A compendium of standards for wastewater reuse in the Eastern Mediterranean Region

World Health Organization
Regional Office for the Eastern Mediterranean
Regional Centre for Environmental Health Activities
CEHA

WHO-EM/CEH/142/E

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Acronyms and abbreviations

AFESD	Arab Fund for Economic and Social Development
BOD_5	Biochemical oxygen demand
CEHA	Centre for Environmental Health Activities
COD	Chemical oxygen demand
DO	Dissolved oxygen
EC_w	Electrical conductivity (of water)
FAO	Food and Agriculture Organization
FOG	Fat, oil and grease
JS	Jordanian Standard
MBAS	Methylene blue active substances
mg/L	Milligram per litre
MPN	Most probable number
SAR	Sodium adsorption ratio
TDS	Total dissolved solids
TSS	Total suspended solids
T-N	Total nitrogen
TC	Thermotolerant coliforms
TTCC	Total thermotolerant coliform count

Names and symbols for chemical compounds and elements

Al	Aluminium	Mg	Magnesium
NH_4	Ammonium	Mn	Manganese
NH_3-N	Ammonia Nitrogen	Hg	Mercury
Sb	Antimony	Mo	Molybdenum
As	Arsenic	Ni	Nickel
Ba	Barium	NO_3	Nitrate
Be	Beryllium	N	Nitrogen
HCO_3	Bicarbonate	PO_4	Phosphate
B	Boron	P	Phosphoros
Cd	Cadmium	Se	Selenium
Cl	Chlorine	Ag	Silver
Cr	Chromium	Na	Sodium
Co	Cobalt	SO_4	Sulfate
Cu	Copper	S	Sulfur
CN	Cyanide	Sn	Tin
F	Flouride	Ti	Titanium
Fe	Iron	W	Tungsten
Pb	Lead	V	Vanadium
Li	Lithium	Zn	Zinc

Introduction

This compendium provides an overview of the quality standards for the reuse of treated wastewater in countries of the Eastern Mediterranean Region. Information was collected through surveys and from the Centre for Environmental Health Activities (CEHA), who contacted countries requesting that ministries of health provide pertinent standards and regulations for wastewater reuse quality standards in their countries. Available standards are summarized for Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, Pakistan, Palestine, Saudi Arabia, Tunisia and Yemen. A summary of this information is shown in Table 1. Available wastewater reuse standards are listed in Tables 8–17 for Jordan, Kuwait, Saudi Arabia and Tunisia. No specific standards are promulgated for wastewater reuse in Egypt, Iraq, Lebanon, Pakistan or Palestine.

Tables 2–4 show the World Health Organization (WHO) and the Food and Agricultural Organization (FAO) reuse guidelines. Tables 5–7 show the recommended guidelines for water and greywater reuse as set by the regional consultation in Amman, Jordan in October 2003 which was held to review national priorities and action plans for wastewater reuse and management, organized by WHO and the Arab Fund for Economic and Social Development (AFESD).

Generally, wastewater reuse standards in countries of the Region are either adopted from WHO standards or other international standards without adapting them to suit local conditions. It is vitally essential that such adopted guidelines be adapted to prevailing epidemiological, sociocultural and environmental local conditions. Local studies are essential as they may result in a relaxation of the guidelines and thus augment the quantities of reclaimed water without compromising public health, or may result in the need for more stringent standards to protect public health. In either case, such studies are deemed necessary to ensure effective and safe implementation of wastewater reuse guidelines, as this will increase confidence in reclaimed water as a valuable resource.

