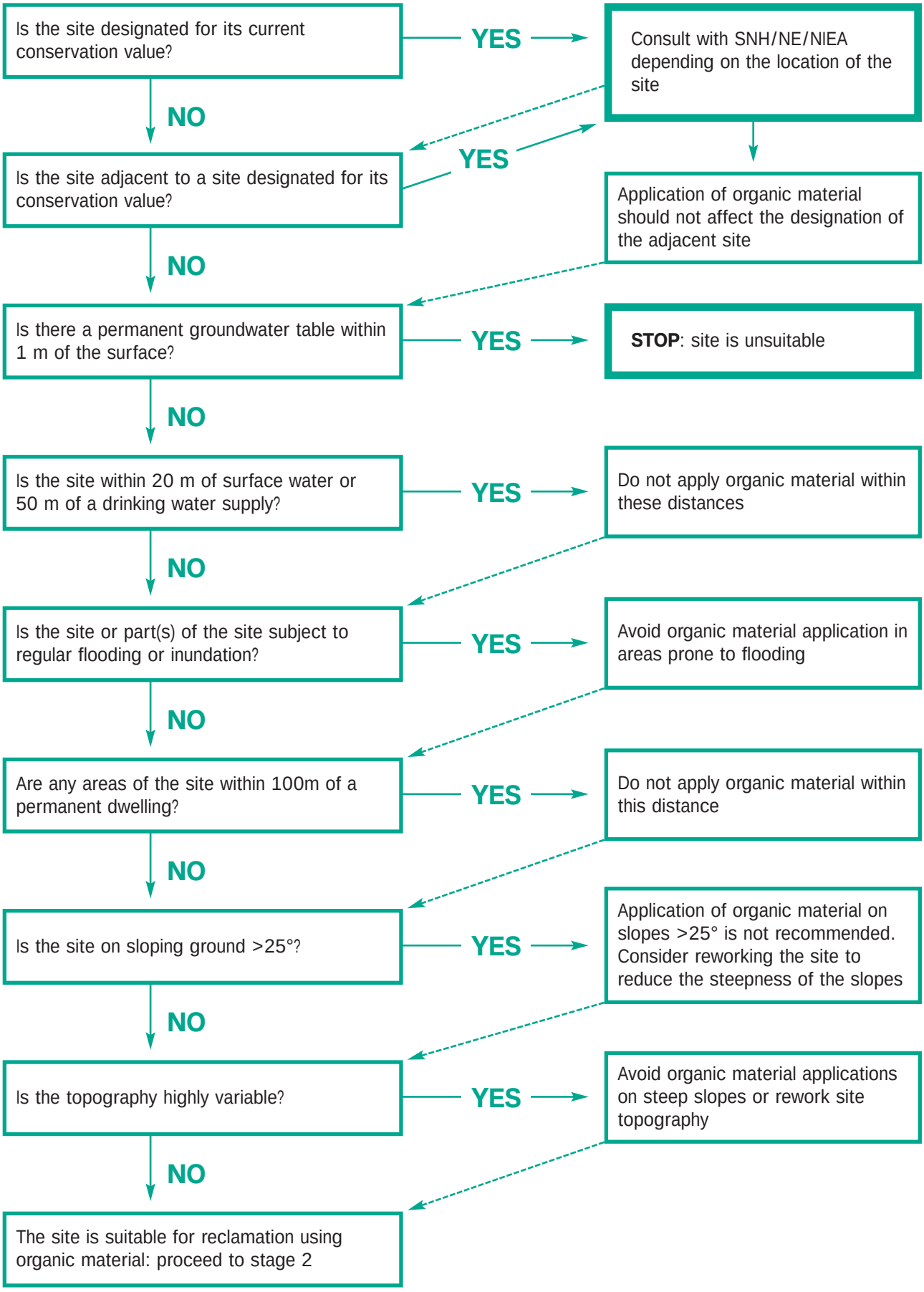
61. A buffer zone of 100 metres should be considered around any permanent dwellings, 50 metres around non-permanent dwellings and non-residential buildings, such as factories, and 20 metres around public highways. This will help to avoid nuisance impact from odour, or from particulate material if the organic matter used is relatively dry and could be dispersed by wind. These boundaries should be taken from the nearest boundary of the property that may be affected rather than the boundary of the site being reclaimed.

