Overview on Existing Regulations for Treated Wastewater Reuse purposes

Within the framework of the Zer0-M project (financed by the Euro-Mediterranean Regional Programme for Local Water Management (Contract No. 2001 0515 59768)) the following laws, guidelines and regulations have been identified to handle wastewater, untreated, treated, or segregated. The different existing legislations can be divided according to figure 1.

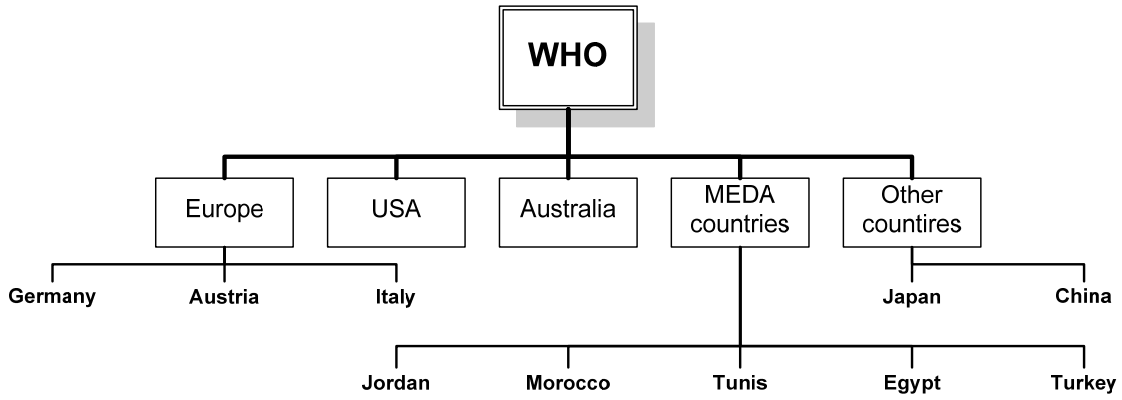

Fig. 1: overview of investigated legislations

WHO	
Official name	Guidelines for the safe use of wastewater, excreta and greywater.
In force since	2006, 3rd edition
Area of reference	ISBN: 92 4 154686 7 (set)
Scope	The WHO Guidelines are an integrated preventive management framework for maximizing the public health benefits of wastewater, excreta and greywater use in agriculture and aquaculture. The Guidelines are built around a health component and an implementation component. Health protection is dependent on both elements. **Health component:** • establishes a risk level associated with each identified health hazard; • defines a level of health protection that is expressed as a health-based target for each risk; • identifies health protection measures that, used collectively, can achieve the specified health-based target. **Implementation component:** • establishes monitoring and system assessment procedures; • defines institutional and oversight responsibilities; • requires system documentation; • requires confirmation by independent surveillance.
Monitoring scope	The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a health protection measure is operating within design specifications (e.g. for wastewater treatment turbidity). Emphasis is given to monitoring parameters that can be measured quickly and easily and that can indicate if a process is functioning properly. Operational monitoring data should help managers to make corrections that can prevent hazard break-through.

Volume 1: Policy and regulatory aspects	
Scope	The information in this volume is meant to give policy-makers and regulators an overview of the risks and benefits associated with the use of wastewater, excreta and greywater in agriculture and aquaculture without going into technical detail. It also presents an overview of the nature and scope of options for protecting public health. This information should be useful in the development of national policies for the safe use of wastewater, excreta and greywater. Detailed technical information on health risk assessment, health protection measures and monitoring and evaluation is presented in Volumes 2, 3 and 4.
Main Policy Issues	• *Public health*: To what extent is waste management addressed in national public health policies? What are the specific health hazards and risks associated with the use of wastewater, excreta and/or greywater in agriculture and aquaculture? Is there a national health impact assessment policy? Is there a policy basis for nontreatment interventions in line with the concepts and procedures contained in the Stockholm Framework? • *Environmental protection*: To what extent and how is the management of wastewater, excreta and greywater addressed in the existing environmental protection policy framework? What are the current status, trends and expected outlook with respect to the production of wastewater, excreta and greywater? What is the capacity to management wastewater, excreta and greywater? What are the current and potential environmental impacts? What are the options for reuse in agriculture or aquaculture? • *Food security*: What are the objectives and criteria laid down in the national policies for food security? Is water a limiting factor in ensuring national food security in the short/medium/long term? Are there real opportunities for the use of wastewater, excreta and greywater in agriculture and aquaculture to (partially) address this problem? Is reuse currently practiced in the agricultural production system? Has an analysis of the benefits and risks of such waste use been carried out?
Volume 2: Wastewater use in agriculture	
Scope	The primary aim of the Guidelines is to maximize public health protection and the beneficial use of important resources. The purpose of this volume of the Guidelines is to ensure that the use of wastewater in agriculture is made as safe as possible, so that the nutritional and household food security benefits can be shared widely within communities whose livelihood depends on wastewater-irrigated agriculture. Thus, the adverse health impacts of wastewater use in agriculture should be carefully weighed against the benefits to health and the environment associated with these practices. Yet this is not a matter of simple trade-offs. Wherever wastewater use in agriculture contributes significantly to food security and nutritional status, the point is to identify associated hazards, define the risks they represent to vulnerable groups and design measures aimed at reducing these risks. Volume 2 of the Guidelines is intended to be used as the basis for the development of international and national approaches (including standards and regulations) to managing the health risks from hazards associated with wastewater use in agriculture, as well as providing a

<table>
<tr><td></td><td colspan="4">framework for national and local decision-making. The information provided is applicable to the intentional use of wastewater in agriculture and is also relevant where faecally contaminated water is used for irrigation unintentionally.
The Guidelines provide an integrated preventive management framework for safety applied from the point of wastewater generation to the consumption of products grown with the wastewater and excreta. They describe reasonable minimum requirements of good practice to protect the health of the people using wastewater or excreta or consuming products grown with wastewater or excreta and provide information that is then used to derive health-based targets. Neither the minimum good practices nor the health-based targets are mandatory limits. The preferred approaches adopted by national or local
authorities towards implementation of the Guidelines, including health-based targets, may vary depending on local social, cultural, environmental and economic conditions, as well as knowledge of routes of exposure, the nature and severity of hazards and the effectiveness of health protection measures available.</td></tr>
<tr><td>Summary of health risks associated with the use of wastewater for irrigation</td><td>exposed group</td><td>Nematode infection</td><td>Bacteria/viruses</td><td>Protozoa</td></tr>
<tr><td></td><td>Consumers</td><td>Significant risk of Ascaris infection for both adults and children with untreated wastewater</td><td>Cholera, typhoid and shigellosis outbreaks reported from use of untreated wastewater; seropositive responses for Helicobacter pylori (untreated); increase in non-specific diarrhoea when water quality exceeds 10^4 thermotolerant coliforms/100 ml
Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission</td><td>Evidence of parasitic protozoa found on wastewater-irrigated vegetable surfaces, but no direct evidence of disease transmission</td></tr>
<tr><td></td><td>Farm workers and their families</td><td>Significant risk of Ascaris infection for both adults and children in contact with untreated wastewater; risk remains, especially for children, when wastewater treated to <1 nematode egg per litre; increased risk of hookworm infection in workers</td><td>Increased risk of diarrhoeal disease in young children with wastewater contact if water quality exceeds 10^4 thermotolerant coliforms/100 ml; elevated risk of Salmonella infection in children exposed to untreated wastewater; elevated seroresponse to norovirus in adults exposed to partially treated wastewater</td><td>Risk of Giardia intestinalis infection was insignificant for contact with both untreated and treated wastewater; increased risk of amoebiasis observed with contact with untreated wastewater</td></tr>
<tr><td></td><td>Nearby communities</td><td>Ascaris transmission not studied for sprinkler irrigation, but same as above for flood or furrow irrigation with heavy contact</td><td>Sprinkler irrigation with poor water quality (10^6–10^8 total coliforms/100 ml) and high aerosol exposure associated with increased rates of infection; use of partially treated water (10^4–10^5 hermotolerant coliforms/100 ml or less) in sprinkler irrigation is not associated with increased viral</td><td>No data on transmission of protozoan infections during sprinkler irrigation with wastewater</td></tr>
</table>

