Annex 21

HELCOM RECOMMENDATION 31E/4

Supersedes HELCOM Recommendation 24/5 from 1st January 2011.

Adopted 20 May 2010,
having regard to Article 20,
Paragraph 1 b) of the Helsinki Convention

PROPER HANDLING OF WASTE/LANDFILLING

THE COMMISSION,

RECALLING Article 3, para 1 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties shall individually or jointly take all appropriate legislative, administrative or other relevant measures to prevent and eliminate pollution in order to promote the ecological restoration of the Baltic Sea Area and the preservation of its ecological balance,

RECALLING Article 5 of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention), in which the Contracting Parties undertake to prevent and eliminate pollution of the marine environment of the Baltic Sea Area caused by harmful substances from all sources,

RECALLING that the 1988 Ministerial Declaration called for a considerable reduction of land based pollution,

RECALLING the Baltic Sea Action Plan adopted in November 2007, that called for an updating of recommendation 24/5 on proper handling of waste/landfilling.

RECALLING FURTHER a need for harmonised requirements on proper handling of inert, non hazardous and hazardous waste, introducing of modern landfill techniques and phasing out improper dumping sites, and noting the EU Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste,

DESIRING to prevent pollution of the Baltic Sea from discharges originating from landfills and dumping sites,

RECOMMENDS that the Governments of all the Contracting Parties not later than 1 January 2011 for existing landfills within the Baltic Sea catchment areas, except for small landfills located in some of the EU countries for which the deadline of 1 July 2012 has been agreed with the European Commission, take measures as follows:

a) existing landfills not fulfilling the criteria of proper landfilling practices required for obtaining a permit should be closed, or restored in accordance with the national legislation;

b) existing landfills which have been nationally granted a permit and do not implement proper handling of waste should be brought in line with the requirements of national legislation or closed down as soon as possible,

RECOMMENDS FURTHER that the Governments of all the Contracting Parties from 1 January 2011 take measures as follows:

a) the amount of waste to be landfilled should be minimised and its hazard level to the environment and human health should be decreased through introduction and wide implementation of waste separation, pre-treatment and recycling;

b) national legislation should be upgraded and enforced in order to reach proper handling of waste and proper landfilling practices and to prevent illegal waste dumping as defined in EC Council Directive 1999/31/EC;

c) proper landfilling should be implemented with regard to location, design, construction of new landfills and their operation, closure and aftercare phases;

d) the environmental risk of already closed landfills should be assessed and pollution prevention measures should be implemented. Both the procedures must be in accordance with national legislation and in proportion to the possible environmental threat,

e) only waste that has been subject to treatment is landfilled. This provision may not apply to inert waste for which treatment is not technically feasible, nor to any other waste for which such treatment does not contribute to the objectives of this recommendation, by reducing the quantity of the waste or the hazards to human health or the environment

RECOMMENDS FURTHER that the enclosed criteria and procedures for acceptance of waste at landfills (cf. Annex to this Recommendation) will be applied in the Contracting Parties as soon as possible, but not later than January 1st, 2013.

RECOMMENDS FURTHER that the Contracting Parties should report to the Helsinki Commission on implementation of this Recommendation in 2014 and every three years thereafter.

HELCOM Recommendation 31E/4, Attachment

DEFINITIONS

UNDERSTANDING under

a) "proper handling of waste" and "proper landfilling" operational techniques and waste management practices which are on the level with the EU Council Directive 1999/31/EC regulations;

b) "risk" a potential hazard for the Baltic Sea area caused by direct and indirect pollution of surface water and groundwater contaminated by landfills;

c) "hazardous waste" is any waste defined as hazardous by national legislation;

d) “non-hazardous waste" means waste which is not covered by paragraph c

e) "inert waste" means waste that does not undergo any significant physical, chemical or biological transformations. Inert waste will not dissolve, burn or otherwise physically or chemically react, biodegrade or adversely affect other matter with which it comes into contact in a way likely to give rise to environmental pollution or harm human health. The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant, and in particular not endanger the quality of surface water and/or groundwater;

f) "municipal waste" means waste from households, as well as other waste which, because of its nature or composition, is similar to waste from household;

g) "landfill" means a waste disposal site for the deposit of the waste on to or into land (i.e. underground), including internal waste disposal sites (i.e. landfill where a producer of waste is carrying out its own waste disposal at the place of production) or permanent site (i.e. more than one year) which is used for temporary storage of waste, but excluding facilities where waste is unloaded in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere, and storage of waste prior to recovery or treatment for a period less than three years as a general rule or storage of waste prior to disposal for a period less than one year.

ANNEX

CRITERIA AND PROCEDURES FOR THE ACCEPTANCE OF WASTE AT LANDFILLS

Introduction

This Annex lays down the uniform waste classification and acceptance procedure according to recommendation on landfills.

Section 1 of this Annex lays down the procedure to determine the acceptability of waste at landfills. This procedure consists of the basic characterisation, compliance testing and on-site verification.

Section 2 of this Annex lays down the acceptance criteria for each landfill class. Waste may be accepted at a landfill only if it fulfils the acceptance criteria of the relevant landfill class as laid down in section 2 of this Annex.

Section 3 of this Annex lists the methods to be used for the sampling and testing of waste.

Appendix A defines the safety assessment to be carried out for underground storage.

Appendix B is an informative Annex providing an overview of the landfill options available and examples of possible subcategorisation of landfills' non-hazardous waste.

1. PROCEDURE FOR THE ACCEPTANCE OF WASTE AT LANDFILLS

1.1. Basic characterisation

Basic characterisation is the first step in the acceptance procedure and constitutes a full characterisation of the waste by gathering all the necessary information for a safe disposal of the waste in the long term. Basic characterisation is required for each type of waste.

1.1.1. Functions of basic characterisation

(a) Basic information on the waste (type and origin, composition, consistency, leach ability and — where necessary and available — other characteristic properties)

(b) Basic information for understanding the behaviour of waste in landfills and options for treatment

(c) Assessing waste against limit values

(d) Detection of key variables (critical parameters) for compliance testing and options for simplification of compliance testing (leading to a significant decrease of constituents to be measured, but only after demonstration of relevant information). Characterization may deliver ratios between basic characterization and results of simplified test procedures as well as frequency for compliance testing.

If the basic characterization of waste shows that the waste fulfils the criteria for a landfill class as laid down in section 2 of this Annex, the waste is deemed to be acceptable at this landfill class. If this is not the case, the waste is not acceptable at this landfill class.