62. The general topography of the site should be considered. Applications of organic material are not recommended if the site as a whole is on a slope greater than 25 degrees. In part this is due to the increased risk of surface runoff and in part due to the impracticalities of using spreading machinery on such steep slopes, especially if the ground is not stable. Areas with a slope between 15 and 25 degrees should also be noted, as this has a bearing on the application of organic matter, which is discussed in subsequent stages of the Code. Where sites are generally less steep than 25 degrees, they may contain areas of steep slopes, rock outcrops and plateaux, all of which can affect the application and subsequent distribution of organic matter. The site manager may wish to consider earthworks to reduce the extent of significant slopes on the site.

63. The end product of this assessment should be a map of the site, with the boundary of the area to be reclaimed shown clearly, along with the zones where there might be the potential to apply organic materials, as well as annotations showing where the application of organic matter will be restricted and why. It is recommended that this map is discussed with the relevant planning and environmental regulators prior to continuing to in-depth site investigation.

6 Code of practice for using recycled organic materials in land reclamation

Figure 6.1 Decision tree [AS2] for assessing basic site suitability for reclamation



6 Code of practice for using recycled organic materials in land reclamation

Site-specific investigation and sampling, and assessment of appropriate soil amelioration methods

64. Having established the potential for use of organic matter as part of the restoration process, a more detailed site investigation should be undertaken. This process is summarised in Figure 6.2 and described in the following sections.

65. The availability of existing re-usable soils and soil forming materials on-site should be established through a detailed audit of soil conditions that: a) is separate from any geotechnical or geo-environmental investigation and b) is carried out by a suitably qualified soil scientist (for example, an individual with membership of the Institute of Professional Soil Scientists or similar qualifications). Depending on the nature of the site and ground conditions, the investigation should be carried out by spade, soil auger or machine-dug trial pit. This will enable a plan to be produced that delineates and quantifies the different soil and soil-forming materials present. These different materials can then be characterised in more detail by sampling and analysis which will establish if there is a need for improvement using recycled organic materials and, if so, the most appropriate materials and application rates.

66. Sampling strategies will depend on the form and nature of the soil-forming materials or substrates. The following guidelines are recommended:

- From stockpiled materials, samples should be taken at regular intervals from both the surface 1 m and the core according to standard methods. One composite sample (minimum 2 kg) should represent no more than 5,000m^3 of material.
- From non-stockpiled, surface accessible soil-forming materials, 25 samples should be taken across each separate area identified by the soil audit survey and mixed together to create one composite sample (minimum 2 kg) for analysis. Sampling patterns based on a rectilinear grid or a random “figure of W” are equally suitable, but large areas (>5 ha) should be subdivided into smaller areas for sampling. The depth of the sampling will depend on the thickness of the specific material being sampled and should be representative of the full depth, but should always include a 15cm sample.
- Buried resources of soils or soil-forming materials will need to be sampled from a trial pit.
- Any areas of known or probable contamination should be investigated further and specialist knowledge should be sought with regard to any further treatment.

67. The soil samples should be analysed using auditable, published standard analytical methods and undertaken in an laboratory accredited by the United Kingdom Accreditation Service (UKAS) for the determinands listed in Table 6.1. Accredited laboratories can be found on the UKAS website at http://www.ukas.org/. Statutory and advisory limits exist for the list of contaminants to be measured (See Table 6.2) and so the rate of application of organic material may be influenced by their concentrations. Further contaminants may be a concern in individual organic materials or soil-forming material at specific sites, therefore this list of contaminants should not be seen as exhaustive in terms of a site investigation.