infection rates

Health-based targets for wastewater use in agriculture

Exposure scenario	Health-based target (disability adjusted life year (DALY) per person per year)	Log10 pathogen reduction needed[a]	Number of helminth eggs per litre
Unrestricted irrigation	$\leq 10^{-6}$ [a]		
Lettuce		6	≤ 1 [b,c]
Onion		7	≤ 1 [b,c]
Restricted irrigation	$\leq 10^{-6}$ [a]		
Highly mechanized		3	≤ 1 [b,c]
Labour intensive		4	≤ 1 [b,c]
Localized (drip) irrigation	$\leq 10^{-6}$ [a]		
High-growing crops		2	No recommendation [d]
Low-growing crops		4	≤ 1 [c]

a Rotavirus reduction. The health-based target can be achieved, for unrestricted and localized irrigation, by a 6–7 log unit pathogen reduction (obtained by a combination of wastewater treatment and other health protection measures); for restricted irrigation, it is achieved by a 2–3 log unit pathogen reduction.

b When children under 15 are exposed, additional health protection measures should be used (e.g. treatment to ≤0.1 egg per litre, protective equipment such as gloves or shoes/boots or chemotherapy).

c An arithmetic mean should be determined throughout the irrigation season. The mean value of ≤1 egg per litre should be obtained for at least 90% of samples in order to allow for the occasional highvalue sample (i.e. with >10 eggs per litre). With some wastewater treatment processes (e.g. waste stabilization ponds), the hydraulic retention time can be used as a surrogate to assure compliance with ≤1 egg per litre.

d No crops to be picked up from the soil.

Maximum tolerable soil concentrations of various toxic chemicals based on human health protection

Chemical	Soil concentration (mg/kg)
Element	
Antimony	36
Arsenic	8
Barium[a]	302
Beryllium[a]	0.2
Boron[a]	1.7
Cadmium	4
Fluorine	635
Lead	84
Mercury	7
Molybdenum[a]	0.6
Nickel	107
Selenium	6
Silver	3
Thallium[a]	0.3
Vanadium[a]	47
Organic compound	
Aldrin	0.48
Benzene	0.14
Chlordane	3
Chlorobenzene	211
Chloroform	0.47
2,4-D	0.25
DDT	1.54
Dichlorobenzene	15
Dieldrin	0.17
Dioxins	0.00012
Heptachlor	0.18
Hexachlorobenzene	1.40
Lindane	12
Methoxychlor	4.27
PAHs (as benzo[*a*]pyrene)	16
PCBs	0.89
Pentachlorophenol	14
Phthalate	13733
Pyrene	41
Styrene	0.68
2,4,5-T	3.82
Tetrachloroethane	1.25
Tetrachloroethylene	0.54
Toluene	12
Toxaphene	0.0013
Trichloroethane	0.68

a The computed numerical limits for these elements are within the ranges that are typical for soils.

<table>
<tr><td></td><td></td></tr>
<tr><td>Main Policy Issues</td><td>• Policy:
Are there clear policies on the use of wastewater? Is wastewater use encouraged or discouraged?
• Legislation:
Is the use of wastewater governed in legislation? What are the rights and responsibilities of different stakeholders? Does a defined jurisdiction exist on the use of wastewater?
• Institutional framework:
Which ministry/agency, organizations, etc. have the authority to control the use of wastewater at the national level and at the district/community level? Are the responsibilities of different ministries/ agencies clear? Is there one lead ministry, or are there multiple ministries/ agencies with overlapping jurisdictions? Which ministry/agency is responsible for developing regulations? Which ministry/agency monitors compliance with regulations? Which ministry/agency enforces the regulations?
• Regulations:
Do regulations exist? Are the current regulations adequate to meet wastewater use objectives (protect public health, prevent environmental damage, meet produce quality standards for domestic and international trade, preserve livelihoods, conserve water and nutrients, etc.)? Are the current regulations being implemented? Is regulatory compliance being enforced? Which ministry/agency enforces the regulations?</td></tr>
<tr><td colspan="2">Volume 3: Wastewater and excreta use in aquaculture</td></tr>
<tr><td>Scope</td><td>The primary aim of the Guidelines is to maximize public health protection and the beneficial use of important resources. The purpose of this volume is to ensure that waste-fed aquacultural activities are made as safe as possible so that the nutritional and household food security benefits can be shared widely in affected communities. Thus, the adverse health impacts of waste-fed aquaculture should be carefully weighed against the benefits to health and the environment associated with these practices. Yet this is not a matter of simple trade-offs. Wherever waste-fed aquaculture contributes significantly to food security and nutritional status, the point is to identify associated hazards, define the risks they represent to vulnerable groups and design measures aimed at reducing these risks.
This volume of the Guidelines is intended to be used as the basis for the development of international and national approaches (including standards and regulations) to managing the health risks from hazards associated with waste-fed aquaculture, as well as providing a framework for national and local decision-making. The information provided is applicable to intentional waste-fed aquacultural practices but also should be relevant to the unintentional use of faecally contaminated waters for aquaculture.</td></tr>
<tr><td>Health-based targets for waste-fed aquaculture</td><td>
<table>
<tr><th>Exposed group</th><th>Hazard</th><th>Health-based targeta</th><th>Health protection measure</th></tr>
<tr><td>Consumers, workers and local communities</td><td>Excreta-related diseases</td><td>10^{-6} DALY</td><td>Wastewater treatment
Excreta treatment
Health and hygiene promotion
Chemotherapy and immunization</td></tr>
<tr><td>Consumers</td><td>Excreta-related diseases</td><td>10^{-6} DALY</td><td>Produce restriction
Waste</td></tr>
</table>
</td></tr>
</table>

