BS EN 14654-2:2013

BSI Standards Publication

Management and control of operational activities in drain and sewer systems outside buildings

Part 2: Rehabilitation

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National foreword

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

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Management and control of operational activities in drain and sewer systems outside buildings - Part 2: Rehabilitation

Gestion et contrôle des opérations de nettoyage des canalisations d'évacuation et d'assainissement - Partie 2: Réhabilitation

Management und Überwachung von betrieblichen Maßnahmen in Abwasserleitungen und -kanälen - Teil 2: Sanierung

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Foreword

This document (EN 14654-2:2013) 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of an identical text or by endorsement, at the latest by July 2013, and conflicting national standards shall be withdrawn at the latest by July 2013.

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.

The standard series EN 14654 contains the following parts:

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

— EN 14654-2, *Management and control of operational activities in drain and sewer systems outside buildings — Part 2: Rehabilitation* (the present document).

Other parts dealing with other activities may be added later.

In drafting this part of this European Standard account has been taken of other available standards, in particular EN 752, *Drain and sewer systems outside buildings*, and EN 13508, *Investigation and assessment of drain and sewer systems outside buildings*.

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard establishes the general principles for the management and control of operational activities in drain and sewer systems outside buildings and specifies requirements for development and implementation of work programmes, and the selection of techniques.

This part covers the management and control of rehabilitation activities.

It is applicable to drain and sewer systems, which operate essentially under gravity, from the point where wastewater leaves a building, roof drainage system, or paved area, to the point where it is discharged into a treatment works or receiving water. Drains and sewers below buildings are included provided that they do not form part of the drainage system of 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 752:2008, *Drain and sewer systems outside buildings*

EN 13508-1:2012, *Investigation and assessment of drain and sewer systems outside buildings — Part 1: General requirements*

3 Terms and definitions

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

3.1
extraneous water
unwanted flow in a drain or sewer system

[SOURCE: EN 752:2008, definition 3.25]

3.2
inspection chamber
chamber with a removable cover constructed on a drain or sewer that permits the introduction of cleaning and inspection equipment from surface level, but does not provide access for personnel

[SOURCE: EN 752:2008, definition 3.34]

3.3
maintenance
routine work undertaken to ensure the continuing performance of drain and sewer systems

[SOURCE: EN 752:2008, definition 3.40]

3.4
manhole
chamber with a removable cover constructed on a drain or sewer to permit entry by personnel

[SOURCE: EN 752:2008, definition 3.41]

3.5
pipeline length
continuous section of drain or sewer between two adjacent nodes

[SOURCE: EN 13508-2:2003, definition 3.26]

3.6
rehabilitation
all measures for restoring or upgrading the performance of existing drain and sewer systems

[SOURCE: EN 752:2008, definition 3.50]

3.7
renovation
work incorporating all or part of the original fabric of the drain or sewer by means of which its current performance is improved

[SOURCE: EN 752:2008, definition 3.52]

3.8
repair
rectification of local damage

[SOURCE: EN 752:2008, definition 3.53]

3.9
replacement
construction of a new drain or sewer, on or off the line of an existing drain or sewer, the function of the new drain or sewer incorporating that of the old

[SOURCE: EN 752:2008, definition 3.54]

4 General

Rehabilitation includes a wide range of activities to restore or upgrade the performance of a drain or sewer system including those examples shown in Table 1.

Table 1 — Scope of rehabilitation

	Examples of system related measures	**Examples of component related measures**
Restore original Performance	• Remove extraneous flows • …	• Cleaning • Repair • Renovation • Replacement (like for like).
Upgrade original Performance	• Maximise use of existing flow capacity • Reduce hydraulic input to the drain or sewer system • Attenuate peak flows • …	• Replacement (increased capacity).

EN 752:2008, Clause 6, outlines the process for preparation and implementation of an integrated drain and sewer system management plan which includes, at a strategic level, a plan for rehabilitation of the drain and sewer system. The amount of detail in the rehabilitation plan in the integrated drain and sewer system plan can vary.

This European Standard sets out a process for implementing the rehabilitation proposals in the integrated drain and sewer system management plan. The process is based on a staged application of the process outlined in Figure 1.

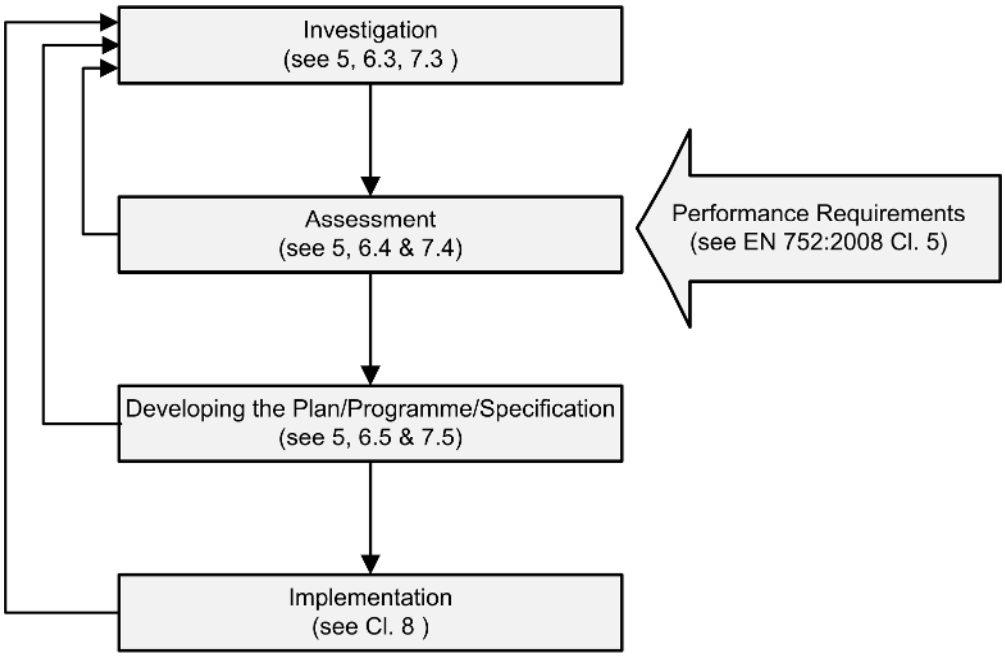

Figure 1 — The integrated sewer system management process (based on EN 752:2008, Figure 5)

The integrated sewer system management process is applied successively to develop a rehabilitation programme based on the integrated sewer system management plan. The programme outlines a series of discrete rehabilitation projects to implement the rehabilitation proposals in the plan. Following this, the integrated sewer system management process is then used to produce a detailed specification for each of these projects in the programme. Finally, following the implementation of each project, the rehabilitation programme and the integrated sewer system management plan are reviewed and updated where necessary. The performance requirements for the rehabilitated systems should be in accordance with EN 752:2008, 5.2. At each stage further investigation and assessment is carried out in accordance with EN 13508-1.

This staged process is summarised in Figure 2.