Available standards for wastewater reuse in the Region

Table 1. A summary of available standards for water reuse in the Region

No	Country	Name of national regulation	Issuing agency	Year of issuance	Quality standards for	Remarks
1	Bahrain	–	–	–	–	WHO and FAO adopted guidelines (See Tables 2, 3 and 4).
2	Egypt	Decree No. (44) /2000–Amendment to Executive Bulletin of Law No. 93/1962 concerning discharge of liquid wastes.	Ministry of Housing, Utilities and Building Societies	2000	Liquid wastes	No specific standards exist for wastewater reuse.
3	Iraq	Environmental legislation.	Ministry of Health	1998	Environment	No specific standards exist for wastewater reuse.
4	Jordan	Treated domestic wastewater; JS893:1995.	Standards and Meteorology Corporation	2002	Treated domestic wastewater	See Tables 8, 9 and 10.
5	Kuwait	Annex No. (15), Decree No. (210), 2001.	Environment Public Authority	2001	Treated wastewater reuse for irrigation	See Table 11.
6	Lebanon	Ministry of Environment Decree No. 52/1–Standards for the minimization of pollution to air, water and soil.	Ministry of Environment	1996	Standards for urban wastewater minimum levels for treated domestic wastewater	No specific standards exist for wastewater reuse.
7	Oman	Ministerial Decision 145/93, dated 13 June 1993. Regulation for wastewater reuse and discharge.	Ministry of Regional Municipalities and Environment	1993	Wastewater reuse and discharge	See Tables 12, 13 and 14 (Unofficial translation).
8	Pakistan	–	–	–	–	No specific standards exist for wastewater reuse.

Table 1 (*cont.*) A summary of available standards for water reuse in the Region

No	Country	Name of national regulation	Issuing agency	Year of issuance	Quality standards for	Remarks
9	Palestine	–	–	–	–	No specific standards exist for wastewater reuse.
10	Saudi Arabia	Treated Wastewater and Reuse Bylaw No. 42, 2000.	Council of Ministers	2000	Treated wastewater and reuse	See Tables 15 and 16.
11	Tunisia	Treated wastewater use for agricultural purposes.	Ministry of Agriculture	1997	Treated wastewater	See Table 17.
12	Yemen	Proposed standards for treated wastewater in Yemen.	Yemeni Association for Standards Meteorology and Quality Control	2002	Treated wastewater	The proposed standards are an adoption of Jordanian Standards JS:893/1995.

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Table 2. WHO microbiological quality guidelines for wastewater use in agriculture[a]

Category	Reuse conditions	Exposed group	Intestinal nematodes[b] (arithmetic mean no of eggs per litre[c])	Faecal coliforms (geometric mean no per 100 mL[c])
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks[d]	Workers, consumers, public	≤ 1	≤ 1000[d]
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees[e]	Workers	≤ 1	No standard recommended
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account, and the guidelines modified accordingly.
[b] *Ascaris* and *Trichuris* species and hookworms.
[c] During the irrigation period.
[d] A more stringent guideline (≤ 200 faecal coliforms per 100 mL) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.
[e] In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

Table 3. FAO guidelines for trace metals in irrigation water[a]

Element	Recommended maximum concentration[b] (mg/L)	Remarks
Al	5.0	Can cause non-productivity in acid soils (pH <5.5), but more alkaline soils at pH > 7.0 will precipitate the ion and eliminate any toxicity.
As	0.10	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to > 0.05 mg/L for rice.
Be	0.10	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Cd	0.10	Toxic to beans, beets and turnips at concentrations as low as 0.1 mg/L in nutrient solutions. Conservative limits recommended due to its potential for accumulation in plants and soils to concentrations that may be harmful to humans.
Co	0.05	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Cr	0.10	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on its toxicity to plants.
Cu	0.20	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solutions.
F	1.0	Inactivated by neutral and alkaline soils.
Fe	5.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of availability of essential phosphorus and molybdenum. Overhead sprinkling may result in unsightly deposits on plants, equipment and buildings.
Li	2.5	Tolerated by most crops up to 5 mg/L; mobile in soil. Toxic to citrus at low concentrations (< 0.075 mg/L). Acts similarly to boron.
Mn	0.20	Toxic to a number of crops at a few tenths to a few mg/L, but usually only in acid soils.
Mo	0.01	Not toxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high concentrations of available molybdenum.
Ni	0.20	Toxic to a number of plants at 0.5 mg/L to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Pb	5.0	Can inhibit plant cell growth at very high concentrations.
Se	0.02	Toxic to plants at concentrations as low as 0.025 mg/L and toxic to livestock if forage is grown in soils with relatively high levels of added selenium. An essential element to animals but in very low concentrations.
Sn	–	Effectively excluded by plants; specific tolerance unknown.
Ti	–	Effectively excluded by plants; specific tolerance unknown.
W	–	Effectively excluded by plants; specific tolerance unknown.
V	0.10	Toxic to many plants at relatively low concentrations.
Zn	2.0	Toxic to many plants at widely varying concentrations; reduced toxicity at pH > 6.0 and in fine textured or organic soils.

