INTERNATIONAL STANDARD

ISO 20760-1

First edition
2018-02

Water reuse in urban areas — Guidelines for centralized water reuse system —

Part 1: Design principle of a centralized water reuse system

Réutilisation de l'eau en milieu urbain - Lignes directrices concernant les systèmes centralisés de réutilisation de l'eau —

Partie 1: Principe de conception d'un système centralisé de réutilisation de l'eau

Reference number
ISO 20760-1:2018(E)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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

A list of all parts in the ISO 20760 series can be found on the ISO website.

Introduction

With economic development, climate change and increases in population and rapid urbanization, 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 sustainable development of society. To address these shortages, reclaimed water is increasingly being used to satisfy water demands and this strategy has proven useful in increasing the reliability of long-term water supplies in many water-scarce areas.

The role of water reuse is growing for urban areas in many countries including landscape 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. These centralized water reuse systems have been developed to the degree that they are now considered as an effective component of urban water management and are used in many cities and countries.

The essential components of a centralized water reuse system include a source water, wastewater collection systems (sewers and pumping stations), a wastewater treatment facility, a reclaimed water distribution system, reclaimed water storage, a water quality monitoring system and operation and maintenance provided by experienced and certified operators. The variable nature and diversity in source water present a challenge to ensuring water safety and reliability in each system component. A further complication to distributing the reclaimed water is that different water reuse applications can have different levels of water quality, which would consider installing satellite treatment.

This document provides design principles for centralized water reuse systems in urban areas. It considers and addresses the critical issues and factors in the design of the different system components and is intended to assist water engineers, authorities, decision makers and stakeholders in considering feasible and cost-effective approaches for safe and reliable fit-for-purpose water reuse. For details on the management of a centralized water reuse system, see ISO 20760-2.

Water reuse in urban areas — Guidelines for centralized water reuse system —

Part 1: Design principle of a centralized water reuse system

1 Scope

This document provides guidelines for the planning and design of centralized water reuse systems and water reuse applications in urban areas.

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

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

This document provides:

— standard terms and definitions;

— system components and possible models of a centralized water reuse system;

— design principles of a centralized 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 centralized 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:—[1], *Water reuse — Terminology*

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 https://www.electropedia.org/

1) Under preparation. Stage at the time of publication: ISO/DIS 20670:2017.

3.1
backflow
movement of the fluid from downstream to upstream within an installation

[SOURCE: EN 1717: 2000, 3.5]

3.2
backflow protection device
device which is intended to prevent contamination of potable water by *backflow* (3.1)

[SOURCE: EN 1717: 2000, 3.6]

3.3
destratification system
use of mechanical devices (e.g. bubble plumes, draft-tube mixers or unconfined mixers) to reduce water column stratification, increase the vertical transfer of dissolved oxygen and heat in a tank/reservoir, in order to improve chemical water quality and to control phytoplankton growth

3.4
reliability assessment
formal determination and review of the reliability of reclaimed water system components and equipment

Note 1 to entry: The assessment reviews and details the operating standards, maintainability, critical operating conditions, spare parts requirements and availability, and any other issues that affect the reliability or the treatment performance of the reclamation facility.

3.5
water reclamation facility
facility for recovering reclaimed water of a quality which is suitable for beneficial use

3.6
water reuse in urban areas
beneficial use of reclaimed water for non-potable and/or indirect potable applications in urban areas

EXAMPLE Landscape uses, street cleaning, firefighting, industrial applications, environmental enhancement, recreational applications, flushing and other domestic uses, etc.

4 Abbreviated terms

AI	alkalinity index
AGP	algal growth potential
AOC	assimilable organic carbon
BDOC	biodegradable dissolved organic carbon
BGP	bacterial growth potential
BOD	biochemical oxygen demand
CAPEX	capital expense
COD	chemical oxygen demand
HPC	heterotrophic plate count
LR	Larson ratio

LSI	Langelier saturation index
OPEX	operating expense
POU	point-of-use
RSI	Ryznar stability index
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
TWW	treated wastewater
WWTP	wastewater treatment plant

5 Planning and design of a centralized water reuse system

5.1 General

Planning is fundamental to ensure the effectiveness of a centralized water reuse system. When a reclaimed water master plan is being developed, the following aspects should be considered and carefully defined:

