

Nederlandse norm

NEN-EN 16941-2

(en)

Locatie gebonden niet-drinkwatersystemen - Deel
2: Systemen voor het gebruik van grijs water

On-site non-potable water systems - Part 2:
Systems for the use of treated greywater

Vervangt NEN-EN 16941-2:2017 Ontw.

ICS 93.025
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- EN 16941-2:2021,IDT

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 16941-2

January 2021

ICS 93.025

English Version

**On-site non-potable water systems - Part 2: Systems for
the use of treated greywater**

Réseaux d'eau non potable sur site - Partie 2 : Systèmes
pour l'utilisation des eaux ménagères traitées

Vor-Ort-Anlagen für Nicht-Trinkwasser - Teil 2:
Anlagen für die Verwendung von behandeltem
Grauwasser

This European Standard was approved by CEN on 20 December 2020.

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Contents

Page

European foreword.....	4
Introduction	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	7
4 Functional elements and greywater quality.....	8
5 Design	8
5.1 General.....	8
5.2 Collection	9
5.3 Treatment	9
5.4 Storage	10
5.4.1 General.....	10
5.4.2 Materials.....	10
5.4.3 Dimensions.....	10
5.4.4 Capacity.....	10
5.4.5 Structural behaviour.....	10
5.4.6 Watertightness.....	11
5.4.7 Connections and internal pipe system	11
5.4.8 Access	11
5.4.9 Overflow	11
5.5 Back-up water supply	11
5.5.1 General.....	11
5.5.2 Backflow protection device	12
5.6 Pumping.....	14
5.6.1 General.....	14
5.6.2 Pumps for collected greywater	14
5.6.3 Pumps for treated greywater.....	14
5.6.4 Expansion vessel	15
5.6.5 Pump control unit	15
5.7 System control with monitoring.....	15
5.8 Metering	16
5.9 Distribution.....	16
6 Sizing.....	16

6.1	General	16
6.2	Calculation method	17
6.2.1	General	17
6.2.2	Demand and yield hierarchies.....	17
6.2.3	Basic approach.....	17
6.2.4	Detailed approach	18
7	Installation	19
8	Differentiation and identification.....	20
9	Commissioning	21
10	Quality of non-potable water	21
11	Testing of water quality	21
12	Maintenance	22
	Annex A (informative) Greywater yield and demand.....	23
	Annex B (informative) Types of greywater systems	24
	Annex C (informative) Example of dye testing for distribution pipework cross-connections	25
	Annex D (informative) Example for water quality requirements.....	27
	Bibliography	30

European foreword

This document (EN 16941-2:2021) 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 2021, and conflicting national standards shall be withdrawn at the latest by July 2021.

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

The EN 16941 series, *On-site non-potable water systems*, consists of the following parts:

- *Part 1: Systems for the use of rainwater;*
- *Part 2: Systems for the use of treated greywater.*

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Ecological and sustainable water management is a goal of greywater management.

Greywater varies in volume and composition depending on different sources (see Figure 1) which would need different levels of treatment depending on its intended use. Therefore greywater systems can vary significantly in their complexity and size. They can be grouped according to the type of system (see Annex B).

Greywater can also be used for heat recovery and cooling demands. Principles and design for such applications are not covered by this document.

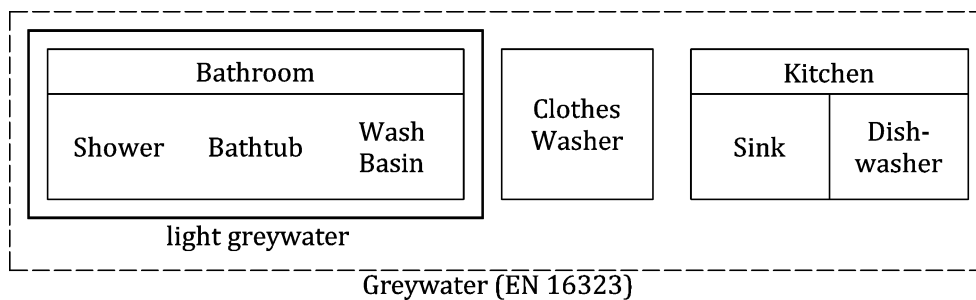


Figure 1 — Types and sources of light greywater

EN 16941-2:2021 (E)**1 Scope**

This document specifies the principles of design, sizing, installation, identification, commissioning and maintenance of greywater systems with the purpose of use of greywater on-site.

It applies preferably for the use of treated greywater for:

- WC flushing;
- garden watering;
- laundry;
- cleaning purposes.

This document also specifies the minimum requirements for greywater systems.

Excluded from the scope of this document are:

- the use as drinking water and for food preparation;
- the use for personal hygiene purposes;
- direct use systems without treatment;
- product design for specific system components;
- industrial effluents;
- heat recovery and cooling demands.

NOTE Conformity with this document does not exempt from compliance with the obligations arising from local or national regulations.

2 Normative references

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

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

EN 806 (all parts), *Specifications for installations inside buildings conveying water for human consumption*

EN 809, *Pumps and pump units for liquids - Common safety requirements*

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

EN 1717, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow*

EN 12050 (all parts), *Wastewater lifting plants for buildings and sites*

EN 12056-2, *Gravity drainage systems inside buildings - Part 2: Sanitary pipework, layout and calculation*

EN 12056-4, *Gravity drainage systems inside buildings - Part 4: Wastewater lifting plants - Layout and calculation*

EN 12056-5, *Gravity drainage systems inside buildings - Part 5: Installation and testing, instructions for operation, maintenance and use*

EN 12566-3, *Small wastewater treatment systems for up to 50 PT - Part 3: Packaged and/or site assembled domestic wastewater treatment plants*

EN 13076, *Devices to prevent pollution by backflow of potable water - Unrestricted air gap-Family A - Type A*

EN 13077, *Devices to prevent pollution by backflow of potable water - Air gap with non-circular overflow (unrestricted) - Family A - Type B*

EN 13564-1, *Anti-flooding devices for buildings - Part 1: Requirements*

EN 60335-2-41, *Household and similar electrical appliances - Safety - Part 2-41: Particular requirements for pumps*

EN ISO 4064-1, *Water meters for cold potable water and hot water - Part 1: Metrological and technical requirements (ISO 4064-1)*

EN ISO 4064-5, *Water meters for cold potable water and hot water - Part 5: Installation requirements (ISO 4064-5)*

ISO 7010, *Graphical symbols - Safety colours and safety signs — Registered safety signs*

3 Terms and definitions

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

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

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

3.1

greywater

domestic wastewater excluding wastewater from WC and urinal

[SOURCE: EN 16323:2014, 2.1.2.1]

3.2

light greywater

greywater excluding kitchen and clothes washer wastewater

3.3

storage device

unit for the storage of treated greywater

3.4

cistern

fixed container for holding water at atmospheric pressure for use as part of the plumbing system

EN 16941-2:2021 (E)**3.5****non-potable water**

water which has been made available for use, except drinking, food preparation and personal hygiene

3.6**non-return valve**

device that prevents backflow of water

[SOURCE: EN 16323:2014, 2.2.5.12, modified – “wastewater” was changed to “water”.]

