SLOVENSKI STANDARD
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**Kakovost vode - Navodilo za strateški pristop k obnovi vodotokov**

Water quality - Guidance standard on a strategic approach to river restoration

Wasserbeschaffenheit - Leitfaden für einen strategischen Ansatz zur Renaturierung von Fließgewässern

Qualité de l'eau - Guide pour une approche stratégique de la restauration des rivières



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# Water quality - Guidance standard on a strategic approach to river restoration

Qualité de l'eau - Guide pour une approche stratégique de la restauration des rivières

Wasserbeschaffenheit - Leitfaden für einen strategischen Ansatz zur Renaturierung von Fließgewässern

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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# Contents

Page

# European foreword

This document (EN 18025:2025) has been prepared by Technical Committee CEN/TC 230 “Water analysis”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2026 of DOP, and conflicting national standards shall be withdrawn at the latest by March 2026 of DOW.

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# Introduction

Most European rivers and their catchments no longer function naturally. This loss of natural functioning is the result of human modification undertaken over many centuries for (among other things) flood defence, hydroelectric power generation, the provision of water for agricultural, industrial, and domestic consumption, land use and land drainage. These activities have often resulted in disturbed river functioning and led to degraded physical habitats and, as a consequence, to reductions in biodiversity, reduced resilience to flooding, drought and temperature extremes, and a decline in ecosystem services such as recreation. Climate change is now compounding the issues created by human modification, and the need to restore rivers will become increasingly pressing to ensure the conservation of their naturally occurring habitats and species and the sustainable provision of their ecosystem services. Accordingly, river restoration following a nature-based approach is an imperative requirement to allow river ecosystems to recover, a concept advocated by the International Union for Conservation of Nature (IUCN) [1].

River restoration is the act of returning natural functioning and form to a river that has been directly or indirectly altered by human activity. Ideally it should result in uninterrupted lateral, longitudinal, and vertical connectivity of hydraulic, sedimentary, chemical, thermal and biological processes, allowing unhindered channel and floodplain evolution, and the associated mosaic of habitats that support a characteristic array of flora and fauna. In many locations, physical and other constraints will affect what restoration is practicable, but the ambition should be to achieve the greatest degree and spatial scale of re-naturalization possible.

Rivers are restored for many reasons including to: re-establish natural patterns of water and sediment movement and so remove the costs associated with managing modified channels; restore habitats and biodiversity; manage flood risk through natural flood management; enhance the aesthetics of an area; and create opportunities for recreation. Key policy and legal frameworks to drive river restoration within the European context include the Water Framework Directive (WFD), Habitats Directive and the Floods Directive. Furthermore, the EU Biodiversity Strategy 2030, and the UN Framework Convention on Climate Change, for example, provide additional impetus for increased restoration efforts. Although the motivation for restoring rivers and the extent to which rivers can be restored vary, a fundamental basis common to all restoration projects should be the re-establishment of natural physical processes, leading to the development of natural form and features, and the sustainable evolution of instream, riparian and floodplain habitats. Activities such as adding gravel to construct specific spawning areas can be part of a larger river restoration scheme, but are not by themselves considered to be river restoration unless they are measures for restoring natural river processes.



Specifying the desired outcome of restoration is an essential element of any plan, and the meaningful monitoring and appraisal of any project will depend upon the clarity in setting this goal.

# 1 Scope

This document gives guidelines for the restoration of rivers, including their channels, riparian zones and floodplains. The word 'river' is used as a generic term to describe permanently flowing and intermittent watercourses of all sizes, with the exception of artificial water bodies such as canals. Some aspects of landscape restoration beyond the boundaries of what are often considered typical river processes are also considered.

A clear framework of guiding principles to help inform the planning and implementation of river restoration work is provided. These principles are applicable to individuals and organizations wishing to restore rivers, and stress the importance of monitoring and appraisal. This document makes reference to existing techniques and guidance, where these are appropriate and within the scope of this document.

This document gives guidelines on:

— the core principles of restoration;

— aims and overall outcomes of river restoration;

— the spectrum of typical approaches to river restoration with a focus on those that are nature-based and restore both physical and ecological aspects;

— identifying opportunities for restoration and possible constraints, with a focus on physical and natural rather than socio-economic aspects;

— different scales of restoration and how restoration works across different catchments and landscapes;

— the importance of monitoring and appraising restoration work across the range of approaches and scales.



