



**International
Standard**

ISO 8228

**Ecotoxicological evaluation and
classification of sludge for land
application**

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 275, *Sludge recovery, recycling, treatment and disposal*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Sludge is a kind of organic-based material originating from wastewater treatment, rich in humic substances, nitrogen, phosphorus and other trace nutrients, and its application to land is a significant pathway for nutrient cycling and improving soil fertility. However, sludge also contains various toxic pollutants, including heavy metals, organic pollutants, pathogenic bacteria and emerging pollutants. These contaminants are raising significant environmental and health concerns, with potential toxicity to humans and the ecosystem. Therefore, ecotoxicological evaluation is essential to ensure their safe and beneficial reuse.

This document provides requirements and recommendations on ecotoxicological evaluation, classification, and determination methods for sludge. It establishes a two-step evaluation procedure. The first step is to analyse the concentrations of heavy metals and harmful organic pollutants. If the concentration of any pollutant exceeds the limit of the standard, the sludge cannot be used for land application. If the concentrations of all contaminants are below their respective concentration limits, a second step of ecotoxicological evaluation is performed, including seed germination test of higher plants and reproduction toxicity test of earthworms.

Based on ecotoxicological evaluation results, this document classifies sludge into three distinct grades, Classes I, II, and III, to determine the appropriate land application pathway:

- class I, the lowest toxicity level, with inhibition ratios for both seed germination and earthworm reproduction at or below 10 %, is suitable for land application in human-accessible areas;
- class II, with inhibition ratios up to 20 %, is suitable for landscaping in human-accessible areas;
- class III, a higher toxicity level with inhibition ratios up to 30 %, is restricted to landscaping in human-inaccessible areas, such as sandy land rehabilitation, and mine rehabilitation.

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Ecotoxicological evaluation and classification of sludge for land application

1 Scope

This document provides requirements and recommendations for the ecotoxicological evaluation and classification of sludge for land application, and suitable land application pathways. This document applies to sludge from wastewater treatment plants.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 11268-2:2023, *Soil quality — Effects of pollutants on earthworms — Part 2: Determination of effects on reproduction of Eisenia fetida/Eisenia andrei and other earthworm species*

ISO 11465, *Sludge and solid environmental matrices — Determination of dry residue or water content and calculation of the dry matter fraction on a mass basis*

ISO 15799, *Soil quality — Guidance on the ecotoxicological characterization of soils and soil materials*

ISO 18763, *Soil quality — Determination of the toxic effects of pollutants on germination and early growth of higher plants*

ISO 21268-1, *Soil quality — Leaching procedures for subsequent chemical and ecotoxicological testing of soil and soil-like materials — Part 1: Batch test using a liquid to solid ratio of 2 l/kg dry matter*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 sludge

mixture of water and solids originating from various types of wastewaters during natural and artificial treatment

3.2 heavy metal

metal with relatively high density as a natural constituent of the environment, commonly detected in air, water and soil

3.3 persistent organic pollutant

chemical substance that persists in the environment, bioaccumulates through the food web, poses a risk of causing adverse effects to human health and the environment, and can be subject to long range transport away from its original source

3.4

ecotoxicological assessment

ecotoxicological evaluation

process of evaluating the potential adverse effects of a substance, mixture or material on ecological receptors, such as plants, soil organisms, aquatic organisms or microorganisms, using ecotoxicological test methods and relevant lines of evidence

EXAMPLE The assessment can include seed germination tests, seed germination index tests and earthworm reproduction toxicity tests.

3.5

toxic exposure test

test to determine adverse effects of pollutants or test materials on organisms under defined exposure conditions.

Note 1 to entry: Toxic exposure tests can use different exposure pathways, exposure periods and toxicity endpoints to support safety or risk evaluation.