		Foodborne trematodes	Absence of trematode infections	application/timing Depuration Food handling and
		Chemicals	Tolerable daily intakes as specified by the Codex Alimentarius Commission	preparation Produce washing/disinfection Cooking foods
	Workers and local communities	Excreta-related pathogens	10^{-6} DALY	Access control Use of personal protective
		Skin irritants	Absence of skin disease	equipment Disease vector control Intermediate host
		Schistosomes	Absence of schistosomiasis	control Access to safe drinking-water and sanitation at
		Vector-borne pathogens	Absence of vectorborne disease	aquacultural facilities and in local communities Reduced vector contact (insecticide-treated nets, repellents)
	[a] Absence of disease associated with waste-fed aquaculture-related exposures.			
Main Policy Issues	In developing a national policy framework to facilitate safe waste-fed aquaculture, it is important to define the objectives of the policy, assess the current policy environment and develop a national approach. National approaches for safe waste-fed aquacultural practices based on the WHO Guidelines will protect public health the most when they are integrated into comprehensive public health programmes that include other sanitary measures, such as health and hygiene promotion and improving access to safe drinkingwater and adequate sanitation. Other complementary programmes, such as chemotherapy campaigns, should be accompanied by health promotion/education to change behaviours that would otherwise lead to reinfection with foodborne trematodes or intestinal helminths. National approaches need to be adapted to the local sociocultural, environmental and economic circumstances, but they should be aimed at progressive improvement of public health. Interventions that address the greatest local health threats first should be given the highest priority. As resources and new data become available, additional health protection measures can be introduced.			
Volume 4: Excreta and greywater use in agriculture				
Scope	The primary aim of the Guidelines is to maximize public health protection and the beneficial use of important resources. The purpose of this volume is to ensure that the use of excreta and greywater in agriculture is made as safe as possible so that the nutritional and household food security benefits can be shared widely in affected communities. Thus, the adverse health impacts of excreta and greywater use in agriculture should be carefully weighed against the benefits to health and the environment associated with these practices. Yet this is not a matter of simple trade-offs. Wherever excreta and greywater use contributes significantly to food security and nutritional status, the point is to identify associated hazards, define the risks they represent to vulnerable groups and design measures aimed at reducing these risks. Volume 4 of the Guidelines is intended to be used as the basis for the development of international and national approaches (including standards and regulations) to managing the health risks from hazards associated with excreta and greywater use in agriculture, as well as			

providing a framework for national and local decision-making. The information provided is applicable to the intentional use of excreta and greywater in agriculture, but it should also be relevant to their unintentional use. The Guidelines provide an integrated preventive management framework for safety applied from the point of household excreta and greywater generation to the consumption of products grown with treated excreta applied as fertilizers or treated greywater used for irrigation purposes. They describe reasonable minimum requirements of good practice to protect the health of the people using treated excreta or greywater or consuming products grown with these for fertilization or irrigation purposes and provide information that is then used to derive health-based targets. Neither the minimum good practices nor the health-based targets are mandatory limits. The preferred approaches adopted by national or local authorities towards implementation of the Guidelines, including health-based targets, may vary depending on local social, cultural, environmental and economic conditions, as well as knowledge of routes of exposure, the nature and severity of hazards and the effectiveness of health protection measures available.

Verification monitoring in large-scale treatment systems of greywater, excreta and faecal sludge for use in agriculture

	Helminth eggs (number per gram total solids or per litre)	***E. coli* (number per 100 ml)**
Treated faeces and faecal sludge	<1/g total solids	<1000/g total solids
Greywater for use in:		
• Restricted irrigation	<1/litre	$<10^{5;\,a}$ Relaxed to $<10^6$ when exposure is limited or regrowth is likely
• Unrestricted irrigation of crops eaten raw	<1/litre	$<10^3$ Relaxed to $<10^4$ for high-growing leaf crops or drip irrigation

[a] These values are acceptable due to the regrowth potential of *E. coli* and other faecal coliforms in greywater.

Recommendations for storage treatment of dry excreta and faecal sludge before use at the household and municipal levels

Treatment	**Criteria**	**Comment**
Storage; ambient temperature 2-20°C	1.5–2 years	Will eliminate bacterial pathogens; regrowth of *E. coli* and *Salmonella* may need to be considered if rewetted; will reduce viruses and parasitic protozoa below risk levels. Some soil-borne ova may persist in low numbers.
Storage; ambient temperature >20-35°C	>1 year	Substantial to total inactivation of viruses, bacteria and protozoa; inactivation of schistosome eggs (<1 month); inactivation of nematode (roundworm) eggs, e.g. hookworm (*Ancylostoma*/*Necator*) and whipworm (*Trichuris*); survival of a certain percentage (10–30%) of *Ascaris* eggs (≥4 months), whereas a more or less complete inactivation of *Ascaris* eggs will occur within 1 year.
Alkaline treatment pH > 9	during >6 months	If temperature >35 °C and moisture <25%, lower pH and/or wetter material will prolong the time for absolute elimination.

Recommended storage times for urine mixture[a] based on estimated pathogen content[b] and recommended crops for larger systems[c]

Storage temperature (°C)	**Storage time (months)**	**Possible pathogens in the urine mixture after storage**	**Recommended crops**
4	≥1	Viruses, protozoa	Food and fodder crops that are to be processed
4	≥6	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥1	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥6	Probably none	All crops[e]

a Urine or urine and water. When diluted, it is assumed that the urine mixture has a pH of at least 8.8 and a nitrogen concentration of at least 1 g/l.

b Gram-positive bacteria and spore-forming bacteria are not included in the underlying risk assessments, but are not normally recognized as a cause of any infections of concern.

c A larger system in this case is a system where the urine mixture is used to fertilize crops that will be consumed by individuals other than members of the household from whom the urine was collected.

d Not grasslands for production of fodder.

e For food crops that are consumed raw, it is recommended that the urine be applied at least one month before harvesting and that it be incorporated into the ground if the edible parts grow above the soil surface.

Main Policy Issues	In developing a national policy framework to facilitate the safe use of excreta as fertilizer, it is important to define the objectives of the policy, assess the current policy environment and develop a national approach. National approaches for adequate sanitation based on the WHO Guidelines will protect public health optimally when they are integrated into comprehensive public health programmes that include other sanitary measures, such as health and hygiene promotion and improving access to safe drinkingwater. National approaches need to be adapted to the local sociocultural, environmental and economic circumstances, but they should be aimed at progressive improvement of public health. Interventions that address the greatest local health threats first should be given the highest priority. As resources and new data become available, additional health protection measures can be introduced.

