



BSI Standards Publication

Drain and sewer systems outside buildings - Sewer system management

National foreword

This British Standard is the UK implementation of EN 752:2017. It supersedes BS EN 752:2008, which is withdrawn.

The UK committee draws users' attention to [National Annex NA](#), which provides further guidance to assist users in the application of EN 752:2017 in the UK.

The UK participation in its preparation was entrusted to Technical Committee B/505/22, Drainage Systems Outside Buildings.

A list of organizations represented on this committee can be obtained on request to its secretary.

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31 October 2019	Corrections made to NA 6.4.1 a) and to Figures NA.4 and NA.6
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28 February 2022	Table NA.5 corrected

English Version

Drain and sewer systems outside buildings - Sewer system management

Réseaux d'évacuation et d'assainissement à l'extérieur
des bâtiments - Gestion du réseau d'assainissement

Entwässerungssysteme außerhalb von Gebäuden -
Kanalmanagement

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European foreword

This document (EN 752:2017) has been prepared by Technical Committee CEN/TC 165 “Waste water engineering”, 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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 752:2008.

The principal changes in this revision are as follows:

- a) the terminology has been aligned with EN 16323:2014;
- b) all the text relating to the determination of performance requirements and design criteria has been moved to Clause 5 as these are essentially part of this policy activity and not the design process;
- c) Clause 5 has been updated to include references to show the links to the EU Water Framework Directive (2000/60/EC) together with its daughter directives and the EU Floods Directive (2007/60/EC);
- d) Clause 6 has been updated to align with the latest revision of EN 13508-1 and some text that is duplicated in EN 13508-1 has been deleted;
- e) Clause 6 has been updated to align with EN 14654-2;
- f) contingency and emergency planning has been moved from the former Annex C to Clause 6 as it is part of the integrated sewer system planning process;
- g) some additional text from the former Annex D has been added to Clause 7, this has allowed the former Annex D to be deleted as it largely duplicated Clause 7;
- h) additional requirements have been added to Clause 8 on resilience of drain and sewer systems;
- i) all physical design requirements in the former Clause 9 have been moved to a new Annex D;
- j) all the hydraulic design requirements in the former Clause 9 have been moved to prEN 16933-2 to provide a more coherent narrative;
- k) former Clause 11 (now Clause 10) has been updated to include requirements on dealing with major incidents;
- l) the text of the former Clause 12 has been integrated into 6.5.5, 10.4 (now 9.4) or 11.2 (now 10.2) as appropriate;
- m) the text from the former Annex A has been incorporated either in Clause 5 or Clause 7;
- n) a new Annex B on rehabilitation approaches has been added;

- o) the text from the former Annex C has been incorporated into Clause 6 (for planning activities), Clause 11 or the new Annex C;
- p) the former Annex F has been deleted as this is superseded by the prEN 16932 series.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Drain and sewer systems are part of the overall wastewater system that provides a service to the community. This can be briefly described as:

- removal of wastewater from premises for public health and hygienic reasons;
- prevention of flooding in urbanized areas;
- protection of the environment.

The overall wastewater system has four successive functions:

- collection;
- transport;
- treatment;
- discharge.

Wastewater can, if necessary after treatment, be discharged to the environment or reused.

Collection and transport of wastewater is provided by drain and sewer systems.

Drain and sewer systems were installed because there was a need to remove the polluted water to prevent diseases.

Traditionally, drain and sewer systems were constructed to collect and transport all types of wastewater together irrespective of the initial source. This led to difficulties in handling the peak flows in times of heavy rainfall and to the introduction of combined sewer overflows, which discharged polluted water to surface receiving water bodies.

It was later recognized that separate systems, where foul wastewater was kept separate from runoff derived from surface water, would be an improvement over such combined systems.

Although many drain and sewer systems started out as combined systems there are strong arguments for considering the separation of foul wastewater and surface water. The pollutant effects are not the same and the separation of effluents allows for the different treatment for each element of wastewater, providing more environmentally friendly solutions.

This concept is included in the approach of integrated sewer management.

This European Standard provides a framework for the design, construction, maintenance operation and rehabilitation of drain and sewer systems outside buildings. This is illustrated in the upper part of the diagram in Figure 1. This European Standard is supported by more detailed standards for the investigation, design, construction, organization and control of drain and sewer systems.

Investigation and assessment standards include:

- EN 13508 (all parts), *Investigation and assessment of drain and sewer systems outside buildings*.

Design and construction standards include:

- prEN 16932 (all parts), *Drain and sewer systems outside buildings — Pumping systems*,
- prEN 16933-2, *Drain and sewer systems outside buildings — Design — Part 2: Hydraulic design*,
- EN 1295 (all parts), *Structural design of buried pipelines under various conditions of loading*,

- EN 1610, *Construction and testing of drains and sewers*,
- EN 12889, *Trenchless construction and testing of drains and sewers*,
- EN 15885, *Classification and characteristics of techniques for renovation and repair of drains and sewers*.

Management and control standards include:

- EN 14654 (all parts), *Management and control of operational activities in drain and sewer systems outside buildings*.

To support these detailed standards information comes from specifications produced by individual organizations for their own use. Product standards should also take into account the functional requirements in this European Standard through EN 476, EN 13380 and EN 14457.

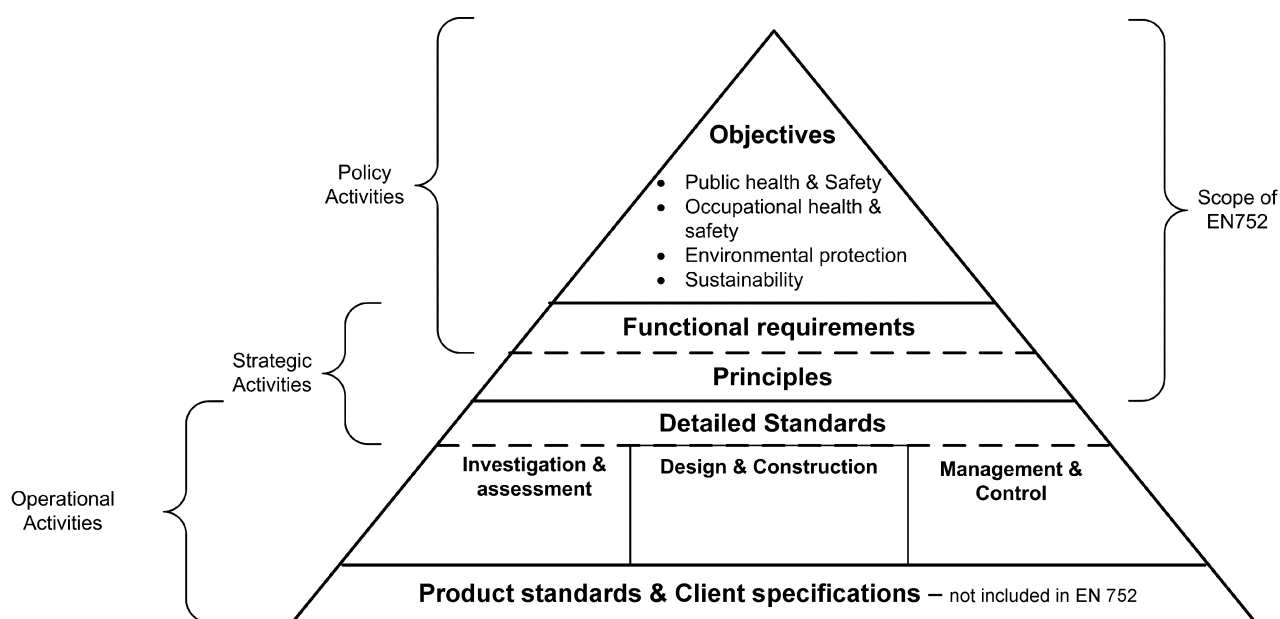


Figure 1 — Pyramid diagram

The EU Public Procurement Directive (2014/25/EU) governs the procurement of goods and services by public authorities. This includes procurement in relation to drain and sewer systems.

The Construction Products Regulation (No 305/2011) provides for uniform assessment methods of the performance of construction products which are set out in harmonized European Standards.

1 Scope

This European Standard specifies the objectives for drain and sewer systems outside buildings. It specifies the functional requirements for achieving these objectives and the principles for strategic and policy activities relating to planning, design, installation, operation, maintenance and rehabilitation.

It is applicable to drain and sewer systems from the point where wastewater leaves a building, roof drainage system, or paved area, to the point where it is discharged into a wastewater treatment plant or receiving water body.