The producer of the waste or, in default, the person responsible for its management, is responsible for ensuring that the characterization information is correct.

The operator shall keep records of the required information for a period to be defined by the Contracting Parties.

1.1.2. Fundamental requirements for basic characterisation of the waste

(a) Source and origin of the waste

(b) Information on the process producing the waste (description and characteristics of raw materials and products)

(c) Description of the waste treatment.

(d) Data on the composition of the waste and the leaching behaviour, where relevant

(e) Appearance of the waste (smell, colour, physical form)

(f) The landfill class at which the waste maybe accepted

(g) If necessary, additional precautions to be taken at the landfill

(h) Check if the waste can be recycled or recovered.

1.1.3. Testing

As a general rule waste must be tested to obtain the above information. In addition to the leaching behaviour, the composition of the waste must be known or determined by testing. The tests used for basic characterisation must always include those to be used for compliance testing.

The content of the characterisation, the extent of laboratory testing required and the relationship between basic characterisation and compliance checking depends on the type of waste. A differentiation can be made between:

(a) wastes that are regularly generated in the same process;

(b) wastes that are not regularly generated.

The characterisations outlined in points (a) and (b) will provide information that can be directly compared with acceptance criteria for the relevant class of landfill and, in addition, descriptive information can be supplied (e.g. the consequences of depositing with municipal waste).

(a) Wastes regularly generated in the same process

These are individual and consistent wastes regularly generated in the same process, where:

- the installation and the process generating the waste are well known and the input materials to the process and the process itself are well defined,
- the operator of the installation provides all necessary information and informs the operator of the landfill of changes to the process (especially changes to the input material).

The process will often be at a single installation. The waste can also be from different installations, if it can be identified as single stream with common characteristics within known boundaries (e.g. bottom ash from the incineration of municipal waste).

For these wastes the basic characterisation will comprise the fundamental requirements listed in section 1.1.2 and especially the following:

- compositional range for the individual wastes,
- range and variability of characteristic properties,
- if required, the leach ability of the wastes determined by a batch leaching test and/or a percolation test and/or a pH dependence test,
- key variables to be tested on a regular basis.

If the waste is produced in the same process in different installations, information must be given on the scope of the evaluation. Consequently, a sufficient number of measurements must be taken to show the range and variability of the characteristic properties of the waste. The waste can then be considered characterised and shall subsequently be subject to compliance testing only, unless significant change in the generation processes occur.

For wastes from the same process in the same installation, the results of the measurements may show only minor variations of the properties of the waste in comparison with the appropriate limit values. The waste can then be considered characterised, and shall subsequently be subject to compliance testing only, unless significant changes in the generation process occur.

Waste from facilities for the bulking or mixing of waste, from waste transfer stations or mixed waste streams from waste collectors, can vary considerably in their properties. This must be taken into consideration in the basic characterisation. Such wastes may fall under case (b).

(b) Wastes that are not regularly generated

These wastes are not regularly generated in the same process in the same installation and are not part of a well-characterised waste stream. Each batch produced of such waste will need to be characterised. The basic characterisation shall include the fundamental requirements for basic characterisation. As each batch produced has to be characterised, no compliance testing is needed.

1.1.4. Cases where testing is not required

Testing for basic characterisation can be dispensed with in the following cases:

(a) the waste is on a list of wastes not requiring testing as laid down in section 2 of this Annex;

(b) all the necessary information, for the basic characterisation, is known and duly justified to the full satisfaction of the competent authority;

(c) certain waste types where testing is impractical or where appropriate testing procedures and acceptance criteria are unavailable. This must be justified and documented, including the reasons why the waste is deemed acceptable at this landfill class.

1.2. Compliance testing

When waste has been deemed acceptable for a landfill class on the basis of a basic characterisation pursuant to section 1, it shall subsequently be subject to compliance testing to determine if it complies with the results of the basic characterisation and the relevant acceptance criteria as laid down in section 2.

The function of compliance testing is periodically to check regularly arising waste streams.

The relevant parameters to be tested are determined in the basic characterisation. Parameters should be related to basic characterisation information; only a check on critical parameters (key variables), as determined in the basic characterisation, is necessary. The check has to show that the waste meets the limit values for the critical parameters.

The tests used for compliance testing shall be one or more of those used in the basic characterisation. The testing shall consist at least of a batch leaching test. For this purpose the methods listed under section 3 shall be used.

Wastes that are exempted from the testing requirements for basic characterisation in section 1.1.4(a) and section 1.1.4(c) are also exempted from compliance testing. They will, however, need checking for compliance with basic characterisation information other than testing.

Compliance testing shall be carried out at least once a year and the operator must, in any event, ensure that compliance testing is carried out in the scope and frequency determined by basic characterisation.

Records of the test results shall be kept for a period that will be determined by the Contracting Parties.

1.3. On-site verification

Each load of waste delivered to a landfill shall be visually inspected before and after unloading. The required documentation shall be checked.

For waste deposited by the waste producer at a landfill in his control, this verification maybe made at the point of dispatch.

The waste maybe accepted at the landfill, if it is the same as that which has been subjected to basic characterisation and compliance testing and which is described in the accompanying documents. If this is not the case, the waste must not be accepted.

Contracting Parties shall determine the testing requirements for on-site verification, including where appropriate rapid test methods.

Upon delivery, samples shall be taken periodically. The samples taken shall be kept after acceptance of the waste for a period that will be determined by the Contracting Parties.

2. WASTE ACCEPTANCE CRITERIA

This section sets out the criteria for the acceptance of waste at each landfill class, including criteria for underground storage.

In certain circumstances, up to three times higher limit values for specific parameters listed in this section (other than dissolved organic carbon (DOC) in sections 2.1.2.1, 2.2.2, 2.3.1 and 2.4.1, BTEX, PCBs and mineral oil in section 2.1.2.2, total organic carbon (TOC) and pH in section 2.3.2 and loss on ignition (LOI) and/or TOC in section 2.4.2, and restricting the possible increase of the limit value for TOC in section 2.1.2.2 to only two times the limit value) are acceptable, if

- the competent authority gives a permit for specified wastes on a case-by-case basis for the recipient landfill, taking into account the characteristics of the landfill and its surroundings, and
- emissions (including leachate) from the landfill, taking into account the limits for those specific parameters in this section, will present no additional risk to the environment according to a risk assessment.

