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Guidelines for treated wastewater use for irrigation projects —

Part 2: Development of the project

Lignes directrices pour l'utilisation des eaux usées traitées en irrigation —

Partie 2: Développement du projet

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 282, *Water reuse*, Subcommittee SC 1, *Treated wastewater use for irrigation*.

This second edition cancels and replaces the first edition (ISO 16075-2:2015), which has been technically revised. The main changes compared to the previous edition are as follows:

— updating the values of turbidity in Table 1— suggested treated wastewater quality according to chemical, physical and biological parameters);

— updating the issue of Irrigation of public gardens in Table 2 —Suggested types and accredited number of barriers;

— updating the subject of public and private gardens irrigation by treated wastewater (TWW);

— adding chapter 7: Public health aspects of garden irrigation with treated greywater and;

— updating Table A.1 added new column— washing or disinfection the produce.

A list of all parts in the ISO 16075 series can be found on the ISO website.

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

The increasing water scarcity and water pollution control efforts in many countries have made treated municipal and industrial wastewater a suitable economic means of augmenting the existing water supply especially when compared to alternatives such as desalination or the development of new water sources involving dams and reservoirs. Water reuse makes it possible to close the water cycle at a point closer to cities by producing "new water" from municipal wastewater and reducing wastewater discharge to the environment.

An important new concept in water reuse is the "fit-for-purpose" approach, which entails the production of reclaimed water quality that meets the needs of the intended end-users. In the situation of reclaimed water for irrigation, the reclaimed water quality can induce an adaptation of the type of plant grown. Thus, the intended water reuse applications are to govern the degree of wastewater treatment required and inversely, the reliability of water reclamation processes and operation.

Treated wastewater can be used for various non-potable purposes. The dominant applications for the use of treated wastewater (also referred to as reclaimed water or recycled water) include agricultural irrigation, landscape irrigation, industrial reuse, and groundwater recharge. More recent and rapidly growing applications are for various urban uses, recreational and environmental uses, and indirect and direct potable reuse.

Agricultural irrigation was, is, and will likely remain the largest reuse water consumer with recognized benefits and contribution to food security. Urban water recycling, landscape irrigation in particular, is characterized by fast development and will play a crucial role for the sustainability of cities in the future including energy footprint reduction, human well-being, reduction of water importation and environmental restoration.

The suitability of treated wastewater for a given type of reuse depends on the compatibility between the wastewater availability (volume) and water irrigation demand throughout the year, as well as on the water quality and the specific use requirements. Water reuse for irrigation can convey some risks for health and environment, depending on the water quality, the irrigation water application method, the soil characteristics, the climate conditions, and the agronomic practices. Consequently, the public health and potential agronomic and environmental adverse impacts are to be considered as priority elements in the successful development of water reuse projects for irrigation. To prevent such potential adverse impacts, the development and application of guidelines for the use of treated wastewater is essential.

The main water quality factors that determine the suitability of treated wastewater for irrigation are pathogen content, salinity, sodicity, specific ion toxicity, heavy metals' concentration, other chemical elements, and nutrients. Local health authorities are responsible for establishing water quality threshold values depending on authorized uses and they are also responsible for defining practices to ensure health and environmental protection taking into account local specificities.

From an agronomic point of view, the main limitation in using treated wastewater for irrigation arises from its quality. Treated wastewater, unlike water supplied for domestic and industrial purposes, contains higher concentrations of inorganic suspended and dissolved materials (total soluble salts, sodium, chloride, boron, and heavy metals), which can damage the soil and the irrigated crops. Dissolved salts are not removed by conventional wastewater treatment technologies and appropriate good management, agronomic, and irrigation practices should be used to avoid or minimize potential negative impacts.

The presence of nutrients (nitrogen, phosphorus, and potassium) can become an advantage due to possible saving in fertilizers. However, the amount of nutrients provided by treated wastewater along the irrigation period is not necessarily synchronized with crop requirements and the availability of nutrients depends on the chemical forms.

This guideline provides guidance for healthy, hydrological, environmental and good operation, monitoring, and maintenance of water reuse projects for unrestricted and restricted irrigation of agricultural crops, gardens, and landscape areas using treated wastewater. The quality of supplied treated wastewater has to reflect the possible uses according to crop sensitivity (health-wise and agronomy-wise), water sources (the hydrologic sensitivity of the project area), the soil, and climate conditions.

This guideline refers to factors involved in water reuse projects for irrigation regardless of size, location, and complexity. It is applicable to intended uses of treated wastewater in a given project even if such uses will change during the project's lifetime as a result of the changes in the project itself or in the applicable legislation.

