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Code of practice for the selection of water reuse systems

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Contents

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2013. It was prepared by Technical Committee CB/506, *Water reuse*. A list of organizations represented on this committee can be obtained on request to its secretary.

The initial drafting of this British Standard was produced in association with BIS as part of their ongoing programme of support for standardization.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Particular attention is drawn to the following regulations:

- The Private Water Supplies Regulations [1], comprising The Private Water Supplies Regulations 2009; The Private Water Supplies (Wales) Regulations 2010 as amended; The Private Water Supplies (Scotland) Regulations 2006 as amended; The Private Water Supplies Regulations (Northern Ireland) 2009 as amended;
- The Workplace (Health, Safety and Welfare) Regulations 1992 [2];
- The Confined Spaces Regulations 1997 [3];
- The Work at Height Regulations 2005 [4].

In this document, the following national regulations, which apply to plumbing systems in premises to which a supply of public mains water has been provided, are referred to collectively as the "Water Fittings Regulations [5]":

- The Water Supply (Water Fittings) Regulations 1999, in England and Wales;
- The Water Byelaws 2004 (Scotland), in Scotland;
- The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009, in Northern Ireland.

Introduction

Water reuse refers to the collection and utilization of previously used water and rainwater. The collection and reuse of water is an alternative or supplement to the public mains water supply for a variety of non-potable water uses. In addition, for rainwater harvesting systems, it may also provide benefits for the attenuation of surface water run-off.

The term "water reuse systems" is not to be confused with the more comprehensive term "alternative water supply systems", which applies to all non-potable water supply, sanitation and sustainable drainage systems (SuDS). For example, private borehole water supplies are an alternative water supply system but are not considered to be water reuse.

The suitability of water reuse systems at any particular location is in part dependent on the needs and constraints of the local environment and infrastructure. For example, rainwater harvesting systems could be selected to help manage the surface water run-off with the additional benefit of reducing mains water use. Similarly, water reuse systems might not be deemed appropriate in areas where water scarcity, pollution from combined sewer overflows or other such environmental constraints are not of concern.

This British Standard has been written:

- to assist developers, designers and specifiers in taking into account local needs and constraints when evaluating the suitability of specific water reuse systems;
- to aid the development of evidence-based policies on water reuse by water and wastewater service suppliers, lead local flood authorities (LLFAs), local planning authorities (LPAs), internal drainage boards (IDBs) and the Environment Agency;
- to complement BS 8515, BS 8525-1 and BS 8525-2, which deal in detail with rainwater harvesting systems and greywater systems.

1 Scope

This British Standard gives recommendations on how to select water reuse system(s), taking into account water resources, surface water management, water supply and sewage infrastructure. It applies to both new and existing developments in residential and non-residential premises.

This British Standard covers the following water reuse systems: rainwater harvesting, stormwater harvesting and greywater reuse. It covers the supply of water for domestic water uses that do not require potable water quality, such as laundry, toilet flushing and garden watering. It does not cover systems supplying potable water for drinking, food preparation and cooking, dishwashing and personal hygiene.

This British Standard does not cover other sources of non-potable water, such as treated effluent, reclaimed industrial process water and water abstracted from wells and boreholes.

NOTE 1 Although this British Standard does not give specific recommendations relating to the use of rainwater, stormwater or greywater for fire suppression or commercial irrigation, these applications are not excluded.

It does not cover water butts or direct reuse systems for external use. It also does not cover product design for specific system components or the design and installation of water reuse systems.

NOTE 2 Further information on the design and installation of water reuse systems can be found in BS 8515, BS 8525-1 and BS 8525-2.

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.

Standards publications

BS 8515:2009, *Rainwater harvesting systems – Code of practice*

BS 8525-1:2010, *Greywater systems – Part 1: Code of practice*

BS 8525-2, *Greywater systems – Part 2: Domestic greywater treatment equipment – Requirements and test methods*

BS 8542:2011, *Calculating domestic water consumption in non-domestic buildings – Code of practice*

BS ISO 15686-5, *Buildings and constructed assets – Service-life planning – Part 5: Life-cycle costing*

Other publications

[N1]WATER REGULATIONS ADVISORY SCHEME. *Information and Guidance Note No. 9-02-05, Issue 3. Marking and identification of pipework for water reuse systems*. Newport: WRAS, 2011.

3 Terms and definitions

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

3.1 carbon footprint
measure of the emissions of greenhouse gases (GHG) used over the whole life of a product (goods or services), from the extraction of raw materials and manufacturing right through to its use and final reuse, recycling or disposal

3.2 embodied carbon
greenhouse gases released during resource extraction, transport, manufacturing of a product and its final disposal

NOTE The SI units are $kgCO_2/kg$.

3.3 greywater
domestic wastewater excluding faecal matter and urine

[SOURCE: BS EN 1085:2007, **2190**]

NOTE 1 This British Standard covers systems using bathroom greywater. For ease of reference, where the standard refers to "greywater", this is assumed to be "bathroom greywater".

NOTE 2 For the purposes of this British Standard, greywater excludes kitchen wastewater.

3.4 harvested rainwater
rainwater collected from roof catchments

3.5 harvested stormwater

rainwater run-off collected from impermeable surfaces other than roofs

NOTE Impermeable surfaces might include paved surfaces, pedestrian pathways, roads and water collected by permeable pavements. Rainwater run-off is likely to contain a higher level of contamination from urban pollutants in comparison to harvested rainwater.

3.6 life cycle analysis (LCA)

method to assess impacts associated with all stages of a product's life, focusing on an economic assessment using profiles of current and future costs and benefits to calculate a discounted net present value of the life cycle costs, including capital costs, operating costs and end of life costs

3.7 multi-user system

residential and commercial rainwater/greywater reuse systems designed to serve multiple properties and users, such as flats, residential and/or housing associations, hotels, offices and other commercial applications

3.8 operational carbon

emissions of carbon and other greenhouse gases during operation of a system

3.9 potable water

water suitable for human consumption

NOTE 1 Attention is drawn to Section 67 of the Water Industry Act 1991 [6], Section 76J of the Water (Scotland) Act 1980 [7] and Article 107 of the Water and Sewerage Services (2006 Order) (Commencement No. 3) Order (Northern Ireland) 2010 [8].

NOTE 2 Potable water can also be referred to as "wholesome" water.

3.10 rainwater

water arising from atmospheric precipitation

[SOURCE: BS 8515:2009, **3.23**]

3.11 reclaimed water

greywater, or harvested rainwater or stormwater

3.12 single user system

rainwater and greywater system designed for a single user

3.13 sustainable drainage systems (SuDS)

surface water drainage systems developed in line with the principles of sustainable development

3.14 water reuse

systematic collection and utilization of non-mains water or previously used water for non-potable purposes only