Drains and sewers below buildings are included provided that they do not form part of the drainage system for the building.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 476, *General requirements for components used in drains and sewers*

EN 858-1, *Separator systems for light liquids (e.g. oil and petrol) — Part 1: Principles of product design, performance and testing, marking and quality control*

EN 858-2, *Separator systems for light liquids (e.g. oil and petrol) — Part 2: Selection of nominal size, installation, operation and maintenance*

EN 1295-1, *Structural design of buried pipelines under various conditions of loading — Part 1: General requirements*

EN 1610, *Construction and testing of drains and sewers*

EN 1825-1, *Grease separators — Part 1: Principles of design, performance and testing, marking and quality control*

EN 1825-2, *Grease separators — Part 2: Selection of nominal size, installation, operation and maintenance*

EN 1990:2002, *Eurocode — Basis of structural design*

EN 12889, *Trenchless construction and testing of drains and sewers*

EN 13508-1, *Investigation and assessment of drain and sewer systems outside buildings — Part 1: General Requirements*

EN 14654-1, *Management and control of operational activities in drain and sewer systems outside buildings — Part 1: Cleaning*

EN 16323:2014, *Glossary of wastewater engineering terms*

prEN 16932 (all parts), *Drain and sewer systems outside buildings — Pumping systems*

prEN 16933-2, *Drain and sewer systems outside buildings — Design — Part 2: Hydraulic design*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16323:2014 and the following apply.

Note 1 to entry: Certain key definitions from EN 16323:2014 have been repeated below for clarity. The following additional terms used in this European Standard are defined in EN 16323:2014:

aerobic,	anaerobic,	backdrop manhole,
biochemical oxygen demand,	catchment area,	collection tank,
combined sewer overflow,	combined system,	confined space,
dam board,	detention tank,	domestic wastewater,
drain,	dry weather flow,	exfiltration,
extraneous flow,	foul wastewater,	gradient,
gravity system,	hydro-biological stress,	industrial wastewater,
infiltration (see Figure 2),	inspection chamber,	inverted syphon,
jetting,	maintenance,	manhole,
non-domestic wastewater	outfall,	pumping station,
ramp manhole,	receiving water body,	rehabilitation,
relevant authority,	renovation, repair,	replacement,
retention period,	rising main,	rodding,
runoff coefficient,	self-cleansing,	self-purifying capacity,
separate system,	septic wastewater,	sewer, sewer system,
surcharge,	tank sewer,	time of concentration,
time of flow,	wastewater,	wastewater treatment plant,
winching.		

3.1

backwater level

elevation of the surface of the wastewater predicted or occurring in a drain and sewer system due to the hydraulic conditions downstream

3.2

design working life

assumed period for which a structure or part of it is to be used for its intended purpose with anticipated repair and maintenance but without renovation or replacement being necessary

[SOURCE: EN 1990:2002, modified to provide consistency with the terminology in EN 16323]

3.3

expected frequency

average rate of occurrence of an event

Note 1 to entry: The expected frequency can be expressed as a return period (once in T years) or a probability of occurrence in any one year (1/T) (see return period 3.11).

**3.4
flooding**

condition where water overflows onto a surface or enters a building where it is not intended

**3.5
flushing**

use of a temporary substantially increased flow to facilitate removal of obstructions or sediments from drains or sewers

**3.6
integrated water policies**

co-ordinated policies for the management of all bodies of water within a river basin including urban drainage systems within it

**3.7
operations**

actions taken in the course of normal functioning of drain and sewer systems

EXAMPLE Monitoring and regulation or diversion of wastewater.

**3.8
pumping installation**

pumping station together with any associated rising main(s)

**3.9
rainfall intensity**

depth of rain falling in unit time, or volume of rain falling in unit time per unit area

**3.10
rainwater**

water arising from atmospheric precipitation, which has not yet collected matter from the surface

Note 1 to entry: See Figure 2.

[SOURCE: EN 16323:2014, 2.1.1.1]

**3.11
return period**

expression of the expected frequency of an event expressed as the average recurrence interval between the events equalling or exceeding a specified magnitude (see expected frequency 3.3)

Note 1 to entry: The probability that an event of a certain return period being exceeded in any one year period is the inverse of that return period measured in years.

**3.12
runoff**

water from precipitation that flows off a surface to reach a drain, sewer or receiving water

Note 1 to entry: See Figure 2.

[SOURCE: EN 16323:2014, 2.1.1.2]

3.13**sewer flooding**

condition where wastewater escapes from or cannot enter a drain and sewer system and either lies on the surface or enters buildings

3.14**structural condition**

state of a drain and sewer in matters relating to the integrity of its fabric

3.15**surface receiving water body**

receiving water body that is on the surface of the ground (e.g. river, lake or sea)

Note 1 to entry: See Figure 2.

[SOURCE: EN 16323:2014, 2.1.3.7]

3.16**surface water**

water from precipitation, which has not seeped into the ground and is discharged to the drain or sewer system directly from the ground or from exterior building surfaces

Note 1 to entry: See Figure 2.

[SOURCE: EN 16323:2014, 2.1.1.3]

3.17**urban drainage system**

infrastructure for the management of wastewater and runoff in the built environment

3.18**drainage**

<built environment> group of technologies techniques and actions to achieve satisfactory hygiene and public health relating to wastewater, including both foul wastewater and surface water

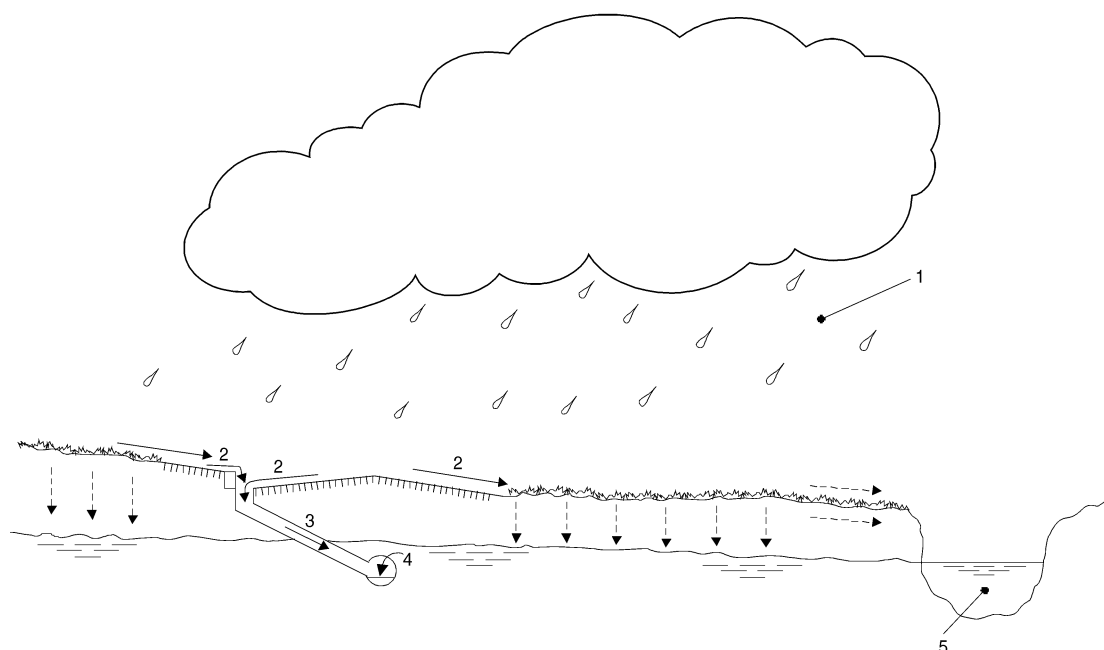
3.19**wastewater**

water composed of any combination of water discharged from domestic, industrial or commercial premises, surface run-off and accidentally any sewer infiltration water

[SOURCE: EN 16323:2014, 2.3.10.65]

3.20**whole life cost**

aggregate cost of a scheme over its design working life, being the sum of the construction, operating, maintenance and end of life costs all calculated at the same time base



Key

- 1 rain water
- 2 runoff
- 3 surface water
- 4 infiltration
- 5 surface receiving water body

Figure 2 — Terminology for flows derived from rain water [SOURCE: EN 16323:2014]

4 Objectives

4.1 General

The four objectives of drain and sewer systems are:

- public health and safety;
- occupational health and safety;
- environmental protection;
- sustainable development.

Objectives can be divided in objectives for the physical system and objectives for managing the activities related to the physical system.

A number of European Union Directives (e.g. the EU Urban Wastewater Treatment Directive (91/271/EEC)) make requirements for drain and sewer systems which relate to these objectives.

These objectives are the basis for the integrated sewer system management, including asset management of the drain and sewer system.

The objectives are the basis for determining the functional requirements and the performance requirements as illustrated in Figure 3.