Sources: Food and Agriculture Organization. *Water quality for agriculture. Irrigation and Drainage Paper 29 Rev. 1*, 1985.

[a] Adapted from National Academy of Sciences (1972) and Pratt (1972).

[b] The maximum concentration is based on a water application rate which is consistent with good irrigation practices (10 000 m^3 per hectare per year). If the water application rate greatly exceeds this, the maximum concentrations should be adjusted downward accordingly. No adjustment should be made for application rates less than 10 000 m^3 per hectare per year. The values given are for water used on a continuous basis at one site.

Table 4. FAO guidelines for interpretation of water quality for irrigation[a]

Potential irrigation problem	Units	Degree of restriction on use		
		None	Slight to moderate	Severe
Salinity (affects crop water availability)[b]				
ECw	dS/m	< 0.7	0.7–3.0	> 3.0
(or)				
TDS	mg/L	< 450	450–2000	> 2000
Infiltration (affects infiltration rate of water into the soil. Evaluate using EC_w and SAR together)[c]				
SAR = 0–3 and EC_w =		> 0.7	0.7–0.2	< 0.2
= 3–6 =		> 1.2	1.2–0.3	< 0.3
= 6–12 =		> 1.9	1.9–0.5	< 0.5
= 12–20 =		> 2.9	2.9–1.3	< 1.3
= 20–40 =		> 5.0	5.0–2.9	< 2.9
Specific ion toxicity (affects sensitive crops)				
Na [d]	SAR	< 3.0	3.0–9.0	> 9.0
Surface irrigation	mg/L	< 69.0	> 69.0	–
Sprinkler irrigation				
Cl [d]	mg/L	< 142.0	142.0–355.0	> 355.0
Surface irrigation	mg/L	< 106.5	> 106.5	–
Sprinkler irrigation	mg/L	< 0.7	0.7–3.0	> 3.0
B [e]				
Trace element (See Table)				
Miscellaneous effects (affects susceptible crops)	mg/L	< 5.0	5.0–30.0	> 30.0
NO_3–N [f]	mg/L	< 9.5	91.5–518.5	> 518.5
HCO_3 (overhead sprinkling only)		Normal range 6.5–8.4		
pH				

Sources: Food and Agriculture Organization. *Water quality for agriculture. Irrigation and Drainage Paper 29 Rev. 1*, 1985.

[a] Adapted from University of California Committee of Consultants 1974.

[b] EC_w means electrical conductivity, a measure of the water salinity, reported in deciSiemens per metre at 25 °C (dS/m) or in units millimohs per centimetre (mmho/cm). Both are equivalent. TDS means total dissolved solids, reported in milligrams per litre (mg/L).

[c] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNa. See Figure 1 for the SAR calculation procedure. At a given SAR, infiltration rate increases as water salinity increases. Evaluate the potential infiltration problem by SAR as modified by EC_w. Adapted from Rhoades 1977, and Oster and Schroer 1979.