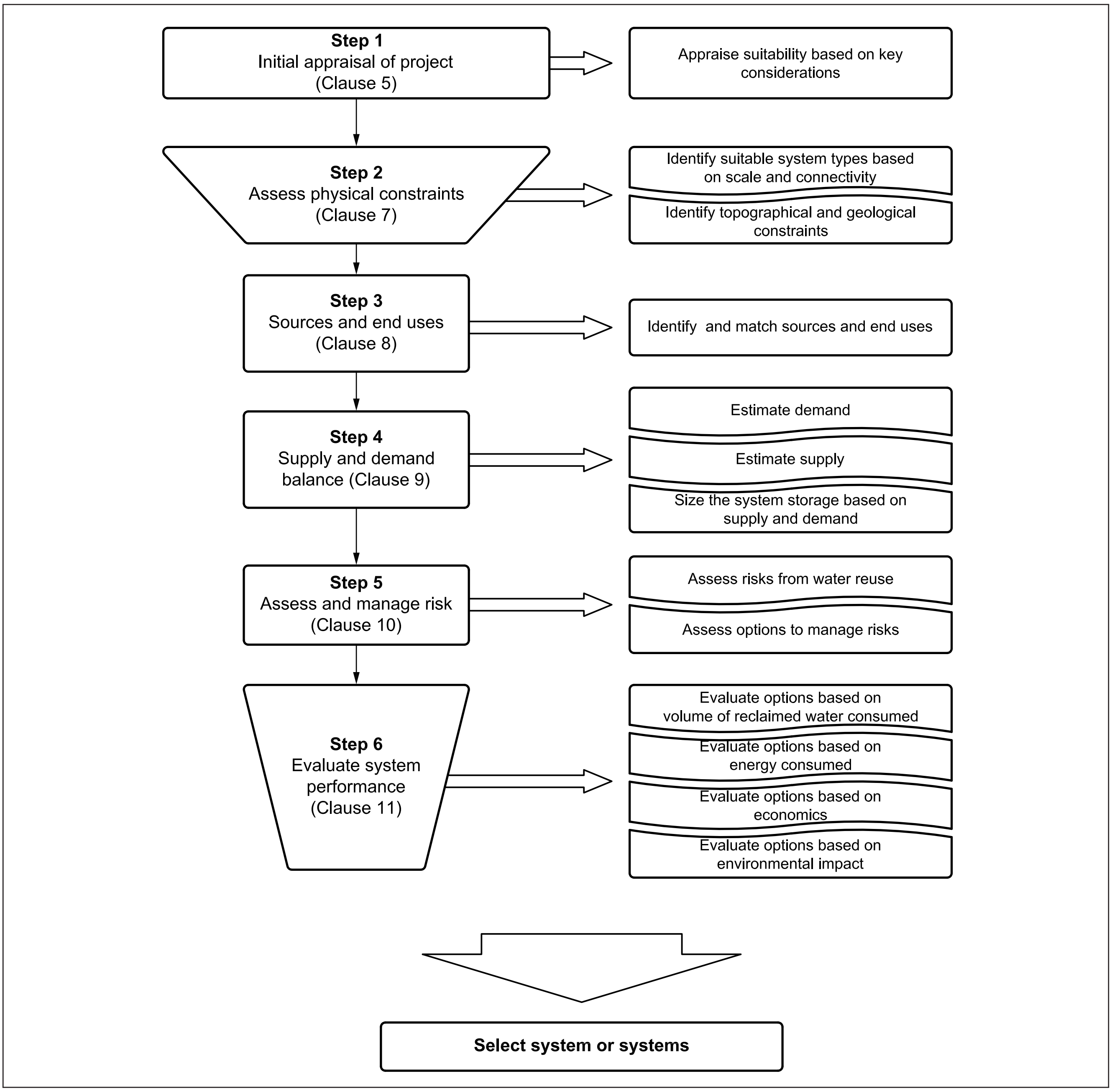
3.15 water safety plan

plan to ensure the safety of treated water using risk assessment and risk management approaches

4 Assessment process

The steps shown in Figure 1 should be followed to select a water reuse system.

Figure 1 **Steps in the selection of a water reuse system**



5 Step 1: Initial appraisal of project

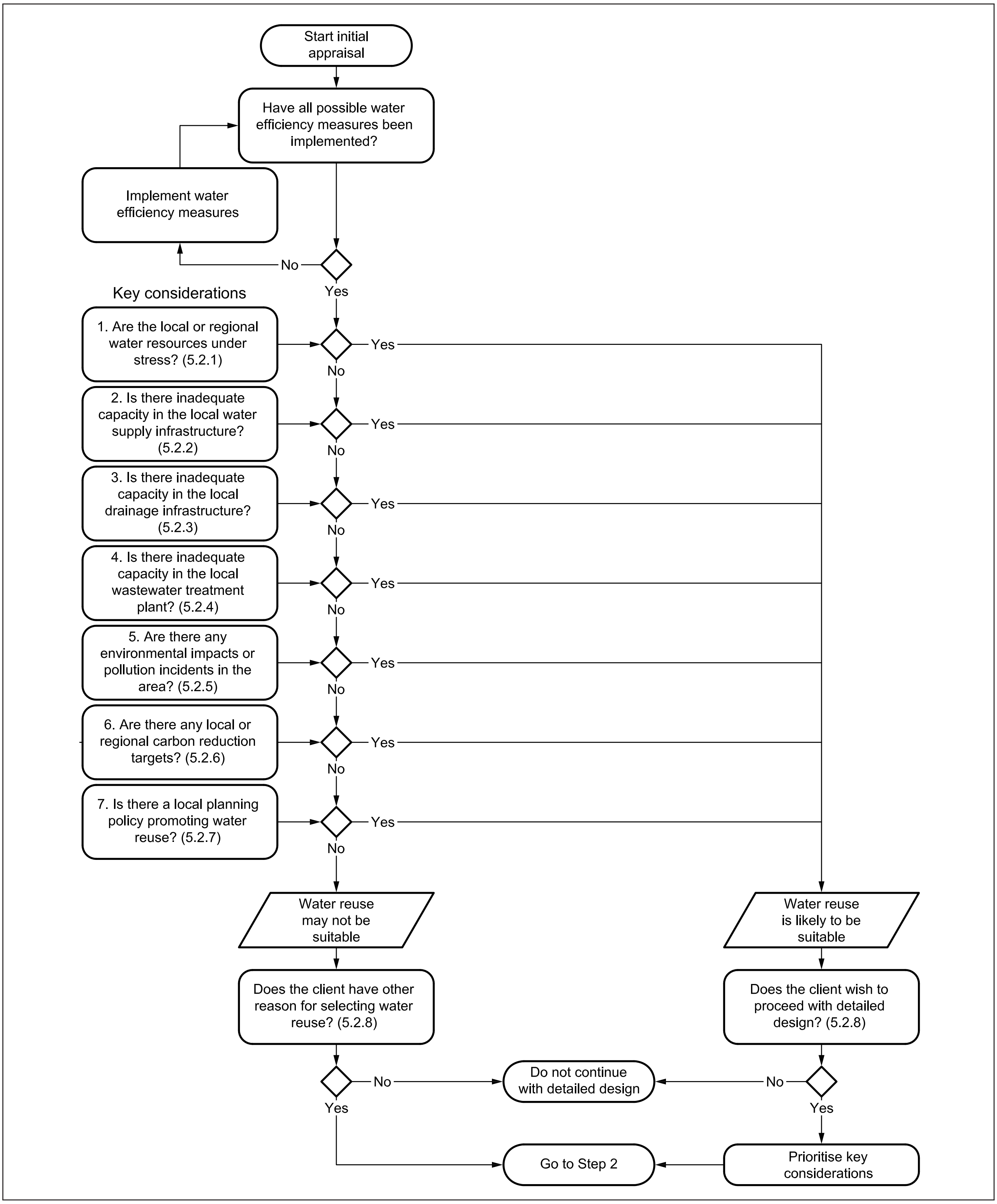
5.1 General

Water efficiency measures should be taken into account and implemented where possible before proceeding with the selection of a water reuse system.

NOTE Examples of water efficiency measures include low flow taps and dual flush toilets.

An initial appraisal should be carried out in accordance with Figure 2 to determine the project’s key considerations and constraints.

Figure 2 **Initial appraisal**



5.2 Key considerations

5.2.1 Levels of stress on water resources (local and regional)

The long-term availability of water supplies should be determined when scoping, evaluating, planning and selecting any water reuse systems.

NOTE 1 Climate change might affect the long-term availability of water supplies within the catchment.

If the site in question lies within a water-stressed catchment, water reuse systems should be designed to help reduce the amount of water abstracted and help reduce the level of water stress in the local area.

NOTE 2 The water stress level for the local catchment for the UK can be obtained from Figure 3. Detailed information about availability of water and whether the location of interest lies in a water-stressed zone can be obtained from the local Environment Agency office, water service providers or from the local water resource management plan.

NOTE 3 Attention is drawn to the EU Water Framework Directive [9].

5.2.2 Water supply infrastructure capacity

The capacity of the local water supply infrastructure to meet current and projected future demands should be assessed; if there is a lack of capacity, a water reuse system may be used to help meet future needs by reducing the overall water demand.

NOTE Information about the capacity of the water supply infrastructure to meet current and future demand can be obtained from local water service providers.

