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# Water reuse in urban areas — Guidelines for decentralized/onsite water reuse system — Design principles of a decentralized/onsite system

*Réutilisation de l'eau en milieu urbain — Lignes directrices concernant les systèmes décentralisés/sur site de réutilisation de l'eau — Principes de conception d'un système décentralisé/sur site*



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# Foreword

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This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 2, *Water reuse in urban areas*.



Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

With economic development, climate change, rapid urbanization and increases in population, water has become a strategic resource especially in arid and semi-arid regions. Water shortages are considered as one of the most serious threats to the sustainable development of society. To address these shortages, reclaimed water is increasingly being used to satisfy water demands that do not require potable water quality. This strategy has proven useful in increasing the reliability of long-term water supplies in many water-scarce areas. The applications of reclaimed water depending on the volumes of reclaimed water available include restricted or unrestricted irrigation, industrial uses, toilet and urinal flushing, firefighting and fire suppression, street cleaning, environmental and recreational uses (ornamental water features, water bodies' replenishment, etc.) and car washing.

While centralized water reuse facilities have been widely implemented under different ownership and management structures, there is also a need to develop decentralized/onsite water reuse systems in cost-effective and resource-efficient ways, which can improve flexibility and convenience. Depending on the size and scope of the system, private and community owned systems can increase the flexibility of the system to the needs of the owner(s). Decentralized/onsite water reuse systems have the advantage that they can be installed for a short-term when needed and have a lower cost than centralized systems due to sewers systems large investments. Moreover, they allow the local reuse of water and therefore increase water productivity. Compared to centralized systems, decentralized/onsite systems still involve local wastewater collection and treatment. They are considered to be much smaller with fewer people connected (single, several or tens or hundreds of households) and less costly, especially when greywater components have been separated from the blackwater for reuse. If the systems are properly situated, designed, operated and managed, they can provide substantial environmental and social benefits (e.g. reduction of freshwater consumption and wastewater generation) as well. The concentrated blackwater can be treated using several treatments (e.g. septic tanks, cesspools, soil drain fields, chemicals, bio-digesters, composting toilets and blackwater recycling systems). Decentralized/onsite water reuse systems can also be integrated into the broader centralized systems in terms of clustered or contracting schemes for decentralized technology with centralized operation.



The design of a decentralized/onsite water reuse system requires a thorough understanding taking into account of scale, system components, end use requirements and other issues. This guideline can be useful for the application of design principles as well as feasible and cost-effective approaches for safe and reliable fit-for-purpose water reuse.

# Water reuse in urban areas — Guidelines for decentralized/onsite water reuse system — Design principles of a decentralized/onsite system

## 1 Scope

This document provides guidelines for the planning, design principles and considerations of a decentralized/onsite water reuse system and water reuse applications in urban areas.

This document is applicable to practitioners and authorities who intend to implement principles and decisions on decentralized water reuse in a safe, reliable and sustainable manner.

This document addresses decentralized/onsite water reuse systems in their entirety and is applicable to any water reclamation system component (e.g. source water collection, treatment, storage, distribution, operation and maintenance and monitoring).

This document provides:

— standard terms and definitions;

— description of system components and possible models of a decentralized/onsite water reuse system;



— design principles of a decentralized/onsite water reuse system;

— common assessment criteria and related examples of water quality indicators, all without setting any target values or thresholds;



— specific aspects for consideration and emergency response.

Design parameters and regulatory values of a decentralized/onsite water reuse system are out of the scope of this document.

## 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.

ISO 20670, *Water reuse — Vocabulary*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 20670 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1**
**cluster system**
**private system**
decentralized water reuse system used to treat and reuse wastewater from a collection of dwellings or facilities located adjacent to each other with typically a few owners

[SOURCE: Asano et al., 2007; CIDWT, 2009]

**3.2**
**community system**
decentralized water reuse system used to treat and reuse wastewater from a community with dwelling units and/or high-rise buildings

Note 1 to entry: A water-tight collection system is used for transport of pre-treated effluent or raw wastewater.

[SOURCE: Asano et al., 2007; CIDWT, 2009]

**3.3**
**onsite water reuse system**
treatment unit that receives, treats and provides reclaimed water at the immediate site of wastewater generation

[SOURCE: Asano et al., 2007]

# 4 Planning of a decentralized/onsite water reuse system



## 4.1 General

Good planning and management of a decentralized/onsite water reuse system are important. The planning and management of a decentralized/onsite water reuse system should consider the following aspects:



— internal planning (e.g. planning principles, targets, scope, project timeline and conceptual design);

— site selection and inspection, including population density, land availability and topography;

— wastewater quantity and quality and reuse potentials;

— scale and layout of the system and coordination and involvement in broader land use planning;

— operational and management conditions;

— operation and maintenance of residuals (e.g. sludge, screenings, trash, etc.);

— recognition and addressing of technological, economic, environmental, social and regulatory issues.