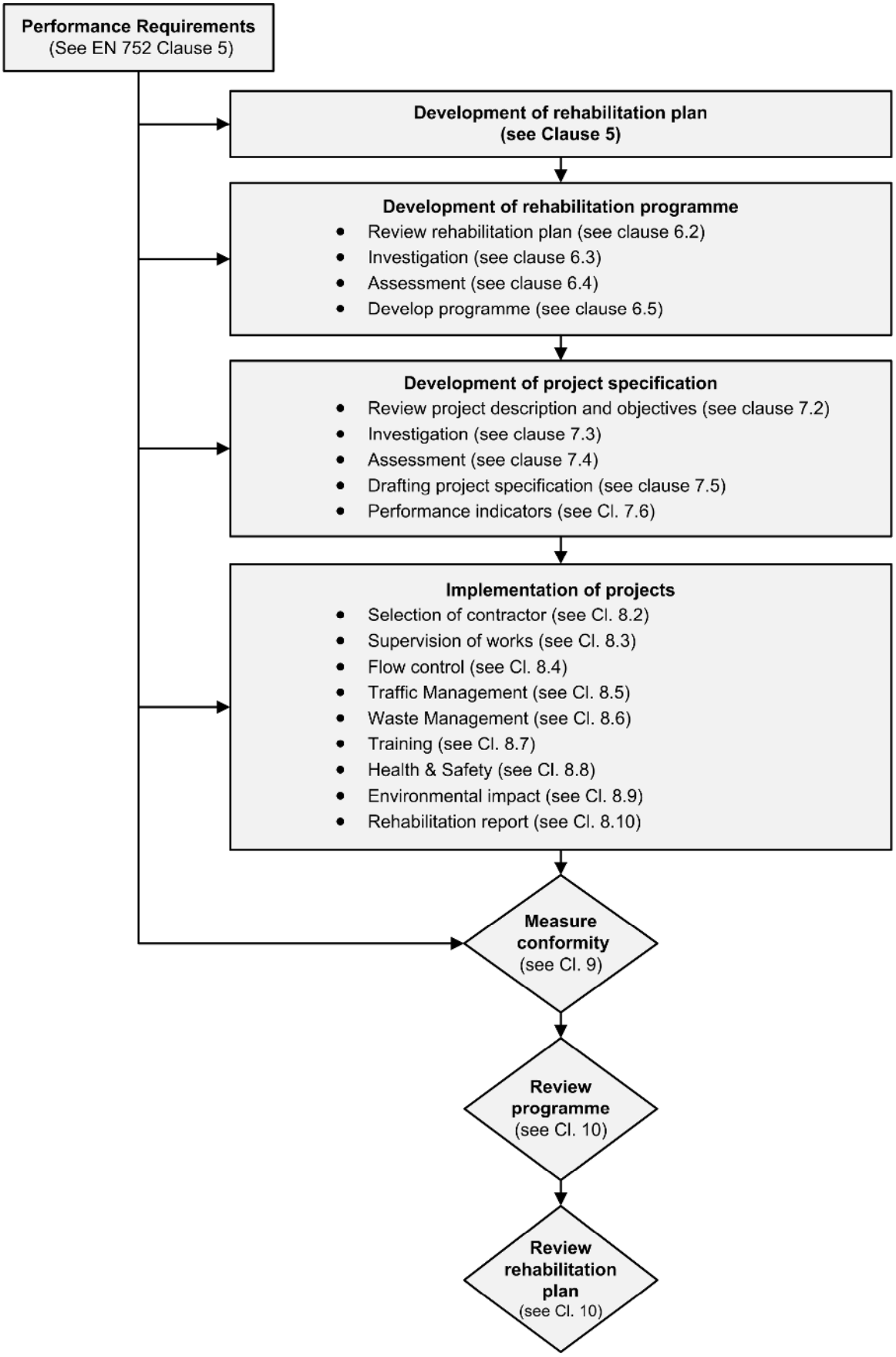

Figure 2 — Summary of the rehabilitation management and control process

5 Rehabilitation plan

An Integrated Sewer System Management Plan prepared in accordance with EN 752:2008, Clause 6, includes:

— new development plan;

— rehabilitation plan;

— operational plan;

— maintenance plan.

A rehabilitation plan, as part of an Integrated Sewer System Management Plan should be prepared for the drain and sewer system prior to design or construction of any rehabilitation works. However, this is not always possible if works are required urgently (e.g. in response to a drain or sewer failure).

It is not necessary for the rehabilitation plan to include detailed descriptions of the solutions. It may include only general descriptions of the approaches to be taken.

A number of different approaches to rehabilitation options which may be used in preparing a rehabilitation plan are described in Annex A (normative).

6 Preparation of rehabilitation programme

6.1 Introduction

The starting point for the preparation of the rehabilitation programme is the rehabilitation plan produced in accordance with EN 752:2008, Clause 6, and the performance requirements produced in accordance with EN 752:2008, Clause 5.

The rehabilitation plan does not generally contain the necessary detail to proceed directly to the production of the project specification. The rehabilitation programme defines a series of projects, in line with the rehabilitation plan, to ensure that the drain and sewer system meets the performance requirements. The rehabilitation programme should define the objectives for each project in sufficient detail so that a project specification can then be produced in accordance with Clause 7.

The preparation of the rehabilitation programme involves:

a) review of the rehabilitation plan (see 6.2) to ensure it is still current and to establish what further investigation is required to develop the programme;

b) further investigation (see 6.3) to provide the information necessary for the more detailed assessment;

c) more detailed assessment (see 6.4) to identify further detail of the performance deficiencies that the programme needs to address;

d) preparation of the programme (see 6.5) setting the scope and objectives for each of the projects.

All stages of the preparation of the rehabilitation programme shall take account of the health and safety principles set out in EN 752:2008, Clause 7.

6.2 Review of the rehabilitation plan

A review should be undertaken of the rehabilitation aspects of the integrated sewer system management plan.

This should include:

a) ensuring the performance requirements used in the preparation of the integrated sewer system management plan are still current;

b) checking that any assumptions regarding projected timescales included in the plan for new developments or other changes to the sewer system are still valid;

c) identifying where further investigation and assessment is required in order to develop the programme of works.

If there have been any changes then the plan should be updated.

6.3 Investigation

The investigation of the drain and sewer system shall be carried out in accordance with EN 752:2008, Clause 6, and EN 13508-1:2012, Clause 5.

The scope of the investigations necessary to produce the rehabilitation programme will depend on the extent of the investigations carried out during the preparation of the integrated sewer system management plan. Investigations shall be carried out where further information is required in order to produce the rehabilitation programme. Examples can include:

— further inspection in parts of the system where the original assessment was based only on sample inspections;

— the production of more detailed sewer flow simulation models, where the original assessment was based on a simplified model;

— more detailed studies of the impact of any discharges on receiving waters.