5.2.3 Drainage network infrastructure capacity

The capacity of the local drainage network infrastructure to meet current and projected future demands should be assessed; if there is a lack of capacity in an area to meet current or projected future drainage requirements (e.g. due to new development, urban creep or observed increases in rainfall due to climate change), a water reuse system may be used to help minimize, or be a component part of a SuDS which prevents discharges of surface water run-off.

NOTE 1 Information about the capacity of the drainage system to meet current and future demand can be obtained from local drainage and sewerage undertakers.

NOTE 2 National or local criteria for new surface water drainage systems are likely to set requirements for development site run-off volumes to be controlled to pre-development equivalents, for the 1 in 100 year event, when discharging either to sewerage or directly to water bodies. In many cases, meeting this criterion might require water harvesting and reuse systems for attenuation.

5.2.4 Wastewater treatment works infrastructure capacity

The capacity of the local wastewater treatment works to meet current and projected future demands should be assessed; if existing wastewater treatment works are unable to meet projected future requirements, a water reuse system may be used to help reduce the volume of wastewater entering the foul drainage system and reduce the demand on existing wastewater treatment works.

NOTE Information about capacity requirements of wastewater treatment works can be sourced from the local sewerage undertakers.

5.2.5 Environmental impact

Information about the risk of pollution, pollution incidents and the quality of the relevant local water bodies should be taken into account during scoping, evaluation, planning and selecting water reuse systems.

NOTE Information about the risk of pollution can be obtained from the local sewerage undertaker, the Environment Agency for England and Wales, the Northern Ireland Environment Agency or the Scottish Environment Protection Agency (SEPA).

Figure 3 **Water stress at abstraction catchment scale for the UK**

NOTE This figure is reproduced with permission from the European Environment Agency (EEA), 2009.

5.2.6 Carbon reduction targets

Information about the carbon footprint of local water supply, wastewater treatment and water reuse systems should be taken into account during scoping, evaluation, planning and selecting the water reuse systems, as water reuse systems might help to reduce the amount of operational carbon consumed in the abstraction, treatment and conveyance of municipal water supply.

NOTE Information about local carbon reduction targets can be obtained from the local water service providers.

5.2.7 Local planning policies

Any policies adopted by the local planning authority promoting water reuse systems should be taken into account during scoping, evaluation, planning and selecting the water reuse systems.

NOTE Information about local planning policies can be obtained from the local planning authority.

5.2.8 Client requirements

The client's own reasons for selecting water reuse systems, such as a reduction in water bills, should be taken into account during scoping, evaluation, planning and selecting the water reuse systems.

5.3 Project objectives: prioritization of key considerations

Once the key considerations have been determined, the priority or priorities of the project should be identified.

Where local availability of water or lack of capacity in the local water supply infrastructure are identified as the primary design considerations, a water reuse system should be installed to minimize consumption of mains water supply.

Where lack of capacity in the stormwater drainage infrastructure is identified as the primary design consideration, priority should be given to an integrated design of rainwater and stormwater harvesting as a method of reducing the volume of rainfall run-off.

Where lack of capacity in the wastewater and foul drainage infrastructure is identified as the primary design consideration, priority should be given to greywater reuse as it might help to reduce the volume of discharge of wastewater into the foul drainage system.

NOTE There might be a need for increased storage and increased retention times, which might require increased treatment to maintain the quality of treated reclaimed water for the longer period.

5.4 Results of initial appraisal

The results of the initial appraisal should be discussed with the client and a decision should be made as to whether to proceed with the project and, if so, what the priority considerations are.

6 System selection

A water reuse system should be selected based on the following criteria:

a) physical constraints (see Clause **7**);

b) sources and end uses (see Clause **8**);

c) supply and demand balance (see Clause **9**);

d) assessment and management of risks (see Clause **10**); and

e) evaluation of system performance (see Clause **11**).

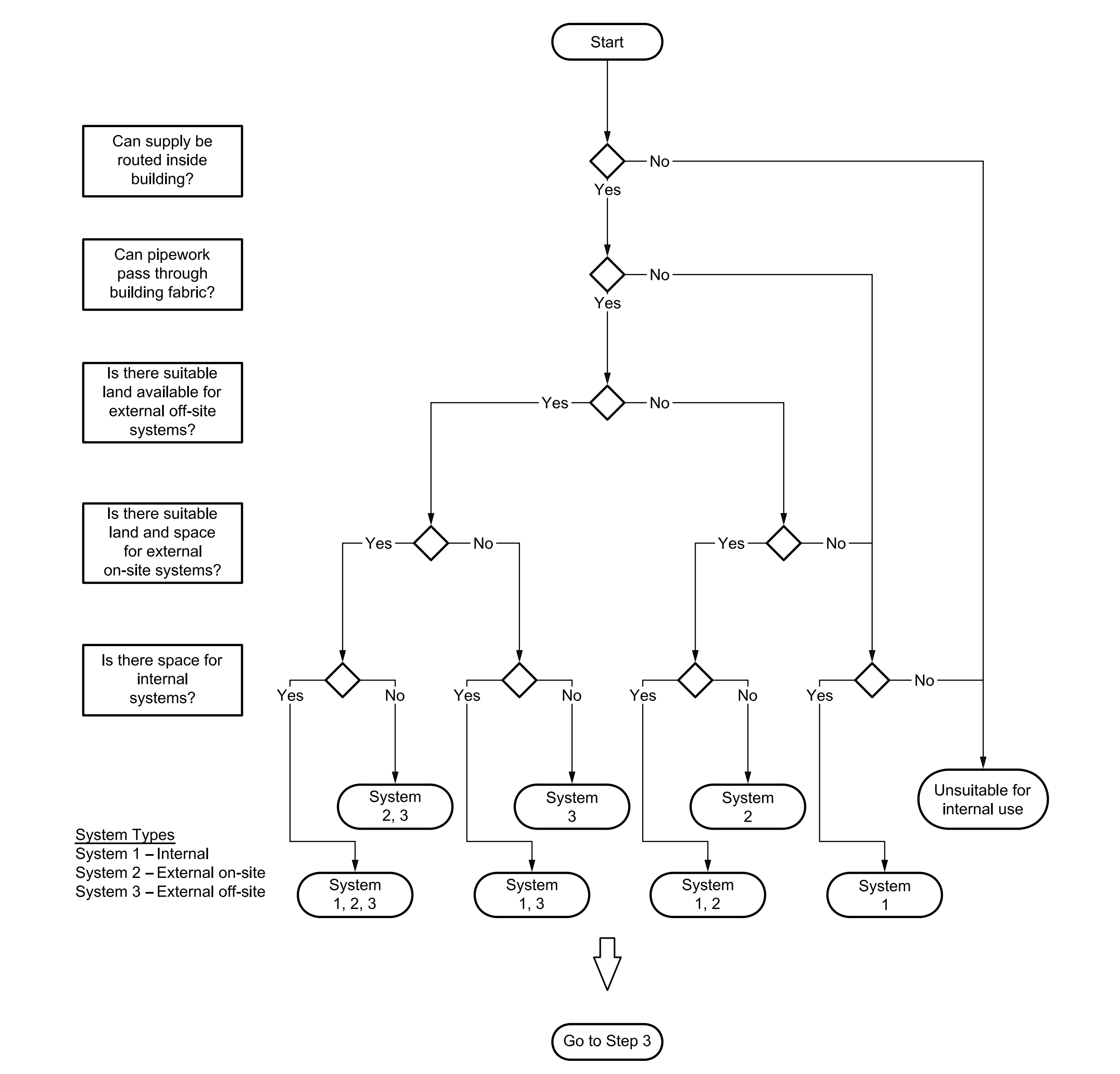
7 Step 2: Assessing physical constraints

7.1 General

The physical constraints on a project should be determined in the selection stage, as this has an impact on the decision to choose a particular system.

The scale of the system installation should be assessed in accordance with Figure 4.