— planning principles and targets, including human health and environment protection;

— planning scope and project timeline;

— water reclamation facility construction, operation and maintenance and potential operational challenges;

— water reclamation production, storage, transmission and distribution system reliability and redundancy;

— reclaimed water applications and related water quality and quantity;

— the urban area to which reclaimed water will be supplied,

— the scale and layout of the system and links/compliance with local or regional water planning;

— economic feasibility and the availability of funding, including tariff strategies and concession agreements;

— stakeholder consultation, open meetings and dialogues;

— customer surveys to determine industrial and domestic demands, value of the reclaimed water (willingness to pay), economic viability and sustainability;

— environmental conscious design and minimization of environmental impacts;

— public comment and social acceptance.

The reclaimed water master plan should be reviewed periodically (by competent authorities) and updated and refined as new information becomes available. For example, water authorities can work together with internal and external stakeholders, including the potential reclaimed water users and the public, throughout the process to ensure that issues and concerns are understood and considered [10] [11].

5.2 Estimation of water demand

5.2.1 General

In the planning stage, the needs of each water reuse application should be assessed including the reclaimed water quantity and quality. Various methods can be applied to estimate current demands and to analyse use applications. Additionally, when transitioning from standard drinking water or wastewater systems to a water reuse system, the sizing of the potable drinking water infrastructure should be heavily evaluated to ensure water quality/water age factors are still intact (i.e. avoiding oversized servicing, increased water age and decreased disinfectant residuals).

5.2.2 Quantity of reclaimed water

When determining the quantity of reclaimed water that is available for reuse, several factors should be considered, including:

a) the quantity and quality characteristics of wastewater discharged to sewer from the various sources (e.g. types of industrial, commercial and institutional discharges, number of houses, infiltration/inflow, surface runoff, combined or separate sewers, etc.);

b) the topography of the service area and location of existing wastewater treatment facilities;

c) diurnal and seasonal dynamics of collected and treated wastewater quantity;

d) the volume of reclaimed water that could be available after treatment and storage.

5.2.3 Review of potential reclaimed water end-users and uses

An assessment should be carried out to identify potential users of reclaimed water, their locations and their water quantity and quality considerations, particularly those users with high quantity and/or quality needs and cost-effective applications. Special attention should be paid to potential drivers and benefits for the use of reclaimed water, in particular for the large end-users.

5.3 Site conditions

When selecting the site for the centralized water reuse system, the following criteria should be considered:

a) location and proximity of current and projected future reclaimed water demands and users;

b) availability of land, routes and rights of way space for the necessary treatment, storage, transmission and distribution systems and pumping facilities;

c) scoping assessment of the land area;

d) land use conflicts and local water reuse policies;

e) proximity (location and quantity of wastewater sources);

f) hydraulic and civil construction factors;

g) opportunities for partnership with other agencies;

h) environmental framework such as climate, geography and topography;

i) water resources such as surface water or groundwater;

j) level of social acceptance of water reuse.

A centralized water reuse system may have two configurations:

— adding advanced treatment to an existing centralized wastewater treatment facility;

— constructing a new centralized reclamation facility for additional wastewater treatment and/or polishing and production of reclaimed water.

It may be difficult to find a site where all site conditions are optimal and adjustments can be considered to compensate for site deficiencies. Planning should consider both the current and future demand for all potential reclaimed water uses and growth in demand may be different for the various water demands being considered. A market assessment should be carried out, particularly in communities with established infrastructure, to determine the needs for reclaimed water. Other issues that should also be considered include the impact of potential land-use zoning changes and the possibility of future land development.

5.4 System components

The following five essential water reclamation components should be considered when planning a centralized water reuse system:

a) source water (quality and quantity);

b) treatment;

c) reclaimed water storage;

d) reclaimed water distribution;

e) monitoring.

The storage system(s) can be located before and/or after the main transmission pipeline depending on the distribution system hydraulic design and should equalize reclaimed water quantity and pressures.