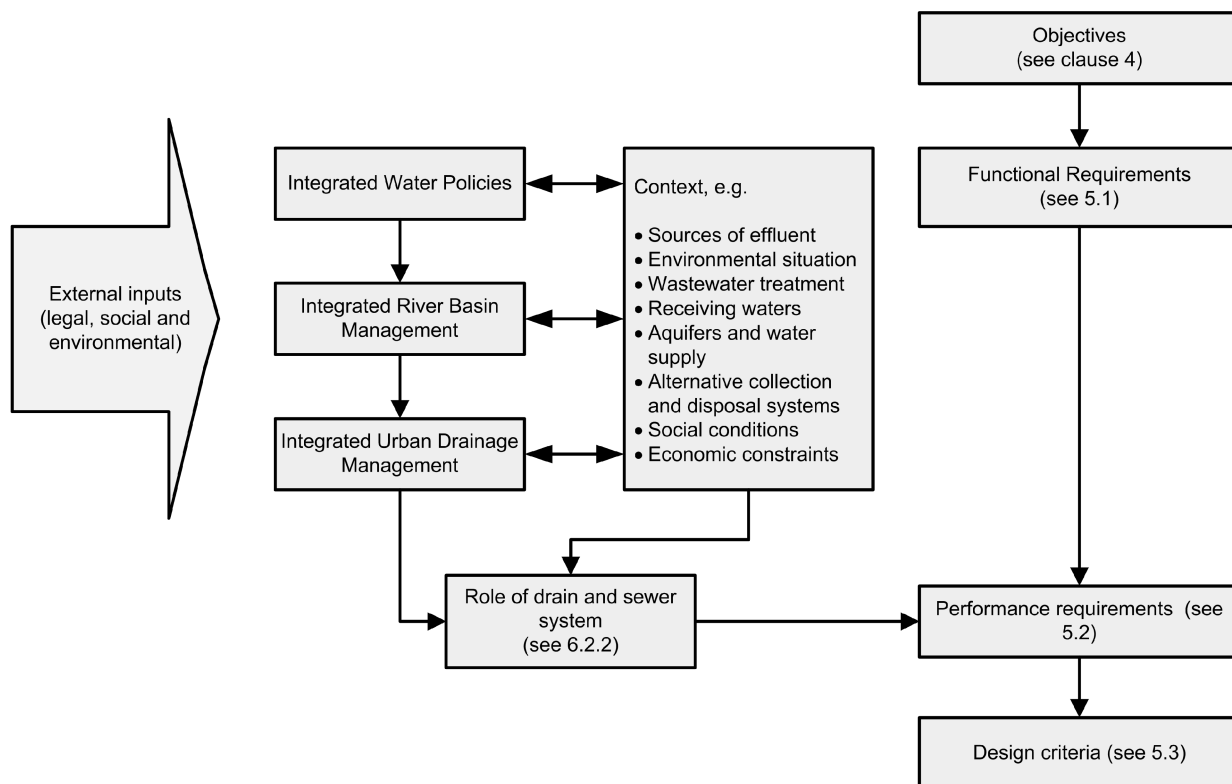


Figure 3 — Process for determining performance requirements from objectives

4.2 Public health and safety

Drain and sewer systems are provided in order to:

- prevent spread of disease by contact with faecal and other waterborne waste;
- protect drinking water sources from contamination by waterborne waste;
- manage rainwater and surface runoff while minimizing hazards to the public (including flooding hazards).

Poorly designed, constructed or maintained systems can cause health or safety hazards to the public.

The objective is to design, construct, operate, maintain and rehabilitate the system in order to minimize the health and safety risks associated with the conveyance of wastewater.

4.3 Occupational health and safety

All work associated with the installation, operation, maintenance and rehabilitation of drain and sewer systems presents a range of occupational health and safety hazards.

The objective is to minimize the occupational health and safety risks likely to arise during installation, operation, maintenance, and rehabilitation.

4.4 Environmental protection

The objective is to design, construct, operate and maintain the system to minimize the impact on the environment. These include impacts on:

- water quality;

- water ecology;
- local water balance.

The impact of drain and sewer systems on the receiving water bodies shall meet the requirements of any national or local regulations or the relevant authority. Other environmental requirements specified by any national or local regulations or the relevant authority shall also be met.

4.5 Sustainable development

The objective is to design, construct, operate, maintain and rehabilitate the system at the best environmental, social and economical costs so that, in particular, it:

- a) uses materials that minimize the depletion of finite resources;
- b) can be operated with the minimum practicable use of energy; and
- c) can be constructed, operated and, at the end of their life, decommissioned with the minimum practicable impact on the environment.

5 Requirements

5.1 Functional requirements

5.1.1 Introduction

The function of the drain and sewer system is to collect and transport wastewater. Functional requirements cover the drain and sewer systems, together with combined sewer overflows, pumping installations and other components, including requirements from external constraints (e.g. effects on surface receiving water bodies and wastewater treatment plants). The requirements shall be considered in respect of the whole system to ensure that additions or modifications to the system do not result in failure to meet the target standards.

Functional requirements shall be established to ensure that the objectives listed in Clause 4 are achieved.

The functional requirements should include those listed in Table 1. Additional functional requirements may be specified.

Each functional requirement can relate to more than one objective. An indication of the relationship between the functional requirements and the objectives is shown in Table 1.

Table 1 — Relationship between objectives and functional requirements

Clause No	Public health and safety	Occupational health and safety	Environmental protection	Sustainable development
<i>Functional requirements relating to the system</i>				
5.1.2 Protection from sewer flooding	XXX	XX	XXX	–
5.1.3 Maintainability	XX	XXX	XX	XX
5.1.4 Protection of surface receiving water bodies	XXX	X	XXX	XX
5.1.5 Protection of groundwater	XXX	–	XXX	XXX
5.1.6 Prevention of odours and toxic, explosive and corrosive gases	XXX	XXX	XXX	XXX
5.1.7 Prevention of noise and vibration	XX	XXX	X	X
5.1.8 Structural integrity and design working life	XXX	XXX	XXX	XXX
5.1.9 Watertightness	XXX	X	XXX	XX
<i>Functional requirements relating to the management of the system</i>				
5.1.10 Sustainable use of products and materials	–	–	XX	XXX
5.1.11 Sustainable use of energy	–	–	XX	XXX
5.1.12 Maintaining the flow	XXX	–	XXX	X
5.1.13 Not endangering adjacent structures and utility services	XXX	XXX	X	XX
5.1.14 Inputs quality	XX	XXX	XXX	XX
Key XXX is High; X is Low; – is not related.				

5.1.2 Protection from sewer flooding

Flooding from drains and sewers can have an impact on the health of people affected. It can also cause damage to buildings and urban infrastructure. The economic impact can be high and depends on the type of location flooded.

Sewer flooding shall be limited to nationally or locally prescribed frequencies taking into account the:

- health and safety effects of the sewer flooding;
- costs arising from sewer flooding;
- extent to which any sewer flooding on the surface of the ground can be controlled without causing damage;
- whether surcharge is likely to lead to sewer flooding of basements.

NOTE In some jurisdictions it is the responsibility of the property owner to provide protection to prevent sewer flooding of basements due to surcharge.

The hydraulic capacity shall limit sewer flooding to nationally or locally prescribed levels and frequencies taking into account backwater levels. The hydraulic capacity shall allow for foreseeable increases in flow over the design working life of the system.

Other forms of flooding can also impact on the drain and sewer system including:

- a) river flooding – water from rivers and lakes which flows onto the land;
- b) coastal flooding – water from the sea which flows onto the land;
- c) surface water flooding – runoff that does not enter a drainage system;
- d) groundwater flooding – water on land when the groundwater level rises above the ground level.

The effects of flows discharged into downstream sewers or receiving water bodies shall be considered. Further details are included in Clause 8.

Where there are components in the system, which have a high risk of failure, measures should be taken to avoid or minimize the risk of sewer flooding in the event of failure of those components.

5.1.3 Maintainability

The system shall be planned, designed, constructed and rehabilitated to allow appropriate maintenance activities to be carried out safely and without risks to the health of personnel.

Adequate access and working space shall be provided for maintenance purposes.

5.1.4 Protection of surface receiving water bodies

Surface receiving water bodies shall be protected from pollution within nationally or locally prescribed limits.

The impact of drain and sewer systems on the surface receiving water bodies shall meet the requirements of any national or local regulations or the relevant authority. Other environmental requirements specified by any national or local regulations or the relevant authority shall also be met.

The measures to achieve the standards required under EU Water Framework Directive (2000/60/EC) are summarized in the water framework river basin plan.

5.1.5 Protection of groundwater

Groundwater shall be protected from pollution within nationally or locally prescribed limits. The effect of the drain and sewer system on the local recharge of aquifers shall be considered. Where infiltration drainage systems are proposed, the effects of rainwater quality and quantity shall be considered.