Figure 4 **Assessing the scale of a system installation**



NOTE Installing water reuse systems is often more straightforward in new developments, as space and connectivity requirements can be incorporated during the design phase. Water reuse systems can also help the development to achieve relevant sustainability standards that might be required by the local planning authority or the developers.

In existing buildings, space for the installation of water reuse systems and connection of the system to the end use fixtures and fitting are critical decision variables. If both needs cannot be met, then the water reuse systems cannot be installed.

7.2 System type, scale and connectivity

The selection of the scale of a water reuse system should be decided by taking into account the building constraints and system complexity, as these can have a material impact on the costs of installation and future maintenance of a water reuse system (see Table 1).

Table 1 **System type and scale**

System type	Storage	Treatment	Complexity [A)]	Example
System 1 – Internal	Internal – within building	Internal – within building	Low to medium	Individual or communal rainwater or greywater storage systems, serving individual or multiple users in same building (e.g. block of flats, offices)
System 2 – External on-site	External to the building but within property curtilage	External to the building but within property curtilage	Low to medium	Individual or communal rainwater or greywater storage systems, serving single or multiple buildings (e.g. single house, flats, offices, campus)
System 3 – External off-site	External to the building and outside property curtilage	External to the building and outside property curtilage	High	Large communal systems serving multiple buildings where the system is owned and operated by a third party (e.g. municipal or sub-municipal scale systems)

[A)] See Annex A for details on how systems are classified as low, medium or high complexity.

7.3 Topography and ground conditions

The topography and geology of an area should be evaluated as they affect:

- the cost of excavation for laying pipes, installing tanks and other related infrastructure;
- the cost of pumping of treated reclaimed water; and
- the cost of disposing of excavated soil.

NOTE 1 Costs for disposal can be high if the ground is classed as "contaminated" and requires disposal to a licensed facility or the soil to be treated on site.

NOTE 2 General topographic information can be obtained from the Ordnance Survey and other companies providing land survey information. However, a topographical survey of the site might be necessary.

NOTE 3 Geological information can be obtained from British Geological Survey. Land contamination information can be obtained from the local environment agency offices (the Environment Agency for England and Wales, SEPA or the Northern Ireland Environment Agency) or from other data service providers.

NOTE 4 Annex B gives examples of how topography and ground conditions might affect the selection and siting of the water reuse system.

8 Step 3: Sources and end uses

The sources of reclaimed water and the potential end uses of treated reclaimed water should be identified. This should be done before evaluating the supply–demand balance.

NOTE Table 2 shows the type of end uses, the suitable sources of reclaimed water and the corresponding treatment standards for particular end uses.

Table 2 **Water quality criteria for greywater and rainwater systems**

Type of end uses (based on source)		**Human exposure level if water untreated**	**Relevant regulations**
Greywater systems and combined greywater/rainwater systems	**Rainwater system only**		
• Bathing and washing • Irrigation of crops to be eaten raw • Commercial air conditioners	• Bathing and washing • Use in commercial air conditioners	High	The Water Supply (Water Quality) Regulations [10]
• Vehicle washing • Clothes washing • Surface landscape irrigation, irrigation of crops to be eaten cooked • Impoundments • Fire protection systems	• Clothes washing	Medium	No current regulatory requirements
• Toilet flushing • Hand-basin toilets • Sub-surface landscape irrigation	• Toilet flushing • Surface or sub-surface landscape irrigation, irrigation of crops to be eaten cooked	Low	No current regulatory requirements

NOTE 1 For stormwater treatment criteria, refer to the Australian guidelines for water recycling *[11] and* Recycled water quality guide *[12].*

NOTE 2 Examples are not exhaustive.

NOTE 3 Hand-basin toilets use the discharge from hand basins directly without further treatment for flushing toilets.

9 Step 4: Supply and demand balance

9.1 General

The supply and demand of reclaimed water should be estimated in order to determine the most suitable size of the system storage.

NOTE 1 Supply refers to the volume of reclaimed water available from identified source(s); demand refers to the volume of reclaimed water required by identified end use(s).

The water supply and demand should be estimated for all systems, whether external off-site, external on-site or internal.

NOTE 2 The supply and demand for individual properties is dependent upon occupancy, end uses and user behaviour. For larger developments, with representative populations, average use assumptions can be made.

Where water efficiency measures are being used alongside water reuse, such as low flow taps, low and/or dual flush toilet cisterns, the water supply–demand balance calculations should be based on the lower consumption rates of the water efficient fixtures and fittings.

NOTE 3 This can be calculated using a water efficiency calculator. See <https://www.gov.uk/government/publications/the-water-efficiency-calculator-for-new-dwellings> for details [last viewed 13 September 2013].

9.2 Simplified approach

9.2.1 General

A simplified approach should be suitable for individual residential or "single-user" systems using only one source of non-potable water supply (greywater, rainwater or stormwater).

9.2.2 Non-potable water demand

The non-potable residential water demand should be calculated in accordance with Table 3.

Table 3 **Estimated daily non-potable water demand**

Occupancy	Demand (L/day)		
	Toilet	Laundry A)	Other non-potable uses B)
1 person	25	15	10
2 persons	50	30	20
3 persons	75	45	30
4 persons	100	60	40
5 persons	125	75	50
6 persons	150	90	60

A) Average daily demand based on weekly use.
B) For example, garden watering.

NOTE Taken from BS 8525-1:2010, Table 1.

9.2.3 Estimating greywater yield

A relatively constant daily supply of 50 L per person should be assumed.

9.2.4 Estimating rainwater yield

The annual yield should be calculated using the following formula:

$$Y_R = A \times e \times AAR \times h$$

where:

Y_R is the annual rainwater yield (L);

A is the collecting area (m²);

e is the yield coefficient (%);

AAR is the depth of annual average rainfall (mm);

h is the hydraulic filter efficiency.

9.2.5 Sizing system storage

9.2.5.1 Greywater system storage

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

a) the peak capacity treatment rate;

b) the demand, usage or behaviour patterns.

Storage of treated greywater should be minimized to that needed for immediate use.

NOTE As there is generally a ready supply of untreated greywater, storage equal to a single day's use is considered sufficient.

9.2.5.2 Rainwater harvesting system storage

For rainwater or stormwater harvesting without stormwater control, the storage capacity should be calculated in accordance with BS 8515:2009, **4.1.2.3**.

For rainwater or stormwater harvesting with stormwater control, the intermediate approach for rainwater or stormwater harvesting with stormwater control should be used in accordance with BS 8515:2009, **A.2**.

NOTE See Annex C for additional information on using rainwater harvesting for stormwater control.

9.2.6 Storage sizing of integrated systems

For systems integrated after treatment (where each source is treated and stored in separate tanks), the methods used in **9.2.5** should be used to size the system storage requirements independently.

NOTE Simplified approach is not suitable to evaluate systems integrated before treatment.

9.3 Detailed approach

9.3.1 General

A detailed approach should be used for any integrated water reuse system using more than one of rainwater, stormwater and greywater, and for communal or multi-user systems where the demand or the yield is irregular.

9.3.2 Non-potable water demand

Non-potable residential water demand should be calculated in accordance with BS 8525-1:2010, **4.1.2.4.2**.

Non-potable non-residential water demand should be calculated in accordance with BS 8542:2011, **5.2**.

9.3.3 Non-potable water yield

The greywater yield should be calculated in accordance with BS 8525-1.

The rainwater or stormwater yield should be calculated in accordance with BS 8515.

9.3.4 System storage sizing

The detailed approach should be used for communal or "multi-user" systems.

The greywater water system sizing should be based on the supply–demand balance, and the same approach outlined in **9.2.5.1** should be used.

The required storage for rainwater or stormwater harvesting without stormwater control should be calculated using the detailed approach in accordance with BS 8515:2009, **4.1.2.4**.

The required storage for rainwater or stormwater harvesting with stormwater control should be calculated using the detailed approach in accordance with BS 8515:2009, **A.3**.

9.3.5 Integrated systems

9.3.5.1 Systems integrated after treatment

For an integrated water reuse solution where each source is treated and stored in separate tanks, the methods used in **9.3.4** should be used to size the system storage requirements independently.