<table>
<tr><th colspan="2">European Legislation</th></tr>
<tr><td>Official name</td><td>Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

Measures are required under the following directives (for the complete list, please refer to annex VI, part A in the directive):
The Drinking Water Directive (80/778/EEC) as amended by Directive (98/83/EC)
The Sewage Sludge Directive (86/278/EEC)
The Urban Waste-water Treatment Directive (91/271/EEC)
The Integrated Pollution Prevention Control Directive (96/61/EC)
The Bathing Water Directive (76/160/EEC)</td></tr>
<tr><td>In force since</td><td>22. 12. 2000</td></tr>
<tr><td>Area of reference</td><td>All EU member states</td></tr>
<tr><td>Scope</td><td>All inland waters (surface- and groundwater), transitional and coastal waters</td></tr>
<tr><td>Monitoring scope</td><td>Streams basins > 10 km^2, lakes area > 50 ha</td></tr>
<tr><td>Common objective</td><td>Preventing deterioration of all water bodies</td></tr>
<tr><td>Environmental objectives</td><td>Surface waters: Good status, the result of a good chemical status and a good ecological status
Groundwater: Good status, the result of a good chemical status and a good quantitative status</td></tr>
<tr><td>Thresholds for surface waters</td><td>Chemical status: Quality values of 32 priority substances
Ecological status: Slightly deviation of undisturbed conditions of phytho-plankton, macropyhthes, macrozoobenthos, fishes</td></tr>
<tr><td>Thresholds for groundwater</td><td>Chemical status: Nitrate 50 mg/l and pesticides 0,1 ug/l (under discussion, not approved)
Quantitative status: Groundwater abstraction has to be lower than its creation</td></tr>
<tr><th colspan="2">The Drinking Water Directive (1998/83/EC)</th></tr>
<tr><td>Parameters and Parametric Values</td><td>Microbiological parameters:
<table>
<tr><td>Parameter</td><td>Parametric value (number/100 ml)</td></tr>
<tr><td>Escherichia coli (E. coli)</td><td>0</td></tr>
<tr><td>Enterococci</td><td>0</td></tr>
</table>
The following applies to water offered for sale in bottles or containers:
<table>
<tr><td>Parameter</td><td>Parametric value</td></tr>
<tr><td>Escherichia coli (E. coli)</td><td>0/250 ml</td></tr>
<tr><td>Enterococci</td><td>0/250 ml</td></tr>
<tr><td>Pseudomonas aeruginosa</td><td>0/250 ml</td></tr>
<tr><td>Colony count</td><td>22 ºC 100/ml</td></tr>
<tr><td>Colony count</td><td>37 ºC 20/ml</td></tr>
</table>
Chemical parameters:
<table>
<tr><td>Parameter</td><td>Parametric value</td><td>Notes</td></tr>
<tr><td>Acrylamide</td><td>0.10 µg/l</td><td>Note 1</td></tr>
<tr><td>Antimony</td><td>5.0 µg/l</td><td></td></tr>
<tr><td>Arsenic</td><td>10 µg/l</td><td></td></tr>
<tr><td>Benzene</td><td>1.0 µg/l</td><td></td></tr>
</table></td></tr>
</table>

	Benzo(a)pyrene	0.010 µg/l	
	Boron	1.0 mg/l	
	Bromate	10 µg/l	Note 2
	Cadmium	5.0 µg/l	
	Chromium	50 µg/l	
	Copper	2.0 mg/l	Note 3
	Cyanide	50 µg/l	
	1,2-dichloroethane	3.0 µg/l	
	Epichlorohydrin	0.10 µg/l	Note 1
	Fluoride	1.5 mg/l	
	Lead	10 µg/l	Notes 3 and 4
	Mercury	1.0 µg/l	
	Nickel	20 µg/l	Note 3
	Nitrate	50 mg/l	Note 5
	Nitrite	0.50 mg/l	Note 5
	Pesticides	0.10 µg/l	Notes 6 and 7
	Pesticides — Total	0.50 µg/l	Notes 6 and 8
	Polycyclic aromatic hydrocarbons	0.10 µg/l	Sum of concentrations of specified compounds; Note 9
	Selenium	10 µg/l	
	Tetrachloroethene and Trichloroethene	10 µg/l	Sum of concentrations of specified parameters
	Trihalomethanes — Total	100 µg/l	Sum of concentrations of specified compounds; Note 10
	Vinyl chloride	0.50 µg/l	Note 1

Note 1: The parametric value refers to the residual monomer concentration in the water as calculated according to specifications of the maximum release from the corresponding polymer in contact with the water.

Note 2: Where possible, without compromising disinfection, Member States should strive for a lower value. For the water referred to in Article 6(1)(a), (b) and (d), the value must be met, at the latest, 10 calendar years after the entry into force of the Directive. The parametric value for bromate from five years after the entry into force of this Directive until 10 years after its entry into force is 25 µg/l.

Note 3: The value applies to a sample of water intended for human consumption obtained by an adequate sampling method (1) at the tapand taken so as to be representative of a weekly average value ingested by consumers. Where appropriate the sampling and monitoring methods must be applied in a harmonised fashion to be drawn upin accordance with Article 7(4). Member States must take account of the occurrence of peak levels that may cause adverse effects on human health.

Note 4: For water referred to in Article 6(1)(a), (b) and (d), the value must be met, at the latest, 15 calendar years after the entry into force of this Directive. The parametric value for lead from five years after the entry into force of this Directive until 15 years after its entry into force is 25 µg/l. Member States must ensure that all appropriate measures are taken to reduce the concentration of lead in water intended for human consumption as much as possible during the period needed to achieve compliance with the parametric value. When implementing the measures to achieve compliance with that value Member States must progressively give priority where lead concentrations in water intended for human consumption are highest.

Note 5: Member States must ensure that the condition that [nitrate]/50 + [nitrite]/3 ≤ 1, the square brackets signifying the concentrations in mg/l for nitrate (NO3) and nitrite (NO2), is complied with and that the value of 0,10 mg/l for nitrites is complied with ex water treatment works.

Note 6: 'Pesticides' means:

— organic insecticides,
— organic herbicides,
— organic fungicides,
— organic nematocides,
— organic acaricides,
— organic algicides,
— organic rodenticides
— organic slimicides,
— related products (*inter alia*, growth regulators) and their relevant metabolites, degradation and reaction products. Only those pesticides which are likely to be present in a given supply need be monitored.

Note 7: The parametric value applies to each individual pesticide. In the case of aldrin, dieldrin, heptachlor and heptachlor epoxide the parametric value is 0,030 µg/l.

Note 8: 'Pesticides — Total' means the sum of all individual pesticides detected and quantified in the monitoring procedure.

Note 9: The specified compounds are:

— benzo(b)fluoranthene,
— benzo(k)fluoranthene,
— benzo(ghi)perylene,
— indeno(1,2,3-cd)pyrene.

Note 10: Where possible, without compromising disinfection, Member States should strive for a lower value. The specified compounds are: chloroform, bromoform, dibromochloromethane, bromodichloromethane. For the water referred to in Article 6(1)(a), (b) and (d), the value must be met, at the latest, 10 calendar years after the entry into force of this Directive. The parametric value for total THMs from five years after the entry into force of this Directive until 10 years after its entry into force is 150 µg/l. Member States must ensure that all appropriate measures are taken to reduce the concentration of THMs in water intended for human consumption as much as possible during the period needed to achieve compliance with the parametric value. When implementing the measures to

achieve this value, Member States must progressively give priority to those areas where THM concentrations in water intended for human consumption are highest.