The capacity of the owner or operator to manage the system should be factored into the decision-making process leading to the planning and selection of a system or set of systems appropriate for the local household or community. An initial screening using criterion for safety, reliability, stability, operability and economics is a critical element of good planning. The dynamics of the reuse system that can be taken into consideration include system density, hydraulic and pollutant loadings, proximity to water bodies, soil and hydrogeological conditions and the potential impacts of water quality/quantity on groundwater and surface waters. For system reliability, it is important to conduct a risk management approach that consider the consequences of system failures or malfunctions in terms of public health and environmental impacts (see Table 1). In cases of high risk or non-conformance due to failures (e.g. power or treatment processes), procedures or options can be established/built to consider use of traditional networks, such as constructing holding or surge tanks, constructing connections to other nearby decentralized systems or other site-specific options.

Site investigation and assessment are important to ensure that the system is integrated into existing and proposed urban planning which includes future development, proposed road, water or sewer line extensions, zoning classifications, etc.

**Table 1 — Considerations for risk management of a decentralized/onsite water reuse system**

| Potential issues | Contributing factors | Key risks |
|---|---|---|
| Treatment and reuse system and disposal area | — Soil; Topography<br>— Planning (lot size)<br>— Environmental sensitivity<br>— Flooding<br>— Operation and maintenance<br>— Loading rates<br>— Water extraction (boreholes, wells, springs) | Release of contaminants due to failure of the decentralized/onsite water reuse system |
| Surrounding soil | — Soil type and horizon depth<br>— Physical characteristics<br>— Chemical characteristics<br>— Water table depth | Inability to renovate effluent and prevent contaminants from reaching groundwater and/or surface water |
| Public health | — Surface exposure<br>— Water resources<br>— Aerosols<br>— Pests (e.g. mosquitoes) | A considerable health risk due to exposure to contaminants and pathogens from water/ surrounding environment |
| Environment | — Surface runoff<br>— Groundwater discharge<br>— Flooding<br>— Water table | Release of contaminants into the receiving environment (ground/ surface waters) causing environmental harm (such as eutrophication) and odour and noise considerations |

NOTE Adapted from Carroll, et al. (2006)[17].



## 4.2 Possible models of the system

### 4.2.1 General

Decentralized/onsite water reuse systems come in a wide variety of options and scales. An important aspect in considering the use of decentralized/onsite systems is the appropriate scale of implementation to ensure proper operation and management. Onsite systems generally refer to allotment scale systems, including onsite family/household-based systems and onsite building scale systems (e.g. urban communities, industries, or other facilities). Decentralized systems can encompass a wider range of scales such as a cluster system, a community system, a seasonal operation system, etc.

Traditionally, the main application of a decentralized/onsite water reuse system is for servicing areas that are difficult to service with centralized water reuse systems due to technical or economic considerations. There are increasing opportunities to apply decentralized systems beyond the small town and rural communities by a mixture of different scales. Compared to centralized systems, the planning of decentralized/onsite water reuse systems require a thorough understanding of temporal and spatial demand variability for the end use requirements to determine an optimal design scale.

### 4.2.2 Onsite water reuse system

Onsite systems typically treat wastewater close to the source, and are generally applied to serve small to medium scale development. Figures 1 and 2 show typical examples of an onsite family/household-based water reuse system and a building scale water reuse system respectively. Back flow preventers should be considered as required by many jurisdictions when potable water and reclaimed water are supplied to the same equipment (e.g. toilets, washing machines, irrigation, etc.) for safety of individual and public systems. The maintenance and operational costs of onsite systems can be relatively high which usually relies on additional motivation, such as limited available supply of water (drought or arid lands) or high costs for disposal or positive environmental attitudes of individuals and households, etc.

Onsite systems for seasonally operated facilities such as seasonal hotels or campsites should be capable of adapting to changing conditions and deal with a high variability of organic load.