The measures to achieve the standards required under the EU Water Framework Directive are summarized in the river basin management plan produced in accordance with the water framework river basin plan.

5.1.6 Prevention of odours and toxic, explosive and corrosive gases

Sewer systems shall be planned, designed, constructed, maintained, operated and rehabilitated as far as practicable to avoid odour nuisance, or toxic, explosive or corrosive gases.

5.1.7 Prevention of noise and vibration

The system shall be planned, designed, constructed, maintained, operated and rehabilitated so that noise and vibration are minimized.

5.1.8 Structural integrity and design working life

Drains, sewers and other components shall be planned, designed, constructed, maintained, operated and rehabilitated to ensure structural integrity over the design working life.

5.1.9 Watertightness

New drains, sewers and ancillary structures, other than those specifically designed for infiltration drainage, shall be watertight in accordance with the testing requirements of EN 1610. Existing drains, sewers and ancillary structures shall be watertight in accordance with national or local testing requirements.

5.1.10 Sustainable use of products and materials

Products, materials, and their construction methods shall be selected that minimize depletion of finite resources having regard to the design working life of the component and the potential for re-use or recycling, for example minimizing the volume of excavated material and the reuse of excavated material.

5.1.11 Sustainable use of energy

The design and operation of the drain and sewer system shall, so far as is practical, minimize the use of energy over the design working life of the system.

5.1.12 Maintaining the flow

The system shall be planned, designed, constructed, maintained, operated and rehabilitated to reliably convey all permissible flows that can be discharged into the system to the point of discharge, ensuring that the operation of the system is safe, environmentally acceptable and economically efficient.

5.1.13 Not endangering adjacent structures and utility services

The planning, design, construction, maintenance, operation and rehabilitation of drains and sewers shall not endanger existing adjacent structures and utility services.

5.1.14 Inputs quality

The drain and sewer system can be designed to receive both domestic and non-domestic wastewater inputs. The quality of the non-domestic wastewater inputs shall be controlled so that they do not

compromise the integrity of the fabric of the system or its function or constitute a danger for the environment. National or local regulations can give requirements for inputs quality.

5.2 Determination of performance requirements for the drain and sewer system

5.2.1 Introduction

In order to evaluate the performance of the system and to allow development of design standards, measurable performance requirements shall be determined from each functional requirement. The process for deriving performance requirements is illustrated in Figure 3.

Drain and sewer systems are part of the urban drainage system (see Figure 4). Urban drainage systems comprise all infrastructures or the management of wastewater and rain water in the built environment. The extent and role of the drain and sewer system within the urban drainage system depends on local circumstances for each system.

Urban drainage systems are part of a wider system of water management (see Figure 4). The EU Water Framework Directive (2000/60/EC) and the EU Floods Directive (2007/60/EC) provide the basis for integrated management of the whole water management system through the river basin management plans and flood risk management plans.

Integrated sewer system management is the coordinated management of the planning, design, construction, rehabilitation, operation and maintenance of all drain and sewer systems in a catchment area taking into account all aspects of their performance. It includes a consideration of the interactions of the drain and sewer system with the urban drainage system as a whole, and the wider water environment.

The performance requirements should take account of the role of the drain and sewer system which should be determined within the context of the whole river basin catchment and the other elements of the urban drainage system (see Figure 4). To determine this role account should be taken of integrated water policies set by any national or local regulations or the relevant authority together with any requirements of the integrated river basin management plan.

Integrated urban drainage management is the coordinated management of the planning, design, construction, rehabilitation, operation and maintenance of all urban drainage systems in a catchment area taking into account all aspects of their performance. Account should also be taken of any policies resulting from integrated urban drainage management.

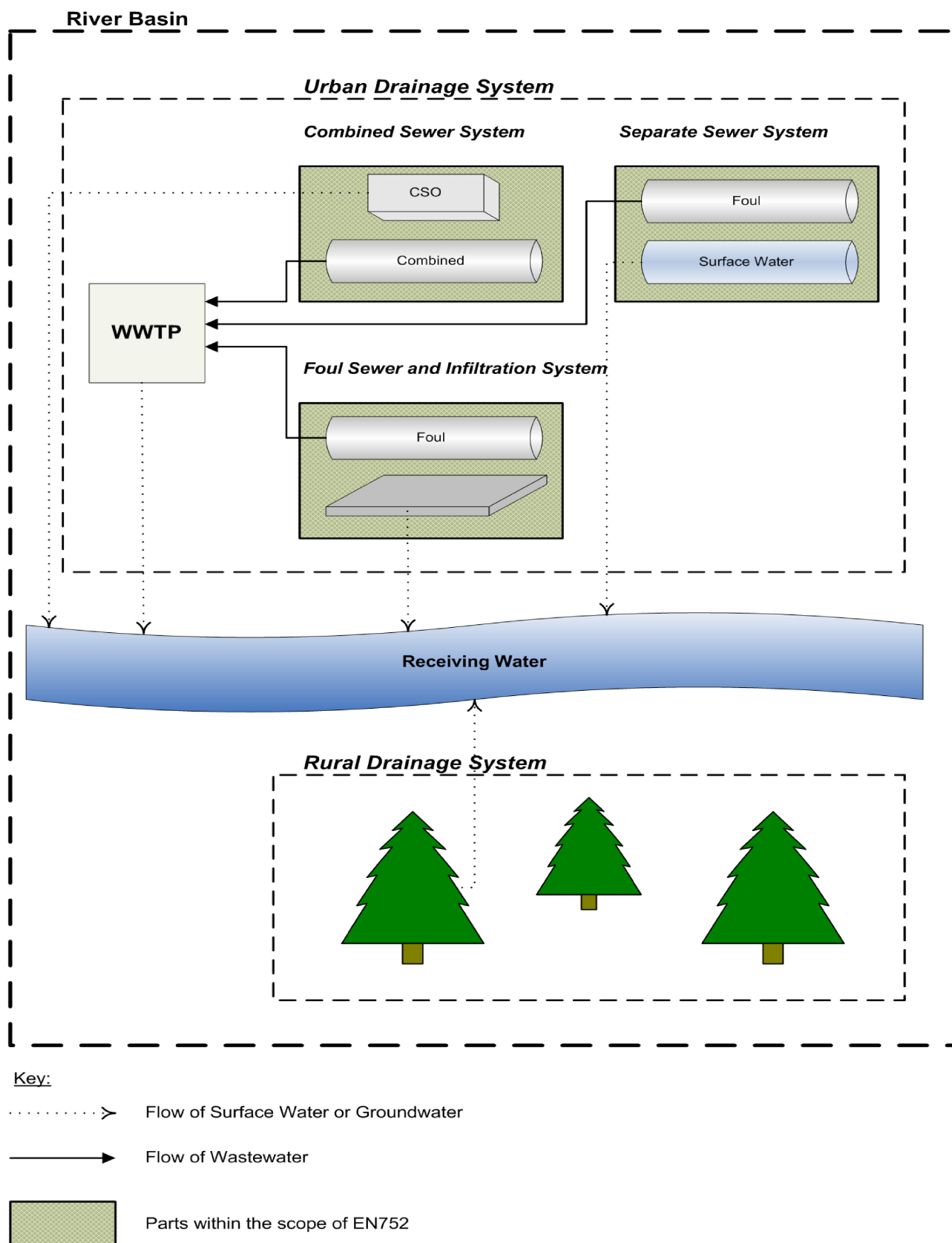


Figure 4 — Drain and sewer systems in the river basin

For each functional requirement there can be legal requirements, public expectations and financial constraints which influence the performance requirements.

Examples of performance requirements in use in different countries can be obtained from the organizations listed in Annex A.

Performance requirements shall be reviewed periodically and updated if necessary. The performance requirements for the system should be updated after major extension, maintenance or rehabilitation.

In principle the performance requirements for a rehabilitated system shall be the same as those for a new system.

5.2.2 Environmental performance requirements

The EU Water Framework Directive (2000/60/EC), together with its daughter directives including the EU Bathing Waters Directive (2006/7/EC), the EU Shellfish Water Directive (2006/113/EC), the EU Urban Wastewater Treatment Directive (91/271/EEC) and the EU Groundwater Directive (2006/118/EC) provide a basis for setting performance requirements relating to the status of water bodies including ground water, inland surface water bodies and coastal waters.

The EU Bathing Waters Directive (2006/7/EC) makes provisions for the monitoring and classification of bathing water quality, the management of bathing water quality and the provision of information to the public on bathing water quality. It specifies mandatory and guideline water quality standards. It applies to surface water bodies where the competent authority expects a large number of people to bathe and it has not imposed a permanent bathing prohibition, or issued permanent advice against bathing.