4 Functional elements and greywater quality

Any greywater system is described through four main functional elements:

- collection;
- treatment;
- storage; and
- distribution.

Greywater systems shall be designed, installed, marked, operated and maintained in such a way that the required level of safety is ensured at any time and that the required servicing work can be easily carried out.

Greywater systems shall not cause flooding and therefore shall include potential bypasses and/or properly dimensioned overflows.

Volume and pollution of different kinds of greywater depend on their origin. Where greywater is taken from a sink or dishwasher, the level of pollutant is far higher than light greywater and may require more intensive treatment.

5 Design**5.1 General**

The following factors should be identified in order to determine the type and treatment capacity of the greywater system:

- a) demand and yield, based on:
 - 1) the number and type of intended appliances, both present and future;
 - 2) the volume and usage patterns of these appliances;
 - 3) discharge figures of greywater appliances connected for use.
- b) peak capacity treatment rate;
- c) water quality requirements for the intended use.

These requirements shall be in accordance with local and/or national regulations (an example of water quality requirements is given in Annex D).

The different types of greywater systems can be distinguished according to Annex B.

NOTE Residual disinfectant or by-products might be present in the treated greywater. Colour could also be present. Systems containing these mentioned products might not be suitable for laundry use or garden watering. Furthermore, if it is intended that treated greywater is to be used for garden watering, water that has been artificially softened might not be suitable for some plants and soils because of salt carryover in the treated greywater.

It is noted that greywater discharge rates vary depending on the appliances that are in use. For example, a shower can discharge at a rate between 0,1 l/s (or less) and 0,3 l/s, while a full bath typically discharges at between 0,4 l/s and 0,5 l/s. The greywater system shall manage these varying incoming flow rates.

The materials selected for the tank and other components should be suitable for the location and temperature ranges and structural loadings anticipated. All components of the greywater system should be capable of withstanding all pollutants of greywater for the lifetime of the products.

Consideration should be given to the environmental impact of materials used. Where appropriate, existing resources on site should be utilized to limit the environmental impacts of the greywater system, materials should be reused where ever possible.

5.2 Collection

Greywater shall be collected in separate wastewater drainage pipework and allowed to flow from collection appliances to the greywater system by gravity. Where this is not practicable, pumps need to be considered (see 5.6).

Collection pipework shall be:

- a) dedicated to greywater;
- b) sized and laid out in accordance with EN 12056-2, such that the generation of foam is minimized. As air entrainment is a major factor in the generation of foam, turbulence and the use of bends shall be minimized;
- c) identified (see Clause 8); and
- d) free draining to avoid stagnation.

Collection pipework shall prevent water from other sources entering the greywater system.

It is recommended to minimize coarse pollutants, e.g. hair, entering the greywater system.

The greywater system should at least have a bypass to divert the greywater away from the system during periods of maintenance, blockage or system isolation. The bypass shall not overload the drainage system.

5.3 Treatment

The collected greywater quality and the intended use of the treated greywater shall be considered in order to determine which treatment is needed and which method is appropriate, e.g. physical, chemical or biological.

The collected greywater shall at least be treated to the extent needed to meet the water quality guidelines of the application being supplied (see Annex D).

After choosing the degree of treatment, the sustainability aspects and the environmental impact shall also be considered in order to determine the most appropriate type of treatment.

Types of treatment shall include one or more of the following sub-steps:

- a) sedimentation/flotation, e.g. via settlement tanks;

EN 16941-2:2021 (E)

- b) screening, e.g. large particulate filtration;
- c) mechanical fine filtration, e.g. membrane filtration;
- d) biological treatment, e.g. aeration;
- e) chemical treatment e.g. precipitation;
- f) disinfection, e.g. ultraviolet (UV) radiation.

5.4 Storage**5.4.1 General**

The storage of untreated greywater should be avoided. Where storage of treated greywater is necessary, it may be incorporated as part of the greywater treatment process or provided separately, e.g. in combination with a rainwater harvesting system.

The selection of storage should take into account:

- a) the peak capacity treatment rate;
- b) the necessary storage temperature and allow natural ventilation;
- c) the maximum storage period and any other conditions related to the treatment equipment; and
- d) whether the system is to be dedicated to greywater only or combined with a rainwater harvesting system.

5.4.2 Materials

The materials used shall not have a negative effect on the stored water and the environment of the installation. The storage device shall be made from non-translucent material.

The materials (e.g. concrete, steel, Polyvinylchloride (PVC-U), Polyethylene (PE), Polypropylene (PP), Glass Reinforced Polyester (GRP-UP)) used for the storage device shall meet the material properties described in EN 12566-3. The materials of components in contact with water shall be chosen considering the risk of corrosion.

5.4.3 Dimensions

When prefabricated components are used, the overall dimensions, access and connection dimensions and tolerances shall be stated by the manufacturer. Individual storage devices may be connected to each other.

5.4.4 Capacity

The nominal capacity is the maximum volume of water that can be retained within the storage device and shall be stated by the manufacturer or designer.

The capacity can be determined by testing or calculation

5.4.5 Structural behaviour

Underground storage devices shall withstand the maximum stresses and loads exerted during their handling, installation, use and maintenance. This shall be assessed either by calculation or testing.

Above-ground storage devices shall withstand the action of hydrostatic pressure without generating excessive deformation adversely affecting their function. This shall be assessed either by calculation or testing.