Indicator parameters

Parameter	Parametric value	Notes
Aluminium	200 µg/l	
Ammonium	0.50 mg/l	
Chloride	250 mg/l	Note 1
Clostridium perfringens (including spores)	0 number/100 ml	Note 2
Colour	Acceptable to consumers and no abnormal change	
Conductivity	2500 µS cm^{-1} at 20 ºC	Note 1
Hydrogen ion concentration	≥ 6.5 and ≤ 9.5 pH units	Notes 1 and 3
Iron	200 µg/l	
Manganese	50 µg/l	
Odour Acceptable to consumers and no abnormal change		
Oxidisability	5.0 mg/l O_2	Note 4
Sulphate	250 mg/l	Note 1
Sodium	200 mg/l	
Taste	Acceptable to consumers and no abnormal change	
Colony count 22º	No abnormal change	
Coliform bacteria	0 number/100 ml	Note 5
Total organic carbon (TOC)	No abnormal change	Note 6
Turbidity	Acceptable to consumers and no abnormal change	Note 7
RADIOACTIVITY		
Tritium	100 Bq/l	Notes 8 and 10
Total indicative dose	0.10 mSv/year	Notes 9 and 10

Note 1: The water should not be aggressive.
Note 2: This parameter need not be measured unless the water originates from or is influenced by surface water. In the event of non-compliance with this parametric value, the Member State concerned must investigate the supply to ensure that there is no potential danger to human health arising from the presence of pathogenic micro-organisms, e.g. cryptosporidium. Member States must include the results of all such investigations in the reports they must submit under Article 13(2).
Note 3: For still water put into bottles or containers, the minimum value may be reduced to 4,5 pH units. For water put into bottles or containers which is naturally rich in or artificially enriched with carbon dioxide, the minimum value may be lower.
Note 4: This parameter need not be measured if the parameter TOC is analysed.
Note 5: For water put into bottles or containers the unit is number/250 ml.
Note 6: This parameter need not be measured for supplies of less than 10 000 m3 a day.
Note 7: In the case of surface water treatment, Member States should strive for a parametric value not exceeding 1,0 NTU (nephelometric turbidity units) in the water ex treatment works.
Note 8: Monitoring frequencies to be set later in Annex II.
Note 9: Excluding tritium, potassium -40, radon and radon decay products; monitoring frequencies, monitoring methods and the most relevant locations for monitoring points to be set later in Annex II.
Note 10: The proposals required by Note 8 on monitoring frequencies, and Note 9 on monitoring frequencies, monitoring methods and the most relevant locations for monitoring points in Annex II shall be adopted in accordance with the procedure laid down in Article 12. When elaborating these proposals the Commission shall take into account *inter alia* the relevant provisions under existing legislation or appropriate monitoring programmes including monitoring results as derived from them. The Commission shall submit these proposals at the latest within 18 months following the date referred to in Article 18 of the Directive.

The Sewage Sludge Directive (86/278/EEC)

Limit Values for Heavy-Metal in Sludge

Parameters	Limit values (mg/kg of dry matter)
Cadmium	20 to 40
Copper	1000 to 1750
Nickel	300 to 400
Lead	750 to 1200
Zinc	2500 to 4000
Mercury	16 to 25
Chromium(1)	—

(1) It is not possible at this stage to fix limit values for chromium. The Council will fix these limit values later onthe basis of proposals to be submitted by the Commission within one year following notification of this Directive.

The Urban Waste-water Treatment Directive (91/271/EEC)

Scope:
Article 4

(1) Member States shall ensure that urban waste water entering collecting systems shall before discharge be subject to secondary treatment or an equivalent treatment as follows:

— at the latest by 31 December 2000 for all discharges from agglomerations of more than 15 000 p.e.,
— at the latest by 31 December 2005 for all discharges from agglomerations of between 10 000 and 15 000 p.e.,
— at the latest by 31 December 2005 for discharges to fresh-water and estuaries from agglomerations of between 2 000 and 10 000 p.e.

(2) Urban waste water discharges to waters situated in high mountain regions (over 1 500 m above sea level) where it is difficult to apply an effective biological treatment due to low temperatures may be subjected to treatment less stringent than that prescribed in paragraph (1), provided that detailed studies indicate that such discharges do not adversely affect the environment.

Requirements for discharges from urban waste water treatment plants

Parameters	Concentration	Minimum percentage of reduction(1)	Reference method of measurement
Biochemical oxygen demand (BOD_5 at 20ºC) without nitrification(2)	25 mg/l O_2	70-90, 40 under Article 4 (2)	Homogenized, unfiltered, undecanted sample. Determination of dissolved oxygen before and after five-day incubation at 20 ºC ± 1 ºC, in complete darkness. Addition of a nitrification inhibitor
Chemical oxygen demand (COD)	125 mg/l O_2	75	Homogenized, unfiltered, undecanted sample Potassium dichromate
Total suspended solids	35 mg/l(3)	90(3)	— Filtering of a representative sample through a 0,45 μm filter membrane. Drying at 105 ºC and weighing
	35 under Article 4 (2) (> 10 000 p.e.)	90 under Article 4 (2) (more than 10 000 p.e.)	
	60 under Article 4 (2) (2 000-10 000 p.e.)	70 under Article 4 (2) (2 000-10 000 p.e.)	— Centrifuging of a representative sample (for at least five mins with mean acceleration of 2800 to 3200 g), drying at 105 ºC and weighing

(1) Reduction in relation to the load of the influent.
(2) The parameter can be replaced by another parameter: total organic carbon (TOC) or total oxygen demand (TOD) if a relationship can be established between BOD_5 and the substitute parameter.
(3) This requirement is optional.

Discharge into Sensitive Areas

Parameters	Concentration	Minimum percentage of reduction(1)	Reference method of measurement
Total phosphorus	2 mg/l (10 000 — 100 000 p.e.)	80	Molecular absorption spectrophotometry
	1 mg/l (more than 100 000 p.e.)		
Total nitrogen(2)	15 mg/l (10000 — 100000p.e.)(3)	70-80	Molecular absorption spectrophotometry
	10 mg/l (> 100000 p.e.)(3)		

(1) Reduction in relation to the load of the influent.
(2) Total nitrogen means the sum of total Kjeldahl nitrogen (organic and ammoniacal nitrogen) nitrate-nitrogen and nitrite-nitrogen.
(3) These values for concentration are annual means as referred to in Annex I, paragraph D.4(c). However, the requirements for nitrogen may be checked using daily averages when it is proved, in accordance with Annex I, paragraph D.1, that the same level of protection is obtained. In this case, the daily average must not exceed 20 mg/l of total nitrogen for all the samples when the temperature from the effluent in the biological reactor is superior or equal to 12 ºC. The conditions concerning temperature could be replaced by a limitation on the time of operation to take account of regional climatic conditions.