The key factors in assuring the health, environmental, and safety of water reuse projects in irrigation are the following:

— adequate monitoring of TWW quality to ensure the system functions as planned and designed;

— design and maintenance instructions of the irrigation systems to ensure their proper long-term operation;

— compatibility between the TWW quality, the distribution method, and the intended soil and crops to ensure a viable use of the soil and undamaged crop growth;

— compatibility between the TWW quality and its use to prevent or minimize possible contamination of groundwater or surface water sources.

This document is not intended to prevent the creation of more specific standards or guides which are better adapted to specific regions, countries, areas, or organizations. If such documents are written, it is recommended to reference this document to ensure uniformity throughout the treated wastewater use community.

Guidelines for treated wastewater use for irrigation projects —

Part 2: Development of the project

1 Scope

This document covers the following issues:

— guideline for the design of treated wastewater (TWW) irrigation projects intended to prevent public health risks within the population that has been in direct or indirect contact with the TWW or with any product that has come in contact with the TWW;

— specifications of the following:

i) TWW quality for irrigation purposes;

ii) types of crops for TWW irrigated;

iii) TWW and crops qualities integration;

iv) use of barriers to reduce risks arising from TWW irrigation;

v) correlation between the quality of the TWW, irrigated crops, and the types of barriers that can be used;

vi) distance between TWW irrigated areas and residential areas.

None of the documents of ISO 16075 are intended to be used for certification purposes.

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 20670:2018, *Water reuse — Vocabulary*

ISO 16075-1:2020[1)], *Gridlines for treated wastewater for irrigation projects Part 1: The basis of a reuse project for irrigation*

3 Terms, definitions, and abbreviated terms

For the purposes of this document, the following terms and definitions given in ISO 20670 and ISO 16075-1:2020 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/

1) Under preparation. Stage at the time of publication: ISO/DIS 20670:2020.

3.1 Abbreviated terms

BOD	biochemical oxygen demand
CFU	colony forming units
COD	chemical oxygen demand
MF	microfiltration
NF	nanofiltration
NPW	non-potable water
NTU	nephelometric turbidity units
TSS	total suspended solids
TWW	treated wastewater
UF	ultrafiltration
UV	ultraviolet
WW	wastewater
WWTP	wastewater treatment plant

4 Public health and TWW quality to considerations

4.1 TWW quality levels

TWW classes (based on quality levels) should be characterized by the levels of specified contaminants and further correlated to the various potential uses and corresponding wastewater treatment.

Two main TWW quality parameters should be considered:

1. quality components that examine the level of the treatment of the wastewater in the treatment facility. These components include the levels of BOD and the TSS in the effluents, and

2. quality components that examine the sanitary quality of the TWW and the health risk associated with the use of TWW for irrigation. These components include concentrations of indicator bacteria and nematodes.

The quality levels of the TWW and the concentration of the various components according to which the quality level is determined are presented in Table 1. This table also presents the various potential uses and corresponding TWW.

The definitions of the various quality levels of wastewater are set out in Clause 3 (3.1.3 to 3.1.7) correlated to their essential parameters and treatment types and summarized in Table 1.

Table 1 — Suggested treated wastewater quality according to chemical, physical and biological parameters[a]

Cat.	Type of treated wastewater	BOD[b,j]		TSS		Turbidity[c]		Thermo-tolerant coliforms[d]		Intestinal nematodes[e,l]		Potential uses without barriers	Potential corresponding treatment
		mg l^{-1}		mg L^{-1}		NTU		no./100 ml		Egg l^{-1}			
		Ave.	Max	Ave.	Max	Ave.	Max	95 %ile	Max	Ave.	Max		
A	Very high quality treated wastewater[d]	≤5 mg/l	10 mg/l	≤5 mg/l	10 mg/l	≤3	6	≤10 or below the detection limit	100	—	—	Unrestricted urban irrigation [l] and agricultural irrigation of food crops consumed raw	Secondary[f], contact filtration or membrane filtration[g] and disinfection[h]

NOTE With each type of treated-wastewater quality, the use of a higher quality treated wastewater is always possible.

a An example to the limits are elaborated on the basis of international regulations, e.g. WHO (2006) and USEPA (2012) and apply to the reclaimed water at the outlet of the treatment facility. After storage in open reservoirs and for spray or localized irrigation, additional filtration could be necessary. Sampling frequency and the calculation of the average values are given in ISO 16075-4.

b BOD_5 is determined with a five-day test.