The EU Shellfish Waters Directive (2006/113/EC) specifies mandatory and guideline water quality standards for the quality of shellfish waters and applies to those coastal and brackish waters designated by the Member States as needing protection or improvement in order to support shellfisheries.

The EU Urban Wastewater Treatment Directive (91/271/EEC) makes requirements for the collection, treatment and discharge of wastewater. It requires the design, construction and maintenance of wastewater collection systems have regard to the volume and characteristics of the wastewater, the prevention of leaks and the limitation of pollution of receiving waters due to combined sewer overflows. The directive contains the following advisory footnote: "Given that it is not possible in practice to construct collecting systems and treatment plants in a way such that all waste water can be treated during situations such as unusually heavy rainfall, Member States shall decide on measures to limit pollution from storm water overflows¹⁾. Such measures could be based on dilution rates or capacity in relation to dry weather flow, or could specify a certain acceptable number of overflows per year."

The EU Groundwater Directive (2006/118/EC) establishes measures to prevent and control groundwater pollution. These measures include criteria for the assessment of good groundwater chemical status.

National or local regulations or the relevant authority can also specify performance requirements in relation to the environmental performance of drain and sewer systems.

Environmental performance requirements for drain and sewer systems can be set in terms of emission limits for discharges or in terms of the impact on the status of the receiving water body (including groundwater, inland surface water bodies and coastal water bodies). The requirements should take into account the impact of other emissions. The requirements should take account of the anticipated

1) In EN 752 the term "combined sewer overflows" has broadly the same meaning as the term "storm water overflow" in the Directive.

frequency of discharges, the physical (e.g. scour due to flow velocity), chemical, biochemical and other relevant considerations.

Proposed controls on discharges from the drain and sewer systems shall take account of the water environment in the river basin (see Figure 3) and in particular:

- a) the current status of the receiving water bodies within the river basin including the chemical status, the ecological status;
- b) the objectives for the future status of the receiving water bodies;
- c) any other proposed measures to improve or adversely affect the status of the receiving water bodies;
- d) any policies for achieving the objectives.

Emission limits can be also set in terms of the frequency, duration of the discharges as well as their physical, chemical or biological composition. Environmental modelling can be necessary to establish appropriate emission limits.

Alternatively standards can be set by specifying a method of treatment (e.g. screening or vegetative treatment).

5.2.3 Hydraulic performance requirements

The EU Floods Directive (2007/60/EC) provides a framework for the management of flood risk from all sources. However, the Directive permits member states to exclude sewer flooding from these arrangements.

Performance requirements should be set taking into account the potential for damage and the hazards. Separate requirements may be set for sewer flooding with surface water and sewer flooding with foul or combined wastewater.

National or local regulations or the relevant authority can specify performance requirements in relation to surcharge frequencies or sewer flooding frequencies.

There are two commonly used methods of setting hydraulic performance requirements within the drain and sewer system:

- The expected frequency of sewer flooding in any year, or the return period of sewer flooding. Different flood frequency requirements can be specified depending on the type of property impacted and the extent of damage to people and property that would result from the sewer flooding. In this way the requirements can reflect the sewer flood risk, taking account of both the expected frequency of the sewer flooding (the expected frequency) and its impact (for example the type of property flooded).
- The expected frequency of surcharge in drains or sewers can be specified depending on the type of property impacted and the expected frequency that surcharge would result in sewer flooding (e.g. the presence of basement properties).

The sensitivity of the surcharge or expected sewer flooding frequency to possible changes in rainfall due to climate change should be considered.

Discharges of surface water or combined wastewater can impact on flood risk in surface receiving water bodies. Performance requirements can also be set to limit the rate or volume of discharge from drain and sewer systems in order to limit flood risk in the surface receiving water bodies.

Hydraulic performance requirements for drain and sewer systems shall therefore take account of the wider river basin (see Figure 4) and in particular:

- a) the current flood risk in the drain and sewer system and in the river basin;
- b) the objectives for future flood risk in the drain and sewer system and in the river basin;
- c) any other proposed measures to improve or adversely affect the flood risk in the drain and sewer system and in the river basin;
- d) any policies for achieving the objectives for flood risk.

5.2.4 Structural requirements

The components of the system shall resist the foreseeable imposed loads throughout the design working life without defects which can:

- a) lead to unacceptable risk of loss of structural integrity;
- b) impair the function of the system so that other performance requirements are not achieved.

5.2.5 Operational requirements

Operations should:

- a) ensure that the entire system is operationally ready at all times and functions in accordance with the other performance requirements;
- b) ensure that the operation of the system is safe, environmentally acceptable, and economically efficient;
- c) ensure that as far as possible the failure of one part of a sewer system not adversely affects the performance of other parts of the system.

5.3 Design criteria

5.3.1 Introduction

To ensure that the system achieves the performance requirements during its design working life, design criteria should be set which usually exceed the performance requirements. The design criteria should be set at a level which ensures that the system continues to meet the performance criteria taking account of any foreseeable changes over the design working life of the system. Design criteria shall take into account any changes expected over the design working life of the drain and sewer system if these changes are not otherwise taken into account in the design.

The changes that should be taken into account can include:

- a) increased flows due to new developments;
- b) reduced flows due to changes in the development and changes in water use;
- c) increased flows resulting from changes to existing developments;
- d) reduced hydraulic capacity resulting from increased hydraulic pipeline roughness (e.g. due to deterioration) in the drains or sewers or wear in pumps;
- e) reduced hydraulic capacity due to build-up of sediments in sewers.

5.3.2 Hydraulic design criteria

5.3.2.1 Introduction

Design criteria shall take into account any changes in flows expected over the design working life of the drain and sewer system if these changes are not otherwise taken into account in the design. The potential effects of climate change should be considered. This is to ensure that the sewer continues to meet the performance criteria over the design working life of the system.

The frequency of an event can be expressed either as a return period or a probability of occurrence in any one-year period.

Design criteria can be set for:

- a) the expected frequency at which no surcharge occurs in the drain and sewer system;
- b) the expected frequency at which a specified amount of surcharge occurs in the drain and sewers system;
- c) the expected frequency of sewer or surface water flooding (this can occur without surcharge); and
- d) the impact of the flows from surface water outfalls on river flooding from surface receiving water bodies or on groundwater flooding;
- e) the impact of flows on the operation of the wastewater treatment plant.

The nature of design criteria depends on the type of design methods used.

In setting hydraulic design performance criteria for surface water sewers, allowance shall be made for the design methods that are likely to be used. In all cases the scale of the consequences of sewer flooding should be taken into account.

Where simple design methods are used, design criteria are typically expressed in terms of the frequencies of design rainfall events that just fill the pipe without surcharge in the knowledge that this generally provides protection against sewer flooding from more severe rainfall events. The degree of flood protection depends on local factors (e.g. topography, sewer gradient).

Where more complex methods are used and it is possible to predict expected sewer flood frequencies, sewer flooding design criteria should also be used.

Both the expected rainfall event frequency and the expected flood frequency can be expressed as a return period, which is the average period in years between events, or a probability that an event will be exceeded in any one year.

5.3.2.2 Full pipe design rainfall criteria

The design rainfall frequency is the rainfall intensity that causes the pipe to be just full without surcharge. Different design criteria may be set for combined and separate systems.

National or local regulations or the relevant authority can specify design rainfall.

In setting design rainfall criteria for use when combined or surface water drains and sewers are designed for full pipe flow the following points should be considered:

- a) whether there are any connected basements not protected by anti-flooding devices, effluent lifting stations or pumping stations;
- b) whether the surcharge is likely to lead to sewer flooding of basements;
- c) whether design criteria for flood frequency are also specified for the design.

Examples of design rainfall frequency criteria are given in Table 2, however the criteria can vary widely between countries.

Table 2 — Examples of design rainfall frequencies for pipes to run just full without surcharge

Location	Design rainfall frequency ^a	
	Return period <i>years</i>	Probability of exceeding in any 1 year
Rural areas	1	100 %
Residential areas	2	50 %
City centres/industrial/commercial areas	5	20 %
Underground railway/underpasses	10	10 %
^a For the selected design rainfall event the pipe shall be no more than just full and shall be without surcharge.		

5.3.2.3 Sewer flooding design criteria

Design sewer flooding frequencies should be set in order to manage the risk of sewer flooding, having regard to both the frequency and consequences of sewer flooding.

NOTE The arrangement of the drain and sewer system together with the above ground space are considered together to achieve these design criteria.

The effect of sewer flooding depends on the type of surface or building it affects. This depends on the characteristics of the surface and the movement of the flood water across the surface. The impacts can include damage to property and impacts on the health or safety of people.