The Integrated Pollution Prevention Control Directive (96/61/EC)

Considerations when

1. the use of low-waste technology;
2. the use of less hazardous substances;
3. the furthering of recovery and recycling of substances generated and used in the

<table>
<tr><td>determining best available techniques</td><td>process and of waste, where appropriate;
4. comparable processes, facilities or methods of operation which have been tried with success on an industrial scale;
5. technological advances and changes in scientific knowledge and understanding;
6. the nature, effects and volume of the emissions concerned;
7. the commissioning dates for new or existing installations;
8. the length of time needed to introduce the best available technique;
9. the consumption and nature of raw materials (including water) used in the process and their energy efficiency;
10. the need to prevent or reduce to a minimum the overall impact of the emissions on the environment and the risks to it;
11. the need to prevent accidents and to minimize the consequences for the environment;
12. the information published by the Commission pursuant to Article 16 (2) or by international organizations.</td></tr>
<tr><td>Main Polluting Substances</td><td>Water
1. Organohalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphorus compounds
3. Organotin compounds
4. Substances and preparations which have been proved to possess carcinogenic or mutagenic properties or properties which may affect reproduction in or via the aquatic environment
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances
6. Cyanides
7. Metals and their compounds
8. Arsenic and its compounds
9. Biocides and plant health products
10. Materials in suspension
11. Substances which contribute to eutrophication (in particular, nitrates and phosphates)
12. Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.).</td></tr>
<tr><td colspan="2">The Bathing Water Directive (2006/7/EC)</td></tr>
<tr><td>Hygienic Parameters</td><td>For inland waters
<table>
<tr><th>Parameter</th><th>Excellent quality</th><th>Good quality</th><th>Sufficient</th><th>Reference methods of analysis</th></tr>
<tr><td>Intestinal enterococci (cfu/100 ml)</td><td>200 (*)</td><td>400 (*)</td><td>330 (**)</td><td>ISO 7899-1 or ISO 7899-2</td></tr>
<tr><td>Escherichia coli (cfu/100 ml)</td><td>500 (*)</td><td>1000 (*)</td><td>900 (**)</td><td>ISO 9308-3 or ISO 9308-1</td></tr>
</table>
For coastal waters and transitional waters
<table>
<tr><th>Parameter</th><th>Excellent quality</th><th>Good quality</th><th>Sufficient</th><th>Reference methods of analysis</th></tr>
<tr><td>Intestinal enterococci (cfu/100 ml)</td><td>100 (*)</td><td>200 (*)</td><td>185 (**)</td><td>ISO 7899-1 or ISO 7899-2</td></tr>
<tr><td>Escherichia coli (cfu/100 ml)</td><td>250 (*)</td><td>500 (*)</td><td>500 (**)</td><td>ISO 9308-3 or ISO 9308-1</td></tr>
</table>
(*) Based upon a 95-percentile evaluation.
(**) Based upon a 90-percentile evaluation.</td></tr>
</table>

MEDA Countries	
Area of reference	MEDAWARE project (http://www.uest.gr/medaware), national laws and directives
Scope	This table gives an overview of the existing legislative in the MEDA partner counties, especially: • Egypt, • Jordan, • Morocco, • Tunisia, • Turkey.
Mediterranean guidelines	Because of the absence of comprehensive international guidelines and of a scientific consensus, a proposal of common guidelines on water reuse in all Mediterranean countries should be made. These guidelines, proposed by *Bahri* and *Brissaud* (2003) and *Blumenthal et al.* (2000) are based on the consideration that: (a) an agricultural Mediterranean market is developing with large amounts of agricultural products (vegetables, fruits, etc) imported and exported among Europe and other Mediterranean countries; (b) tourism is an essential part of the economic activity of the region; its development might be jeopardized in the long term by disease outbreaks linked to wastewater mismanagement; (c) there is a growing concern of consumers about the food quality and health hazards; (d) unfair competition among farmers should be avoided. Mediterranean guidelines are minimum requirements which should constitute the basis of water reuse regulations in every country of the region. Wealthy countries might wish higher protection. Due to late development of wastewater treatment in several countries, all of them cannot be expected to comply with the guidelines within the same time frame. However, every country could commit itself to reach the guidelines within this period depending on its current equipment and financial capacities. Only four categories of reclaimed water uses are considered, apart from groundwater recharge, in order to facilitate the implementation of the guidelines and take cost effective water reuse into account. Water quality criteria are proposed for non potable water reuse categories I to IV. (a) Category I: urban and residential reuses, landscape and recreational impoundments. (b) Category II: unrestricted irrigation, landscape impoundments (contact with water not allowed), and industrial reuses. (c) Category III: restricted agricultural irrigation. (d) Category IV: irrigation with recycled water application systems or methods (drip, subsurface, etc) providing a high degree of protection against contamination and using water more efficiently. Groundwater recharge guidelines depend on whether the aquifer water is potable or not, the intended use of non potable recharged aquifer, the technique of recharge and the hydrogeological context.

Recommended microbiological guidelines for water reuse in the Mediterranean region, (Source: Adapted from *Bahri* and *Brissaud*, 2003)

	Quality criteria			
Water category	**Intestinal nematode[a] (No. eggs per liter)**	**FC or E. coli[b] (cfu/100 ml)**	**SS[c] (mg/L)**	**Wastewater treatment expected to meet the criteria**
Category I				
a) Residential reuse: private garden watering, toilet flushing, vehicle washing. b) Urban reuse: irrigation of areas with free admittance (greenbelts, parks, golf courses, sport fields), street cleaning, fire-fighting, fountains, and other recreational places. c) Landscape and recreational impoundments: ponds, water bodies and streams for recreational purposes, where incidental contact is allowed (except for bathing purposes).	0 - 0.1[h]	0 – 200[d]	0 - 10	Secondary treatment + filtration + disinfection
Category II				
a) Irrigation of vegetables (surface or sprinkler irrigated), green fodder and pasture for direct grazing, sprinkler-irrigated fruit trees b) Landscape impoundments: ponds, water bodies and ornamental streams, where public contact with water is not allowed. c) Industrial reuse (except for food industry).	0 - 0.1[h]	0 – 1000[d]	0 - 20 0 - 150[f]	Secondary treatment or equivalent[g] + filtration + disinfection or Secondary treatment or equivalent[g] + either storage or well-designed series of maturation ponds or infiltration percolation
Category III				
Irrigation of cereals and oleaginous seeds, fibre, & seed crops, dry fodder, green fodder without direct grazing, crops for canning industry, industrial crops, fruit trees (except sprinkler-irrigated), plant nurseries, ornamental nurseries, wooden areas, green areas with no access to the public.	0 - 0.1[h]	None required	0 - 350 0 - 150[f]	Secondary treatment or equivalent[g] + a few days storage or Oxidation pond systems
Category IV				
a) Irrigation of vegetables (except tuber, roots, etc.) with surface and subsurface trickle systems (except micro-sprinklers) using practices (such as plastic mulching, support, etc.) guaranteeing absence of contact between reclaimed water and edible part of vegetables. b) Irrigation of crops in category III with trickle irrigation systems (such as drip, bubbler, microsprinkler and subsurface). c) Irrigation with surface trickle irrigation systems of greenbelts and green areas with no access to the public. d) Irrigation of parks, golf courses, sport fields with sub-surface irrigation systems.	None required	None required	Pretreatment as required by the irrigation technology, but not less than primary sedimentation	