9.3.5.2 Systems integrated before treatment

For systems with integrated storage any combination of the following should be used:

- rainwater (without storm attenuation);
- stormwater (without storm attenuation);
- greywater.

The detailed approach for sizing rainwater harvesting systems should be used. The greywater supply should be included as a water source into the storage system.

For integrated systems that include stormwater control, the detailed approach for rainwater or stormwater harvesting with stormwater should be used.

10 Step 5: Assessment and management of risks

10.1 Assessment of risks

*COMMENTARY ON **10.1***

The risks of using reclaimed water are dependent on the magnitude of human exposure, as outlined in Table 2.

10.1.1 Health impact assessment (HIA)

Health impacts from water reuse systems, both positive and negative, should be evaluated in the assessment and management of risks.

The full health and safety implications of using reclaimed water or implementing a water reuse system should be assessed by undertaking a Health Impact Assessment (HIA).

NOTE 1 HIAs identify the types of hazard to which system users might be exposed. A HIA might be supplemented by undertaking a quantitative microbial risk assessment (QMRA), depending on the type of reuse system and intended end uses under consideration.

NOTE 2 By implementing some types/scales of water reuse, negative health impacts can be alleviated. Where water reuse assists with surface water flooding, negative health impacts, ranging from mental health issues to minor injuries and infection or death, could be avoided.

10.1.2 Water quality risks

The risk assessment should take into account potential sources of contamination of water entering or already in the rainwater, stormwater or greywater system.

The risk assessment should be used to identify the need for any further water quality control measures, including additional monitoring.

The risks and management options should be identified and addressed in a water safety plan.

NOTE The World Health Organization endorses the "water safety plan" approach to protect the safety of water supplies. This involves a system of risk assessment and risk management. See Annex D for additional information on preparing a water safety plan for water reuse systems.

10.2 Management of risks

10.2.1 General

The risks posed by water reuse systems should be managed by:

- treatment of reclaimed water to reduce health risks;
- maintenance of the systems;
- sampling of the treated water to monitor the performance of the system;
- controls to monitor the state of the system; and
- labelling to identify pipes supplying reclaimed water.

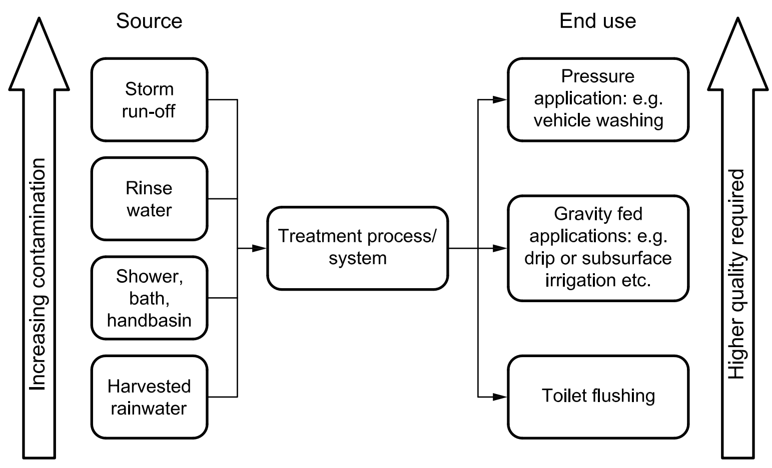
NOTE For a communal multi-user system, a reporting system on the operational state of the water reuse system might be needed.

10.2.2 Treatment requirements

*COMMENTARY ON **10.2.2***

The level of treatment required for reclaimed water is dependent on the proposed end use, the likelihood of human contact and the level of risk. Figure 5 shows the variability in contamination based on the source of reclaimed water and the variability in required quality of water based on end uses.

Figure 5 **Water quality and treatment considerations**



NOTE 1 The examples given in this figure are not exhaustive.

NOTE 2 Adapted from BSRIA, TN 7/2002 [13].

The most appropriate treatment method should be selected following a HIA (see **10.1.1**).

NOTE The principle treatment methods are shown in Table 4.

Table 4 **Treatment methods for reclaimed water**

	Rainwater	Greywater [A)]	Stormwater [B)C)]
Coarse screening	✓	✓	✓
Fine screening		Possible	✓
Dissolved air flotation			✓
Filtration	✓	✓	✓
Biological treatment		✓	✓
Chemical treatment	D)	✓	✓
Ultraviolet disinfection	D)	D)	D)

A) Refer to BS 8525-2 for further details on treatment methods and requirements for greywater systems.
B) Stormwater run-off needs to be monitored for water quality prior to designing the treatment system.
C) For stormwater treatment criteria, refer to the *Australian guidelines for water recycling* [11] and *Recycled water quality* [12].
D) Option might be selected if end uses have high risk of human exposure.

10.2.3 Assessment and management of risks associated with integrated systems

COMMENTARY ON ***10.2.3***

Integrated systems can either be operated as separate, independent systems or be combined into a single supply source.

10.2.3.1 Systems integrated after treatment

Where systems are to be operated independently or integrated after treatment, the rainwater harvesting system should conform to BS 8515 and the greywater system should conform to BS 8525-1 and BS 8525-2.

NOTE Stormwater, greywater and rainwater systems can be integrated at various points, e.g. within the tank/cistern, within the distribution pipework or at the point of use/appliance, with either a direct or indirect supply connection.

Where systems from different manufacturers are to be combined into a single supply, the compatibility of the systems should be investigated and taken into account.

10.2.3.2 Systems integrated before treatment

Systems which are integrated before treatment are considered to be specialized installations and all aspects of the treatment system should be evaluated. The following issues should be taken into account:

a) the variability of influent;

b) the type of treatment equipment required;

c) the management of excess water loads;

d) environmental considerations, e.g. electricity consumption; and

e) the validity of treating the whole of the flow from both greywater and rainwater.

NOTE 1 This list is not exhaustive.

All elements of the system situated downstream of the point of integration should conform to BS 8525-1.

NOTE 2 This type of treatment can affect the installation cost, operational cost and environmental footprint (energy/carbon) of a water reuse system.

10.2.4 Maintenance

10.2.4.1 General

The maintenance requirements of the water reuse system should be identified and covered under the water safety plan (see Annex D).

10.2.4.2 Reclaimed water treatment unit (or plant)

*COMMENTARY ON **10.2.4.2***

The maintenance requirements of the systems are dependent on the technology employed in the treatment system and the configuration and design of the system.

The maintenance should be carried out in accordance with the manufacturers' instructions.

10.2.4.3 Conveyance system (pipes, pumps)

The pipes should not require maintenance except in the case of failure.

Pumps should be maintained in accordance with the manufacturer's recommendations.

NOTE The failure of the pipes can occur as a result of settlement and ground movement. For further guidance on considerations to be taken during maintenance, see CIRIA C626 [14].

10.2.4.4 Water quality sampling

The water safety plan should inform the sampling frequency based on risks to the end users.

Water quality sampling should be carried out in accordance with the following standards and guidance:

- harvested rainwater should be monitored and sampled in accordance with BS 8515;
- greywater should be monitored and sampled in accordance with BS 8525-1;
- for harvested stormwater, a sampling regime and schedule should be prepared based on monitored quality and the treatment.

The costs associated with sampling should be incorporated in the economic evaluation of the water reuse system (see **11.5**).

NOTE An example of stormwater quality sampling can be found in the Australian guidelines for water recycling *[11].*

10.2.4.5 System controls

*COMMENTARY ON **10.2.4.5***

System controls and the information displayed on the control units form a critical part of the monitoring and management of risks.

Information on the system's operational state is critical and should be displayed to inform the user or the operator of the functional state of the system.

Operational performance information is not critical to the operation of the system, but should be shown to inform the user about the system state and the water efficiency benefits achieved.

NOTE For further information on system control information, see BS 8515, BS 8525-1 and BSRIA TN 7/2002 [13].

The non-potable water supply pipework (internal and external), and the fixtures and fittings connected to such pipework should be labelled in accordance with WRAS Information and Guidance Note No. 9-02-05 [N1].