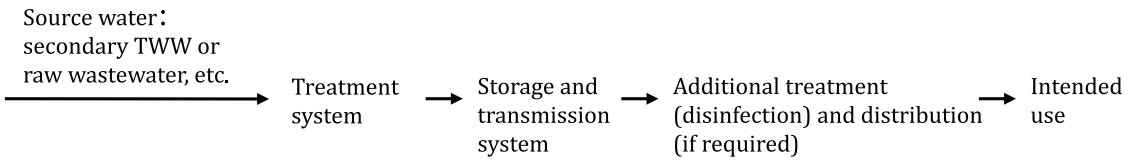
5.5 Possible models of the system

5.5.1 General

There are four generic models of a centralized water reuse system, namely single application, multiple applications, environmental storage and reuse applications and cascading uses, ranging from simple to more complicated water use patterns considered in this document.

5.5.2 Model I — Single application

Model I produces reclaimed water for only one type of water reuse quality application. This model is relatively simple (Figure 1). Secondary TWW is typically used as source water in a centralized water reuse system. In some cases, when water reclamation is integrated in the wastewater treatment with the intended purpose of water reuse, untreated wastewater from sewer systems is considered as source water (see detailed descriptions in 6.1). A typical example of Model I is given in Figure 1.



NOTE Additional treatment is optional and not compulsory, which depends on the reclaimed water quality and use.

Figure 1 — Typical example of Model I for single application

Model I should be considered when

a) reclaimed water is being provided to a single user, such as one industrial plant or an individual building, or

b) reclaimed water is being provided to a single reclaimed water use or standard for a single user or similar users, such as a regional or community-based residential area where the quality of the reclaimed water should meet all the water reuse applications.

Using accepted design principles, the treatment technology or combination of technologies should be selected to achieve the reclaimed water quality targets for the specific uses and the overall reclaimed water system performance, see ISO 20761, ISO 20468-1 and Reference [12].

5.5.3 Model II — Multiple applications

Model II produces multiple reclaimed water streams, each with a different water quality criterion. This model is more complex in design and operation and the treatment is organized into a hierarchical structure. A typical example of Model II is given in Figure 2.

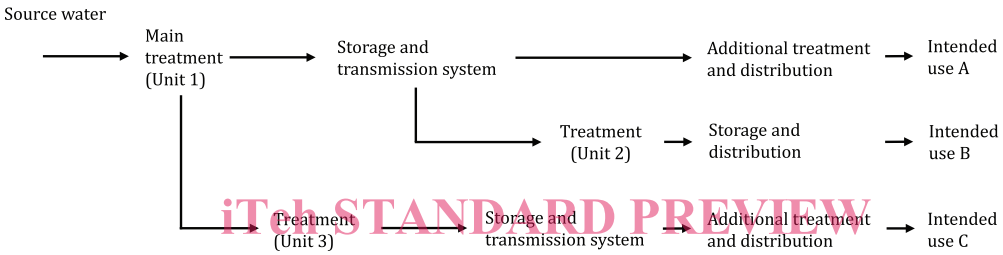


Figure 2 — Typical example of Model II for multiple applications

Model II should be used when reclaimed water is supplied to multiple end uses with different water quality, such as in an industrial park with several industries, or a region with industrial and domestic applications for reclaimed water.

The following issues should be considered when selecting a reclaimed water treatment technology or technology combinations:

a) treatment Unit 1 is designed to satisfy the water quality and quantity specialities for the large and high priority users;

b) small users with higher quality demands can connect to the main treatment unit (Unit 1) and either provide an additional treatment unit before distribution or at the point-of-use (POU). The control and responsibility of an end user at the utility site would demand a very detailed contract and access to the site to ensure quality is maintained to their needs. There are two scenarios that could be applied:

   — the reclaimed water utility contracts with the end user for a system with a specified quantity and quality and the utility controls the additional treatment;

   — the small user contracts for the quantity that is being provided and builds the enhanced treatment at its own site where the user has control and responsibility of the system construction and operation;

c) small users with quality demands that are generally lower than the quality of the produced reclaimed water can connect directly to the main treatment unit (Unit 1) without consideration for further treatment.

The minimum water quality should be guaranteed by the service provider (operator). The water quality demands for specific users could be achieved using additional treatment (e.g. Unit 2 and 3).