The types of investigation can include:

— investigations of the existing drain and sewer system (e.g. visual inspections, radar, sonar, flow measurements, sewer flow simulation modelling, wastewater quality simulation modelling);

— more detailed investigations of the impact of proposed new developments in the area (e.g. hydraulic modelling etc.);

— other investigations to determine feasibility of options (e.g. preliminary topographical, geotechnical and other investigations (see EN 752:2008, 8.1, item 2 in list, and EN 752:2008, 9.3)).

Details of investigation techniques for existing drains and sewers are described in EN 13508-1.

6.4 Assessment

The performance of the drain or sewer systems shall be assessed in accordance with EN 13508-1:2012, Clause 6, using the results of the investigation (see 6.3). The assessments carried out during the preparation of the rehabilitation plan should be reviewed and updated in the light of any new information identified during the investigations. The performance at each planning horizon shall be compared to the performance requirements to identify the needs for rehabilitation.

The assessment should identify the location of those components of the drains and sewer system where proactive or reactive rehabilitation are to be carried out. This shall be based on:

— a knowledge of the characteristics and structural condition of the drain and sewer system;

— an understanding of existing and past failures and their association with performance deficiencies including their impact on operations and maintenance of parts of the drain and sewer system concerned;

— an analysis of the performance of the drain and sewer system;

— a review of the available information including the evolution of failures and performance deficiencies over time.

The individual pipeline lengths and other components shall be described with the existing information, in order to optimise the rehabilitation programme.

It is advisable to carry out an analysis of the information to be able to determine:

— the extent and the nature of the structural defects, leak tightness, hydraulic deficiencies and mechanical damage and chemical attack (corrosion and abrasion);

— the cause of these failures and performance deficiencies;

— the environmental impact of the defect.

This analysis is carried out using available information including the results of the specific investigations carried out to develop the programme (see 6.3).

The results of the assessment should be checked with the assessment made during the production of the integrated sewer system management plan and if there are significant differences the plan should be reviewed to ensure that it is still valid.

6.5 Develop the programme

6.5.1 Introduction

The rehabilitation programme comprises a number of projects which together shall meet the rehabilitation objectives. The programme shall define the scope and objectives of each project in the programme. The programme should include the phasing of the projects including the relationship to any external constraints such as budgets, new developments, and interactions with other utility or development programmes (e.g. highway works). The programme shall take account of the safety principles in EN 752:2008, Clause 7. The programme should specify the classes of solutions (see Table 2) to be adopted.

The process of developing the programme is summarised in Figure 3 below.

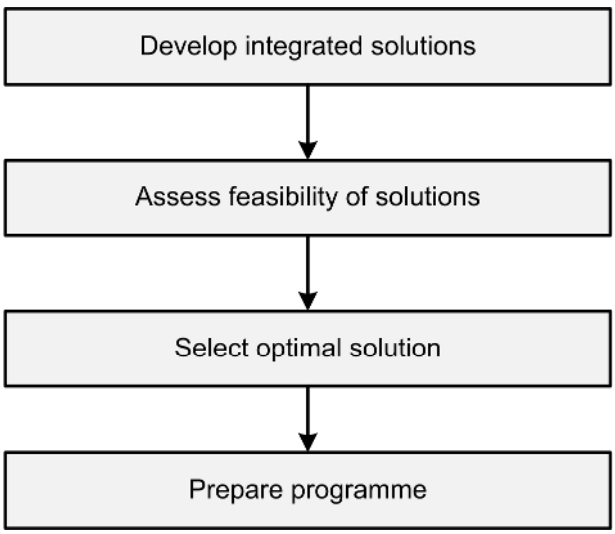

Figure 3 — The solution development process

6.5.2 Developing integrated solutions

To meet the rehabilitation objectives, detailed solutions should be developed in accordance with any current rehabilitation plan for the catchment. This should include issues relating to new development and solutions involving major upgrading work and maintenance, as well as changes to operational practices. Within this framework a number of feasible options should be developed.

Where appropriate the options should include solutions that address a number of problems. Examples include:

— replacement of a pipe to resolve a structural problem could also be used to resolve a hydraulic problem on a neighbouring area by diverting flow from a neighbouring area into the new pipe;

— reduction of flows could be used both to reduce flooding and to reduce discharges from combined sewer overflows.

The assessment of each performance deficiency identified in the rehabilitation plan should be reviewed taking account of the additional information collected in developing the programme (see 6.3 and 6.4). The options should specify the group and class of solution. Examples of solutions are given in Table 2 below.

Table 2 — Solution types, groups and classes for rehabilitation

Type	Group	Class
Hydraulic	Maximise use of existing flow capacity.	Removal of constrictions.
		Reducing hydraulic pipeline roughness (including head losses at structures, junctions, etc.).
		Cleansing.
	Source control – Reducing the hydraulic input to the drain or sewer system.	Diversion of surface water flows to infiltration drainage systems or pervious areas.
		Use of porous pavements.
		Diversion of flows to another system.
		Manage surface water on the surface.
		Reduction of infiltration and inflow of extraneous water.
	Attenuate peak flows.	Utilisation of existing storage potential within the system (strategically placed flow controls).
		Utilisation of surface storage (including storage within the property boundary).
		Provision of additional storage (tank sewer or detention tank).
	Increase drain or sewer system flow capacity.	Replacement with larger pipe.
		Construction of additional pipeline.
Environmental	Reduce pollutant inputs to system.	Sediment basins and grit separators.
		Use of vegetation to absorb pollutants from runoff before entering the system.
		Controlling inputs (e.g. trade effluents).
	Decrease planned pollutant discharges to receiving waters.	Increase of flows to treatment (see hydraulic solutions above).

Type	Group	Class
		Treatment of surface water discharges (e.g. by separators, retention ponds, etc.).
		Improve solids retention and hydraulic performance of combined sewer overflows.
		Real time control.
	Decrease impact by relocation of points of discharge.	
	Reduce exfiltration by rehabilitation measures.	Repair techniques (e.g. sealing leaks).
		Renovation techniques (e.g. provision of watertight lining).
		Replacement of pipeline using open-cut or trench-less techniques.
Structural	Protect fabric of drain or sewer by provision of appropriate linings or internal coatings.	
	Rehabilitate fabric of pipeline.	Repair (see EN 15885).
		Renovation (see EN 15885).
		Replacement.
Operational	Planned inspection and cleaning of a drain or sewer. The management and control of sewer cleaning activities should be carried out in accordance with EN 14654-1.	
	Increased frequency of maintenance of pumps or pumping stations.	
This list is not exhaustive.		

Examples of the decision processes for considering solutions are given in Figures 4 and 5. Figure 4 gives an example of the decision process for the solutions involving only structural rehabilitation of the fabric of pipelines and Figure 5 gives an example of the process for solutions involving hydraulic rehabilitation.