(a) Ascaris and Trichuris species and hookworms; the guideline limit is also intended to protect against risks from parasitic protozoa.
(b) FC or E. coli (CFU/100 ml): faecal coliforms or Escherichia coli (cfu: colony forming unit/100 ml).
(c) SS: Suspended solids.
(d) Values must be conformed at the 80% of the samples per month, minimum number of samples 5.
(e) In the case of fruit trees, irrigation should stop two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.
(f) Stabilization ponds.
(g) Such as advanced primary treatment (APT).
(h) As very few investigations, if any, have been carried out on how to reach < 0.1 nematode egg /l, this criterion is considered a medium term objective and is provisionally replaced by <1 nematode egg l.

Egypt

Institutional	Several ministries are directly and indirectly involved in water quality

Framework	activities for planning, operations, research, monitoring and regulation. An inventory of these agencies has been prepared to identify their mandates, responsibilities, activities and facilities in connection with water quality. Figure 1 presents a schematic summary of this inventory. The main ministries and agencies are : • Ministry of Water Resources and Irrigation • Egyptian Environmental Affairs Agency • Ministry of Health and Population • Ministry of Agriculture and Land Reclamation • Ministry of Industry, General Organization for Industry (gofi) • Ministry of Scientific Research • Ministry of Housing, Utilities and New Communities • Ministry of Local Development, Organisation for the Restructure and Development of Egyptian Villages (ordev).
Main Policy Issues	The Executive Statutes of the present law shall determine the specifications, controls, and the minimum limits. Establishments wishing to extend the prescribed time limit for making the required adjustments are to submit their applications to the EEAA. The applications shall include justifications for such an extension and the procedures taken for the implementation of the provisions of the attached Executive Regulations. Substantial management laws and ministerial decrees were enacted during the seventies era such as Law 48/1982 concerning protection of the River Nile and waterways from pollution , Law 102/1983 concerning natural protectorates , Law 137/ 1981 concerning labor , and Law 3/1982 of urban planning. In 1982, the presidential decree number 631 was issued and the Egyptian Environmental Affairs Agency (EEAA) was established as the coordinating body for environmental policy making in Egypt. Egypt also participated in various regional and international relevant conventions and protocols. During the last two decades, several environmental plans, such as Environmental Action Plan, 1992, were drafted and several laws and ministerial decrees concerning the environment, such as Law 4/1994 were issued. This law is composed of 10 Sections divided into 100 articles. The introductory section concerns the environment and is divided into General Regulations, Environmental Affairs and Environmental Protection Fund. The 10 sections are entitled as follows: Land pollution control, i.e. development and environment, materials and toxic waste (1); Air pollution control (2); Water pollution control (3); Penalties (4); Concluding regulations (5); Report of the Joint Committee (composed of delegates from the following ministries: Health Affairs, Environment, Constitution, Industry, Energy, Agriculture and Irrigation, Local Administration) (6); Clarifying note for the drafting of Law on Environmental protection (7); Clarifying note on the drafting of Law on air pollution control (8); Clarifying note for the drafting of Law on water pollution control (9). The latter provides the EEAA broad authority to use of the Environmental Impact Assessment (EIA) process in the context of licensing new expansion, or rehabilitation projects, based upon the following main principles: 1- Type of activities performed 2- extent of natural resources exploitation

<table>
<tr><td></td><td>3- location
4- Type of energy used to operate
Three categories according to severity of possible environmental impact were identified as follows:
1- white list projects (for establishments with minor environmental impact)
2- grey list projects (for establishments which may result in substantial environmental impacts)
3- black list projects (for establishments which require full EIA due to their potential impact).

In 1997, a specific Minister of State for the environmental affairs was appointed. Nevertheless, the Egyptian environmental performance shades light on drawbacks in legislations. Law 4/1994 demonstrates little emphasis to issues, such as environmental risks and costs whereas little is known about the economic and social costs for environmental compliance, variations in environmental performance, and carrying capacity, the existing pollution levels of ambient water and air quality (Gomaa, S. (1997), "Environmental Policy Making in Egypt", AUC, Cairo.)</td></tr>
<tr><td>NAWQAM, (2004). Operational Drainage Water Reuse Guidelines, DR-TR-0103-006-DR</td><td>
Water quality standards for drainage water reuse
<table>
<tr><th>Parameter</th><th>Unit</th><th>permissible level</th></tr>
<tr><td>Boron</td><td>mg/l</td><td>3</td></tr>
<tr><td>Nitrate (NO_3)</td><td>mg/l</td><td>30</td></tr>
<tr><td>Sulphate (SO_4)</td><td>mg/l</td><td>1000</td></tr>
<tr><td>Chloride</td><td>mg/l</td><td>100-700</td></tr>
<tr><td>BOD_5</td><td>mgO_2/l</td><td>40</td></tr>
<tr><td>Fecal Coliform</td><td>(CFU/100ml)</td><td>1000</td></tr>
<tr><td>Inorganic elements</td><td></td><td></td></tr>
<tr><td>Aluminum</td><td>mg/l</td><td>5</td></tr>
<tr><td>Cadmium</td><td>mg/l</td><td>0.01</td></tr>
<tr><td>Cobalt</td><td>mg/l</td><td>0.05</td></tr>
<tr><td>Copper</td><td>mg/l</td><td>0.2-1.0</td></tr>
<tr><td>Iron</td><td>mg/l</td><td>5</td></tr>
<tr><td>Manganese</td><td>mg/l</td><td>0.2</td></tr>
<tr><td>Nickel</td><td>mg/l</td><td>0.2</td></tr>
<tr><td>Lead</td><td>mg/l</td><td>5</td></tr>
<tr><td>Zinc</td><td>mg/l</td><td>1.0-5.0</td></tr>
<tr><td>Organic Compounds</td><td></td><td></td></tr>
<tr><td>Benzene</td><td>mg/l</td><td>2.5</td></tr>
<tr><td>Phenol</td><td>mg/l</td><td>2</td></tr>
<tr><td>Atrazine</td><td>mg/l</td><td>0.01</td></tr>
</table>
Irrigation water Quality Guidelines
<table>
<tr><th>Parameter</th><th>Min</th><th>Max</th><th>Cropping Restriction</th></tr>
<tr><td rowspan="4">EC dS/m</td><td>< 0.5</td><td></td><td>Sensitive crops to salinity</td></tr>
<tr><td>0.5</td><td>1.5</td><td>Moderately sensitive crops</td></tr>
<tr><td>1.5</td><td>4</td><td>Moderately tolerant crops</td></tr>
<tr><td>4</td><td>6</td><td>Tolerant crops</td></tr>
<tr><td rowspan="4">SAR</td><td></td><td>>6</td><td>Unusable or can be used with tolerant and moderately tolerant crops with reduction in crop yield</td></tr>
<tr><td>< 5</td><td></td><td>Sensitive crops</td></tr>
<tr><td>5</td><td>9</td><td>Moderately sensitive crops</td></tr>
<tr><td>9</td><td>15</td><td>Moderately tolerant crops</td></tr>
<tr><td></td><td>> 15</td><td>Tolerant crops</td></tr>
<tr><td rowspan="3">Boron mg/l</td><td>< 0.7</td><td></td><td>Sensitive crops</td></tr>
<tr><td>0.7</td><td>3</td><td>Moderately sensitive crops</td></tr>
<tr><td></td><td>>3</td><td>Tolerant crops</td></tr>
</table>
</td></tr>
<tr><td>Criteria and Specifications when Discharged into the Marine</td><td>Without prejudice to the provisions of Law No. 48 of 1982 concerning the Protection of the River Nile and its Executive Regulations, the discharge of the substances indicated hereunder shall not exceed the levels indicated in the opposite column.
In all cases, discharge into the marine environment is not permitted except at a minimum distance of 500 meters from the shoreline and may not interfere</td></tr>
</table>