[d] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chloride; use the values shown. Most annual crops are not sensitive; use the salinity tolerance tables (Tables 4 and 5). For chloride tolerance of selected fruit crops, see Table 14 in (http://www.fao.org/ag). With overhead sprinkler irrigation and low humidity (< 30%), sodium and chloride may be absorbed through the leaves of sensitive crops. For crop sensitivity to absorption, see Tables 18, 19 and 20 in (http://www.fao.org/ag).

[e] For boron tolerances, see Tables 16 and 17 in (http://www.fao.org/ag).

[f] NO_3-N means nitrate nitrogen reported in terms of elemental nitrogen (NH_4-N and Organic-N should be included when wastewater is being tested).

Table 5. Recommended guidelines for treated wastewater in agriculture[a]

Category	Reuse conditions	Exposed group	Irrigation technique	Intestinal nematodes[b] and larvae of *Strongyloides stercoralis* (larvae/eggs per litre[c])	Thermotolerant coliforms[d] (geometric mean no per 100 mL[c])	Wastewater treatment expected to achieve required microbiological quality
	Unrestricted irrigation					
A	For vegetable and salad crops eaten uncooked, sports fields, public parks[e]	Workers, consumers, public	Any	< detection	≤ 10^3	Waste stabilization ponds with a retention time of 21 days or secondary treatment followed by equivalent storage or slow sand filtration or equivalent
B	**Restricted irrigation**					
	Cereal crops, industrial crops, fodder crops, pasture and trees[f]	Workers, nearby communities	Spray or sprinkler	< detection	≤ 10^5	As for category A
		Workers, nearby communities	Flood/furrow	< detection	≤ 10^3 [g]	As for category A
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Trickle, drip or bubbler	Not applicable	Not applicable	Pre-treatment as required by the irrigation technology, but not less than primary sedimentation

Source: Report of the WHO/AFESD *Regional consultation to review national priorities and action plans for wastewater reuse and management* (WHO-EM/CEH/106/E).

[a] In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account and the guidelines modified accordingly.

[b] *Ascaris* and *Trichuris* species and hookworms; the guideline limit is also intended to protect against risks from parasitic protozoa.

[c] Guideline values are given for design purposes. They should be achieved during the planning and design stages for effluent reuse projects, and not used as a standard specification for monitoring effluent quality and samples collection.

[d] Scientific studies suggested that *Escherichia coli* (*E.coli*) is the preferred indicator of faecal contamination. *E. coli* is approximately equivalent to 90% of the faecal coliforms. (TTA/CEHA).

[e] A more stringent guideline limit (≤ 200 thermotolerant coliforms/100 mL) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.

[f] In the case of fruit trees, irrigation should stop two weeks before fruit is picked, and no fruit should be picked off the ground. Spray/sprinkler irrigation should not be used.

[g] In cases where the treatment method fails to achieve the guideline limit, use thermotolerant coliforms < 10^5, provided that precautions are taken such as protective clothes, crop restriction and providing a buffer zone between the irrigated area and nearby communities.

Table 6. The permitted limit for greywater reuse according to the use type

Test	Permitted limit		
	(A) Irrigation of ornamental fruit trees and fodder crops	**(B) Irrigation of vegetables likely to be eaten uncooked**	**(C) Toilet flushing**
BOD_5 (mg/L)	≤ 240	≤ 20	≤ 10
Sample number	Sample/month	Two samples/month	Sample/week
TSS (mg/L)	≤ 140	≤ 20	≤ 10
Sample number	Sample/month	Two samples/month	Sample/week
Thermotolerant coliforms (cfu/100 mL)	≤ 1000	≤ 200	≤ 10
Sample number	Two samples/month	Sample/two weeks	Sample/week

Source: Report on the WHO/AFESD regional consultation to review national priorities and action plans for wastewater reuse and management (WHO-EM/CEH/106/E).