5.4.6 Watertightness

The storage device shall be watertight at the level of:

- the walls constituting it;
- the couplings ensuring the hydraulic connections; and
- penetrations through the storage device wall used for the possible passage of electric cables.

5.4.7 Connections and internal pipe system

The nominal diameters of the inlet and outlet fittings of the storage device shall be stated by the designer of the system.

The inlets, outlets and other connections of the storage device shall be equipped with fittings (i.e. sockets, spigots) of standardized dimensions equipped with seals and enabling assembly using standardized pipes.

5.4.8 Access

The storage device shall be equipped with an access to permit regular inspection and maintenance. The access shall be secured (e.g. by a cover with a locking feature or sufficient weight).

For the access of a person the dimensions given in EN 476 shall be considered. When access of a person is not intended an opening with a dimension (i.e. width for a square section or diameter for a circular section) not less than 400 mm minimum shall be used.

Shafts and access covers shall prevent unintentional contamination of the storage device.

5.4.9 Overflow

All storage devices shall be equipped with an overflow to allow excess water to be discharged into the sewer system. An overflow discharge into a foul sewer shall be equipped with an odour trap.

Protection against sewer backflow as specified in EN 13564-1 shall be provided.

Every overflow shall have provisions to avoid pollution. The mounted parts shall not cause any narrowing of the cross-section. During overflow a siphonage of the storage device shall be avoided.

The capacity of the overflow shall be equal or greater than the inlet flow.

Appropriate protection against the entry of small animals shall be provided.

5.5 Back-up water supply

5.5.1 General

The greywater treatment system shall incorporate a back-up water supply where continuous availability of water is needed. The back-up water may be introduced into:

- a break cistern prior to its pump, for delivery to the distribution pipework, e.g. purpose-designed module; or
- an intermediate cistern, usually located at high level, e.g. gravity supply; or
- the storage device, for treated greywater.

EN 16941-2:2021 (E)

In the case of back-up supply using potable water, the potable supply system shall be protected with an appropriate protection unit (see 5.5.2).

The possibility of a flooding of the back-up supply device (e.g. via reflux) shall be eliminated; e.g. by installing the back-up supply device above the backwater level.

When the water level in the storage device is below a given minimum, the back-up supply control shall automatically ensure the operational reliability of the system. This can also be achieved by a control system (see 5.7).

The back-up supply shall be fitted with a control mechanism which ensures that the amount of water supplied is minimized to that needed for immediate use. It is recommended that this is provided from a make-up module or an intermediate cistern.

To avoid water becoming stagnant, the design of the system shall ensure that there are no dead legs upstream, e.g. on the potable water supply and suitable turnover of water is achieved.

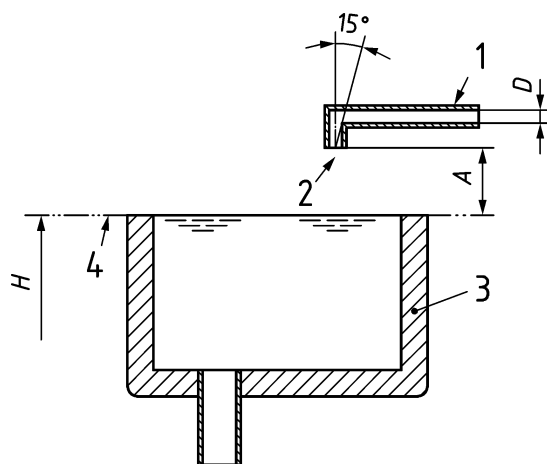
In order to prevent wasting potable water, the storage device with valve-controlled water inputs shall have a warning system so any failure is readily noticeable.

5.5.2 Backflow protection device

To prevent non-potable water entering the potable or public water supply, the back-up supply shall be fitted with a protection unit that is capable of providing protection against contamination by category 5 fluids (an air gap) in accordance with EN 1717, such as described:

— in EN 13076, for family A type A, “AA unrestricted air gap”, disconnectors (see Figure 2):

An “AA” air gap is a visible unobstructed and complete air gap placed permanently and vertically between the lowest point of the inlet feed orifice and any surface of the receiving vessel that determines the maximum operational level at which the device overflows;