Contracting Parties shall define criteria for compliance with the limit values set out in this section.

2.1. Criteria for landfills for inert waste

2.1.1. List of wastes acceptable at landfills for inert waste without testing

Wastes on the following short list are assumed to fulfill the criteria as set out in the definition of inert waste in point e) in the definitions in this recommendation and the criteria listed in section 2.1.2. The wastes can be admitted without testing at a landfill for inert waste.

The waste must be a single stream (only one source) of a single waste type. Different wastes contained in the list maybe accepted together, provided they are from the same source.

In case of suspicion of contamination (either from visual inspection or from knowledge of the origin of the waste) testing should be applied or the waste refused. If the listed wastes are contaminated or contain other material or substances such as metals, asbestos, plastics, chemicals, etc. to an extent which increases the risk associated with the waste sufficiently to justify their disposal in other classes of landfills, they may not be accepted in a landfill for inert waste.

If there is a doubt that the waste fulfils the definition of inert waste and the criteria listed in section 2.1.2 or about the lack of contamination of the waste, testing must be applied. For this purpose the methods listed under section 3 shall be used.

Description	**Restrictions**
Waste glass-based fibrous materials	Only without organic binders
Glass packagingGlas	
Concrete	Selected C & D waste only(*)
Bricks	Selected C & D waste only(*)

Tiles and ceramics	Selected C & D waste only(*)
Mixtures of concrete, bricks, tiles and ceramics	Selected C & D waste only(*)
Glass	
Soil and stones	Excluding topsoil, peat; excluding soil and stones from contaminated sites
Glass	
Glass	Separately collected glass only
Soil and stones	Only from garden and parks waste; Excluding top soil, peat

(*) Selected construction and demolition waste (C & D waste): with low contents of other types of materials (like metals, plastic, soil, organics, wood, rubber, etc). The origin of the waste must be known.

- No C & D waste from constructions, polluted with inorganic or organic dangerous substances, e.g. because of production processes in the construction, soil pollution, storage and usage of pesticides or other dangerous substances, etc., unless it is made clear that the demolished construction was not significantly polluted.
- No C & D waste from constructions, treated, covered or painted with materials, containing dangerous substances in significant amounts.

Waste not appearing on this list must be subject to testing as laid down under section 1 to determine if it fulfils the criteria for waste acceptable at landfills for inert waste as set out in section 2.1.2.

2.1.2. Limit values for waste acceptable at landfills for inert waste

2.1.2.1. Leaching limit values

The following leaching limit values apply for waste acceptable at landfills for inert waste, calculated at liquid to solid ratios (L/S) of 2 l/kg and 10 l/kg for total release and directly expressed in mg/l for C_0 (the first eluate of percolation test at L/S = 0,1 l/kg). Contracting Parties shall determine which of the test methods (see section 3) and corresponding limit values in the table should be used.

Component	L/S = 2 l/kg	L/S = 10 l/kg	Co (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	0,1	0,5	0,06
Ba	7	20	4
Cd	0,03	0,04	0,02
Cr total	0,2	0,5	0,1
Cu	0,9	2	0,6
Hg	0,003	0,01	0,002
Mo	0,3	0,5	0,2

Ni	0,2	0,4	0,12
Pb	0,2	0,5	0,15
Sb	0,02	0,06	0,1
Se	0,06	0,1	0,04
Zn	2	4	1,2
Chloride	550	800	460
Fluoride	4	10	2,5
Sulphate	560 (*)	1 000 (*)	1 500
Phenol index	0,5	1	0,3
DOC (**)	240	500	160
TDS (***)	2 500	4 000	—

(*) If the waste does not meet these values for sulphate, it may still be considered as complying with the acceptance criteria if the leaching does not exceed either of the following values: 1 500 mg/l as C0 at L/S = 0,1 l/kg and 6 000 mg/kg at L/S = 10 l/kg. It will be necessary to use a percolation test to determine the limit value at L/S = 0,1 l/kg under initial equilibrium conditions, whereas the value at L/S = 10 l/kg maybe determined either by a batch leaching test or by a percolation test under conditions approaching local equilibrium.

(**) If the waste does not meet these values for DOC at its own pH value, it may alternatively be tested at L/S = 10 l/kg and a pH between 7,5 and 8,0. The waste maybe considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 500 mg/kg. (A draft method based on prEN 14429 is available).

(***) The values for total dissolved solids (TDS) can be used alternatively to the values for sulphate and chloride.

2.1.2.2. Limit values for total content of organic parameters

In addition to the leaching limit values under section 2.1.2.1, inert wastes must meet the following additional limit values:

Parameter	Value mg/kg
TOC (total organic carbon)	30 000 (*)
BTEX (benzene, toluene, ethylbenzene and xylenes)	6
PCBs (polychlorinated biphenyls, 7 congeners)	1
Mineral oil (C10 to C40)	500
PAHs (polycyclic aromatic hydrocarbons)	Contracting Parties to set limit value

(*) In the case of soils, a higher limit value maybe admitted by the competent authority, provided the DOC value of 500 mg/kg is achieved at L/S = 10 l/kg, either at the soil's own pH or at a pH value between 7,5 and 8,0.

2.2. Criteria for landfills for non-hazardous waste

Contracting Parties may create subcategories of landfills for non-hazardous waste.

In this Annex limit values are laid down only for non-hazardous waste, which is land filled in the same cell with stable, non-reactive hazardous waste.

2.2.1. Wastes acceptable at landfills for non-hazardous waste without testing

Municipal waste as defined in point f) in the definitions in this recommendation, separately collected non-hazardous fractions of household wastes and the same non-hazardous materials from other origins can be admitted without testing at landfills for non-hazardous waste.

2.2.2. Limit values for non-hazardous waste

The following limit values apply to granular non-hazardous waste accepted in the same cell as stable, non-reactive hazardous waste, calculated at L/S = 2 and 10 l/kg for total release and directly expressed in mg/l for C_0 (in the first eluate of percolation test at L/S = 0,1 l/kg). Granular wastes include all wastes that are not monolithic. Contracting Parties shall determine which of the test methods (see section 3) and corresponding limit values in the table should be used.