Table 7. Risk analysis of reuse

Variable	Risk		
	Low	**Intermediate**	**High**
Population	Small population (single family)	–	Large population (multiple occupancy)
Exposure	No body contact (subsurface irrigation)	Some contact (toilet flushing, bathing	Ingestion (drinking)
Dose-response	< 1 virus per sample < 1 virus per sample	–	> 1 virus per sample > 10^6 bacteria per sample
Delay before reuse	Immediate reuse	Reuse within 48 hours	Reuse after 2 days

Source: Report of the WHO/AFESD *Regional consultation to review national priorities and action plans for wastewater reuse and management* (WHO-EM/CEH/106/E).

Wastewater reuse standards in some countries of the Region

Jordan

Table 8. Jordanian Standard (JS: 893/2002) for discharge to streams, storage

Parameter	Unit	Discharge to streams, wadis and water storage areas	Ground water recharge
Group A			
BOD_5	mg/L	60.0[a]	15.0
COD	mg/L	150.0[b]	50.0
DO	mg/L	> 1.0	> 2.0
TSS	mg/L	60.0[b]	50.0
pH	unit	6.0–9.0	6.0–9.0
Turbidity	NTU	–	2.0
NO_3	mg/L	45.0	30.0
NH_4	mg/L	-	5.0
T-N	mg/L	70.0	45.0
E. coli	MPN/100 mL	1000.0	< 2.2
Intestinal helminth eggs	egg/L	≤ 1.0	≤ 1.0
FOG	mg/L	8.0	–
Group B			
Phenol	mg/L	< 0.002	< 0.002
MBAS	mg/L	25.0	25.0
TDS	mg/L	1500.0	1500.0
Total PO_4	mg/L	15.0	15.0
Cl	mg/L	350.0	350.0
SO_4	mg/L	300.0	300.0
HCO_3	mg/L	400.0	400.0
Na	mg/L	200.0	200.0
Mg	mg/L	60.0	60.0
Ca	mg/L	200.0	200.0
SAR	mg/L	6.0	6.0
Al	mg/L	2.0	2.0
As	mg/L	0.05	0.05
Be	mg/L	0.1	0.1
Cu	mg/L	0.2	0.2
F	mg/L	1.5	1.5
Fe	mg/L	5.0	5.0
Li	mg/L	2.5	2.5
Mn	mg/L	0.2	0.2
Mo	mg/L	0.01	0.01
Ni	mg/L	0.2	0.2
Pb	mg/L	0.2	0.2
Se	mg/L	0.05	0.05
Cd	mg/L	0.01	0.01
Zn	mg/L	5.0	5.0
Cr	mg/L	0.02	0.02
Hg	mg/L	0.002	0.002
V	mg/L	0.1	0.1
Co	mg/L	0.05	0.05
B	mg/L	1.0	1.0

[a]: BOD_5 measured as soluble for waste stabilization ponds effluents and those with polishing ponds and as total for all others.

[b]: Twice this value may be allowed for effluents of waste stabilization ponds and those with polishing ponds.

Table 9. Jordanian Standard (JS: 893/2002) for effluent reuse for agricultural irrigation, 1

Parameter	Unit	Cooked vegetables, parking areas, playgrounds and side of roads inside cities	Plenteous trees and green areas, side of roads outside cities	Field crops, industrial crops and forestry
Group		**A**	**B**	**C**
BOD_5	mg/L	30.0	200	300
COD	mg/L	100	500	500
DO	mg/L	> 2.0	–	–
TSS	mg/L	50.0	150	150
pH	unit	6.0–9.0	6.0–9.0	6.0–9.0
Turbidity	NTU	10.0	–	–
NO_3	mg/L	30.0	45.0	45.0
T-N	mg/L	45.0	70.0	70.0
E. coli	MPN/100 mL	100	1000	–
Intestinal helminth eggs	egg/L	≤ 1.0	≤ 1.0	≤ 1.0