Table 6.1 Determinands to be measured in soil samples

Category		Determinands
Soil fertility properties		pH, organic matter content
		Total & mineral N (i.e. nitrate and ammonium), extractable P, K, Mg
Site-specific soil properties		Pyrite (if expected as in certain colliery spoils), calcium carbonate content (if pH >7.5)
Contaminants	Chemical	As, Cd, Cu, Cr, F, Ni, Hg, Mo, Pb, Se, Zn
	Physical	Glass, plastic, inert materials (if appropriate)

68. The organic material(s) intended for the site, as well as any other inorganic materials to be used in the soil forming process should undergo similar analyses, or typical composition data supplied by an accredited laboratory should be provided as an alternative.

6 Code of practice for using recycled organic materials in land reclamation

69. If the soil has an average pH value across the site of less than 5.0, then organic matter application should only be considered if a lime-rich product is to be used or if separate pH adjustment will be undertaken. Many sites that can be reclaimed are acidic and organic matter addition is an effective means of reducing the acidity of the resulting soil. This in turn reduces the mobility and bioavailability of many contaminants that may be found on the site.

70. Table 6.2 lists the maximum permissible concentrations of potentially toxic elements in soil of a range of potentially toxic substances at different levels of acidity (above pH 5.0). It is recommended that applications of organic matter do not result in concentrations in the surface layer of the finished soil above these limits. Predicted concentrations after different rates of incorporation can be calculated from the analyses of the organic matter and the soil-forming material in which it is to be incorporated, along with anticipated rates of application.

71. It is acknowledged that in some cases reclamation may require an application of organic matter that results in a concentration of potentially toxic substances in excess of these levels. In these cases, it is the responsibility of those undertaking the reclamation project to provide justification to the regulatory authorities that the application is necessary, it will result in genuine ecological improvement and it will not result in harm to the wider environment.

Table 6.2 Statutory and advisory maximum permissible concentration of potentially toxic substances in soil (mg kg^{-1} dry solids)

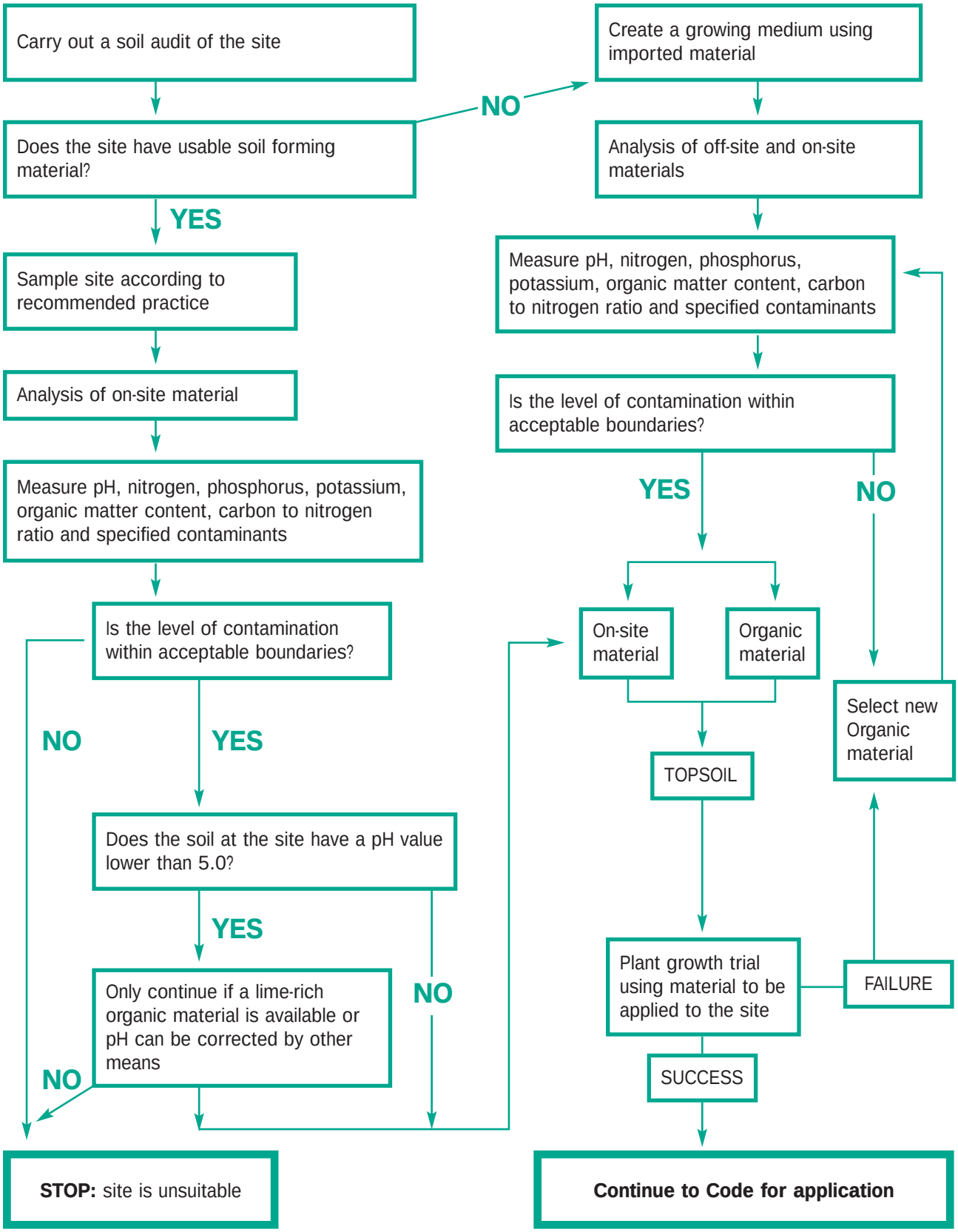
Substance	**Maximum permissible concentration of potentially toxic substances in soil (mg kg^{-1} dry soil)**			
			pH	
	5.0<5.5	5.5<6.0	6.0-7.0	>7.0[1]
Zinc	200	200	200	300
Copper	80	100	135	200
Nickel	50	60	75	110
	For pH 5.0 and above			
Cadmium	3			
Lead	300			
Mercury	1			
Chromium	400			
Molybdenum	4			
Selenium	3			
Arsenic	50			
Fluoride	500			
Notes				