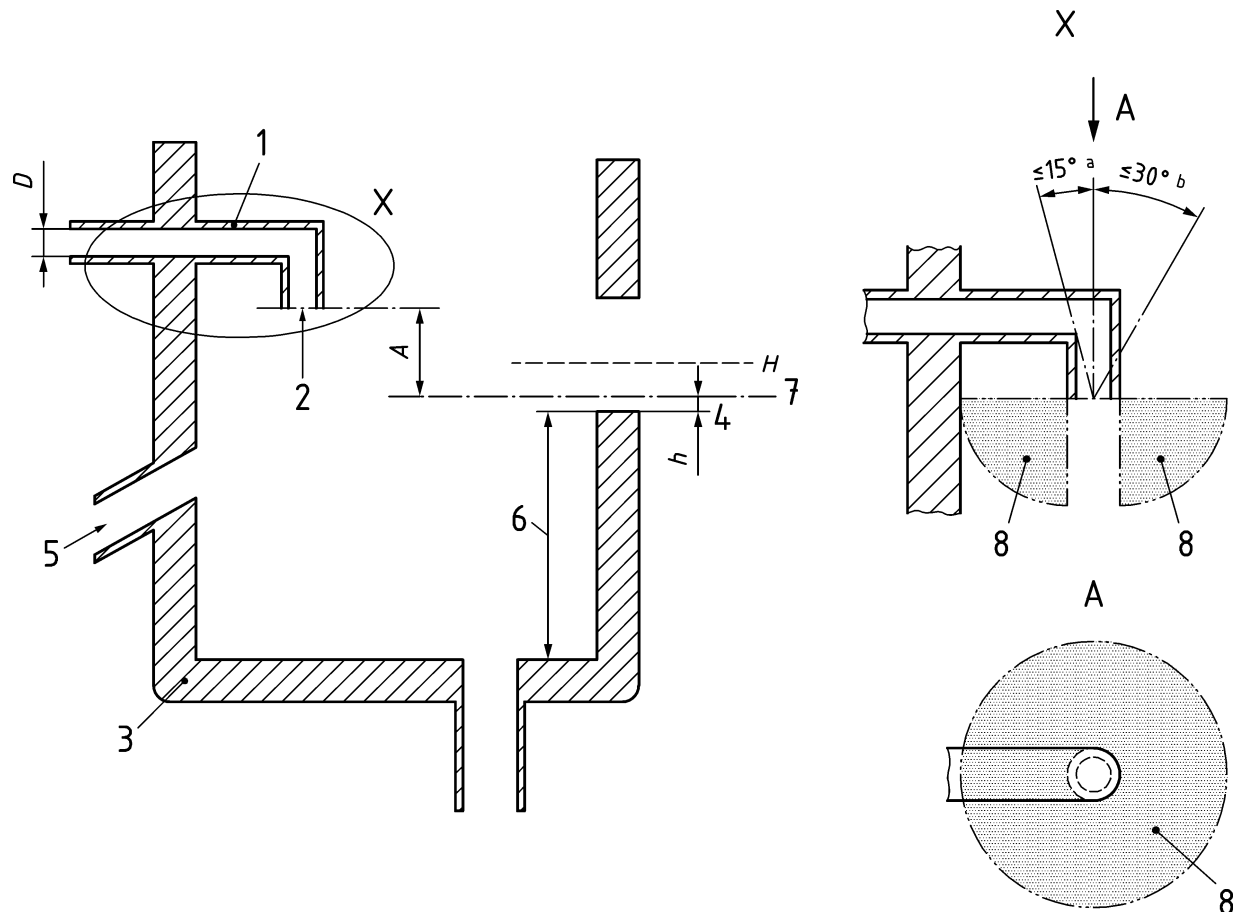
Key

1	feed pipe	A	air gap (double the inner diameter of the feed orifice with a minimum of 20 mm)
2	feed orifice	D	internal diameter of feed pipe (bore)
3	receiving vessel	H	maximum water level
4	spillover level		

Figure 2 — Unrestricted Type AA air gap according to EN 13076

- in EN 13077, for family A type B, “AB air gap with non-circular overflow” disconnectors (see Figure 3):

An “AB” air gap is a permanent and vertical distance between the lowest point of the feed orifice and the critical water level. The overflow shall be of non-circular design and shall be able to evacuate the maximum flow of water in the event of overpressure.



Key

1	feed pipe	7	critical water level (distance h)
2	feed orifice	8	2D Minimum radial clearance
3	receiving vessel	A	air gap (distance)
4	spillover level	D	internal diameter of feed pipe (bore)
5	optional warning pipe	H	maximum water level
6	$U_w \geq 5h$ (internal vertical surface)	a	15° maximum from the vertical (validation by test or calculation)
		b	30° maximum from the vertical (validation by test only)

Figure 3 — Unrestricted Type AB air gap with non-circular overflow according to EN 13077

Flow rates, head loss and installation requirements shall be taken into account when selecting the backflow prevention device.

Where the backflow prevention device is to provide water to the storage device directly and there is a risk of odours venting back into the building, an odour trap shall be installed.

EN 16941-2:2021 (E)**5.6 Pumping****5.6.1 General**

For systems, other than those which distribute the collected greywater by gravity, one or more pumps shall be used to ensure its continual availability.

NOTE 1 The operational safety and hydraulic demand will dictate whether a single pump or multiple-pump systems are needed.

The flow rate and the required pressure head of the pump shall be determined in accordance with EN 12056-4 and the EN 12050 series.

The pump shall be selected and arranged such that:

- energy use and noise are minimized;
- air is not introduced into the suction lines;
- it is protected against freezing;
- it is provided with isolation valves for maintenance and repair.

The pump shall be equipped with dry-run protection, which may be part of the pump or provided by an external control device (see 5.7).

Surges, water hammer and hunting from the pump shall be absorbed and prevented from causing undue high pressures, e.g. by the incorporation of expansion vessels or pressure controls, in order to prevent bursting and excessive draw off.

The pumps shall comply with either EN 60335-2-41 for a domestic installation or EN 809 for other types of installations.

Multiple pump systems shall conform to EN 12056-4 or the EN 12050 series, with a standby pump if necessary.

NOTE 2 Several pumps can operate alternately to equalize their operating time.

The pumps shall ensure the distribution of water under the conditions stated in 5.9.

5.6.2 Pumps for collected greywater

Pumps for collected greywater shall be able to accommodate any solid matter likely to be contained in the greywater as detailed in EN 12050-2.

The pump installation shall be sized and laid out in accordance with EN 12056-4.

If the pump incorporates any filtering or traps, these shall be accessible for maintenance and cleaning.

Where accumulation of the flow from the collection appliances would be detrimental to users and/or the system, means shall be provided to divert untreated greywater to the foul sewer system. Alternatively, a standby pump shall be installed.

5.6.3 Pumps for treated greywater**5.6.3.1 Pumps for treated greywater located outside the tank**

If installed outside the storage device, the pump shall have a control system which ensures a constant fully primed condition. The suction line to the pump shall be laid with a steady gradient upwards towards the pump. The pump shall be placed in a ventilated location and protected from extremes of temperature, with sound-absorbing and vibration-absorbing mountings.

A non-return valve shall be provided in the suction line to the pump in order to prevent the water column from draining down. The pressure line of the pump shall be supplied with an isolating valve.

The pump installation shall be sized and laid out in accordance with EN 806-2 and EN 806-3.

5.6.3.2 Pumps for treated greywater located inside the tank

The immersion depth of the pump shall be in accordance with the pump manufacturer's instructions. The pump shall be removable for maintenance purposes. A non-return valve shall be provided, with an isolating valve to enable the non-return valve to be maintained.

A minimum level of water needs to be maintained above the pump inlet in order to prevent damage by sucking in air, sediment or debris.

The pump installation shall be sized and laid out in accordance with EN 806-2 and EN 806-3.

5.6.4 Expansion vessel

An expansion vessel may be required to prevent the pump from starting too frequently if the system has a risk of low extraction or leaks.

The expansion vessel shall be sized according to the type of controls used (e.g. fixed or variable speed) and ensure the exchange of water within the vessel.

The use of an expansion vessel can allow the pump to be used less and therefore improve the energy balance.

5.6.5 Pump control unit

The pumps shall be equipped with a pump control unit to automatically control the pumps, with a manual override. The control shall permit manual operation.

The pump control unit shall:

- control pumps and minimize operational wear and energy use; and
- protect the pumps from running dry.