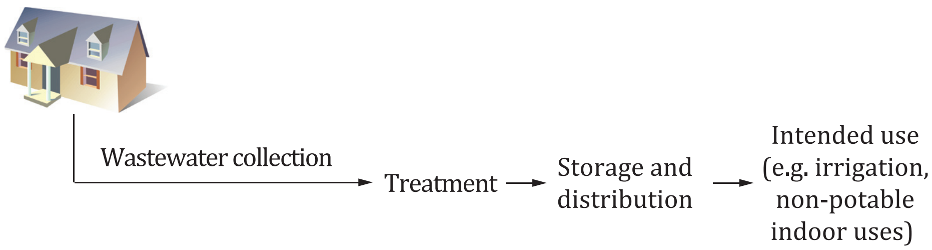
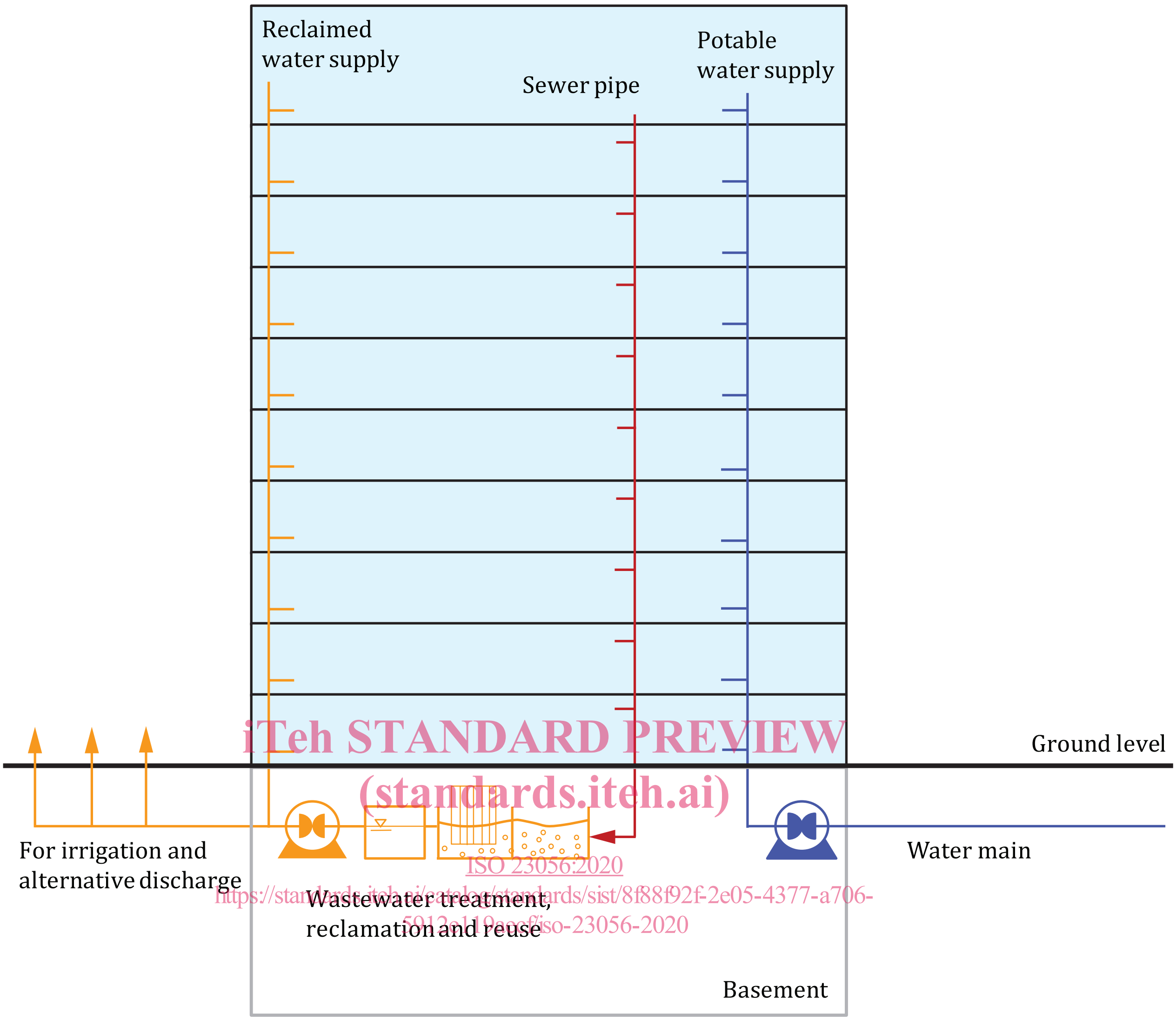



**Figure 1 — Typical example of an onsite family/household-based water reuse system**








NOTE Other collection and distribution systems could be used such as greywater.

**Figure 2 — Typical example of an onsite building scale water reuse system**

### 4.2.3 Cluster water reuse system

Cluster systems can be a combination of systems applied either at single onsite or communal scale systems or both. Cluster systems offer economies and maintainability of scale, as it is more efficient for a number of households to invest in and utilize a decentralized technology than for each household to own and operate its own system. Additional advantages are reducing the risk for system failure and facilitating repair. A typical example of cluster system is given in Figure 3.