11 Step 6: Evaluation of system performance

COMMENTARY ON ***CLAUSE 11***

A simple economic analysis of water reuse systems does not account for the wider benefits that such a system can bring. Its use could help to address current and predicted stresses on national water supply and surface water management infrastructure, and on sewer infrastructure. For example, water reuse systems can lead to reduced pressure on water resources and the associated supply infrastructure, a reduction in the requirements for urban drainage and attenuation of local storm water discharge, and a reduction in the volume of water discharged to the sewer.

The economic analysis needs to take into account who pays for and who accrues the benefits from the use of a proposed system or systems. Consideration of the monetary and non-monetary benefits of a water reuse system are necessary in order to justify and select a system that has the greatest net benefit. However, not all benefits are easily quantifiable. Where such quantitative information is available, the economic benefits need to be taken into account in the whole life cost benefit assessment of the options. Where it is not currently available, a qualitative impact assessment needs to be undertaken to aid comparison of options.

11.1 General

All systems should be evaluated on their performance or projected performance as part of the selection process.

The main steps in the evaluation process should be as follows:

a) identify suitable water reuse technology, its intended benefits and all conditions necessary for the identified technology to deliver the intended benefit;

b) determine the performance of the necessary conditions in the future based on latest advice from the relevant environment agency;

c) determine the resilience of the technology to future changes; and

d) implement, adapt or use an alternative water reuse technology option.

NOTE The following guidance notes help in evaluating future impacts: Water: Planning ahead for an uncertain future – Water in the 2050s *[15] and* Water: Planning ahead for an uncertain future – Water in the 2100s *[16].*

The performance of a system should be evaluated based on one or all of the following criteria:

1) volume of mains and reclaimed water consumed;

2) energy consumption;

3) whole life costs;

4) environmental impacts.

System performance should also be evaluated for the following criteria for large water reuse system (such as communal systems):

i) changes in supply and demand due to changes in occupancy and population;

ii) changes in supply and demand due to climate change.

11.2 Appraisal period

The principle of life cycle analysis (LCA) should be applied to the evaluation of water reuse systems.

For projects with low complexity, such as single-user systems, the life expectancy of the primary equipment should form the basis of the appraisal period.

For projects of high complexity, such as infrastructure works, longer appraisal periods should be used.

NOTE LCA is usually undertaken for a period of 30 years. However, another period of time can be chosen if justified.

11.3 Evaluation of volume of mains and reclaimed water consumed

The evaluation should examine the total water consumption, including the mains water consumption, for the building(s) served by the water reuse system(s).

The performance of different water reuse systems may be compared based on the basis of total water consumption and the reduction in mains water demand; the systems should always be compared with a "do nothing" solution where water reuse is not considered.

NOTE Table 5 provides a template for how the options can be compared.

Table 5 **Template of table to compare options**

Year	**System 1**		**System 2**		**System 3**		**Do nothing**
	Reclaimed water (m^3)	**Mains (m^3)**	**Reclaimed water (m^3)**	**Mains (m^3)**	**Reclaimed water (m^3)**	**Mains (m^3)**	**Mains (m^3)**
1							
2							
3							
4							
–							
–							
Year N							
Sub-total							
Total							

11.4 Evaluation of energy consumption

The evaluation should examine the total energy consumption for the building(s) served by the water reuse system(s), including the energy consumed to provide mains water.

NOTE 1 Annex E provides guidance on assessing the capital and operational carbon and energy implications of the water reuse systems.

The performance of different water reuse systems should be compared on the basis of total energy consumed for the provision of water. The systems should always be compared with a solution where water reuse is not considered.

The treatment of future costs of energy over the appraisal period should be agreed at the outset, and should be based on specific robust forecast data.

NOTE 2 It is reasonable to expect this to be the subject of sensitivity testing in order to establish the effect on the outcome.

11.5 Evaluation based on whole life costs and economic benefits

11.5.1 General

The evaluation of whole life costs and economic benefits should be carried out using life cycle analysis (LCA) in accordance with BS ISO 15686-5.

For water reuse systems the following should be assessed:

a) the cost of installing, operating and maintaining the water reuse system;

b) the direct economic benefits to the end user in terms of reduced bills;

c) the direct economic benefits to the whole water supply and drainage system as result of reduction in costs to transport and treat both water and wastewater;

d) offset economic benefits for reduced need to infrastructure upgrades.

The assessment should be proportionate to the scale of the project. For small projects, such as for a single domestic building, only costs a) and b) should be evaluated. However, on larger projects, in addition to comparing alternative systems, the cost of not using the water reuse system, i.e. using mains and waste water with associated infrastructure costs, should be compared.

The future cost of both water and wastewater should be based on robust forecast data, and should include discussions with the respective service providers. This should be the subject of sensitivity testing in order to establish the effect on the outcome.

11.5.2 Discount rate

*COMMENTARY ON **11.5.2***

For public sector projects with an appraisal period of up to 30 years, HM Treasury stipulates a discount rate of 3.5%, which includes a deduction for underlying inflation. Lower discount rates are applicable for projects with longer timescales. For private sector projects, the discount rate needs to be discussed and agreed with the project client in line with their overall investment strategy.

The same discount rate should be applied to all the options within the analysis for the comparison to be valid.

11.5.3 Installation

*COMMENTARY ON **11.5.3***

Installation during construction makes systems more cost effective, whereas the costs of retrofitting can be very high and the process disruptive. Storage volumes for single house and small commercial applications are relatively small and above ground tanks are feasible.

The use of above ground tanks should be explored, as they can significantly reduce installation costs compared to buried tanks.

11.5.4 Operation and maintenance

*COMMENTARY ON **11.5.4***

Although the capacity cost of greywater is likely to reduce as the scale of system increases, this is offset by the incorporation of more sophisticated and expensive water treatment, requiring more frequent maintenance, which would be more expensive than a simpler rainwater system.

All rainwater and greywater systems should be subject to a planned maintenance regime. Unplanned maintenance, such as replacing failed pumps or controls, should be kept to a minimum by ensuring the standard of the installation works is high, good quality reliable components are used and a strict planned maintenance regime is enforced.

NOTE 1 The system owner is responsible for its maintenance.

NOTE 2 The maintenance requirements for rainwater and greywater systems are detailed in BS 8515 and BS 8525-1.

11.5.5 Removal

Throughout the period of the life cycle assessment an allowance should be made for the replacement of the different components of the system. The decision should be made at the time of the life cycle assessment as to whether the costs of removal and disposal of the system should be allowed for at the end of the period.

NOTE 1 For mechanical equipment, the residual value is usually taken as the scrap or resale value and for older equipment this value is usually small. If it is forming part of major refurbishment works then the cost of removal is not likely to be significant, and if not, the system would be unlikely to be completely removed, but rather decommissioned and the connections isolated and capped off, with the cost kept to a minimum.

A cost should be allowed to reflect what is likely to happen to the system at the end of the assessment period.

NOTE 2 Small residual/removal values at the end of a lengthy appraisal period have little effect on the outcome of the life cycle analysis.

11.5.6 Sensitivity of economic life cycle analysis

*COMMENTARY ON **11.5.6***

The life cycle cost analysis can be extremely sensitive to the price of mains water, the energy costs and the appraisal period. These parameters can be used to undertake a sensitivity analysis of the system costs.

The price of mains water, the energy costs and the appraisal period, together with the discount rate and any remaining input data, which has been based on assumptions, should be varied to test the outcome of the results.

NOTE If the results are significantly affected then further sensitivity analysis might be required.

11.5.7 Ranking of options

The whole life costs of all the alternative options selected for life cycle analysis should be compared with a “do-nothing” or “status quo” option and ranked accordingly.

11.6 Evaluation of environmental impacts

When evaluating any type of water reuse system, an Environmental Impact Assessment (EIA) should be carried out. Relevant planning and regulatory bodies should be consulted at the initial scoping and master planning stage of the project.