# 2 Normative references

There are no normative references in this document.

# 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**
**bank**
side of a river channel or island which extends above the normal (e.g. mean) water level and is only completely submerged during periods of high river flow

Note 1 to entry: In the context of this document, the bank top is marked by the first major break in slope, above which cultivation or development is possible.

[SOURCE: EN 14614:2020, 3.7]

**3.2**
**bar**
in-channel, elevated sediment deposit exposed during periods of low flow, which could be a side bar, (including a point or counterpoint bar, located respectively along the convex or concave bank of a meander bend) or a mid-channel bar

[SOURCE: EN 14614:2020, 3.9]

**3.3**
**Before-After-Control-Impact**
**BACI**
investigation of the effect of an Impact at a site by comparing the conditions 'Before the Impact' with those 'After the Impact' while accounting for natural/background change through the use of a Control site (see 3.11)

**3.4**
**berm**
natural or artificial, flat-topped shelf along the margin of a river channel that is exposed above water level during low flows but is submerged during high flows

Note 1 to entry: Natural berms are vegetated features composed of sediments deposited by the river to the baseflow level.

[SOURCE: EN 14614:2020, 3.13]



**3.5**
**biodiversity**
**biological diversity**
variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems



[SOURCE: Convention on Biological Diversity, Article 2 *Use of Terms* — Convention Text]

**3.6**
**channel**
main landform within river systems, conveying water

**3.7**
**characterization**
selection of properties or special features of a spatial unit that are uniquely relevant to identifying its hydromorphological processes, forms and pressures

[SOURCE: EN 14614:2020, 3.19]

**3.8**
**coarse sediment**
sediment of grain size at or larger than very fine gravel (diameter ≥2 mm, ≤ −1 phi)

EXAMPLE Gravels, cobbles, boulders.

Note 1 to entry: The phi scale defines sediment grain size as the negative logarithm to the base 2 of the grain diameter in millimetres.

[SOURCE: EN 14614:2020, 3.20]

**3.9**
**confirmatory appraisal**
process of confirming the expectations following a restoration intervention through simple observation (cf. investigative appraisal)

**3.10**
**control site**
site representing (ideally identical) conditions to that of the Impact site except for the restoration intervention

**3.11**
**culvert**
arched, enclosed or piped structure constructed to carry water under roads, railways and buildings

[SOURCE: EN 14614:2020, 3.25]



**3.12**
**ecosystem services**
benefits people derive from ecosystems



**3.13**
**embankment**
**artificial levée**
artificial bank built to raise the natural bank level thereby reducing the frequency of flooding of adjacent land

[SOURCE: EN 14614:2020, 3.27, modified — the secondary term 'artificial levee' has been added]

**3.14**
**equilibrium form**
morphological condition of a river that represents physical balance (stable but not necessarily static)

**3.15**
**fine sediment**
sediment of grain sizes equal to or smaller than very coarse sand (diameter ≤2 mm, ≥2 phi), i.e. sands, silt, clay

Note 1 to entry: The phi scale defines sediment grain size as the negative logarithm to the base 2 of the grain diameter in millimetres.

[SOURCE: EN 14614:2020, 3.28, modified — Note 1 to entry added]

**3.16**
**floodplain**
valley floor adjacent to a river that is (or was historically) inundated periodically by flood waters and is formed of sediments deposited by the river

[SOURCE: EN 14614:2020, 3.29]

**3.17**
**fluvial audit**
method for assessing the condition of a river and its associated human pressures, using information from field survey, remote sensing, historical and recent maps, scientific literature and other sources

[EN 16859:2017, 3.18]

**3.18**
**fluvial geomorphology**
scientific study of the physical processes, form and functioning of rivers and streams and their physical interactions with the surrounding landscape

[SOURCE: EN 14614:2020, 3.31]

**3.19**
**hydrodynamic modelling**
numerical tool or methodology used to predict hydraulic patterns in rivers



**3.20**
**hydrology**
study of the distribution and movement of water both on and below the Earth's surface



**3.21**
**hydromorphology**
morphological and hydrological characteristics of rivers including the underlying processes from which they result

[SOURCE: EN 14614:2020, 3.36]