Components	L/S = 2 l/kg	L/S = 10 l/kg	Co (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	0,4	2	0,3
Ba	30	100	20
Cd	0,6	1	0,3
Cr total	4	10	2,5
Cu	25	50	30
Hg	0,05	0,2	0,03
Mo	5	10	3,5
Ni	5	10	3
Pb	5	10	3
Sb	0,2	0,7	0,15
Se	0,3	0,5	0,2
Zn	25	50	15
Chloride	10 000	15 000	8 500
Fluoride	60	150	40
Sulphate	10 000	20 000	7 000
DOC (*)	380	800	250

TDS (**)	40 000	60 000	—

(*) If the waste does not meet these values for DOC at its own pH, it may alternatively be tested at L/S = 10 l/kg and a pH of 7,5-8,0. The waste maybe considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 800 mg/kg (A draft method based on prEN 14429 is available).

(**) The values for TDS can be used alternatively to the values for sulphate and chloride.

Contracting Parties shall set criteria for monolithic waste to provide the same level of environmental protection given by the above limit values.

2.2.3. Gypsum waste

Non-hazardous gypsum-based materials should be disposed of only in landfills for non-hazardous waste in cells where no biodegradable waste is accepted. The limit values for TOC and DOC given in sections 2.3.2 and 2.3.1 shall apply to wastes land filled together with gypsum-based materials.

2.3. Criteria for hazardous waste acceptable at landfills for non-hazardous waste

Stable, non-reactive means that the leaching behaviour of the waste will not change adversely in the long-term, under landfill design conditions or foreseeable accidents:

- in the waste alone (for example, bybiodegradation),
- under the impact of long-term ambient conditions (for example, water, air, temperature, mechanical constraints),
- by the impact of other wastes (including waste products such as leachate and gas).

2.3.1. Leaching limit values

The following leaching limit values applyto granular hazardous waste acceptable at landfills for non-hazardous waste, calculated at L/S = 2 and 10 l/kg for total release and directlyexpressed in mg/l for C_0 (the first eluate of percolation test at L/S = 0,1 l/kg). Granular wastes include all wastes that are not monolithic. Contracting Parties shall determine which of the test methods and corresponding limit values should be used.

Components	L/S = 2 l/kg	L/S = 10 l/kg	C0 (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	0,4	2	0,3
Ba	30	100	20
Cd	0,6	1	0,3
Cr total	4	10	2,5
Cu	25	50	30
Hg	0,05	0,2	0,03
Mo	5	10	3,5
Ni	5	10	3
Pb	5	10	3

Sb	0,2	0,7	0,15
Se	0,3	0,5	0,2
Zn	25	50	15
Chloride	10 000	15 000	8 500
Fluoride	60	150	40
Sulphate	10 000	20 000	7 000
DOC (*)	380	800	250
TDS (**)	40 000	60 000	—

(*) If the waste does not meet these values for DOC at its own pH, it may alternatively be tested at L/S = 10 l/kg and a pH of 7,5-8,0. The waste maybe considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 800 mg/kg (A draft method based on prEN 14429 is available).

(**) The values for TDS can be used alternatively to the values for sulphate and chloride.

Contracting Parties shall set criteria for monolithic waste to provide the same level of environmental protection given by the above limit values.

2.3.2. Other criteria

In addition to the leaching limit values under section 2.3.1, granular wastes must meet the following additional criteria:

Parameter	*Value*
TOC (total organic carbon)	5 % (*)
pH	Minimum 6
ANC (acid neutralisation capacity)	Must be evaluated

(*) If this value is not achieved, a higher limit value maybe admitted by the competent authority, provided that the DOC value of 800 mg/kg is achieved at L/S = 10 l/kg, either at the material's own pH or at a pH value between 7,5 and 8,0.

Contracting Parties must set criteria to ensure that the waste will have sufficient physical stability and bearing capacity.

Contracting Parties shall set criteria to ensure that hazardous monolithic wastes are stable and non-reactive before acceptance in landfills for non-hazardous waste.

2.3.3. Asbestos waste

Construction materials containing asbestos and other suitable asbestos waste maybe land filled at landfills for non-hazardous waste without testing.

For landfills receiving construction materials containing asbestos and other suitable asbestos waste the following requirements must be fulfilled:

- the waste contains no other hazardous substances than bound asbestos, including fibres bound by a binding agent or packed in plastic,
- the landfill accepts only construction material containing asbestos and other suitable asbestos waste. These wastes may also be land filled in a separate cell of a landfill for non-hazardous waste, if the cell is sufficiently self-contained,

- in order to avoid dispersion of fibres, the zone of deposit is covered daily and before each compacting operation with appropriate material and, if the waste is not packed, it is regularlysprinkled,
- a final top cover is put on the landfill/cell in order to avoid the dispersion of fibres,
- no works are carried out on the landfill/cell that could lead to a release of fibres (e.g. drilling of holes),
- after closure a plan is kept of the location of the landfill/cell indicating that asbestos wastes have been deposited,
- appropriate measures are taken to limit the possible uses of the land after closure of the landfill in order to avoid human contact with the waste.

2.4. Criteria for waste acceptable at landfills for hazardous waste

2.4.1. Leaching limit values

The following leaching limit values apply for granular waste acceptable at landfills for hazardous waste, calculated at L/S = 2 and 10 l/kg for total release and directly expressed in mg/l for C_0 (in the first eluate of percolation test at L/S = 0,1 l/kg). Granular wastes include all wastes that are not monolithic. Contracting Parties shall determine which of the test methods and corresponding limit values in the table should be used.

Components	L/S = 2 l/kg	L/S = 10 l/kg	C0 (percolation test)
	mg/kg dry substance	mg/kg dry substance	mg/l
As	6	25	3
Ba	100	300	60
Cd	3	5	1,7
Cr total	25	70	15
Cu	50	100	60
Hg	0,5	2	0,3
Mo	20	30	10
Ni	20	40	12
Pb	25	50	15
Sb	2	5	1
Se	4	7	3
Zn	90	200	60
Chloride	17 000	25 000	15 000
Fluoride	200	500	120
Sulphate	25 000	50 000	17 000

DOC (*)	480	1 000	320
TDS (**)	70 000	100 000	—

(*) If the waste does not meet these values for DOC at its own pH, it may alternatively be tested at L/S = 10 l/kg and a pH of 7,5-8,0. The waste maybe considered as complying with the acceptance criteria for DOC, if the result of this determination does not exceed 1 000 mg/kg. (A draft method based on prEN 14429 is available.)

(**) The values for TDS can be used alternatively to the values for sulphate and chloride.