NOTE 1 Carrying out the EIA might not only ensure the prevention of negative environmental impacts, but will also assist with identifying positive impacts that might enhance the cost-effectiveness (rather than cost-benefit) of a system, depending on the type of assessment used.

NOTE 2 Attention is drawn to the following regulations: EU directive 2001/42/EC [17], the Environmental Impact Assessment (Agriculture) (England) (No.2) Regulations 2006 [18], the Environmental Impact Assessment (Forestry) (England and Wales) Regulations 1999 [19] and the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations 1999 [20].

11.7 Assessment of options based on environmental impacts

*COMMENTARY ON **11.7***

Assessing the environmental impact of different water reuse systems can only be undertaken qualitatively as many parameters cannot be directly quantified, e.g. improvement in environmental ecosystem services.

Life cycle analysis (LCA) should be undertaken for all options under consideration for the water reuse systems. LCA should be used to:

- identify opportunities to improve the environmental performance of products at various points in their life cycle;
- inform decision makers in strategic planning, priority setting and process design;
- select relevant indicators of environmental performance, including measurement techniques.

The information assembled or produced for LCA should then be used to compare the suitability of different water reuse systems based on their environmental impacts and enable qualitative ranking.

NOTE For further information on carrying out LCA, see BS EN ISO 14040 and BS EN ISO 14044.

12 Comparison of options

For small scale projects where one or only a few buildings are being considered, one of the appraisal methods in **11.3**, **11.4** and **11.5** should be used to compare system options. The appropriate appraisal method should be selected based on local priorities and after discussions with the client.

For larger projects where a large number of properties are being considered for water reuse system installation (or connection), multi-criteria analysis (MCA) of the appraisal methods in **11.3**, **11.4** and **11.5** should be used to assess the performance of alternate options.

To carry out MCA, subjective weighting should be given to indicators and criteria. After discussions with the client and other local stakeholders (such as local planning officers and water and wastewater service providers) explicit weights should be given to each of the criteria to reflect their relative importance. This method should be used to rank options and identify a preferred option.

NOTE For further guidance on MCA, see Multi-criteria analysis: a manual *[21].*

Annex A (informative) System scale and design complexity

A.1 General

The detail and complexity of design for a water reuse system is dependent upon the type of buildings to be served by it and the scale of the system being considered (see Table A.1). Scale and complexity are directly related to system ownership and the operation and maintenance responsibilities. This can have a material impact on the costs of installation and future maintenance of any water reuse systems. These costs can be determined during the economic evaluation of systems.

Economies of scale might be achieved with communal systems, as well as potentially reduced risk to end-users through systems that are professionally monitored and maintained.

Table A.1 **Classification of the scale and complexity of a project**

Building	Property ownership	Occupier	Occupier same as owner	Example	Project type
Single	Single	Single	Yes	Owner/occupier	Low complexity
	Single	Single	No	Single tenant (house, office building)	Low complexity
	Single	Multiple	No	Flats, office building	Medium complexity
Multiple	Single	Single	Yes	Campus	Medium complexity
	Single	Single	No	Tenanted campus	Medium complexity
	Multiple	Single/ multiple	No	City block, business park, large multi-phase and multi-tenure homes developments	High complexity

A.2 Low complexity

Water reuse systems are classed as low complexity where a single person owns the building (or part thereof) and the water reuse system and are responsible for its maintenance. Examples include:

- owner-occupied residential building or unit;
- tenanted residential building or unit;
- owner occupied non-residential building.

Building scale rainwater harvesting and greywater recycling system are suitable for projects classed as small scale or low complexity. Suitable systems are generally referred to as "single-user systems".

A.3 Medium complexity

A system can be considered medium complexity where:

a) collected water is supplied to several premises (whether rented or owned);

b) any constituent parts of the system are located in communal areas;

c) where water is collected from buildings or land in more than one ownership; and/or

d) where there are multiple occupants in a single building and the ownership and maintenance responsibility does not rest with the individual occupants.

Examples of such configurations are:

1) student housing, nursing homes, barrack blocks;
2) multiple occupants in single sub-divided commercial buildings, e.g. offices, shops;
3) industrial complex with multiple buildings occupied by more than one company; and
4) multiple buildings in proximity, e.g. University campus, business park or campus, extra care village.

Where there are multiple occupants in a single building and the ownership and maintenance responsibility does not rest with the occupants, the following systems are suitable:

i) multiple individual (single-user) systems; and
ii) communal or "multi-user" system(s).

A.4 High complexity

High complexity systems are similar to medium complexity systems, but contain additional complexity brought on by:

a) multiple land ownership for pipes to pass through from the central water reuse system to the end users; and/or
b) the users of the system and operators of the system being different.

The following system configurations are suitable at this scale, from most decentralized to least decentralized:

1) multiple individual or "single user system" systems;
2) multiple communal or "multi-user" systems; or
3) single communal or "multi-user" system.

Annex B (informative) Geology and ground conditions

Ground conditions, geology and environmental hazards might either be consistent or vary across an entire site.

To minimize development risk, a preliminary desk-based site analysis is carried out, supplemented when possible by verification through carefully selected trial holes and boreholes. Even though such investigations may be thorough, pockets of inconsistent conditions might nonetheless be revealed during construction.

Contaminated land has the following implications for water reuse systems with any land-based external component(s):

- excavation of contaminated material carries increasingly high disposal costs and transportation carbon implications;
- penetrating any previously installed capping material (where contaminated material has been retained at a lower level) requires reconfiguration of the capping;
- disposal of water reuse system overflows by way of soakaway or infiltration might not be possible.

Overflows from water reuse systems can be catered for. Geology and ground conditions are relevant where such overflows are not ultimately conveyed away by a sewer, and might be pivotal to the decision on an appropriate disposal method.

Rainwater overflows can be routed to a soakaway or other infiltration system, or to the stormwater sewer, where this is acceptable to the environmental regulator and drainage service provider. Ground permeability affects whether any water reuse overflow can be discharged to a soakaway, infiltration trench or borehole. The groundwater sensitivity and vulnerability can be assessed together with any potential contaminants associated with the stored rainwater to ensure that risks to groundwater sources are not significant.

NOTE In parts of the UK, the draft National Standards for SuDS will apply, setting out the conditions for determining acceptability of infiltration systems, and where full risk assessments and or discharge consents are required.

Where the groundwater has connectivity with a surface water body of environmental significance, then this body might dictate the conditions for infiltration.

The presence of a water course or aquifer within or near the site requires particular attention in regard to outgoing water quality, and might require a Consent to Discharge from the relevant agency or authority.

Annex C (informative) Rainwater harvesting for storm attenuation

C.1 General

A rainwater harvesting system has the potential to retain storm run-off if the storage tank has spare capacity when the rainfall begins. However, the spare capacity is a function of the preceding precipitation and patterns of water consumption by the household.

There are likely to be two reasons for putting in larger rainwater harvesting tanks to control stormwater run-off than that needed for water saving.

a) As part of a site drainage strategy. Appropriately designed rainwater harvesting and use systems can contribute towards limiting the volume of discharge from the site, as well offering the potential for reducing the required site attenuation storage.

b) As retrofit drainage components in cities to address local or wider flooding risks, and/or unacceptable spills from combined sewer overflows.

There are costs in providing a harvesting system, but the additional cost of increased storage to provide storm run-off control is likely to be small. The benefits of a combined system which reduces mains water consumption and offers reductions in run-off volumes during flood events are attractive.

Storage tanks are filled quickly but intermittently by storm run-off, the characteristics for which are defined by the harvested roof area and the total depth of rainfall. This can be thousands of litres from one severe rainstorm. The tanks are then drained relatively slowly but consistently (tens of litres per day) by the consumption of stored water by domestic appliances, a function of the number of occupants.

There are two principal methods of tank design for stormwater management – passive and active rainwater harvesting systems.

A passive system is the “normal” rainwater harvesting systems where the water stored in a tank at any time is directly a function of demand and supply.

An active system is one where the stored water is managed to maintain spare storage at all times for the eventuality of a large storm taking place.