4 Procedure for sludge toxicity evaluation

The evaluation procedure for sludge follows the two-step approach shown in [Figure 1](#). Initially, chemical analysis is conducted to determine the concentrations of heavy metals, persistent organic pollutants and other organic compounds concerned. When all chemical contaminants in the sludge are below their respective concentration limits ([Table 1](#)), the sludge may be used for land application. When the concentration of any pollutant exceeds the concentration limit in this standard, the sludge should not be used for land application. Subsequently, comprehensive toxicity exposure tests are performed to evaluate the overall toxicity levels. Based on these test results, the sludge is classified into appropriate classes as shown in [Table 2](#), to ensure compatibility with specific land application types.

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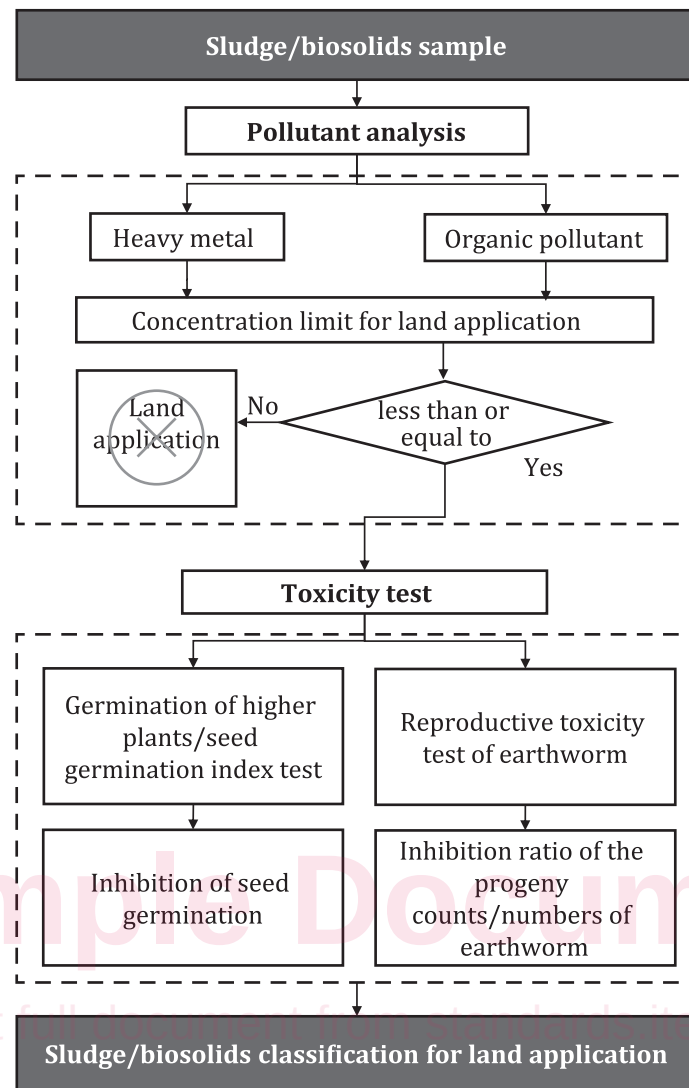


Figure 1 — Sludge toxicity evaluation procedure

5 General requirements of sludge for land application

The water content of sludge should be appropriate to the selected handling, transport and application method. Where dewatered material is required for the land application pathway, the water content should not exceed 60 %. Odour emissions and pathogen levels can be subject to applicable local regulatory requirements. [Table 1](#) lists the concentration limits for heavy metals and organic pollutants in sludge intended for land application. Sludge should not be used for land application when any chemical contaminant is confirmed to be above its respective concentration limit shown in [Table 1](#), which provides the baseline limits for countries to develop their individual requirements.

The maximum sludge application rate with the specified concentrations is 7,5 tons per hectare per year (dry solids). The maximum application period is 10 years. After 10 years, a reassessment should be conducted based on pollutant accumulation to determine if land application can be continued or not. See [Annex E](#) for further information. This document provides the baseline limits for countries to develop their individual requirements on application rates and maximum application periods.