5.7 System control with monitoring

A control and monitoring system shall be incorporated in the greywater treatment system to ensure, as a minimum, that users are aware of whether the system is operating:

The control unit shall:

- a) make the user/operator aware when any consumable items need replenishment or replacement, to prevent a system failure;
- b) ensure that treated greywater is not stored for a period that would allow water quality to deteriorate beyond the specified quality (see Clause 10) or that exceeds the manufacturer's requirements;
- c) in the event of any system failure: make the user/operator aware, e.g. by a visible or audible warning;
- d) ensure that the bypass directs untreated greywater to the foul sewer system;
- e) in the event of a treatment failure, ensure that the appliances supplied by the greywater system are fed from the back-up water supply;

EN 16941-2:2021 (E)

- f) control pumps and minimize operational wear and energy use;
- g) activate the back-up water supply automatically when required by the treatment unit;
- h) provide an output to enable the greywater system to be linked to a building management system (BMS), where appropriate.

For non-electrically powered greywater units, e.g. simple filters, provision shall be made to enable the performance or condition of the treatment equipment to be monitored visually, so that it can then be replaced or cleaned as necessary.

5.8 Metering

When meters are required to quantify the volumes of greywater used inside the building and discharged into the public sewer system, reference shall be made to the specifications of EN ISO 4064-1 to EN ISO 4064-5.

5.9 Distribution

The purpose of distribution is to feed the points of use with the treated greywater and the possibility of back-up water supply. The distribution performed shall ensure the integrity and protection of public and private potable water distribution systems.

Requirements specified for potable water systems in the EN 806 series (Parts 1 to 5) are considered good plumbing practice for all systems, regardless of the source of water.

Treated greywater and drinking water usually have different chemical characteristics (pH for instance). The materials constituting the pressure pipe and the end use appliances shall be chosen considering the risk of corrosion and degradation of the fittings and fixtures, e.g. rubber seals.

Pipework shall be sized to provide adequate flow and pressure (see the EN 806 series (Parts 1 to 5)).

The treated greywater shall be distributed by:

- pumping it from the storage device directly to the point of use; or
- pumping it from the storage device to an intermediate cistern/tank, followed by distribution via pump or gravity to the point of use.

Cross-connections between the non-potable water piping systems and other piping systems are not permitted.

6 Sizing**6.1 General**

Depending on the type of greywater system, the optimum storage capacity for treated greywater should be determined by the following factors:

- a) the yield, demand or behaviour patterns;
- b) the maximum capacity treatment rate.

The overall sizing of the system shall be determined by lowest value of the calculation results of either yield or demand and it is recommended that storage of treated greywater be minimized. As there is generally a ready supply of untreated greywater, storage equal to 50 % up to a single day's use is normally considered sufficient.

6.2 Calculation method

6.2.1 General

The type and capacity of the greywater system should be calculated using one of the following methods:

- a) the basic approach, where the bathroom greywater is to be used for WC flushing and/or laundry within single residential premises (see 6.2.3);
- b) the detailed approach, where the bathroom greywater is to be used for e.g. WC flushing, laundry and garden watering in residential, commercial, industrial or public premises (see 6.2.4).

Where a property is intended for use as a hotel, hall of residence or similar accommodation buildings, or where more than one property is to be supplied by a single greywater system, the detailed approach should be used.

6.2.2 Demand and yield hierarchies

It is recommended that demand drives the specification of the greywater system, in order to prevent the collection and treatment of water that cannot be used. The following demand order of preference should be considered for potential non-potable uses:

- a) WC flushing;
- b) external use – non-spray;
- c) laundry use, i.e. clothes washer;
- d) external use – spray.

For reducing the effort of treatment, the following order of collection preference should be considered:

- e) showers and baths;
- f) wash basins;
- g) clothes washer;
- h) kitchen sinks and/or dishwasher.

Where clothes washers are both taking water from and feeding water into the greywater system, the system needs to incorporate a suitable treatment process and only utilize suitable greywater.

NOTE It is assumed in this document that the appliances from which greywater is collected will be used normally. Where it is anticipated that an appliance will be used in an unusual manner, e.g. for the soak disinfection of cotton towel nappies or for hair colouring, further consideration might need to be given.

6.2.3 Basic approach

The basic approach is based on a balance of the following assumptions and valid for residential buildings only:

- a) relatively constant daily demand per person for WC flushing and for clothes;
- b) relatively constant daily yield of light greywater per person.

EN 16941-2:2021 (E)

When calculating the daily treatment capacity of the greywater system, the average daily yield and demand per person shall be taken into account. Examples of typical average daily greywater yield and demand are given in Annex A (Table A.1)

6.2.4 Detailed approach**6.2.4.1 General**

The detailed approach assumes that the yield and demand are constant and exclude usage peaks.

6.2.4.2 Greywater yield

The following Formula (1) shall be used to determine the greywater yield, Y_G , in litres per day (l/day):

$$Y_G = n \cdot (Q_S \cdot t_S \cdot u_S + V_{BT} \cdot u_{BT} + Q_{HWB} \cdot t_{HWB} \cdot u_{HWB} + V_{WM} \cdot u_{WM} + Q_{KS} \cdot t_{KS} \cdot u_{KS} + V_{DW} \cdot u_{DW}) \quad (1)$$

where

Y_G	is the yield of greywater in litres per day (l/d);
n	is the number of persons (p);
Q_S	is the volume flow of shower in litres per minute (l/min);
t_S	is the duration per usage of shower in minutes (min);
u_S	is the shower usage rate per person per day (1/(p · d));
V_{BT}	is the volume of water per usage of the bathtub in litres (l) (not maximum filling volume);
u_{BT}	is the usage rate of bathtub per person per day (1/(p · d));
Q_{HWB}	is the volume flow of wash basin in litres per minute (l/min);
t_{HWB}	is the duration per usage of wash basin in minutes (min);
u_{HWB}	is the handwash usage rate per person per day (1/(p · d));
V_{WM}	is the volume of water for clothes washer per operation cycle in litres (l);
u_{WM}	is the number of operation cycles of clothes washer per person per day (1/(p · d));
Q_{KS}	is the volume flow of taps (warm and cold water) at kitchen sink in litres per minute (l/min);
t_{KS}	is the duration per usage of kitchen sink in minutes (min);
u_{KS}	is the usage rate of tap at kitchen sink per person per day (1/(p · d));
V_{DW}	is the volume of water for dishwasher per operation cycle in litres (l);
u_{DW}	is the operation cycles of dishwasher per person per day (1/(p · d)).