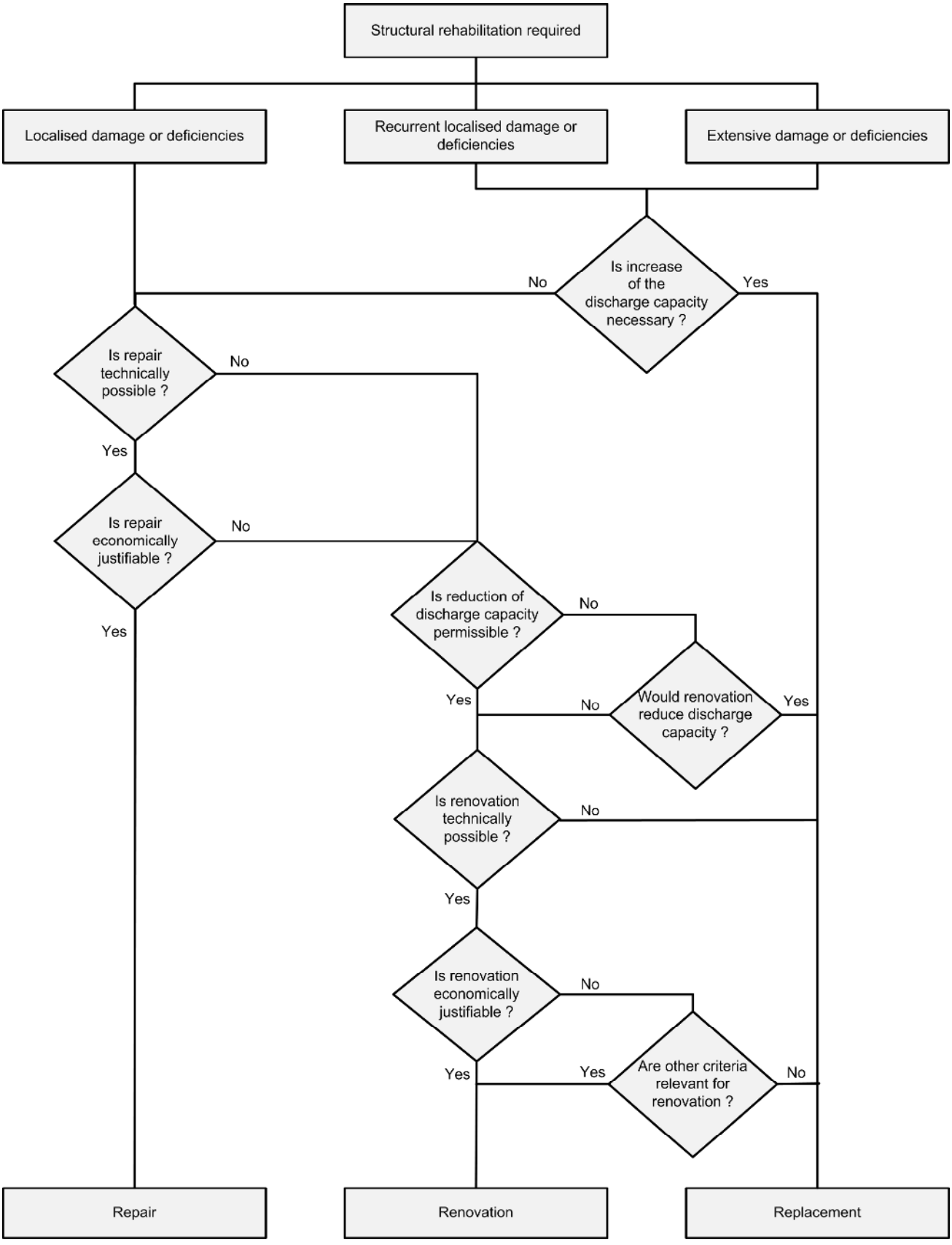

Figure 4 — Example of process for selection of technique class for structural rehabilitation of pipelines

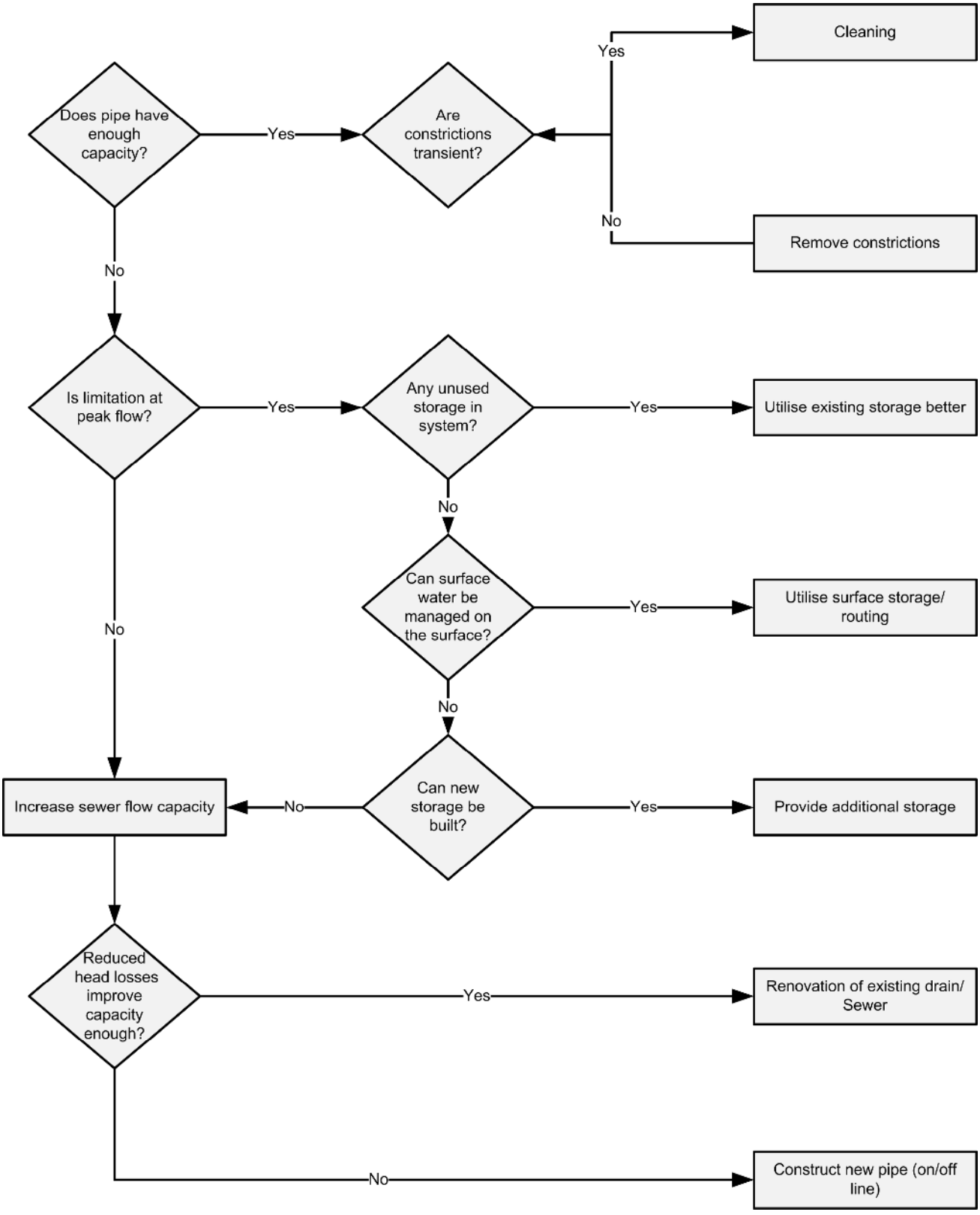

Figure 5 — Examples of process for selection of technique class for hydraulic solution types

6.5.3 Assess technical feasibility of solutions

The options developed in 6.5.2 should first be assessed to establish the extent to which they will meet the rehabilitation objectives and minimum performance requirements, and whether it would be feasible to implement them.