c Continuous measurement of the turbidity can be implemented. The average value should be based on a 24-time period. If suspended solids are used in lieu of turbidity, the average TSS should not exceed 5 mg/l. If membrane filtration is used for treatment, the turbidity should not exceed 0,2 NTU.

d Residual chlorine dosage between 0,2 mg/l and 1 mg/l that measured after 30 min contact time can be necessary for high and very high-quality treated wastewater. If other method of disinfection achieving is used, it should also be monitored.

e Intestinal nematodes (helminth eggs) might not be routinely monitored if it was demonstrated that the number of helminth eggs in untreated wastewater is consistently below 10 eggs/l.

f Secondary treatment includes activated sludge, trickling filters, rotating biological contactors, biofilters, bioreactors, sequence batchreactors, etc.

g Filtration includes microscreening, cartridge filtration, high rate sand filtration, dual media filtration, cloth filters, and disc filters without or with chemical addition (contact filtration) as well as membrane processes including membrane bioreactors.

h Disinfection includes UV irradiation, ozonation, chlorination, or other chemical, physical chemical, or membrane processes.

i High rate clarification includes coagulation, flocculation, and lamella settling.

j Well-designed stabilization pond systems can meet coliform limits without additional disinfection. The soluble BOD values are considered.

k The physical-chemical parameters (BOD, TSS) could be adjusted according to local wastewater treatment regulations with the possible addition of COD.

l If there is a risk of aerosolization, the Legionella spp should be less than 1 000 CFU/l for Greenhouses.

Table 1 *(continued)*

Cat.	Type of treated wastewater	BOD[b,j]		TSS		Turbidity[c]		Thermo-tolerant coliforms[d]		Intestinal nematodes[e,l]		Potential uses without barriers	Potential corresponding treatment
		mg l^{-1}		mg L^{-1}		NTU		no./100 ml		Egg l^{-1}			
		Ave.	Max	Ave.	Max	Ave.	Max	95 %ile	Max	Ave.	Max		
B	High quality treated wastewater[d]	≤10 mg/l	20 mg/l	≤10 mg/l	25 mg/l	—	—	≤200	1 000	—	—	Restricted urban irrigation and agricultural irrigation of processed food crops	Secondary[f], filtration[g] and disinfection[h]
C	Good quality treated wastewater	≤20 mg/l	35 mg/l	≤30 mg/l	50 mg/l	—	—	≤1 000	10 000	≤1	—	Agricultural irrigation of non-food crops	Secondary[f] and disinfection[h]

NOTE With each type of treated-wastewater quality, the use of a higher quality treated wastewater is always possible.

[a] An example to the limits are elaborated on the basis of international regulations, e.g. WHO (2006) and USEPA (2012) and apply to the reclaimed water at the outlet of the treatment facility. After storage in open reservoirs and for spray or localized irrigation, additional filtration could be necessary. Sampling frequency and the calculation of the average values are given in ISO 16075-4.

[b] BOD_5 is determined with a five-day test.

[c] Continuous measurement of the turbidity can be implemented. The average value should be based on a 24-time period. If suspended solids are used in lieu of turbidity, the average TSS should not exceed 5 mg/l. If membrane filtration is used for treatment, the turbidity should not exceed 0,2 NTU.

[d] Residual chlorine dosage between 0,2 mg/l and 1 mg/l that measured after 30 min contact time can be necessary for high and very high-quality treated wastewater. If other method of disinfection achieving is used, it should also be monitored.

[e] Intestinal nematodes (helminth eggs) might not be routinely monitored if it was demonstrated that the number of helminth eggs in untreated wastewater is consistently below 10 eggs/l.

[f] Secondary treatment includes activated sludge, trickling filters, rotating biological contactors, biofilters, bioreactors, sequence batchreactors, etc.

[g] Filtration includes microscreening, cartridge filtration, high rate sand filtration, dual media filtration, cloth filters, and disc filters without or with chemical addition (contact filtration) as well as membrane processes including membrane bioreactors.

[h] Disinfection includes UV irradiation, ozonation, chlorination, or other chemical, physical chemical, or membrane processes.

[i] High rate clarification includes coagulation, flocculation, and lamella settling.

[j] Well-designed stabilization pond systems can meet coliform limits without additional disinfection. The soluble BOD values are considered.

[k] The physical-chemical parameters (BOD, TSS) could be adjusted according to local wastewater treatment regulations with the possible addition of COD.

[l] If there is a risk of aerosolization, the Legionella spp should be less than 1 000 CFU/l for Greenhouses.