See Annex A.

6.2.4.3 Greywater demand (WC flushing and clothes washer use)

The following Formula (2) shall be used to determine greywater demand, D_G , in litres per day (l/d) where the treated greywater is to be distributed for flushing, clothes washer use, garden watering, cleaning, etc., as relevant.

NOTE Where more than one type of WC is installed, the consumption can be calculated for each WC or it can be assumed that all WCs will be used equally, in which case the standard consumption for each type can be calculated and the results simply averaged.

$$D_G = n \cdot (V_T \cdot u_T + V_U \cdot u_U + V_{WM} \cdot u_{WM}) + V_{misc} \quad (2)$$

where

- D_G is the demand of greywater in litres per day (l/d);
- n is the number of person (p);
- V_T is the volume of water for WC flushing per flush in litres (l);
- u_T is the usage rate of WC per person and day (1/(p · d));
- V_U is the volume of water for urinal flushing per flush in litres (l);
- u_U is the usage rate of urinal per person and day (1/(p · d));
- V_{WM} is the volume of water for clothes washer per operation cycle in litres (l);
- u_{WM} is the operation cycles of clothes washer per person and day (1/(p · d));
- V_{misc} is the volume of water for other purposes (e.g. garden watering, cleaning) in litres per day (l/d).

See Annex A.

6.2.4.4 Greywater demand for other purposes

The quality of treated greywater allows other usages e.g. garden watering, cleaning, cooling, etc. The demand depends on a number of factors and shall be estimated.

7 Installation

The plumbing work shall be carried out in accordance with good plumbing practice as used for water supply and wastewater systems (see EN 806 (all parts), EN 12056-5, EN 1610). National regulations and the designer's or manufacturer's installation instructions shall be taken into account.

The location of the underground treatment and storage device shall respect a minimum distance of 3 m from any tree or plant that develops a significant root system. A grassed surface is permitted. Plants closer than 3 m to the treatment and storage devices may require the implementation of root barriers intended to protect it.

Manufacturer's installation instructions shall contain comprehensive data for the installation of the system and shall, where appropriate, cover at least:

- required location characteristics;
- assembly of components;
- access for maintenance and/or replacement of consumable parts;
- pipe connections;
- electrical connections;
- temperature considerations;

EN 16941-2:2021 (E)

- health and safety aspects (e.g. secure access).

Prior to installation of underground devices, any site specific factors that might affect the installation process shall be taken into account. Such additional factors include:

- ground strength and stability;
- land contamination;
- backfill for underground installation;
- groundwater level situations for underground installation;
- proximity to utilities and foundations;
- avoidance of any future loads above the storage device which are not considered in the design;
- existing pipework and cables;
- access routes.

8 Differentiation and identification

Differentiation and identification through labelling and marking provides users and maintenance staff who are likely to work on the installation with suitable information to ensure safe operation of the greywater treatment and potable water distribution system.

To prohibit misuse it is recommended that all non-potable water taps shall be equipped with a safety device (e.g. detachable lever).

All pipework (both collection and distribution), fittings and points of use for non-potable water systems shall be marked and labelled to prevent accidental consumption or cross-connection between the potable and non-potable water and cross-connection between foul and grey water collection pipework:

- Draw-off points for non-potable water shall be identified with the words “Non-potable water” or by a prohibition sign as shown in Figure 4. If the majority of draw-off points on industrial premises are for non-potable water, the draw-off points for potable water may be identified by the words “Potable water” or by the “Potable water” symbol specified in Figure 4, provided that notices are posted to draw attention to this deviation from normal practice.



Figure 4 — Sign “Drinking water” (left) according to ISO 7010-E015 and prohibition sign “Not drinking water” (right) according to ISO 7010-P005

- the pipes of the non-potable water distribution systems shall be clearly identifiable; this can be ensured by different colour from potable water pipes or by an identification band with the pipe;
- close to the drinking water mains valve a sign with a notice of the existence of a non-potable water system shall be installed.

9 Commissioning

Before it's commissioning the complete installed greywater system shall be checked according to designer's recommendations.

The distribution and collection pipework shall be flushed and inspected for watertightness (see EN 806-4, EN 12056-5, EN 1610) and cross-connections either by dye testing (see example in Annex C) or pressure test between the different pipe systems.

The electrical part of the greywater system shall also be tested in accordance with applicable standards and national regulations to ensure that it is electrically safe and that there is no interference to or from other electrical or electronic equipment, or wiring in the vicinity, before it is commissioned.

A commissioning sheet shall be established certifying that the system is technically correct and fully operational. The commissioning sheet shall be submitted to the owner of the installation.

10 Quality of non-potable water

It is essential that greywater systems are designed in a way that ensures the non-potable water produced is fit for purpose and presents no undue risk to health. The examples given in Annex D are minimum requirements. Stricter national or project specific values shall take precedence over the values given in Annex D.

Risk assessment shall be carried out to determine whether the system is safe and fit for purpose. This should take place when the system is being designed.

The risk assessment shall consider the effects of exposure to, and the potential impacts of, the system on people, the environment, and physical assets.

The risk assessment shall consider the design, installation, testing and commissioning, operation and maintenance of the system, including water quality (see also Clause 11), structural stability, electrical safety and access provision.

11 Testing of water quality

Depending on the risk assessment a test shall be done when the system for greywater treatment is in treatment operation to verify the water quality declared by the manufacturer and proper operation.

Testing immediately following the commissioning of systems is not recommended as water quality is not representative.

Further testing and testing parameters are depending on the usage of greywater.

The sampling point shall be installed in the distribution system of treated greywater. All samples shall be taken as grab samples during treatment operation of the system.

The examples given in Annex D can be used for orientation in the case when national requirements are not existing.

Water quality can be measured as shown in the examples in Table D.1 for parameters relating to health risk, and Table D.2 for parameters relating to system operation, which provide an indication of the water quality that a well-designed and maintained system is expected to achieve for the majority of operating conditions.

EN 16941-2:2021 (E)

The results of bacteriological monitoring can be interpreted with reference to Table D.3. The results of general system monitoring should be interpreted with reference to Table D.4.