For hydraulic solutions the study should establish effects and feasibility of, for example:

a) the extent of and feasibility of works necessary to remove constrictions;

b) the feasibility of reducing hydraulic inputs and the effect of those reductions;

c) the feasibility and effects of mobilising storage in the system or in ponds or tanks;

d) the feasibility of diverting flows out of the system;

e) the route and profile of new pipelines;

f) the feasibility of increasing flow capacity by renovation of pipelines.

For environmental solutions the study should establish, for example:

g) the feasibility of reducing pollutant inputs and the scope of works necessary;

h) the feasibility of reducing discharges by increasing hydraulic capacity;

i) the feasibility of improving performance of combined sewer overflows or relocating the discharge point;

j) the class of solution necessary to reduce exfiltration.

For structural solutions the study should establish, for example:

k) the group or class of solution necessary to restore the structural integrity of a pipeline.

For operational solutions the study should establish, for example:

l) the feasibility of increasing capacity by drain or sewer cleaning.

All options that meet the minimum performance requirements and that are technically feasible to implement should be taken forward to the next stage.

6.5.4 Select optimum solution

The selection of the most appropriate option shall then take account of a wide range of costs and benefits of each of the options. These should take account of the extent (if any) to which any option would result in the drain or sewer system achieving more than the minimum performance requirements or providing additional capacity beyond that currently anticipated.

Criteria for assessing the costs and benefits of different options in order to select the optimum solution are given in EN 752:2008, 6.4.3.

6.5.5 Producing the programme

The rehabilitation programme should contain the description of a number of defined projects that are within the framework of the integrated sewer system management plan. The programme should contain the following information for each project:

— the precise objectives;

— the legal requirements and permits, including the timescale of improvements;

— the performance criteria;

— the priorities;

— the proposed works including costs and phasing;

— other options for upgrading the system;

— relationships to other construction or planned development;

— consequences for operations and maintenance;

— any items that are conditional on any new developments;

— the social impact of works on people living in proximity.

7 Preparation of the project specification

7.1 Introduction

The project specification should contain all the information, including any drawings, necessary to carry out the project.

The starting point for the preparation of the project specification is the project description and project objectives in the rehabilitation programme produced in accordance with Clause 6 and the performance requirements produced in accordance with EN 752:2008, Clause 5.

Further information is still likely to be required to carry out the detailed design and produce the specification.

The preparation of the project specification involves:

— review of the project description and project objectives;

— further investigation;

— further assessment (if necessary);

— producing the project specification.

All stages of the preparation of the project specification shall take account of the health and safety principles set out in EN 752:2008, Clause 7.

7.2 Review of the project description and project objectives

The project description and objectives as set out in the rehabilitation programme should be reviewed to ensure it is still current. Any related new developments or other utility works should be reviewed. Where there have been any changes in the nature or the timing of the development or other works which might impact on the project or its phasing the programme should be revised.

The information available should be reviewed to determine what further investigations are necessary in order to produce the project specification.

7.3 Investigation

The types of investigations necessary to produce the project specification can include:

a) Further investigations of the existing drain or sewer system. Information on these techniques can be found in EN 13508 (all parts). Examples of such investigations include:

   1) detailed visual inspections or other investigations of existing structures to determine feasibility of a particular renovation technique;

   2) more detailed sewer flow simulation modelling to determine the inputs from new developments as the designs of these are completed or to obtain more accurate information on inputs from other parts of the system;

   3) investigations to determine the effect of other projects in the programme that have already been implemented.

b) Other investigations to determine the feasibility of options or to provide information for design calculations include:

   1) detailed topographical surveys;

   2) geotechnical investigations;

   3) investigations to determine the location of other utility services;

   4) investigations to determine any possible impact on adjacent structures.

c) Investigations to determine the impact of the proposed works include:

   1) investigations of the likely social disruption associated with different construction methods (e.g. traffic surveys, noise surveys, etc.);

   2) environmental studies to determine the impact of construction.

7.4 Assessment

EN 13508-1 gives guidance on the assessment of existing drain and sewer systems. The assessment should be sufficiently detailed to allow decisions to be taken on the solutions for the project.

Following the completion of the assessment the project objectives should be reviewed to ensure that they are still valid.

7.5 Drafting the project specification

7.5.1 Introduction

The drafting of the project specification involves the following stages:

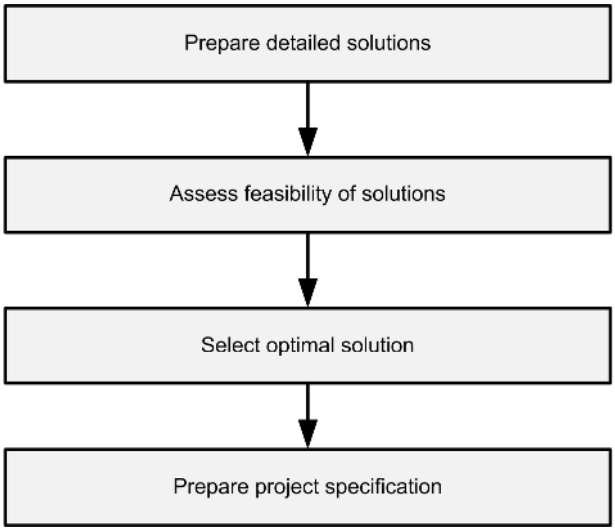

Figure 6 — Detailed solution selection process

7.5.2 Prepare detailed solutions

The rehabilitation programme will have selected the class of solution (see Table 2) from which detailed solutions should be derived where appropriate. These more detailed levels of solutions are referred to as technique families. For renovation and repair systems these technique families and their classification characteristics are described in more detail in EN 15885. For other classes of solution no standardised classification of technique families currently exists.

Within the scope described in the rehabilitation programme for the project, a number of possible detailed options for the project should be developed taking into account the data from the investigation and the assessment (see 7.3 and 7.4).

Calculations should be carried out as appropriate to confirm the feasibility of each option. The detailed preparation of the options phase should be used to check that all the essential points are taken into account in the specification.