Contracting Parties shall set criteria for monolithic waste to provide the same level of environmental protection given by the above limit values.

2.4.2. Other criteria

In addition to the leaching limit values under section 2.4.1, hazardous wastes must meet the following additional criteria:

Parameter		*Value*
LOI (*)	10 %	
TOC (*)	6 % (**)	
ANC (acid neutralisation capacity)	Must be evaluated	

(*) Either LOI or TOC must be used.

(**) If this value is not achieved, a higher limit value maybe admitted by the competent authority, provided that the DOC value of 1 000 mg/kg is achieved at L/S = 10 l/kg, either at the material's own pH or at a pH value between 7,5 and 8,0.

2.5. Criteria for underground storage

For the acceptance of waste in underground storage sites, a site-specific safety assessment as defined in Annex A must be carried out. Waste maybe accepted only if it is compatible with the site-specific safety assessment.

At underground storage sites for inert waste, only waste that fulfils the criteria set out in section 2.1 maybe accepted.

At underground storage sites for non-hazardous waste, only waste that fulfils the criteria set out in section 2.2 or in section 2.3 maybe accepted.

At underground storage sites for hazardous waste, waste maybe accepted only if it is compatible with the site-specific safety assessment. In this case, the criteria set out in section 2.4 do not apply. However, the waste must be subject to the acceptance procedure as set out in section 1.

3. SAMPLING AND TEST METHODS

Sampling and testing for basic characterisation and compliance testing shall be carried out by independent and qualified persons and institutions. Laboratories shall have proven experience in waste testing and analysis and an efficient quality assurance system.

Contracting Parties may decide that:

1. the sampling maybe carried out by producers of waste or operators under the condition that sufficient supervision of independent and qualified persons or institutions ensures that the recommendations are achieved;

2. the testing of the waste maybe carried out by producers of waste or operators if they have set up an appropriate quality assurance system including periodic independent checking.

The following methods shall be used.

Sampling

For the sampling of waste — for basic characterisation, compliance testing and on-site verification testing — a sampling plan shall be developed.

General waste properties

Determination of TOC in waste, sludge and sediments

Calculation of dry matter by determination of dry residue or water content

Leaching tests

Leaching behaviour test -Up-flow percolation test (Up-flow percolation test for inorganic constituents)

Leaching — Compliance test for leaching of granular waste materials and sludges:

part 1: L/S = 2 l/kg, particle size < 4mm

part 2: L/S = 10 l/kg, particle size < 4mm

part 3: L/S = 2 and 8 l/kg, particle size < 4mm

part 4: L/S = 10 l/kg, particle size < 10 mm

Digestion of raw waste

Digestion for subsequent determination of aqua regia soluble portion of elements (partial digestion of the solid waste prior to elementary analysis, leaving the silicate matrix intact)

Microwave-assisted digestion with hydrofluoric (HF), nitric (HNO_3) and hydrochloric (HCl) acid mixture for subsequent determination of elements (total digestion of the solid waste prior to elementary analysis)

Analysis

Analysis of eluates — Determination of pH, As, Ba, Cd, Cl, Co, Cr, CrVI, Cu, Mo, Ni, NO_2, Pb, total S, SO_4, V and Zn (analysis of inorganic constituents of solid waste and/or its eluate; major, minor and trace elements)

Analysis of eluates — Determination of ammonium, AOX, conductivity, Hg, phenol index, TOC, easilyliberatable CN, F (analysis of inorganic constituents of solid waste and/or its eluate (anions))

Determination of hydrocarbon content in the range of C10 to C40 by gas chromatography.

Appendix A

SAFETY ASSESSMENT FOR ACCEPTANCE OF WASTE IN UNDERGROUND STORAGE

1. SAFETY PHILOSOPHY FOR UNDERGROUND STORAGE: ALL TYPES

1.1. The importance of the geological barrier

Isolation of wastes from the biosphere is the ultimate objective for the final disposal of wastes in underground storage. The wastes, the geological barrier and the cavities, including any engineered structures constitute a system that together with all other technical aspects must fulfill the corresponding requirements.

1.2. Site-specific risk assessment

The assessment of risk requires the identification of:

- the hazard (in this case the deposited wastes),
- the receptors (in this case the biosphere and possibly groundwater),
- the pathways by which substances from the wastes may reach the biosphere, and
- the assessment of impact of substances that may reach the biosphere.

The acceptance criteria for underground storage can be obtained only by referring to the local conditions. This requires a demonstration of the suitability of the strata for establishing a storage, i.e. an assessment of the risks to containment, taking into account the overall system of the waste, engineered structures and cavities and the host rock body.

The site specific risk assessment of the installation must be carried out for both the operational and post-operational phases. From these assessments, the required control and safety measures can be derived and the acceptance criteria can be developed.

An integrated performance assessment analysis shall be prepared, including the following components:

1. geological assessment;
2. geomechanical assessment;
3. hydrogeological assessment;
4. geochemical assessment;
5. biosphere impact assessment;
6. assessment of the operational phase;
7. long-term assessment;
8. assessment of the impact of all the surface facilities at the site.

1.2.1. Geological assessment

A thorough investigation or knowledge of the geological setting of a site is required. This includes investigations and analyses of kind of rocks, soils and the topography. The geological assessment should demonstrate the suitability of the site for underground storage. The location, frequency and structure of any faulting or fracturing in surrounding geological strata and the potential impact of seismic activity on these structures should be included. Alternative site locations should be considered.

1.2.2. Geomechanical assessment

The stability of the cavities must be demonstrated by appropriate investigations and predictions. The deposited waste must be part of this assessment. The processes should be analysed and documented in a systematic way.

The following should be demonstrated:

1. that during and after the formation of the cavities, no major deformation is to be expected either in the cavity itself or at the earth surface which could impair the operability of the underground storage or provide a pathway to the biosphere;
2. that the load-bearing capacity of the cavity is sufficient to prevent its collapse during operation;
3. that the deposited material must have the necessary stability compatible with the geo-mechanical properties of the host rock.

1.2.3. Hydrogeological assessment

A thorough investigation of the hydraulic properties is required to assess the groundwater flow pattern in the surrounding strata based on information on the hydraulic conductivity of the rock mass, fractures and the hydraulic gradients.

1.2.4. Geochemical assessment

A thorough investigation of the rock and the groundwater composition is required to assess the present groundwater composition and its potential evolution over time, the nature and abundance of fracture filling minerals, as well as a quantitative mineralogical description of the host rock. The impact of variability on the geochemical system should be assessed.