Table 10. Jordanian Standard (JS: 893/2002) for effluent reuse for agricultural irrigation, 2

Parameter (mg/L)	Guideline values (maximum permissible)
FOG	8.0
Phenol	< 0.002
MBAS	100.0
TDS	1500.0
Total PO_4	30.0
Cl	400.0
SO_4	500.0
HCO_3	400.0
Na	230.0
Mg	100.0
Ca	230.0
SAR	9.0
Al	5.0
As	0.1
Be	0.1
Cu	0.2
F	1.5
Fe	5.0
Li	2.5 (0.075 for citrus crop)
Mn	0.2
Mo	0.01
Ni	0.2
Pb	5.0
Se	0.05
Cd	0.01
Zn	5.0
Cr	0.1
Hg	0.002
V	0.1
Co	0.05
B	1.0

Kuwait

Table 11. Treated wastewater criteria for reuse in Kuwait

Parameter	Maximum allowable
pH	6.5–8.5
BOD_5 (5 days, 20 °C)	20.0
COD (dichromate)	100.0
FOG	5.0
TSS	15.0
TDS	1500.0
PO_4	30.0
NH3-N	15.0
Total Kjeldahl nitrogen	35.0
Total recoverable phenol	1.0
F	25.0
S	0.1
Cl_2	0.5–1.0
DO	> 2.0
Hydrocarbons	5.0
Floatables	Nil
Al	5.0
As	0.1
Ba	2.0
B	2.0
Cd	0.01
Cr	0.15
Ni	0.2
Hg	0.002
Co	0.2
Fe	5.0
Sb	–
Cu	0.2
Mn	0.2
Zn	2.0
Pb	0.5
Most probable number of total coliforms	400.0
Most probable number of faecal coliforms (MPN/100 mL)	20.0
Egg parasites (no/litre)	< 1.0
Worm parasites	Absent

Source: Annex No. (15), Decree No. (210), 2001.
All units are in mg/L except where noted otherwise.

Oman

Table 12. Regulations for wastewater reuse and discharge (145/193, 1993), Oman

Parameter	Standards (see Table 14)	
	A	B
BOD (5 days at 20 °C)	15.0	20.0
COD	150.0	200.0
TSS	15.0	30.0
TDS	1500.0	2000.0
EC (micro S/cm)	2000.0	2700.0
SAR[a]	10.0	10.0
pH (within range)	6.0–9.0	6.0–9.0
Al	5.0	5.0
As	0.1	0.1
Ba	1.0	2.0
Be	0.100	0.300
B	0.500	1.0
Cd	0.010	0.010
Cl	650.0	650.0
Cr	0.050	0.050
Co	0.050	0.050
Cu	0.050	1.0
CN	0.05	0.100
F	1.0	2.0
Fe	1.0	5.0
Pb	0.100	0.200
Li	0.070	0.070
Mg	150.0	150.0
Mn	0.100	0.500
Hg	0.001	0.001
Mo	0.01	0.05
Ni	0.100	0.100
Ammoniacal (as N)	5.0	10.0
Nitrate (as NO_3)	50.0	50.0
Organic (Kjeldahl) (as N)	5.0	10.0
FOG (total extractable)	0.500	0.500
Phenols (total)	0.001	0.002
P	30.0	30.0
Se	0.02	0.02
Ag	0.010	0.010
Na	200.0	300.0
SO_4	400.0	400.0
S	0.0100	0.010
V	0.100	0.100
Zn	5.0	5.0
Faecal coliform bacteria (per 100 mL)	200.0	1000.0
Viable nematode ova (per litre)	< 1.0	< 1.0

[a]:The effect of sodium as soil absorption.

All units are in mg/L excepted where noted otherwise.