NOTE Water quality is likely to fluctuate as different people use the collection appliances, such as baths and showers, in different ways and the collected greywater is therefore subject to varying levels of dirtiness and use of surfactants.

12 Maintenance

Maintenance instructions shall be available, retained and followed for the installed greywater system. These instructions shall contain comprehensive data for the maintenance and all operating conditions including pipe connections, electrical connections and commissioning and start-up procedures.

The extent of maintenance depends on the possible use of treated greywater, the dimension of the system and national requirements.

In order to enable the correct operation and maintenance, all information relevant to the installation shall be readily available.

Manufacturer's documentation (e.g. Technical Product Information (TPI)) related to the operation and maintenance of appliances shall be available, retained and followed.

The commissioning report shall be part of the documentation.

The maintenance shall be recorded and stored in such a way that the data are auditable.

For greywater systems the owner shall establish a log book, in particular including:

- the name and address of the person or company in charge of the servicing;
- the greywater treatment equipment drawing, showing the piping and draw-off taps for the greywater distribution systems and for water for human consumption, which he sends to the occupants of the building;
- the commissioning sheet;
- the date of the checks made and the details of the servicing operations.

The user/operator of the greywater system is responsible for storing the log book.

Observations for water quality (i.e. smell, colour) shall be made during maintenance to check the performance of the greywater system. If the system is not operating satisfactorily tests should be undertaken to investigate the cause (see Clause 11).

Annex A (informative)

Greywater yield and demand

A.1 Greywater yield and demand

Table A.1 — Typical average daily greywater yield and demand

Occupancy	Yield ^a	Demand		
		WC	Laundry ^b	Other non-potable uses ^c
1 person	60	35	15	10
^a Yield from showers, baths and/or wash basins. ^b These figures are based on average daily demand. It is noted that a clothes washer usually uses 30 l to 60 l per cycle. ^c For example, garden watering.				

A.2 Examples of water usage and demand

The following Table A.2 and A.3 shows typical ranges for water usage for the determination of the greywater yield and demand.

NOTE European Community energy labels for washing machines either for sale or hire are required to display efficiency data based on a standard 60 °C cotton wash. For clothes washers, this includes information on water consumption (W) and load capacity (l). Where the performance of the washing machine is unknown, the ratio can be approx. 8 l per kilogram.

Table A.2 — Typical range for water usage

Water usage	Unit	Range
Volume flow of shower (Q_S)	(l/min)	5 to 15
Volume of water per usage of the bathtub (not maximum filling volume) (V_{BT})	(l)	70 to 200
Volume of water for clothes washer per operation cycle (V_{WM})	(l/cycle)	30 to 60
Volume flow of taps (warm and cold water) at kitchen sink (Q_{KS})	(l/min)	5 to 15
Volume of water for dishwasher per operation cycle (V_{DW})	(l)	10 to 20

Table A.3 — Typical range for water demand

Water demand	Unit	Range
Volume of water for WC flushing per flush (V_T)	(l/flush)	3 to 8
Volume of water for urinal pressure flushing per flush (V_U)	(l/flush)	1 to 2
Volume of water for washing machine per operation cycle (V_{WM})	(l/cycle)	30 to 60

Annex B

(informative)

Types of greywater systems

Greywater systems vary significantly in their complexity and size, and can be grouped according to the type of treatment they use, as follows.

a) Direct use systems without treatment

These systems use simple devices to collect greywater from appliances and deliver it directly to the points of use, with no treatment and minimal, or no, storage, e.g. a greywater diverter valve.

It is possible to use greywater without any treatment, provided that extended storage is not required. As untreated greywater quality deteriorates rapidly, the collected greywater ideally needs to be used as soon as possible.

Where no treatment is included in the greywater system, applications are restricted to sub-surface irrigation and non-spray applications.

b) Short retention systems

These systems apply a very basic treatment technique, such as skimming debris off the surface of the collected greywater and allowing particles to settle to the bottom of the tank. They aim to avoid odour and water quality issues by ensuring that the treated greywater is not stored for an extended period.

c) Basic physical/chemical systems

These systems use a filter to remove debris from the collected greywater prior to storage while chemical disinfectants are generally used to stop bacterial growth during storage.

d) Biological systems

These systems use aerobic or anaerobic bacteria to digest any unwanted organic material in the collected greywater. In the case of aerobic treatment, technical installations or aquatic plants can be used to aerate the water.

e) Bio-mechanical systems

These systems combine biological and physical treatment, e.g. removing organic matter by microbial cultures and solid material by separation. They encourage bacterial activity by aeration.

Annex C

(informative)

Example of dye testing for distribution pipework cross-connections

The test-set-up for dye testing shall be as shown in Figure C.1. Testing for cross-connections shall be carried out before the greywater treatment system is in full operation and carried out as follows.

NOTE Experience has shown that biodegradable food colorants red and blue are suitably visible.

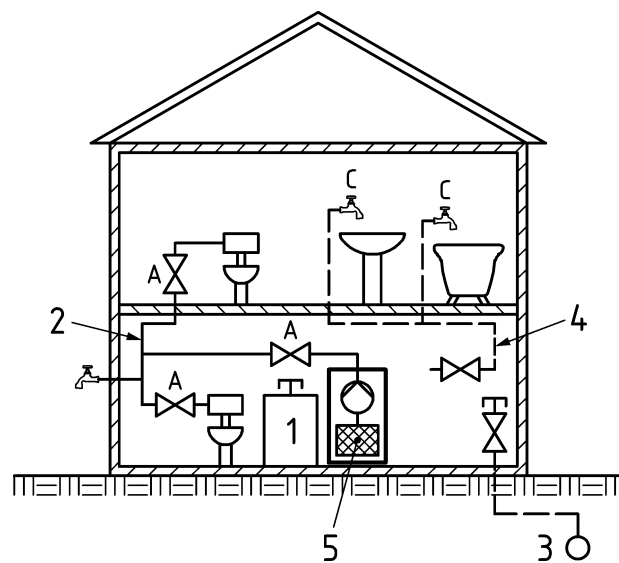
a) Control of the treated greywater distribution system:

- 1) Disconnect the system from potable water supply and cap the potable water supply prior to testing.
- 2) Open all inline servicing valves.
- 3) Dose dye into storage tank for treated greywater and start pressure pump for the distribution.
- 4) Control all distribution points concerning the appearance of coloured water:
 - Outlets for non-potable water showing coloured water: PASS;
 - Outlets for potable water with coloured or non-coloured outflow: FAIL; prohibited cross-connection between potable and non-potable water distribution system.

b) Control of cross-connections in the greywater harvesting system:

- 1) Dosing of dye into all non-greywater harvesting points (e.g. toilet, kitchen sink)
 - i) No coloured water in the greywater treatment system: PASS;
 - ii) Coloured water in the greywater treatment system: FAIL; wrongly connected collection points.