Where the problem is related to the structural rehabilitation of an existing pipeline (including manholes), the process for the selection of the technique family should initially be undertaken using the following criteria:

a) external loads capacity – the capacity of the rehabilitated structure to resist internal negative pressures, external groundwater pressure, ground loads, traffic loads and other imposed loads (see EN 15885:2010, 7.2.1);

b) internal pressure capacity – the capacity of the rehabilitated structure to resist internal positive pressures either due to surcharging of the drain or sewer or deliberate pressurisation (see EN 15885:2010, 7.2.2);

c) structural integrity of the rehabilitated pipe based on internal loads capacity – whether the technique has the capacity to span holes in the pipe, has independent ring stiffness (not dependent on adhesion of a liner to the host pipe), or can resist failure of the host pipe (see EN 15885:2010, 7.2.2);

d) site impacts – the surface area and extent of excavation required for installation (see EN 15885:2010, 7.3);

e) size of pipe – whether the technique is suitable for the size of pipe;

f) shape of pipe – whether the technique is suitable only for circular pipes or non-circular pipes;

g) hydraulic performance – whether the installation of the technique in this situation would result in an unacceptable deterioration in the hydraulic performance of the system.

7.5.3 Assess feasibility of solutions

Depending on the class of solution the following criteria should be used, where relevant, to establish the technical feasibility of each option:

a) **Physical criteria of the existing pipelines** – The physical criteria correspond to the condition of the drain or sewer described in the diagnostic study (see 6.3). The possible solution should be compatible with the following features of the host pipe:

   1) its material and construction;

   2) its shape and its interior dimensions (production tolerances, etc.);

   3) the dimensional variations (particularly out-of-roundness);

   4) the singular points of the profile (disconnections, joint gaps, reverse slopes, etc.):

      i) the connections and laterals;

      ii) the associated installations and their junctions, etc.

b) **Hydraulic criteria** - The hydraulic criteria correspond to the functional specifications of the drain or sewer with regard to its usage and its purpose once rehabilitated:

   1) required level of leak tightness (of the installation, the joints if they exist, the connections, the branches and the associated installations (inspection manholes, inspection chambers, etc.);

   2) hydraulic capacity (average/extreme operating conditions, flow rates, speeds);

   3) pressures, depressions (water hammer, siphon effect).

c) **Mechanical criteria** - The mechanical criteria correspond to the mechanical strength and mechanical durability conditions which the rehabilitated drain or sewer are required to meet:

   1) external loads (traffic loads, coverage, fill, type of soil, water table);

   2) internal stresses (internal pressure, abrasion).

d) **Chemical criteria** - The chemical criteria correspond to the compatibility of the elements involved. Taking sufficient account of these criteria can ensure the resistance and durability of the rehabilitated drain or sewer in terms of corrosion and durability, and contributes to safety in the construction and operating phases (Hydrogen sulphide, etc.):

   1) effluent characteristics (temperature, acidity or alkalinity, conductivity, etc.);

   2) environment characteristics (terrain, water table, etc.);

   3) stray electrical currents (neighbouring networks, railways, etc.).

e) **Implementation criteria** - The implementation criteria correspond to the requirements of the relevant authority and the possibilities linked to the surroundings of the installation (on surface or in sub-soil).

f) **Installation environment and conditions** - Possibilities for access and activity by personnel and use of equipment inside or outside the drain or sewer:

   1) scale of the operation;

   2) length of sections;

3) number of interventions;

4) total intervention time (procurement, preparation, rehabilitation work, connections, controls, etc.).

g) **Surface proximity constraints:**

1) conditions of access to the installation;

2) area covered by work site;

3) storage zone, etc.

h) **Sub-soil proximity constraints:**

1) surrounding networks;

2) cavities in the soil;

3) risks of subsidence, etc.

i) **Social and environmental constraints** - Specific characteristics of the site concerning the inconvenience caused:

1) roads (public transport, cars, car parks, resident access, pavements, shoulder, etc.);

2) land use (shops, public gardens, public and private buildings, etc.);

3) sensitivity to nuisances (noise, dust, odours, etc.);

4) risks of pollution (of soil, groundwater, surface receiving waters and air);

5) type of materials used in the installation to be rehabilitated (asbestos cement, etc.);

6) specific crossing points (railways, roads, rivers, buildings, etc.);

7) ecological disturbance (e.g. designated sites);

8) impact on heritage (e.g. archaeological or religious sites).

j) **Other constraints:**

1) flow management constraints (by blocking and storage in upstream part, by storage in detention tank, by bypass with or without pumping);

2) pre-cleaning requirements, etc.

7.5.4 Select optimal solution

The options found to be technically feasible should be compared to identify the optimal solution in accordance with the procedure described in EN 752:2008, 6.4.3.

7.5.5 Prepare project specification

For the selected option further detailed calculations should be carried out and a detailed description of the works should be produced (including drawings) to provide all the information necessary for the construction of the works.

7.6 Performance indicators

7.6.1 Introduction

Performance indicators should be selected to determine whether the project has:

a) been carried out in accordance with the project specification; and

b) achieved the objectives set out in the rehabilitation programme or project.

The performance indicators should be based on easily measurable parameters. They should be used to measure conformity of the completed project (see Clause 9).

7.6.2 Indicators for the assessment of the work quality

Performance indicators should be selected in relation to each of the rehabilitation objectives:

a) Structural integrity:

   1) Mechanical or physical characteristics of:

      i) rehabilitated pipe;

      ii) rehabilitation technique;

      iii) soil/rehabilitated pipe interaction;

      iv) bonding between any lining and the host pipe.

b) Leak tightness:

   1) leakage from the pipe;

   2) rate of infiltration into the pipe.

c) Hydraulic:

   1) longitudinal profile;

   2) cross section;

   3) hydraulic capacity.

d) Chemical resistance.

e) Abrasion resistance.

7.6.3 Indicators for the assessment of the effectiveness of the project or programme

Examples of indicators might include:

— percentage of extraneous water collected in drain or sewer;

— percentage of exfiltration;

— number of flooding incidents per year and per kilometre;

— number of blockages per year and per 1 000 km;

— fissures per kilometre;

— number of collapses per year and per 1 000 km;

— rate of sedimentation.

8 Implementation of projects

8.1 Introduction

The construction of the project shall be carried out in accordance with the principles set out in EN 752:2008, Clause 10. Personnel carrying out the work shall have appropriate training in accordance with EN 752:2008, Clause 13.

8.2 Selection of contractor

The Public Procurement Directives (2004/18/EC) can apply to the selection of contractors.

The selection of the contractor should take into account a number of factors including:

a) The qualifications of the contractor, including:

   1) technical competence and experience;

   2) health and safety procedures;

   3) quality management systems in place;

   4) environmental management systems;

   5) financial stability;

   6) licence to work in the country.

b) Price.

c) The impact of the proposed method of working including:

   1) The proposed resources, including:

      i) personnel (including management);

      ii) equipment;

      iii) materials.

   2) The management of risks including minimising:

      i) risks to the health and safety of operatives on site and of the public;

      ii) environmental risks.

   3) Contract strategy – e.g. a single management contractor with subcontractors, or division of the work between different contracts.