Design criteria should take account of the following:

- a) deep or fast flowing flood water presents an increased hazard to people;
- b) flooding inside buildings can cause high economic damage and present a hazard to life and health;
- c) depending on its extent, flooding that is confined to external surfaces such as roads often causes more limited damage.

For locations with a high potential for damage or hazard, detailed investigations should be undertaken, taking into account the movement of water and the effect of surface features (e.g. kerbs).

Different design criteria may be set for combined and separate sewer systems.

National or local regulations or the relevant authority can specify design sewer flooding frequencies.

Examples of design sewer flooding frequency criteria are given in Table 3, however the criteria can vary widely between countries.

Table 3 — Examples of design sewer flooding criteria for standing floodwater

Impact	Example locations	Examples of design sewer flooding frequency	
		Return period <i>years</i>	Probability of exceeding in any 1 year
Very low	Roads or open spaces away from buildings	1	100 %
Low	Agricultural land (depending on land use, e.g. pasture, arable)	2	50 %
Low to medium	Open spaces used for public amenity	3	30 %
Medium	Roads or open spaces adjacent to buildings	5	20 %
Medium to high	Flooding in occupied buildings excluding basements	10	10 %
High	Deep flooding in occupied basements or road underpasses	30	3 %
Very high	Critical infrastructure	50	2 %
Return period should be increased (probabilities reduced) where the floodwater is fast moving. When undertaking rehabilitation of existing systems and where achieving the same design criteria for a new system would entail excessive cost, a lower value may be considered.			

5.3.2.4 Effect on downstream water bodies

Design criteria can be set for the impact of flows discharged from outfalls on the flood risk in receiving water bodies. The criteria may be given in absolute terms or by reference to the current conditions. Such criteria can include:

- a) controls on the flow rates and volumes for discharges from the area drained; for example:
 - 1) limiting the peak flow rate and volume of the discharge in prescribed rainfall conditions to specified values;
 - 2) ensuring there is no increase in the peak flow rate or volume in prescribed rainfall conditions;
- b) criteria for the flood frequencies from the receiving water body; for example:
 - 1) no increase in flood frequency from the receiving water body;
 - 2) limiting the flood frequency from the receiving water body to prescribed values.

5.3.3 Environmental design criteria

There are several approaches for setting design criteria for the control of pollution from drain and sewer systems including:

- a) uniform emission limits can be set by national or local regulations or the relevant authority for general use with each of the different types of discharge;

- b) site-specific emission limits can be set by any national or local regulations or the relevant authority for individual points of discharge, to satisfy requirements for the quality and characteristics of the receiving water body taking into account any environmental quality standards for the receiving water body and the specific needs of the receiving water body;
- c) specifying a method of treatment for the discharge, which in the opinion of the relevant authority ensures that an adequate emission standard is achieved.

In many cases a combination of the two approaches should be considered.

Uniform emission limits are generally set in relation to what is technically feasible for the different types of discharge. They form a baseline standard prior to the determination of site-specific limits which do not put the self-purifying capacity of the receiving water body at risk. They are unlikely to be applicable where discharge is to sensitive waters such as recreational areas, sources for water supply or lakes. Generally in such cases, more stringent site-specific emission limits are necessary to satisfy the receiving water quality requirements.

The site-specific emission limit approach is sensitive not just to the effects of an individual discharge, but also to the combined effects of the whole range of discharges to receiving water bodies. These discharges, including those from industry, treatment works and non-point sources can demand an integrated approach to the identification of solutions.

The principal advantage of method based criteria is that there is no on-going cost of sampling. The principal disadvantage is reduced confidence in the compliance. For this reason, method-based criteria are generally only set for low risk discharges.

The relevant authority for environmental regulation can classify receiving water bodies according to current or projected uses or interests, for example:

- abstraction for potable supply;
- fishery;
- bathing or other water contact activities;
- special ecosystem.

The emission limits or method based criteria can then be set by any national or local regulations or the relevant authority using, where appropriate, water quality simulation models.

5.3.4 Structural design criteria

Structural design criteria should be set taking account of the actions on the structures in accordance with the EN 1991 series taking account of the principles of structural design set out in EN 1990 or, for buried pipelines, taking account of EN 1295-1. Design criteria can include:

- a) prescribing a design working life for each component;
- b) prescribing the loads that each component shall be able to withstand;
- c) prescribing any special safety factors to be used;
- d) limit states used for design.

5.3.5 Operational criteria

Operational design criteria should be set to ensure:

- a) the safety and welfare of operator personnel when carrying out operation of the system;
- b) the reliable operation of the system (e.g. blockages or pump failures).

6 Integrated sewer system management

6.1 Introduction

Integrated sewer system management is the process of achieving an understanding of existing and proposed drain and sewer systems, and using this information to develop measures to ensure that the hydraulic, environmental, structural and operational performance meets the specified performance requirements taking into account future conditions and economic efficiency. It incorporates the asset management of the drain and sewer system.

Integrated sewer system management should be carried out in the framework of the management principles of the wastewater utility. National or local regulations or the relevant authority can influence these principles.

The principles can include:

- a) technical principles to achieve compliance with the performance requirements. These incorporate any legal requirement regarding the performance of the drain and sewer systems;
- b) asset management principles;
- c) economic principles;
- d) risk management principles;
- e) liabilities to third parties.

Economic principles can include:

- avoiding overall deterioration of the assets or making up for past deterioration;
- determination of the long-term financial requirements to achieve the defined performance through the production of investment requirement plans;
- determination of optimal levels of financial resources taking account of the costs and benefits;
- prediction and balancing of future wastewater tariffs;
- phasing expenditure to produce a manageable expenditure profile throughout the period of the plan;
- phasing with other works;
- phasing work to achieve a consistent work load to make best utilization of personnel and equipment.

Risk management can include:

- risk identification;

- risk analysis;
- risk assessment;
- risk treatment.

The integrated sewer system management process is illustrated in Figure 5.

The integrated sewer system management process has four principal activities:

- appropriate level of investigation of all aspects of the performance of the drain and sewers system;
- assessment of the performance by comparison with the performance requirements including identification of the reasons for any observed performance failures;
- planning – developing the plan of measures to be taken;
- implementation of the plan.

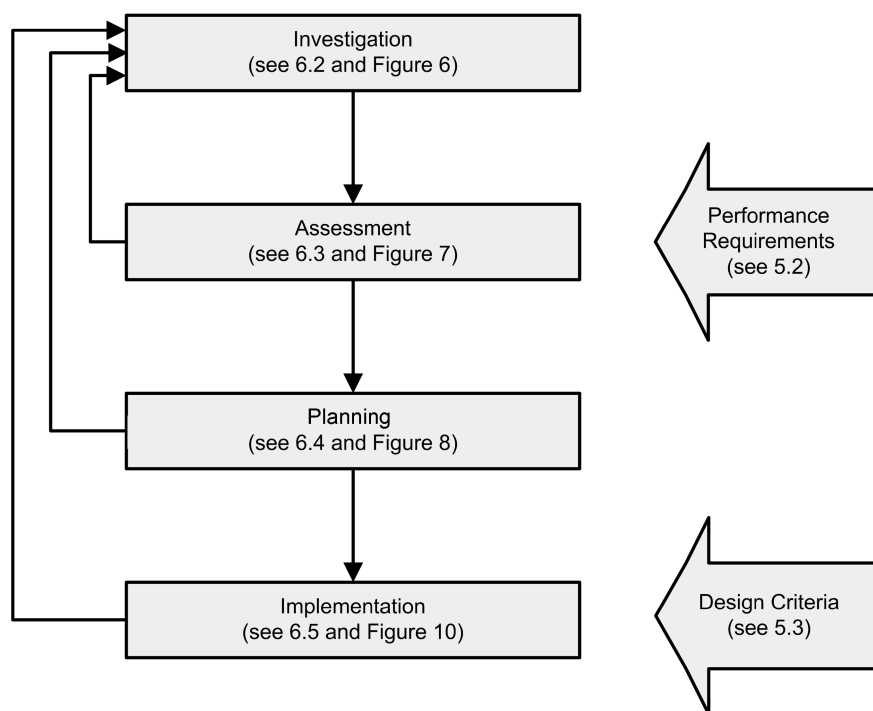


Figure 5 — Integrated sewer system management process

The need for further investigation can become apparent either during the performance assessment or the planning.

Integrated sewer system management forms the basis for the operation and rehabilitation of the drain and sewer system. The information is regularly updated for the future management of the drain and sewer system.

For large drain and sewer systems, for example where one serving a large city, an outline integrated sewer system management plan may first be developed following an outline investigation of the whole system. More detailed plans may then be developed for each sub-catchment within the context of the outline plan (see Figure 6).

The integrated sewer system management plan is further developed during the implementation phase (see 6.5), by subsequent investigation, assessment and planning to develop work programmes and individual projects to implement the plan.