[1] Only applicable to soils with greater than 5% calcium carbonate

72. In order to assess the likely performance of the soil-forming material for the stated end goal, plant growth trials using the organic material on-site (i.e. soil-forming material and organic material mixed in the proportions planned) and the planned plant species might be beneficial on large scale projects (>50ha). In the case of smaller projects, plant growth trials are recommended for onward uses that are sensitive to nutrient or contaminant concentrations in the soil, such as wildflower habitats. Ideally the plant growth trials should take place on-site so that they are representative of the local conditions. If the plant growth trials are successful (i.e. an optimum combination of organic material and on-site mineral material has been identified to produce satisfactory plant growth performance), the full scale application should go ahead; if the trial has been a limited success or has not been successful, a second trial using another source or combination of organic material is recommended.

6 Code of practice for using recycled organic materials in land reclamation

Figure 6.2 Decision tree for assessing site properties



6 Code of practice for using recycled organic materials in land reclamation

Application of recycled organic matter

73. The amount of recycled organic matter that is appropriate for a site is a function of the nature and quality of the organic material to be applied, the quality of the soil forming material available either on-site or imported from elsewhere and the planned end goal of the reclamation project. Application of the recycled organic material (or topsoil created with it) should be undertaken so as to ensure maximum benefit to the site itself, minimal impact on the environment, minimal nuisance to local residents and with regard to the health and safety of site workers. This process is illustrated in Figure 6.3 and described in more detail below.

74. The rate at which organic materials should be applied to the site depends on the final goal of the reclamation project, the physical and chemical quality of the soil or soil-forming material being used, and the chemical quality of the organic material being used in the restoration. Typical maximum application rates are illustrated in Table 6.3. Note that these application rates are **GUIDELINE VALUES.** Other application rates may be suitable for the intended application, depending on the nature of the soil and organic materials used. The analytical work required to determine a precise application rate is described elsewhere in this Code.