**3.22**
**hyporheic zone**
spatio-temporally dynamic ecotone between the surficial benthic substrate and the underlying aquifer

[EN 16772:2016, 2.13]

**3.23**
**impact site**
site at which restoration intervention effects are measured

**3.24**
**investigative appraisal**
process of investigating the outcomes of a restoration intervention through an experimental approach (cf. confirmatory appraisal)

**3.25**
**large wood**
piece of wood that is more than 1 m long and 10 cm in diameter

Note 1 to entry: 'Wood' refers to natural wood (e.g. tree branches)

[SOURCE: EN 14614:2020, 3.37, modified — Note 1 to entry added]

**3.26**
**lateral connectivity**
**lateral continuity**
freedom for water, sediments and biota to move between the channel and the floodplain/hillslopes

[SOURCE: EN 14614:2020, 3.39]

**3.27**
**longitudinal connectivity**
**longitudinal continuity**
freedom for water, sediments and biota to move along the river channel

[SOURCE: EN 14614:2020, 3.41]

**3.28**
**meander**
one of a series of regular, sinuous curves along the course of a stream



[SOURCE: EN 14614:2020, 3.42]



**3.29**
**morphology**
physical form and structure of a river

**3.30**
**natural flood management**
working with nature to reduce and control the impacts of flooding

**3.31**
**nature-based solutions**
actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits

Note 1 to entry: See IUCN *Nature-based Solutions to address global societal challenges* [21].

**3.32**
**oxbow lake**
small lake located in an abandoned meander loop of a river channel

**3.33**
**palaeochannel**
remnant floodplain feature indicating location of a previously active channel

**3.34**
**planform**
geometric form of a river channel viewed from above

EXAMPLE Sinuous, straight.

[SOURCE: EN 14614:2020, 3.43]

**3.35**
**quantitative sampling**
process of collecting measured information (e.g. flow measured in m s-1)

**3.36**
**qualitative sampling**
process of collecting information that is subjectively assessed

**3.37**
**reach**
section of river along which boundary conditions are sufficiently uniform that the river maintains a near consistent internal set of process–form interactions

Note 1 to entry: In some situations, chemical changes along the length of a river, as well as physical and hydrological ones, could also be important in defining river reaches.

[SOURCE: EN 14614:2020, 3.47]



**3.38**
**restoration**
establishment of natural physical processes (e.g. variation of flow and sediment movement), features (e.g. sediment sizes and river shape) and physical habitats of a river system (including submerged, bank and floodplain areas)

[SOURCE: EN 14614:2020, 3.57]

**3.39**
**riparian zone**
transitional, semi-terrestrial area of land adjoining a river channel (including the river bank) that is regularly inundated and influenced by fresh water and can influence the condition of the aquatic ecosystem (e.g. by shading and leaf litter input and through biogeochemical exchanges)

Note 1 to entry: Riparian corridor is the linear extension of this concept along a channel or reach length; in this document, the term riparian zone does not include the wider floodplain.

[SOURCE: EN 14614:2020, 3.51]

**3.40**
**river bed incision**
process where a river has cut vertically to lower its bed

[SOURCE: EN 14614:2020, 3.53]

**3.41**
**runoff**
net discharge of water into the stream from surface-water and groundwater sources with losses occurring from evapotranspiration and other consumptive uses

[SOURCE: EN 14614:2020, 3.58]

**3.42**
**sediment transport**
movement of sediment particles of a range of sizes by flowing water, which could include mobilization and deposition

[SOURCE: EN 14614:2020, 3.61]

**3.43**
**sinuosity**
distance from upstream to downstream along the channel centre line between two points, divided by the distance along the valley course between the same points

[SOURCE: EN 14614:2020, 3.63]

**3.44**
**spatial unit**
subdivision of a catchment at various geographical scales



EXAMPLE Catchment, landscape unit, valley segment, reach.

[SOURCE: EN 14614:2020, 3.64]



**3.45**
**stream power**
rate of energy dissipation against the bed and banks of a river per unit downstream length, which when divided by channel width gives the specific stream power

[SOURCE: EN 14614:2020, 3.65]

**3.46**
**substrate**
material making up the bed of a river

[SOURCE: EN 14614:2020, 3.66]

**3.47**
**vertical connectivity**
freedom for water, biota and nutrients to move between the benthic substrate and the underlying aquifer

**3.48**
**weir**
artificial structure across a river for controlling flow and upstream surface level, or for measuring discharge

[SOURCE: EN 14614:2020, 3.70]

**3.49**
**wetland**
habitat occupying the transitional zone between permanently inundated, and generally dry, environments

EXAMPLE Marsh, fen, shallow temporary water.