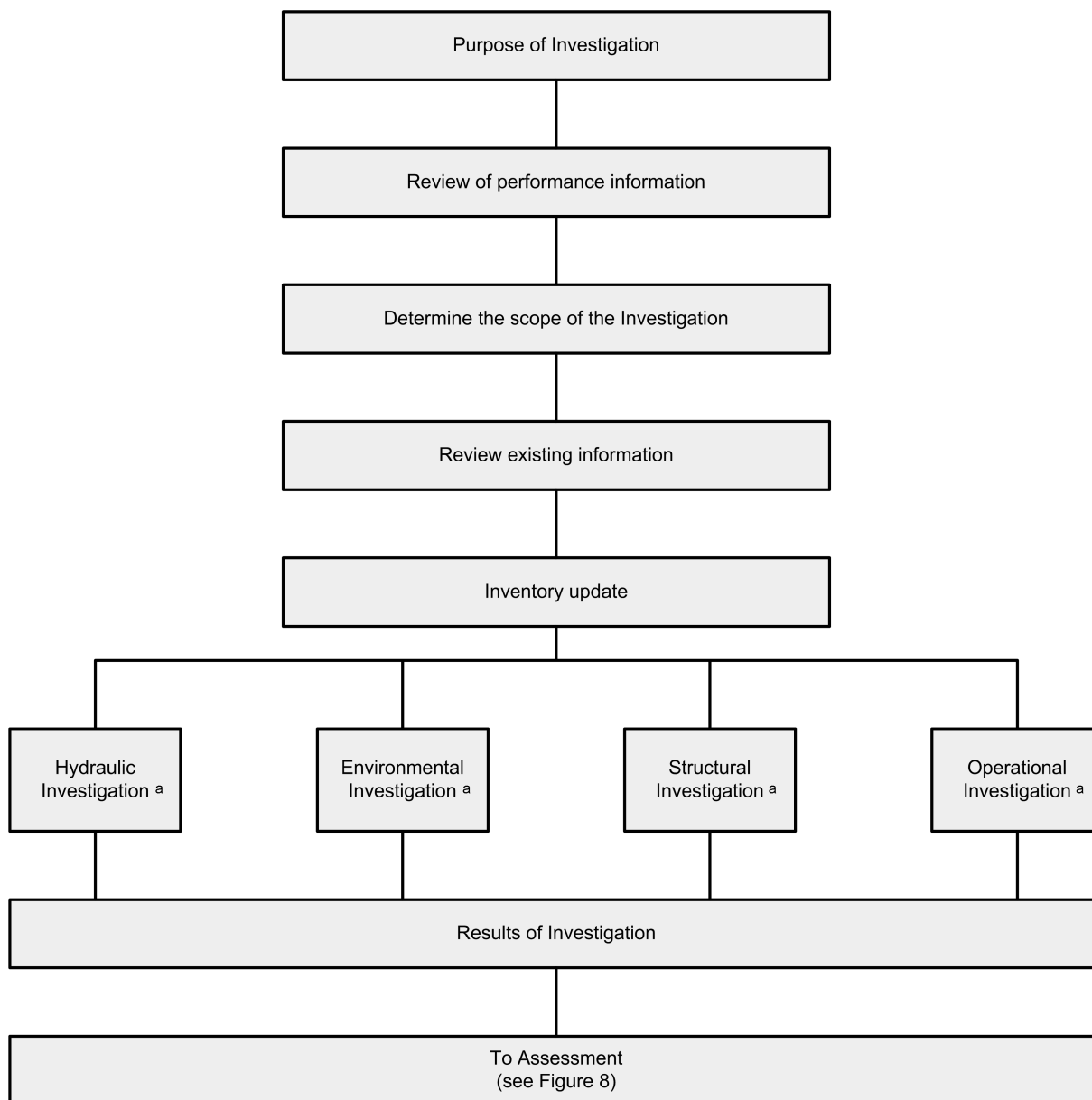
Figure 6 — Increasing degree of detail in integrated sewer system planning

The boundary conditions with adjacent drain and sewer systems and with other urban drainage systems or with river systems should be considered at all stages.

6.2 Investigation

6.2.1 Introduction

The investigation is the first stage in the integrated sewer system management as described in 6.1 (see Figure 5). The process for investigation is outlined in Figure 7.



^a Other types of investigations/monitoring are also possible

Figure 7 — Process for investigation

Damaged, defective or hydraulically overloaded drains and sewers represent a potential hazard through sewer flooding and collapses, and through pollution of surface receiving water bodies, groundwater and soil. The problems found in existing drain and sewer systems are frequently interrelated and upgrading works are often designed to overcome a number of problems at the same time. The investigation and planning of rehabilitation work should be carried out on defined catchment areas in phases if appropriate, so that all problems and their causes can be considered together. The procedures described in this European Standard can be applied in any drain and sewer system, but detailed application should take account of the age, location and type of system, the materials used in its construction, together with functional and climatic factors.

6.2.2 Purpose of investigation

The investigation is carried out in order to make an assessment of the performance of the drain and sewer system and its components. This can include:

- investigation aimed at strategic planning;
- investigation aimed at operational planning.

The purpose of the investigation influences the way in which it is carried out (e.g. choice of method, degree of detail, desired accuracy) and the way in which the results are assessed.

The components of the drain and sewer system included in the investigation shall be those that are necessary to fulfil the purpose of the investigation. The investigation shall be carried out in accordance with EN 13508-1. Any coding of the results from visual inspections should be in accordance with EN 13508-2.

6.2.3 Review of performance information

An indication of the type of performance problems, if any, on existing systems is likely to be known through reports of incidents such as sewer collapses, sewer flooding or polluted watercourses and from previous investigations. For details of performance monitoring see 10.2. Records of past incidents and any other relevant information shall be brought together and analysed. This information should be used to establish the scope of the investigations.

Where large numbers of complete or partial catchments are in need of investigation, the existing information collected may also be used to assign priorities to the investigation of the perceived problems in each catchment (for example by comparing the cost of the investigation with the benefit that might be achieved). These can then be used to draw up a comprehensive programme so that the catchments with the most serious problems are investigated first.

6.2.4 Determine the scope of the investigation

Following the review of the current performance information it is possible to decide whether to carry out an investigation and whether the extent of the problems justifies an investigation of the entire catchment area. The extent and detail of the subsequent investigation of the hydraulic, environmental, structural and operational aspects shall be determined. Further guidance on the type of investigations can be found in EN 13508-1.

6.2.5 Review existing information

The collection and review of all available relevant information about the drain and sewer system shall be carried out and is the basis from which all other activities are subsequently planned.

A review should also be undertaken of the information required to manage the drain and sewer system.

This information should be assessed to determine what further information is required in order to carry out the investigation (see EN 13508-1).

6.2.6 Inventory update

Where the inventory is incomplete it shall be updated so that a sufficient record of the drain and sewer system is available to carry out the investigation.

NOTE The update of the other information is included in the hydraulic, environmental, structural and operational investigations.

6.2.7 Hydraulic investigation

Testing and inspection procedures can be required in order to ensure an adequate evaluation of flows (wet and dry weather, infiltration, flow through gaps in manhole tops (between the cover and frame), exfiltration and wrong connections). Surveys can include precipitation and flow measurements, identification of wrong connections and groundwater measurements.

In some cases it is not possible to understand the hydraulics of the system without using a hydraulic model. This sewer flow simulation model should be based on an as-built report updated after onsite investigation of the main works. However a model is not usually recommended where:

- there are no known hydraulic problems (particularly where the sewer system takes only foul wastewater flows); and
- there are no combined sewer overflows; and
- no significant new developments are proposed within the system; and
- structural problems are to be solved using techniques which do not reduce the hydraulic capacity of the sewer.

Information on the use of computer based sewer flow simulation programs is given in prEN 16933-2.

6.2.8 Environmental investigation

The environmental impact depends on the nature of the wastewater and its potential to escape from the system.

The quality of surface receiving water bodies shall be ascertained to see whether they meet the requirements and if not, whether the sewer system is a significant factor.

Consideration should be given to other environmental factors such as noise, odour, visual intrusion and potential soil and groundwater contamination, taking into account the availability of the information.

6.2.9 Structural investigation

It is important to ensure that investigation of the system is selective in order to avoid duplication of previous work. The structural investigations may include either a complete survey of the drain and sewer system or a more selective approach. Consideration should be given to the age and location of existing infrastructure, geotechnical data including the pipe bedding and surround, and the vulnerability of existing buildings and other utility services, taking into account the availability of the information.