1.2.5. Biosphere impact assessment

An investigation of the biosphere that could be impacted by the underground storage is required. Baseline studies should be performed to define local natural background levels of relevant substances.

1.2.6. Assessment of the operational phase

For the operational phase, the analysis should demonstrate the following:

1. the stability of the cavities as in section 1.2.2;
2. no unacceptable risk of a pathway developing between the wastes and the biosphere;
3. no unacceptable risks affecting the operation of the facility.

When demonstrating operational safety, a systematic analysis of the operation of the facility must be made on the basis of specific data on the waste inventory, facility management and the scheme of operation. It is to be shown that the waste will not react with the rock in any chemical or physical way, which could impair the strength and tightness of the rock and endanger the storage itself. For these reasons wastes that are liable to spontaneous combustion under the storage conditions (temperature, humidity), gaseous products, volatile wastes, wastes coming from collections in the form of unidentified mixtures should not be accepted.

Particular incidents that might lead to the development of a pathway between the wastes and the biosphere in the operational phase should be identified. The different types of potential operational risks should be summarised in specific categories. Their possible effects should be evaluated. It should be shown that there is no unacceptable risk that the containment of the operation will be breached. Contingency measures should be provided.

1.2.7. Long-term assessment

In order to comply with the objectives of sustainable land filling, risk assessment should cover the long-term. It must be ascertained that no pathways to the biosphere will be generated during the long-term post-operation of the underground storage.

The barriers of the underground storage site (e.g. the waste quality, engineered structures, back filling and sealing of shafts and drillings), the performance of the host rock, the surrounding strata and the overburden should be quantitatively assessed over the long-term and evaluated on the basis of site-specific data or sufficiently conservative assumptions. The geochemical and geohydrological conditions such as groundwater flow (see sections 1.2.3

and 1.2.4), barrier efficiency, natural attenuation as well as leaching of the deposited wastes should be taken into consideration.

The long-term safety of an underground storage should be demonstrated by a safety assessment comprising a description of the initial status at a specified time (e.g. time of closure) followed by a scenario outlining important changes that are expected over geological time. Finally, the consequences of the release of relevant substances from the underground storage should be assessed for different scenarios reflecting the possible long-term evolution of the biosphere, geosphere and the underground storage.

Containers and cavity lining should not be taken into account when assessing the long-term risks of waste deposits because of their limited lifetime.

1.2.8. Impact assessment of the surface reception facilities

Although the wastes taken at the site maybe destined for subsurface disposal, wastes will be unloaded, tested and possibly stored on the surface, before reaching their final destination. The reception facilities must be designed and operated in a manner that will prevent harm to human health and the local environment. They must fulfill the same requirements as any other waste reception facility.

1.2.9. Assessment of other risks

For reasons of protection of workers, wastes should be deposited only in an underground storage securely separated from mining activities. Waste should not be accepted if it contains, or could generate, hazardous substances which might harm human health, e.g. pathogenic germs of communicable diseases.

2. ACCEPTANCE CRITERIA FOR UNDERGROUND STORAGE: ALL TYPES

2.1. Excluded wastes

In the light of sections 1.2.1 to 1.2.8, wastes that may undergo undesired physical, chemical or biological transformation after they have been deposited must not be disposed of in underground storage. This includes the following:

(a) wastes recommended not accepted in this recommendation;

(b) wastes and their containers which might react with water or with the host rock under the storage conditions and lead to:

- a change in the volume,
- generation of auto-flammable or toxic or explosive substances or gases, or
- any other reactions which could endanger the operational safety and/or the integrity of the barrier.

Wastes which might react with each other must be defined and classified in groups of compatibility; the different groups of compatibilitymust be physicallyseparated in the storage;

(c) wastes that are biodegradable;

(d) wastes that have a pungent smell;

(e) wastes that can generate a gas-air mixture which is toxic or explosive. This particularly refers to wastes that:

- cause toxic gas concentrations due to the partial pressures of their components,
- form concentrations when saturated within a container, which are higher than 10 % of the concentration which corresponds to the lower explosive limit;

(f) wastes with insufficient stability to correspond to the geomechanical conditions;

(g) wastes that are auto-flammable or liable to spontaneous combustion under the storage conditions, gaseous products, volatile wastes, wastes coming from collections in the form of unidentified mixtures;

(h) wastes that contain, or could generate, pathogenic germs of communicable diseases.

2.2. Lists of waste suitable for underground storage

Inert wastes, hazardous and non-hazardous wastes, not excluded by sections 2.1 and 2.2 maybe suitable for underground storage.

Contracting Parties may produce lists of wastes acceptable at underground storage facilities.

2.3. Site-specific risk assessment

Acceptance of waste at a specific site must be subject to site-specific risk assessment.

The site-specific assessments outlined in section 1.2 for the wastes to be accepted at an underground storage should demonstrate that the level of isolation from the biosphere is acceptable. The criteria have to be fulfilled under storage conditions.

2.4. Acceptance conditions

Wastes can be deposited only in an underground storage securely separated from mining activities.

Wastes that might react with each other must be defined and classified in groups of compatibility; the different groups of compatibility must be physically separated in the storage.

3. ADDITIONAL CONSIDERATIONS: SALT MINES

3.1. Importance of the geological barrier

In the safety philosophy for salt mines, the rock surrounding the waste has a two-fold role:

- it acts as host rock in which the wastes are encapsulated;
- together with the overlying and underlying impermeable rock strata (e.g. anhydrite), it acts as a geological barrier intended to prevent groundwater entering the landfill and, where necessary, effectively to stop liquids or gases escaping from the disposal area. Where this geological barrier is pierced by shafts and boreholes, these must be sealed during operation to secure against ingress of water, and must be hermetically closed after the underground landfill ceases to operate. If mineral extraction continues longer than the landfill operation, the disposal area must, after the landfill has ceased operating, be sealed with a hydraulically impermeable dam which is constructed according to the calculated hydraulically operative pressure corresponding to the depth, so that water which may seep into the still operating mine cannot penetrate through to the landfill area;
- in salt mines, the salt is considered to provide total containment. The wastes will only make contact with the biosphere in the case of an accident or an event in geological time such as earth movement or erosion (for example, associated with sea-level rise). The waste is unlikely to change in storage, and the consequences of such failure scenarios must be considered.