Table 13. Sludge standards for land application (145/193, 1993), Oman

Metal	Maximum concentration (mg/kg of dry solids)	Maximum application rate (kg/ha per year)[a]	Maximum concentration (mg/kg of dry solids)
Cd	20.0	0.15	3.0
Cr	1000.0	10.0	400.0
Cu	1000.0	10.0	150.0
Pb	1000.0	15.0	30.0
Hg	20.0	0.100	1.0
Mo	20.0	0.100	3.0
Ni	300.0	3.0	75.0
Se	50.0	0.15	5.0
Zn	3000.0	15.0	300.0

After the spreading of sludge there must be a minimum period of 3 weeks before grazing or harvesting of forage crops.

Sludge use is prohibited:

– on soils while fruit or vegetable crops, other than fruit trees, are growing or being harvested.

– for 6 months preceding the harvesting of fruit or vegetables which grow in contact with the soil and which are normally eaten raw.

– on soils with a pH < 7.0.

[a] Based on a 10-year average and a soil pH > 7.0.

Table 14. Reuse groups specified for Table 12

Group	A	B
	(See Table 12)	
Crops	Vegetables likely to be eaten raw Fruit likely to be eaten raw and within 2 weeks of any irrigation	Vegetables to be cooked or processed Fruit if no irrigation within 2 weeks of cropping Fodder, cereal and seed crops
Grass and ornamental areas	Public parks, hotel lawns and recreational areas Areas with public access Lakes with public contact (except places which may be used for praying and hand washing)	Pasture Areas with no public access
Aquifer recharge	All controlled aquifer recharge	
Method of irrigation	Spray or any other method of aerial irrigation not permitted in areas with public access unless with timing control	
Any other reuse applications	Subject to the approval of the Ministry	

Saudi Arabia

Table 15. Reclaimed water standards for unrestricted irrigation in Saudi Arabia

Parameter	Maximum concentration
Physical characteristics	
Floating material	Nil
TSS	10.0
pH (SU)	6.0–8.5
Chemical characteristics–organic	
BOD_5	10.0
Turbidity (NTU)	5.0
FOG	Nil
Phenol	0.002
Chemical characteristics	
Al	5.00
As	0.1
Be	0.1
B	0.5
Ba	1.0
Cd	0.01
Cl_2	0.2
Cr	0.1
Co	0.05
Cu	0.4
CN	0.05
F	1.0
Fe	2.0
Pb	0.1
Ag	0.5
Li	0.07
Mn	0.2
Hg	0.001
Mo	0.01
Ni	0.2
Se	0.02
Va	0.1
Zn	2.0
NO_3	10.0
Cl	100.0
SO_4	600.0
NH_3	5.0
Microbiological characteristics	
TTCC (MPN/100 mL)	2.2
Living intestinal nematodes (no/litre)	1.0

Source: Treated Wastewater and Reuse Bylaw No. 42, 2000.
All units are in mg/L unless indicated otherwise.

Table 16: Reclaimed water standards for restricted irrigation in Saudi Arabia

Parameter	Maximum concentration
BOD_5	40.0
TSS	40.0
TDS	2000
TTCC (MPN/100 mL)	1000
Living intestinal nematodes (no/litre)	1.0

Tunisia

Table 17. Tunisian Standards, NT 106–03 (1989)

Parameters	Maximum allowable
PH	6.5 to 8.5
Conductivity	7000 (μs/cm)
COD	90.0[a]
BOD_5	30.0[a]
TSS	30.0
Cl	2000
Fluorides	3.0
Organic chlorine	0.001
As	0.1
B	3.0
Cd	0.01
Co	0.1
Cr	0.1
Cu	0.5
Fe	0.5
Mg	0.5
Hg	0.001
Ni	0.2
Pb	1.0
Se	0.05
Zn	5.0
Arithmetic average of intestinal nematode eggs	$\leq$ 1 (per 1000 mL)

Source: Tunisian Standard NT 106.03 (1989).

[a]: 24-hour composite sample.

All units are in mg/L unless indicated otherwise.