Table 6.3 typical rates of application for different end uses of land

Goal of reclamation	Sub categories	Typical maximum application rate (dry tonnes)	Notes
Habitat establishment/ Amenity land		50-100	Plant growth trials are recommended to ensure that nutrient levels are not excessive for the intended purpose
Soil formation	**Non-food crop production**	100-500[1]	The maximum application rate will vary depending on the condition of the land and contaminant concentration in both the organic amendment and the soil
	Return to agricultural land		
	Landfill cap		
	Colliery spoil restoration		

[1]Depending on the site-specific environmental conditions, particularly in the case of colliery spoil, the maximum application rate may need to be considerably higher than 500 tonnes per hectare, depending on the condition of the land, soil pH and the quality of the organic material(s) used. Application rates in excess of 500 tonnes per hectare would need to be justified to the environmental regulator and approved in advance.

6 Code of practice for using recycled organic materials in land reclamation

75. In addition to the basic information on guideline application rates provided in Table 6.3, the following guidance should be considered.

- Higher than normal rates of organic matter application should only be considered if it can be demonstrated that they are both beneficial and necessary for the planned end-use. Applications in excess of that needed for sustainable ecological improvement could be considered as a waste disposal rather than a land reclamation operation.
- If applying higher rates of organic material try to source a material with relatively low mineral N content, or consider mixing with a material with a high C:N ratio (such as paper crumble) as a means of immobilising N. Also, choose materials with low levels of potentially toxic substances, so as to avoid applications that would exceed limits for applications of metals as shown in Table 6.2.
- The extractable soil P concentration should be measured to reduce the risk of transport of phosphorus into water courses. If the soil has a high P concentration, then P sorption capacity should be measured and be less than 25% saturation. All measures should also be taken to reduce soil erosion at the site to avoid sediment-associated P loss.

Spreading organic material prior to incorporation, note the use of low ground pressure machinery

Compost waiting to be incorporated into surface of restored landfill

Incorporation of recycled matter into the soil following application

6 Code of practice for using recycled organic materials in land reclamation

76. The on-site material and any imported organic materials should be either blended to produce a soil material prior to being deposited across the site or the organic material should be applied directly to the surface of the site. The application of organic material, or manufactured topsoil, should be undertaken using the following best practice guidelines:

- In the case of organic materials being applied to the surface, the material should be incorporated into the soil as soon as possible after application to a maximum depth of 40 cm.
- Applications should avoid any sensitive areas identified in the initial site assessment (i.e. dwellings, roads, watercourses, drinking water abstraction points and designated areas) by the appropriate distances. Refer to the map prepared in stage 1 if necessary.
- Avoid applications on areas of saturated ground or ponded surface water wherever possible. Avoid applications in areas prone to flooding.
- Application should not be undertaken if it will not be possible to apply and incorporate the material before significant rain is forecast.
- Use spreading and incorporation machinery as carefully as possible to avoid compaction of the soil. Use low ground pressure vehicles and avoid indiscriminate vehicle movements. Avoid creating vehicle wheelings running directly downslope to reduce the potential impact of soil erosion and transport processes.
- Avoid applications at times when there is likely to be a greater nuisance to the general public; these include weekends and public holidays. Avoid days when climatic conditions may cause significant disturbance from odours.
- When applying organic materials to slopes, observe the following guidelines:
  - Do not apply material to slopes greater than 25 degrees.
  - On slopes between 15 and 25 degrees avoid using liquid organic materials, as these are most likely to be affected by runoff. Incorporate any organic material as soon as possible after application.
  - On slopes less than 15 degrees use the organic material as specified for the site in general.
- Plant vegetation cover as soon as possible following preparation of the site, to provide additional protection from soil erosion.
- Ensure that all workers involved in the application process are fully briefed with regard to health and safety requirements; this should include the handling of machinery and equipment, protective clothing, and the nature of the material and its associated risks. A COSHH[2] safety data sheet for the material(s) being used as part of the reclamation project should be completed by a suitably qualified person (such as a site manager or a person designated by the site manager) and distributed to all relevant workers (through hard copies or a safety briefing, for example). Further information on COSHH, including safety data sheets, can be obtained from the Health and Safety Executive (http://www.hse.gov.uk/COSHH/index.htm)

77. Recommended options for different former and future land use combinations and different types of organic matter are listed in Table 6.4.