   4) Social disruption – the disruption to local residents and other members of the public.

8.3 Supervision of the works

The supervision of the contractor by the employing authority or their representative should include the following:

a) ensuring that the contracting company has adequate internal management procedures;

b) competency of the contractor's supervisors and license (if required);

c) compliance of the works with the specification;

d) checking the adequacy of resources and methods of working;

e) the verification of health and safety compliance;

f) progress of the works in accordance with the programme;

g) documentation of agreed changes to the contract;

h) reporting, auditing and documentation of test procedures, test results and performance indicators;

i) valuation of works and approval of payments;

j) written confirmation of the satisfactory completion of the works in accordance with the contract;

k) ensuring that records (e.g. as-built drawings) of the works are produced.

In addition the contractor should supervise the works themselves, including:

l) checking the adequacy of resources and methods of working;

m) progress of the works in accordance with the programme;

n) dealing with unforeseen incidents;

o) cost control;

p) health and safety coordination (The Temporary and Mobile Sites Directive (92/57/EEC) can apply).

8.4 Flow control

Where work is being carried out in existing drain and sewer systems, consideration should be given to measures to control the flow. The need for and extent of such measures will depend on the nature of the works and can include:

a) use of temporary stoppers to control the flow for short periods;

b) use of temporary pumps in association with temporary stoppers to pump the flow past the works;

c) temporary diversion of the flow.

The selection of the appropriate approach will depend on the frequency and magnitude of expected flows, having regard to the expected weather and other factors.

8.5 Traffic management

Where works are carried out in roads, the effect of the works on the traffic should be considered and measures taken to limit the impact; for example by local traffic control measures such as temporary traffic signals, or installation of traffic diversions via alternative routes.

8.6 Waste management

Measures should be taken to minimise the impact of wastes from the rehabilitation works. The waste management approach should be in accordance with the following hierarchy:

a) measures should be taken to minimise the amount of waste produced;

b) where waste is produced measures should be taken to reuse as much of the waste as practicable;

c) where it is not possible to reuse the waste measures should be taken to recycle as much of the waste as practicable;

d) where it is not possible to recycle the waste consideration should be given to the use of the waste for energy recovery;

e) where none of the options are possible the disposal of the waste should take account of the environmental impact.

8.7 Training

Training requirements for work in drain and sewer systems are described in EN 752:2008, Clause 13.

Training requirements for those carrying out rehabilitation work essentially depend on chosen techniques and materials.

The contractor shall ensure that personnel working on the site are trained in respect of the particular technique being used. For example, the butt fusion welding for plastics pipes shall be made by properly trained welders.

Personnel at all levels taking part in a rehabilitation construction site shall be made aware of all specific risks of such activity (see also 8.1).

8.8 Health and safety

The works shall be carried out in accordance with the health and safety principles described in EN 752:2008, Clause 7. Further guidance on health and safety is given in EN 752:2008, Annex D.

The main part of the rehabilitation operations comprises work on drains and sewers and in confined spaces. In addition there can be hazards related to the specific nature of the rehabilitation works.

The contractor shall identify the health and safety risks associated with the proposed rehabilitation works including the following:

— risks associated with the use of specific materials in the rehabilitation works (e.g. cements, resins, solvents, etc.);

— risks associated with the construction process depending on the used process, some specific risks on health and safety can arise (e.g. dust generation).

Drain and sewer system rehabilitation sites are frequently close to traffic even when using trenchless construction techniques.

8.9 Environmental impact

The relevant authority can assess, in the early design phase, the risks to the environment that are inherent to the drain and sewer system rehabilitation activities. Environmental management procedures are described in EN ISO 14001.

It is the contractor's responsibility to ensure on the construction site the control of the risks of environment pollution or disturbance it may generate during its activity.

These risks should be taken into account formally in an Environment Management Plan.

As far as rehabilitation is concerned, the following types of impact shall notably be taken into consideration:

a) Impact on surface receiving waters or groundwater:

   1) pollution of groundwater by accidental discharge of hydrocarbons or other polluting agents (especially unreacted resin components);

   2) discharge of wastewater from the site;

   3) discharge of polluted or sediment laden surface water from the site.

b) Impact on site:

   1) safety of the products in contact with surrounding soil;

   2) impact of construction vehicles.

c) Impact on air:

   1) emission of gas and polluting particles by site equipment;

   2) dust generated by the construction site;

   3) toxic emissions (e.g. volatile organic carbons).

d) Impact of noise:

   1) noise emissions from site equipment.

e) Impact of site waste:

   1) sorting of site waste;

   2) handling of excavated materials;

   3) procedure for handling and disposal of contaminated soil and waste materials.

f) Social impact:

   1) tidiness and cleanliness on public or private property;

   2) ecological damage.

8.10 Rehabilitation report

The contractor shall submit a report to the client on completion of the rehabilitation work in accordance with the requirements of the contract. Where there have been any changes to the proposed works during construction 'as constructed' drawings should be produced. The inventory should be updated on completion of the works.

9 Measurement of conformity

9.1 Measuring conformity with the project specification

9.1.1 General

Materials and components used for rehabilitation of drain and sewer systems outside buildings shall fulfil specified requirements in the corresponding product standards. For renovation or repair of drains and sewers this should consider (where appropriate) both requirements at the “M” (manufactured) stage and the “I” (installed) stage.

The contract shall specify the particular requirements in respect of leak tightness (it may specify the reduction rate for extraneous water or the permeability to be reached) and flow.

The results required will depend on the method and should be clearly described in the specification, to ensure that the rehabilitation objectives are achieved. The measurement of conformity should be included in the rehabilitation report (see 8.10).

9.1.2 New or replacement drains or sewers

The performance of the drains and sewers shall be verified during and after installation.

Verifications tests can include (for example):

a) visual inspection;

b) leak tightness testing (using air or water testing or infiltration testing);

c) compaction.

9.1.3 Renovation and repair systems at the “I” stage

The contract shall specify the testing requirements. The renovated or repaired parts of the system shall be visually inspected following installation and tested for leak tightness in accordance with testing requirements specified in the contract. The dimensions of the renovated or repaired pipe and the hydraulic roughness of the pipe wall shall be checked against the specification to ensure there is adequate hydraulic capacity. The thickness and shape of any lining shall be checked to ensure there is adequate structural stability in accordance with the specification.

9.1.4 Measuring conformity

The tools that will be used to measure the performance indicators should be stated in the project specification. Examples include:

a) visual inspection – see EN 13508-1:2012, 5.8.3;

b) leak tightness - see EN 1610;

c) sampling – removal of samples for testing in laboratory to measure the thickness of the renovation system; the quality of the bond between the liner and the host pipe and the contact between the soil and the host pipe, and/or for testing of the mechanical properties of the installed material;

d) load testing to measure the mechanical characteristics of the renovated pipe (see EN 13508-1:2012, 5.8.4);

e) mechanical impedance testing to identify the presence of cavities, failures of bond or compaction of the materials (see EN 13508-1:2012, 5.8.4);

f) ground probing radar to evaluate the thickness of the structure and identify the presence of cavities and the state of the pipe bedding (see EN 13508-1:2012, 5.8.4);

g) ultrasonic imaging to evaluate the bonding of grouts;

h) infrared thermography to examine and assess the bond of the grout;

i) endoscopy or videoscopy to look assess the effectiveness of the treatment of any cracks or fractures in existing pipes;

j) injection monitoring to ensure that cavities around any pipes or linings have been properly filled;

k) pipe permeability test – by means of a water pressure test on a sample of the pipe material.