3.2. Long-term assessment

The demonstration of long-term safety of underground disposal in a salt rock should be principally undertaken by designating the salt rock as the barrier rock. Salt rock fulfils the requirement of being impermeable to gases and liquids, of being able to encase the waste because of its convergent behaviour and of confining it entirely at the end of the transformation process.

The convergent behaviour of the salt rock thus does not contradict the requirement to have stable cavities in the operation phase. The stability is important, in order to guarantee the operational safety and in order to maintain the integrity of the geological barrier over

unlimited time, so that there is continued protection of the biosphere. The wastes should be isolated permanently from the biosphere. Controlled subsidence of the overburden or other defects over long time are acceptable only if it can be shown, that only rupture-free transformations will occur, the integrity of the geological barrier is maintained and no pathways are formed by which water would be able to contact the wastes or the wastes or components of the waste migrate to the biosphere.

4. ADDITIONAL CONSIDERATIONS: HARD ROCK

Deep storage in hard rock is here defined as an underground storage at several hundred meters depth, where hard rock includes various igneous rocks, e.g. granite or gneiss, it may also include sedimentary rocks, e.g. limestone and sandstone.

4.1. Safety philosophy

A deep storage in hard rock is a feasible way to avoid burdening future generations with the responsibility of the wastes since it should be constructed to be passive and with no need for maintenance. Furthermore, the construction should not obstruct recovery of the wastes or the ability to undertake future corrective measures. It should also be designed to ensure that negative environmental effects or liabilities resulting from the activities of present generations do not fall upon future generations.

In the safety philosophy of underground disposal of wastes, the main concept is isolation of the waste from the biosphere, as well as natural attenuation of any pollutants leaking from the waste. For certain types of hazardous substances and waste, a need has been identified to protect the society and the environment against sustained exposure over extended periods of time. An extended period of time implies several thousands of years. Such levels of protection can be achieved by deep storage in hard rock. A deep storage for waste in hard rock can be located either in a former mine, where the mining activities have come to an end, or in a new storage facility.

In the case of hard-rock storage, total containment is not possible. In this case, an underground storage needs to be constructed so that natural attenuation of the surrounding strata mediates the effect of pollutants to the extent that they have no irreversible negative effects on the environment. This means that the capacity of the near environment to attenuate and degrade pollutants will determine the acceptability of a release from such a facility.

The requirements can only be fulfilled by demonstrating the long-term safety of the installation (see section 1.2.7). The performance of a deep storage system must be assessed in a holistic way, accounting for the coherent function of different components of the system. In a deep storage in hard rock, the storage will reside below the groundwater table. For a deep storage in the hard rock, this requirement is respected in that any discharges of hazardous substances from the storage will not reach the biosphere, including the upper parts of the groundwater system accessible for the biosphere, in amounts or concentrations that will cause adverse effects. Therefore the water flow paths to and in the biosphere should be evaluated. The impact of variability on the geohydraulic system should assessed.

Gas formation may occur in deep storage in hard rock due to long-term deterioration of waste, packaging and engineered structures. Therefore, this must be considered in the design of premises for a deep storage in hard rock.

Appendix B

OVERVIEW OF LANDFILLING OPTIONS PROVIDED BY THE LANDFILL DIRECTIVE

Introduction

Figure 1 gives an overview of the landfilling possibilities for waste provided by the Landfill Directive together with some examples of subcategories of the main classes of landfills. The starting point (upper left corner) is a waste which should be landfilled. In accordance with Article 6(a) of the Landfill Directive, some treatment is required prior to landfilling for most wastes. The general definition of 'treatment' is relatively broad and to a large extent left to the competent authorities in the Member States. It is assumed that the waste does not belong to any of the categories listed in Article 5(3) of the Landfill Directive.

Inert-waste landfill

The first question to ask could be whether or not the waste is classified as hazardous. If the waste is not hazardous (according to the Hazardous Waste Directive (91/689/EC) and the current waste list), the next question could be whether or not the waste is inert. If it meets the criteria for waste to be landfilled at an inert landfill (class A, see figure 1 and table 1), the waste may be placed at an inert landfill.

Inert waste may alternatively be placed in landfills for non-hazardous waste provided it fulfils the appropriate criteria (which it generally should).

Non-hazardous waste landfill, including subcategories

If the waste is neither hazardous nor inert, then it must be non-hazardous, and it should go to a landfill for non-hazardous waste. Member States may define subcategories of landfills for non-hazardous waste in accordance with their national waste management strategies as long as the requirements of the Landfill Directive are met. Three major subcategories of non-hazardous waste landfills are shown in figure 1: landfill for inorganic waste with low organic/biodegradable content (B1), landfill for organic waste (B2), and landfill for mixed non-hazardous waste with substantial contents of both organic/biodegradable and inorganic materials. Category B1 sites can be subdivided further into sites for wastes that do not meet the criteria set out in section 2.2.2 for inorganic non-hazardous wastes that may be co-disposed with stable, non reactive hazardous wastes (B1a) and sites for wastes that do meet those criteria (B1b). Category B2 sites may, for example, be further subdivided into bioreactor landfills and landfills for less reactive, biologically treated waste. Further subclassification of non-hazardous landfills may be desired by some Member States, and monofills and landfills for solidified/monolithic waste may be defined within each subcategory (see the footnote below table 1). National acceptance criteria may be developed by the Member States to ensure proper allocation of non-hazardous waste to the various subcategories of non-hazardous waste landfills. If sub-classification of non-hazardous waste landfills is not desired, all non-hazardous waste (subject of course to the provisions of Articles 3 and 5 of the Landfill Directive) may go to a landfill for mixed non-hazardous waste (class B3).

Placement of stable, non-reactive hazardous waste in landfill for non-hazardous waste

If the waste is hazardous (according to Directive 91/689/EC and the current waste list), the treatment may have enabled the waste to meet the criteria for placement of stable, non-reactive hazardous waste in non-hazardous waste landfills within cells for inorganic waste with low organic/biodegradable content that meet the criteria in section 2.2.2 (class B1b). The waste may be granular (rendered chemically stable) or solidified/monolithic.

Hazardous waste landfill

If the hazardous waste does not meet the criteria for placement in a class B1b landfill or cell for non-hazardous waste, the next question could be whether or not it meets the criteria for acceptance at a landfill for hazardous waste (class C). If the criteria are met, then the waste may be placed at a hazardous waste landfill.