78. Subsequent applications of organic materials following initial reclamation of the land may be required to maintain or further improve the quality of the restoration. These applications should be based on additional soil sampling and analyses as described in Table 6.1. Not all poorly-performing landscapes are the result of nutrient deficiencies or toxicity. The physical characteristics of the growing medium (density, porosity and permeability) should also be considered. Certain types of after-use such as woodland might prevent additional applications of organic materials (except liquids) once the trees are established.

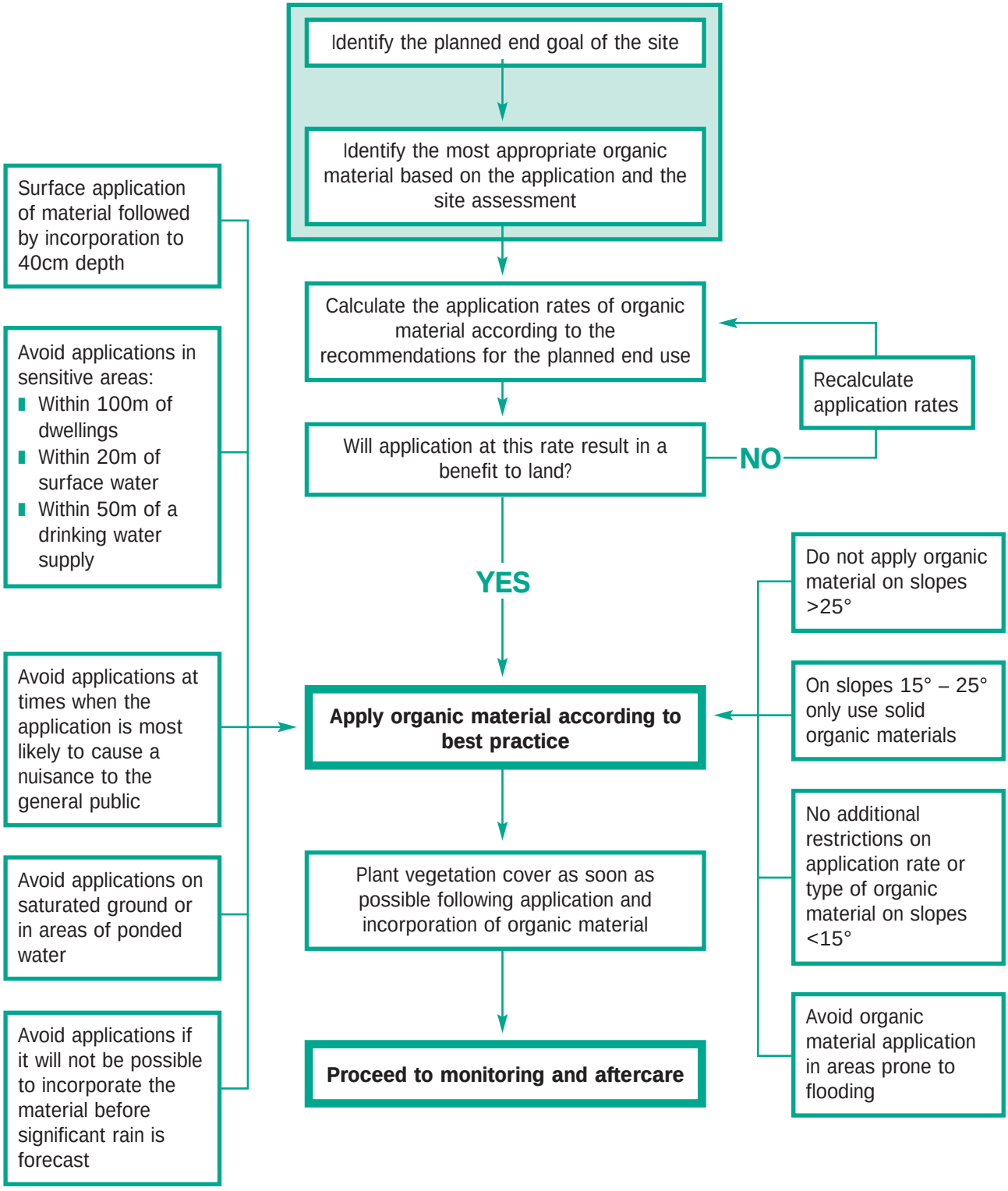
[2]Control of Substances Hazardous to Health