9.1.5 Non-conformities

When non-conformities are found, these should be rectified to meet the requirements of the contract.

After a rehabilitation operation has been completed and the non-conformities have been rectified the completion of the rehabilitation work can be agreed by the owner or his representative.

9.2 Post project appraisal

Following the completion of each project, the upgraded system should be assessed using performance indicators (see 7.6) and other measurements to establish whether the objectives of the project, as set out in the rehabilitation programme, have been achieved.

10 Review of programme and plan

The remaining stages of the programme and the rehabilitation plan shall be reviewed:

a) on completion of a rehabilitation project;

b) if the performance of the rehabilitated system is significantly different to that anticipated in the programme.

Annex A
(normative)

Rehabilitation approaches

A.1 Introduction

The rehabilitation plan should list the major strategic improvement works to be carried out that need to be considered as part of other major works in the catchment (e.g. a major new sewer to alleviate flooding or reduce discharges to surface receiving waters). For minor works, where there is little interaction with other works (e.g. renovation of sewers in poor structural condition), the rehabilitation plan can outline the overall extent of certain types of works and a method for allocating that budget to particular projects. A number of different approaches for determining the extent and prioritisation of such works are described below. The approach selected is likely to be based on one of these approaches or a combination of two or more of them.

The choice of approach should take account of risk in the short, medium and long term. Risk management techniques can be used in the management of rehabilitation.

Rehabilitation includes a programme of work to remedy the defects and problems identified during investigation (see EN 752:2008, 6.2). The reactive rehabilitation approach should only be used where the risk of failure is considered acceptable, taking into account both the probability of failure and the consequence.

A.2 Rehabilitation planning objectives

A.2.1 Introduction

Before determining the rehabilitation approach, measurable objectives for the proposed rehabilitation plan should be clearly defined. These can include technical objectives (e.g. leak tightness, mechanical and hydraulic performances, physicochemical resistance (e.g. corrosion, abrasion)), economic objectives and legal objectives.

A.2.2 Technical objectives

a) **Leak tightness of drains and sewers** - All drains and sewers, from the point of origin of the wastewater up to the point of discharge shall be leak tight at the time of construction. Optical inspections are to be carried out to establish the condition of the drain and sewer system in service to ensure as far as practically possible that this leak tightness is maintained taking into account the relevant regulations (e.g EN 13508 (all parts)).

b) **Structural integrity of drains and sewers -** Drains and sewers shall be structurally sound and be sufficiently robust to ensure that failure will not arise as a result of designed and anticipated superimposed loading and internal loading.

c) **Operational performance of drains and sewers -** The status of a drain or sewer system, in addition to the structural integrity and leak tightness, shall equally be characterised by sufficient operating safety. Operating safety concerns:

    1) the sufficient and secure operation for harmless discharge of wastewater;

    2) the provision of a status (independent of structural condition), which in particular supports:

        i) the avoidance of accidents;

        ii) the minimisation of deposits;

iii) the minimisation of odour and noise emissions.

A.2.3 Economic objectives

Economic objectives of rehabilitation planning can include:

a) avoiding overall deterioration of the assets or making up for past deterioration;

b) determination of the long-term financial requirements to achieve the defined objectives through the production of investment requirement plans;

c) to justify an increase of the financial resources including determining the costs and benefits;

d) prediction and balancing of future wastewater charges;

e) phasing expenditure to produce a manageable expenditure profile throughout the period of the plan;

f) phasing the works to keep traffic disruption and disturbance to residents to acceptable levels;

g) phasing work to achieve a consistent work load to make best utilisation of personnel and equipment.

A.2.4 Legal objectives

There can be a number of objectives that result from national or local legislation, for example:

a) compliance with discharge permits, health and safety regulations, operating licences;

b) liability to third parties.

A.3 Description of rehabilitation approaches

One or more of the following possible approaches can be used to formulate the programme:

a) Asset value approach - A financial based approach that is used to ensure that rehabilitation is carried at a rate that ensures that the value of the system at the end a specified period does not fall below a specified threshold.

b) Area-related approach - One part of the network is selected having common characteristics, requirements and properties, for example: a pumping station catchment area, a groundwater protection zone, a residential or commercial area or the whole of a specific street.

c) Condition based approach - All drains and sewers are inspected and those drains or sewers that do not meet some specified threshold condition are rehabilitated.

d) Multi-utility approach - The rehabilitation of wastewater systems is carried out jointly with rehabilitation of other utility services in the same location in one construction activity.

e) Functional related approach - This is built around the need for changes to improve the performance of the system (e.g. the need to reduce or eliminate discharges to receiving water) and takes the opportunity to do other rehabilitation work where this can be done more efficiently at the same time.

f) Reactive approach - This involves responding to failures and problems as they are identified. Examples can include: restoring structural integrity following a collapse, removing a complete or partial blockage in order to restore the flow, or increasing hydraulic capacity following a flooding incident.

Table A.1 — Advantages and disadvantages of different rehabilitation approaches

	Advantages	***Disadvantages***
Asset value approach	• *The changes in asset value of the system can be made transparent.* • *Suitable for determining a fixed-rate budget.*	• *It is solely financially driven.* • *Needs to be used in combination with other approaches.*
Area-related approach	• *It is easy to get a clearer view of the work and the benefits.* • *It is possible to carry out the work in a defined period.* • *Concentration of work in one area can be financially efficient.* • *Part of the system is comprehensively rehabilitated.*	• *A detailed cost estimate can only be made after detailed investigation of the area.* • *Problems remain in other areas of the system for a longer period.* • *Increased need for coordination with other projects.*
Condition based approach	• *Reduction in need for reactive rehabilitation.* • *The complete drain and sewer system is maintained to a defined standard.*	• *Problems with a lower priority remain in the system for a longer period.* • *Loss of efficiency by the possible need to carry out further works in the same parts of the system at a later time.*
Multi-utility approach	• *Reduced costs through economies of scale by working with other utilities.* • *Improved acceptance by the public.*	• *Loss of control through need to carry out works in cooperation with other utilities.* • *Increased need for coordination.* • *Problems remain in other areas of the system for a longer period.* • *Costs arise before they are necessary in order to achieve coordination.*
Performance-related approach	• *Future-oriented planning creates capacity, alleviating problems before they occur.*	• *Cannot be applied as sole approach.*
Reactive approach	• *Can be cost effective where consequence of failure is low.*	• *Cannot prevent failures occurring.*

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