If the criteria for acceptance at a hazardous waste landfill are not met, the waste may be subjected to further treatment and tested again against the criteria, until they are met.

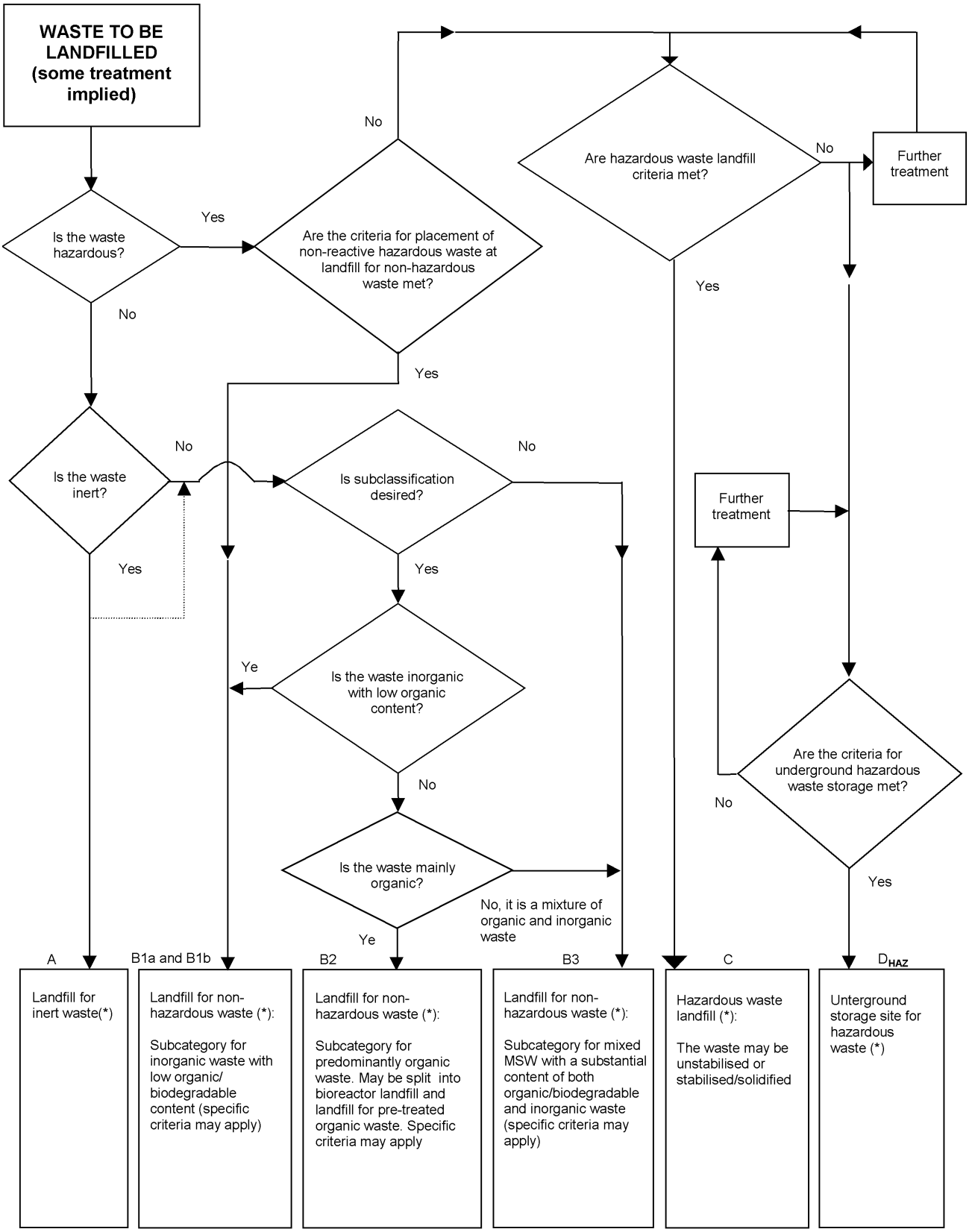
Underground storage

Alternatively, the waste may be tested against the criteria for underground storage. If the criteria are met, the waste may go to an underground storage facility for hazardous waste (landfill class D_{HAZ}). If the underground storage criteria are not met, the waste may be subjected to further treatment and tested again.

Although underground storage is likely to be reserved for special hazardous wastes, this subcategory may in principle be used also for inert waste (class D_{INERT}) and non-hazardous waste (class $D_{NON-HAZ}$).

Figure 1

Diagram showing the landfilling options provided by the Landfill Directive



(*) In principle, underground storage is also possible for inert and non-hazardous waste.

Table 1

Overview of landfill classes and examples of subcategories

Landfill class	Major subcategories (underground storage facilities, monofills and landfills for solidified, monolithic (*) waste possible for all landfill classes)	ID	Acceptance criteria
Landfill for inert waste	Landfill accepting inert waste	A	Criteria for leaching and for content of organic components are set at EU level (section 2.1.2). Criteria for content of inorganic components may be set at Member State level.
Landfill for non-hazardous waste	Landfill for inorganic non-hazardous waste with a low content of organic/biodegradable matter, where the wastes do not meet the criteria set out in section 2.2.2. for those inorganic non-hazardous wastes that may be landfilled together with stable, non-reactive hazardous waste	B1a	Criteria for leaching and total content are not set at EU level
	Landfill for inorganic non-hazardous waste with a low content of organic/biodegradable matter	B1b	Criteria for leaching and content of organics (TOC) and other properties are set at EU level, common for granular non-hazardous waste and for stable, non-reactive hazardous waste (section 2.2). Additional stability criteria for the latter are to be set at Member State level. Criteria for monolithic waste must be set at Member State level
	Landfill for organic non-hazardous waste	B2	Criteria for leaching and total content are not set at EU level
	Landfill for mixed non-hazardous waste with substantial contents of both organic/biodegradable waste and inorganic waste.	B3	Criteria for leaching and total content are not set at EU level
Landfill for hazardous waste	Surface landfill for hazardous waste	C	Criteria for leaching for granular hazardous waste and total content of certain components have been laid down at EU level (section 2.4). Criteria for monolithic waste must be set at Member State level Additional criteria on content of contaminants can be set at MS level
	Underground storage site	D_{HAZ}	Special requirements at EU level are listed in Annex A

(*) Monolithic waste subcategories are only relevant for B1, C and D_{HAZ}, and possibly A.