Table 6.4: Overall recommendations for the use of recycled organic materials in land reclamation projects (green – recommended overall; orange – recommended with caution)

Goal of reclamation	Biosolids	Green compost	Water treatment cake	CLO	Paper crumble	Industrial wastes
Habitat establishment/ Amenity land				The visual quality of some CLO may affect the aesthetic value of the habitat.	The visual impact of paper crumble may be an aesthetic concern in public areas. If paper crumble is used on its own there is a risk of N immobilisation due to the high carbon content of the material. Mixing or composting paper crumble with another organic material may be appropriate.	The specific industrial waste to be used should be appropriate to the intended application, in terms of its nutrient content, contamination, moisture content and organic matter content.
Soil formation	Levels of metal contamination may be a concern in some applications.			Some concern over the visual impact of physical contaminants. Other sources of organic matter are advised if the stated goal at the start of reclamation is to return the land to agricultural use.		
Colliery spoil	Limed sludge cake may be the best option for highly acidic soils.					

6 Code of practice for using recycled organic materials in land reclamation

Figure 6.3 Decision tree for applications of recycled organic matter



6 Code of practice for using recycled organic materials in land reclamation

Monitoring and aftercare

79. Once the site has been prepared, the organic matter applied and the vegetation cover planted, the site will require ongoing monitoring and aftercare to ensure the long-term success of the reclamation project, and to identify and remedy any potential problems as soon as possible. The following recommendations should be used as guidance and a full aftercare plan should be prepared for the site once it has been reclaimed. The details of aftercare may vary, depending on the nature of the reclamation project.

- The responsibility for monitoring and aftercare should be clearly defined; targets and goals for the monitoring and aftercare programme should be agreed before the start of the programme.
- The suggested timings for an aftercare site survey are six months, one year, two years and five years. At this point, if it is the intention to do so, the land can be converted to agricultural land provided the relevant criteria have been met. The land would then be subject to agricultural regulations.
- An additional, optional survey may be carried out after ten years.
- The format of the aftercare survey will vary according to the end goals, targets and timing of the survey, which should be agreed at the start of the aftercare process; the survey would typically include the following:
  - An estimate of vegetation cover across the whole site.
  - A more detailed survey of the number and variety of plant species undertaken in several defined areas across the site. These should be chosen so that they will be accessible and unchanged over the course of the aftercare period in order to ensure consistency.
  - A survey of the health of plants and trees (if applicable) across the same sites. A range of health indicators such as height, foliage and plant loss should be noted.
  - An overall assessment of the health of the vegetation on the site.
  - A note of any concerns over the health of the vegetation on the site, together with suggestions for causes and recommendations for remedial action.
  - An assessment of the ecological status of key fauna on the site, if relevant.
  - An assessment of the overall state of the environment at the site, including, if relevant, watercourses, evidence of soil deterioration and the state of amenities such as access roads, footpaths, benches and shelters.
- The survey should be carried out by appropriately qualified scientists able to identify any issues of concern and provide suitable advice on remedial action.
- The survey should be supplied to the site manager in the form of a concise report, preferably in a standard format agreed at the start of the aftercare programme.

80. It will be the responsibility of the site owner or their management company to act on the advice of the survey.

Undertaking a soil audit following reclamation

7 Further information

Dissemination status
Unrestricted

Use of this report
This Code of Good Practice has been produced by the Scotland and Northern Ireland Forum For Environmental Research (SNIFFER) in Collaboration with, the Department of the Environment (Northern Ireland), the Scottish Environment Protection Agency (SEPA), Scottish Water, the Environment Agency of England and Wales and the Waste and Resources Action Programme (WRAP).

This Code of Good Practice is believed to represent the best scientific information and expert opinion available to the research contractor. No responsibility is claimed by SNIFFER or the research contractor for any actions that result from individuals or contractors following the guidance in this Code.

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