Where appropriate, other qualitative and quantitative investigation techniques may be used. These include sonar (for pipes that are filled with water) and ground probing radar or other geophysical techniques (e.g. for detecting voids behind the wall of the sewer pipe) or mechanical techniques (e.g. internal jacking to measure the stiffness of the side wall support). Investigation of the chemical composition of the groundwater and the soil should be carried out where this can affect the structural integrity.

The results of the structural investigations can also be relevant to the assessments of the hydraulic performance and environmental impact.

6.2.10 Operational investigation

Existing operational procedures, inspection schedules and maintenance plans shall be identified and documented.

The frequency and location of recorded operational incidents (e.g. blockages, pumping station failures, sewer collapses) shall be reviewed.

The impact of operational problems on the hydraulic, environmental and structural performance of the system should be determined from incident records.

The causes of significant recurrent operational incidents shall be investigated.

To deal with operational problems in the most cost effective way, it is necessary to investigate and understand the causes. Further information can be found in 10.4.

6.3 Assessment

6.3.1 Introduction

The performance of the system shall be assessed against the performance requirements (see 5.2). The performance assessment shall include the evaluation of risks of failure to achieve the performance requirements.

The assessment shall be carried out in accordance with EN 13508-1 (see Figure 8).

6.3.2 Assessment of the hydraulic performance

The results of the hydraulic surveys and/or the verified flow simulation model shall be used to assess the hydraulic performance of the system for a range of rainfall conditions related to the performance requirements (see 5.2.3).

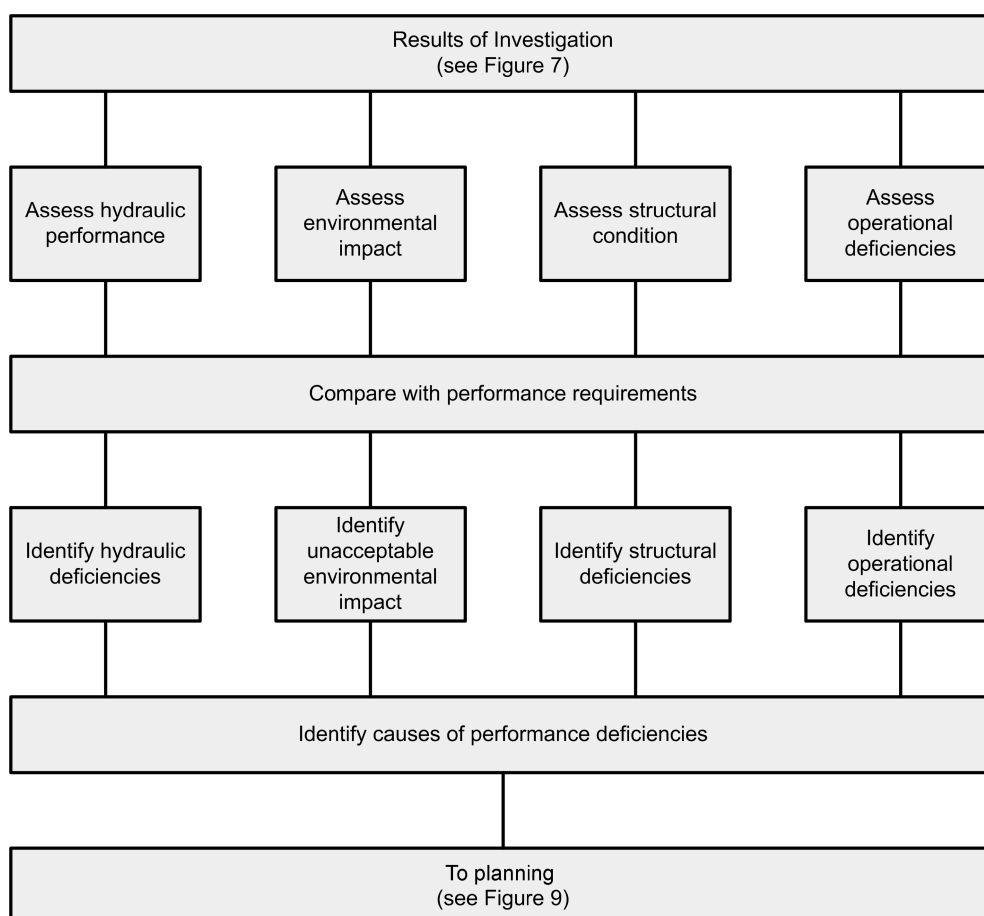


Figure 8 — Process for assessment

6.3.3 Assessment of environmental impact

The results of the investigations shall be considered together with information on the frequency, duration volume and pollution load of discharges to receiving water bodies, determined using a verified flow simulation model or flow and pollution load simulation model (see prEN 16933-2) where this is available or from site measurements. This information shall then be used to assess the environmental impact (including impact on soil and groundwater) of the drain and sewer system.

The results of the structural investigation (see 6.2.9), the industrial wastewater survey and other relevant investigations shall be examined to identify:

- sources of hazardous effluents;
- exceedence of permissible concentrations and discharges;
- other deviations from permits.

6.3.4 Assess structural condition

Once the system has been inspected, the next stage is to examine the results to identify those areas requiring action. A number of methods have been developed to assist in this process. Details of these can be obtained from the organizations listed in Annex A.

6.3.5 Assess operational performance

The operational performance of the system as measured by the number of operational incidents or failures should be assessed. This should be recorded in a data management system.

6.3.6 Compare with performance requirements

The results of the assessment of the hydraulic, environmental, structural and operational performance should be brought together so that the performance of the system and its components can be compared to the performance requirements (see 5.2).

Performance indicators are one method of comparing the performance of a system with performance requirements. Any performance indicators used should be:

- clearly defined, concise and unambiguous;
- verifiable;
- simple and easy to use.

6.3.7 Identify unacceptable impacts

Details of those parts of the system where the hydraulic, environmental, structural or operational performance of the system or its components does not meet the performance requirements should be recorded.

6.3.8 Identify causes of performance deficiencies

Based upon the results of the hydraulic, environmental, structural and operational investigations, the causes of performance deficiencies shall be determined. The relative impact of each cause should be assessed in order to develop appropriate solutions and to set the priority for action.

6.4 Planning

6.4.1 Introduction

The integrated sewer system management plan may take one of two forms.

- a) The plan outlines the approach to be taken (e.g. a major new sewer to alleviate sewer flooding or reduce discharges to surface receiving water bodies). Where an outline plan is produced further detail can be included in detailed plans for parts of the catchment.
- b) The plan describes the proposed activities and measures (e.g. a major new sewer or separation of surface water to alleviate sewer flooding or reducing the discharges to surface receiving water bodies) and specifies the resources and timescales.

Outline plans are likely to be more long term (e.g. 25 years) than medium term integrated sewer system management plans (e.g. 5 years) or detailed work programmes (see 6.5).

The process of developing the plan to fulfil the performance requirements is outlined in Figure 9.

6.4.2 Develop integrated solutions

Integrated solutions shall be developed that fulfil the performance requirements, taking into account future conditions. Different types and groups of solutions are listed in Table 4. Development of solutions for rehabilitation of existing drain and sewer systems should be carried out in accordance with EN 14654-2.

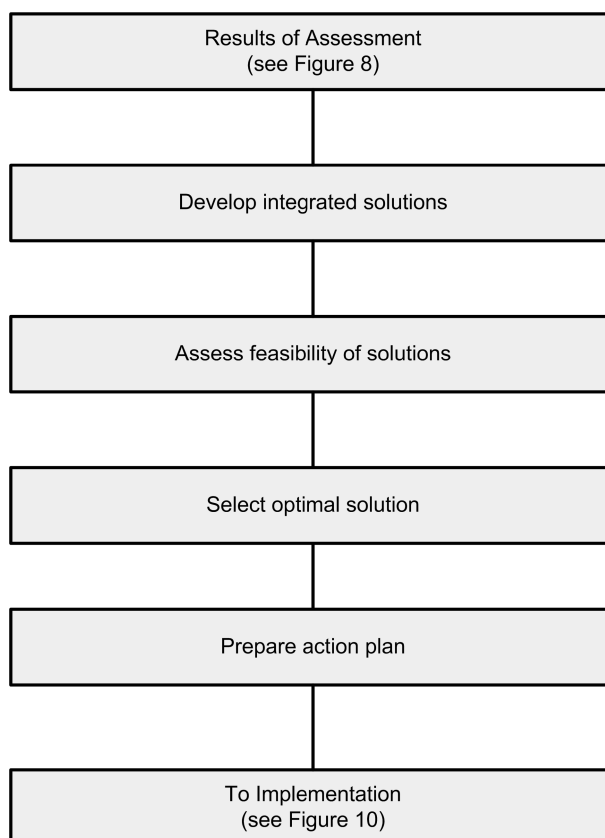


Figure 9 — Process for developing the plan