[SOURCE: EN 14614:2020, 3.71]

**3.50**
**WFD water body**
length of river defined and delineated according to criteria outlined in the European Water Framework Directive

**3.51**
**xylophagous insect**
adult or larva of insects that feed on or bore into wood

## 4 Principle

A standard protocol is described for planning, implementing, and monitoring river restoration and draws on experience from around Europe and elsewhere to provide a common framework that can be applied across a wide geographical range. This document, focused on nature-based solutions, gives guidance on how to apply a strategic approach to practical restoration, but does not attempt to describe the detailed methods used to restore rivers. It emphasizes that restoration should explicitly take account of the dynamic nature of rivers and should be set within a catchment context, even when the scale of restoration is relatively limited. This document recognizes that river restoration is carried out for many reasons, but focuses especially on the importance of restoring hydromorphology for the benefit of biodiversity.



## 5 Aims of river restoration

River restoration is not simply engineering the physical form. It aims to understand and address the modification and damage to river functioning, features and habitats, in the context of the river floodplain corridor and its catchment, and to return the conditions that allow natural processes to operate unhindered. At their simplest, such reference conditions refer to an absence of human interventions and pressures, but these are not necessarily the desired conditions for the system or the river reach after restoration. Reference conditions represent a benchmark against which to assess the degree of impact on the present state of the river from human influence, and upon which restoration targets can be assessed objectively. By restoring river processes, the movement of water and material (sediment and wood) from the land (catchment area) to the mouth (estuary or inland lake) can shape and sustain a dynamic, complex, physical environment and the characteristic flora, fauna and their habitats.

The restoration of physical processes, rather than simply recreating physical form:

— results in rivers that are more sustainable with the re-establishment of characteristic natural habitat;

— provides a focus on tackling the causes of degradation rather than its symptoms;

— creates conditions naturally more appropriate for specific sections of rivers that support characteristic biodiversity;

— incorporates implicitly the dynamic physical processes that are a fundamental characteristic of a naturally functioning river and essential to the evolution of diverse habitats;

— results in dynamic river environments that are more resilient and sustainable than an engineered channel, particularly in the face of climate change;

— reduces construction and maintenance costs, by initiating or working with dynamic physical processes that result in channel and floodplain evolution and associated habitat diversity;

— increases the likelihood of achieving wider ecosystem and societal benefits (i.e. ecosystem services) (see Figure 1).




**Figure 1 — Benefits to society provided by naturally functioning rivers and floodplains**

The water quality and quantity necessary to sustain the expected biodiversity of a naturally functioning river system also enables more cost-effective provision of drinking water (i.e. less treatment required) and a sustainable supply of food and materials. A well-functioning system is able to cope better with societal and economic demands, where those demands recognize the requirement for balance (e.g. water companies investing in upstream catchment management to improve water quality and reduce water supply costs).

Rivers that are fully connected to their floodplains (as opposed to those that have historically been deepened and embanked) help to regulate flood risk by slowing and spreading flood waters, and by reducing the height and delaying the peak of a flood. Restoring the floodplain's hydrology in this way can work with, or perhaps replace, more traditional flood protection measures and help to adapt to climate change. Floodplains are important for fine sediment storage and for nutrient deposition and cycling, through uptake by wetland/floodplain meadow/wet woodland communities. Reinstating these processes has great potential benefit for carbon storage within the floodplain [2].

Many towns and cities were founded on the banks of rivers, thus benefiting from water supply, transport, food resources and security. A restored clean, healthy, river rich in wildlife offers a focal open space in often densely urbanized areas. River corridors provide routes for paths and cycleways, encouraging exercise and access to nature, which promotes physical and mental health. Direct uses include fishing, water sports, and wild swimming. Use and visual amenity promotes better awareness and social understanding of the pressures and impacts on water and habitat quality, with pollution and other deterioration being noticed rapidly and becoming more integrated in local policy and planning.