After testing the whole system shall be thoroughly flushed to remove all residual traces of colorant before it is commissioned and put into operation. The potable water system shall also be flushed prior to reconnection.

**Key**

- 1 greywater treatment unit
- 2 non-potable water distribution pipework
- 3 potable/back-up water supply
- 4 drinking water distribution pipework
- 5 testing unit with pump for greywater system, filled with coloured clean potable water
- A valve
- C outlet for potable water

Figure C.1 — Cross-connection dye test

Annex D (informative)

Example for water quality requirements

Table D.1 — Example of guideline values for bacteriological monitoring according to the BS 8525 series

Parameter CFU/100 ml	Spray application	Non-spray application			Test method		System type
	Pressure washing, garden sprinkler use and car wash	WC flushing	Garden watering	Laundry, i.e. clothes washing machine use	Spray application	Non-spray application	
<i>Escherichia coli</i>	Not detected	250	250	not detected	EN ISO 9308-1	EN ISO 9308-3	Single site and communal domestic systems
Intestinal enterococci	Not detected	100	100	not detected	EN ISO 7899-2 or EN ISO 7899-1	EN ISO 7899-1	Single site and communal domestic systems
<i>Legionella pneumophila</i>	10	N/A ^b	N/A	N/A	EN ISO 11731	N/A	Where analysis is necessary as indicated by risk assessment (see 5.10)
Total coliforms ^a	10	1 000	1 000	10	EN ISO 9308-1	EN ISO 9308-3	Single site and communal domestic systems
^a “Total coliforms” is an indicator parameter for operational interpretation. The bacteriological guideline values given for treated greywater reflect the need to control the quality of treated water for supply and use. ^b N/A = not available							

Table D.2 — Example of values for general system monitoring according to the BS 8525 series

Parameter ^a	Spray application	Non-spray application			Testing	System type
	Pressure washing garden sprinkler use and car washing	WC flushing	Garden watering	Laundry. i.e. washing machine, use		
Turbidity (NTU)	<10	<10	N/A	<10	EN ISO 7027-1	All systems
pH	5 to 9,5	5 to 9,5	5 to 9,5	5 to 9,5	EN ISO 10523	All systems
Residual chlorine (mg/l)	<2,0	<2,0	<0,5	<2,0	EN ISO 7393-2	All systems. where used
Residual bromine (mg/l)	0,0	<5,0	0,0	<5,0	EN ISO 10304-1	All systems, where used
^a In addition to these parameters, all systems should be checked for suspended solids and colour, The treated greywater should be visually clear, free from floating debris and not objectionable in colour for all uses. Colour is particularly relevant for washing machine use.						

Table D.3 — Example for the interpretation of results from bacteriological monitoring according to the BS 8525 series

Sample result ^a	Status	Interpretation
< G	green	System under control
G to 10 G	amber	Re-sample to confirm result and investigate system operation
> 10 G ^b	red	Suspend use of greywater until problem is solved
^a G = Guideline value see Table D.1 ^b In the absence of <i>E.coli</i> , Intestinal enterococci and <i>Legionella</i> , where relevant, there is no need to suspend use of the system if levels of coliforms exceed 10 times the guideline value and is resampled to confirm the results.		

Table D.4 — Example for the interpretation of results from system monitoring according to the BS 8525 series

Sample result ^a	Status	Interpretation
< G	green	System under control
> G	amber	Re-sample to confirm result and investigate system operation
When monitoring pH, the system is considered to be under control (“green” status) when levels are within the range recommended in Table D.3. If levels are outside this range, the system status becomes “amber” and re-sampling is necessary. Where colour or suspended solids are present at levels which are objectionable, it is essential to investigate the system operation to resolve the problem. ^a G = Guideline value see Table D.2		

Bibliography

- [1] EN 16323:2014, *Glossary of wastewater engineering terms*
- [2] EN ISO 5814, *Water quality - Determination of dissolved oxygen - Electrochemical probe method (ISO 5814)*
- [3] EN ISO 7027-1, *Water quality - Determination of turbidity - Part 1: Quantitative methods (ISO 7027-1)*
- [4] EN ISO 7393-2, *Water quality - Determination of free chlorine and total chlorine - Part 2: Colorimetric method using N,N-dialkyl-1,4-phenylenediamine, for routine control purposes (ISO 7393-2)*
- [5] EN ISO 7887, *Water quality - Examination and determination of colour (ISO 7887)*
- [6] EN ISO 7899-1, *Water quality - Detection and enumeration of intestinal enterococci in surface and wastewater - Part 1: Miniaturized method (Most Probable Number) by inoculation in liquid medium (ISO 7899-1)*
- [7] EN ISO 7899-2, *Water quality - Detection and enumeration of intestinal enterococci - Part 2: Membrane filtration method (ISO 7899-2)*
- [8] EN ISO 9308-1, *Water quality - Enumeration of Escherichia coli and coliform bacteria - Part 1: Membrane filtration method for waters with low bacterial background flora (ISO 9308-1)*
- [9] EN ISO 9308-3, *Water quality - Detection and enumeration of Escherichia coli and coliform bacteria in surface and wastewater - Part 3: Miniaturized method (Most Probable Number) by inoculation in liquid medium (ISO 9308-3)*
- [10] EN ISO 10304-1, *Water quality - Determination of dissolved anions by liquid chromatography of ions - Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate (ISO 10304-1)*
- [11] EN ISO 10523, *Water quality - Determination of pH (ISO 10523)*
- [12] EN ISO 11731, *Water quality - Enumeration of Legionella (ISO 11731)*
- [13] BS 8525 (all parts), *Greywater systems*
- [14] Real Decreto 1620/2007, de 7 de diciembre, por el que se establece el régimen jurídico de la reutilización de las aguas depuradas

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