C.2 Tank sizing for active systems

For active systems, an automated management mechanism is required to ensure sufficient storage is available to manage subsequent rainfall events. The system is likely to be based on a switching mechanism that triggers delayed pumping of the water, e.g. a delay of two or three days could potentially ensure that the downstream receiving system is no longer at risk from the rainfall event. The delay in pumping out can be established based on an understanding of the system downstream that requires protection – whether this is a local site drainage system, a city-wide drainage system or a receiving watercourse.

There are two advantages of using an active system. These are:

a) storage volumes will be less than those of passive systems designed for equivalent levels of stormwater control; and

b) the yield/demand (Y/D) ratio does not constrain the opportunity to use rainwater harvesting for stormwater management, and therefore all properties, irrespective of their occupancy levels, can be assumed to contribute zero run-off for the design depth of rainfall used in sizing the tanks.

The disadvantage is the complexity of the system and operating processes and also that a significant proportion of captured rainfall will be "lost" to the receiving catchment, i.e. not re-used.

C.3 Tank sizing for passive systems

BS 8515:2009, Annex A details the methodology needed to increase the tank volume, which will not only meet the water needs of a property but also offer storm run-off detention. These equations are not reproduced here. However, there are two key design principles that are valid if the system is to provide effective control of storm events:

a) the yield to demand (Y/D) ratio (which can be calculated on an annual basis) will be <0.95;

b) the demand can be reasonably assumed to be uniform on a daily basis.

The behaviour of the derived model across a spectrum of run-off yield to user demand (Y/D) ratios was studied, establishing the critical maximum value of Y/D = 0.95, above which stormwater control was unlikely to succeed since the tanks were likely to be full most of the time. The ratio of yield (Y) to demand (D) measures the balance between non-potable water collected and utilized, and accommodates the individual circumstances of each property.

Due to the uncertainty in seasonal rainfall depth variability, and the generic approach taken to volume control, current and proposed national criteria for controlling site surface water run-off do not require climate change impacts to be considered when specifying volume control requirements. However, the sizing of rainwater harvesting systems for stormwater control requires an understanding of site yield and demand. Any likely climate change impacts on demand will be evaluated based on likely future needs associated with the range of end uses proposed for the system. With respect to yield, it is currently assumed that climate change will not have a significant influence on total annual depth of rainfall. However, the Y/D ratio is likely to become more seasonal under future climate change scenarios (e.g. drier summers and wetter winters). In this case, application of the principles might need to move from an annual to seasonal assessment, depending on the stormwater management objectives for the site.

Where there is not a guaranteed regular daily demand, the storage system would need to be extremely large and a time series analysis used to prove the effectiveness of the stormwater management system, or the tank would need to be designed to be actively managed (see **C.2**).

If the rainwater harvesting system is implemented on an individual property basis, there is a degree of uncertainty with regards to the level of demand (based on numbers of people in the property). BS 8515 contains a provision for estimating the proportion of properties on the site without sufficient available storage to effectively control stormwater run-off for a particular event, as a result of the tanks being full. This proportion of "non-compliant" properties reduces with increasing numbers of properties, if they are connected to a communal or centralized system. With sufficient properties, there would be no need to make a "non-compliance" allowance.

As a result of the importance of antecedent rainfall, it is likely that the use of green roofs (and the reduced volume of run-off that they offer) in conjunction with rainwater harvesting storage would make rainwater harvesting very effective for areas of high annual rainfall or buildings with relatively low demand compared to the roof area.

Annex D (informative) Water safety plan

The steps below detail the process for preparing a water safety plan for water reuse systems:

a) Assemble the water safety plan team:
- Specialists in the design, operation and maintenance of the system.
- Specialists in water quality.

b) Describe and document the water supply system:
- Relevant water quality standards.
- Water treatment.
- Distribution.
- Materials in contact with water.
- Storage.
- Staff and competence.
- Uses and users of the potable supply.
- System schematics.
- Chlorine dioxide.

c) Identify the hazards and the hazardous events and assess the risks:
- Process flow diagram.
- Hazard and likelihood of occurrence (certain/possible/rare).
- Severity of the consequences (insignificant/major/catastrophic).
- Public health.
- Other issues, e.g. aesthetics, adequacy of supply, continuity.
- Potential health impacts.

d) Determine and validate control measures, reassess and prioritize the risks:
   - Chemical.
   - Microbial.
   - Physical.
   - Health.

e) Develop, implement and maintain an improvement/upgrade plan:
   - Continuous improvement.

f) Define monitoring of the control measures:
   - Sampling, monitoring schedule, building management system (BMS) feedback.

g) Verify the effectiveness of the water safety plan:
   - Determine effectiveness.

h) Prepare management procedures:
   - Management control plan.
   - Roles and responsibilities.
   - Maintenance requirements.

i) Develop supporting programme/resources:
   - Identify resources including key personnel.

j) Carry out period review of water safety plan:
   - Define responsibilities and review period.

k) Revise the water safety plan after an incident:
   - How the plan can be reviewed following an incident.

Annex E (informative) Energy and carbon implications

E.1 General

In assessing the energy and greenhouse gas emissions (such as methane and carbon dioxide) from water reuse systems, the following types of impact can be accommodated:

a) embodied – energy and carbon embedded in the production of the component materials and the system itself;

b) operational – energy and carbon consumed by the system throughout the duration of its operation;

c) maintenance – energy and carbon consumption associated with maintenance activities.

Energy and carbon costs can, as with environmental impacts, be assessed by a number of methods, including:

1) average incremental carbon cost – this focuses on energy and carbon only and therefore provides a biased assessment, as it does not include other, potentially beneficial, social or environmental impacts;

2) life cycle analysis (LCA) – this is normally a comprehensive assessment and does not focus only on energy and carbon, although energy and carbon can be focused on, if the unit under consideration is specified at the outset of the assessment.

NOTE Refer to the following for further information on LCAs: BS EN ISO 14040, PAS 2050, The Guide to PAS 2050:2011 and Handbook on life cycle assessment *[22].*

For each type of water reuse system under consideration, an assessment could be conducted to facilitate a comparison both between systems and with any centralized infrastructure that the system might replace/supplement.

E.2 Carbon implications

Assessment of carbon footprint of any proposed water reuse system can assist in the selection of the system.

Both operational carbon and embodied carbon footprint will be evaluated based on the LCA techniques.

E.3 Embodied carbon

E.3.1 Embodied carbon: materials

To calculate the embodied CO_2 of any element/component the following will be needed:

a) the compositional materials of all elements and components;

b) the quantity of each material in each component.

This allows for the calculation and estimation of embodied carbon for each of the component and the system as a whole.

The information about the embodied carbon can be sourced from the manufacturer of calculated using verified sources.

NOTE For further information on assessing carbon footprints, see PAS 2050.

E.3.2 Embodied carbon: construction and installation

The carbon footprint of construction activities related to installation of water reuse systems can be evaluated, calculating the following activities:

a) site preparation;

b) excavation;

c) transport and disposal of arisings;

d) transport of infill material;

e) site reinstatement.

NOTE To assess the carbon footprint of the on-site construction activities, use a carbon calculator such as the one provided by the Environment Agency. [1)]

E.4 Operational carbon

E.4.1 Operational carbon: operation

The operational carbon footprint is composed of:

a) carbon footprint of consumed energy;

b) carbon footprint of consumed chemicals.

The carbon footprint of energy consumption can be estimated using carbon footprint figures of local power production.

The carbon footprint of chemicals used in treatment of reclaimed water in the water reuse systems can be calculated based using verified sources.

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1) Available from <http://www.environment-agency.gov.uk/business/sectors/136252.aspx> [last viewed 13 September 2013].

It is important that reasonably accurate estimates of the energy consumption of the different options are used in order to allow a fair comparison. The treatment of future costs of energy over the appraisal period need to be agreed beforehand, and based on specific robust forecast data, and it is reasonable to expect this to be the subject of sensitivity testing in order to establish the effect on the outcome.

E.4.2 Operational carbon: maintenance

The operational carbon for maintenance primarily results from transport related carbon emissions of maintenance staff.

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