<table>
<tr><td>Environment</td><td>with fishing zones, bathing zones or nature reserves in order to preserve the economic or aesthetic value of the area.
<table>
<tr><th>Item</th><th>Maximum limits of Criteria and Specifications (mg/Ltr-unless otherwise indicated.)</th></tr>
<tr><td>Temperature</td><td>Not to exceed 10 degrees over the prevailing rate.</td></tr>
<tr><td>PH</td><td>6 - 9</td></tr>
<tr><td>Colour</td><td>Free of colouring materials</td></tr>
<tr><td>Biochemical Oxygen Demand (BOD)</td><td>60</td></tr>
<tr><td>Chemical Oxgyen Demand (COD)</td><td>100</td></tr>
<tr><td>Total Dissolved Solids</td><td>2000</td></tr>
<tr><td>Volatile Solids</td><td>1800</td></tr>
<tr><td>Suspended materials</td><td>60</td></tr>
<tr><td>Turbidity</td><td>NTU 50</td></tr>
<tr><td>Sulphides</td><td>1</td></tr>
<tr><td>Oil and Greases</td><td>15</td></tr>
<tr><td>Hydrocarbons of oil origin</td><td>0.5</td></tr>
<tr><td>Phosphates</td><td>5</td></tr>
<tr><td>Nitrates</td><td>40</td></tr>
<tr><td>Phenolates</td><td>1</td></tr>
<tr><td>Fluoride</td><td>1</td></tr>
<tr><td>Aluminium</td><td>3</td></tr>
<tr><td>Ammonia (nitrogen)</td><td>3</td></tr>
<tr><td>Mercury</td><td>0.005</td></tr>
<tr><td>Lead</td><td>0.5</td></tr>
<tr><td>Cadmium</td><td>0.05</td></tr>
<tr><td>Arsenic</td><td>0.05</td></tr>
<tr><td>Chromium</td><td>1</td></tr>
<tr><td>Copper</td><td>1.5</td></tr>
<tr><td>Nickel</td><td>0.1</td></tr>
<tr><td>Iron</td><td>1.5</td></tr>
<tr><td>Manganese</td><td>1</td></tr>
<tr><td>Zinc</td><td>5</td></tr>
<tr><td>Silver</td><td>0.1</td></tr>
<tr><td>Barium</td><td>2</td></tr>
<tr><td>Cobalt</td><td>2</td></tr>
<tr><td>Pesticides</td><td>0.2</td></tr>
<tr><td>Cyanide</td><td>0.1</td></tr>
<tr><td>Estimated Fecal Coliform Count in 100 cm3</td><td>5000</td></tr>
</table></td></tr>
<tr><td>Law No. 48 of 1982 concerning the protection of the Nile River and the water channels against pollution</td><td>This Law is divided into 20 articles. To be applied in what is considered water channels: (a) fresh water areas include the Nile River, 2 branches and canals with its different degrees; (b) non fresh water areas include water channels with its different degrees, lakes, pools and water in closed system; (c) undergroundwater reservoir (art. 1). It is forbidden to discharge in water channels solid, liquid or gaseous waters from private dwellings, shops, commercial, industrial and tourist establishments or from sanitary drainage without a licence from the Ministry of Irrigation according to the Ministry of Public Health (art. 2). The owners of House-Boats and tourist House-Boats standing on the Nile River or its tow branches are requested to find a system to treat or gather the wastes and discharge them in the sewage drain or in the</td></tr>
</table>

<table>
<tr><td></td><td>sanitary drain (art. 5). The Ministry of Irrigation is responsible to issue licences for the new houseboats on the Nile and renewal of existing licences (art. 6). It is forbidden for Ferry Boat Units used for transportation, tourist or other to discharge their sewage and bilge waters in the channels. (art. 7) Precaution is to be taken by the Ministry of Agriculture when choosing pesticides to abate agricultural pests (art. 10). Precaution is to be taken by the Ministry of Irrigation when choosing herbicides to abate water herbs (art. 11). It is not allowed to reuse water channels directly or mixed with water for any purpose, unless it is proved valid for use (art. 12). The Implementing Regulation of this Law will fix due fees without exceeding the maximum amount mentioned in the attached statement and will also fix expenses for executing regulations of this Law (art. 15). The Ministry of Irrigation will issue the Implementing Regulation of this Law after consulting the concerned Ministries within three months from the publication of the Law (art. 17). Articles 10-12, 16, and 19 are now cancelled from Law no. 93 of 1962 concerning liquid waste discharge and any regulation contradicting the regulations of this Law (art. 18).</td></tr>
<tr><td>Permissible Limits of Wastewater Discharge</td><td>
<table>
<tr><td>Parameter</td><td>Unit</td><td>Value</td></tr>
<tr><td>pH</td><td>-</td><td>7-8.5</td></tr>
<tr><td>Temperature</td><td>°C</td><td>5 °C above ambient</td></tr>
<tr><td>Colour</td><td>-</td><td>Colorless</td></tr>
<tr><td>Dissolved oxygen</td><td>mg/l</td><td>>2</td></tr>
<tr><td>BOD</td><td>mg/l</td><td><20</td></tr>
<tr><td>COD (permenganate mehtod)</td><td>mg/l</td><td><30</td></tr>
<tr><td>COD (dichromate mehtod)</td><td>mg/l</td><td><60</td></tr>
<tr><td>Suspended solids</td><td>mg/l</td><td><20</td></tr>
<tr><td>Sulfides</td><td>mg/l</td><td><0.5</td></tr>
<tr><td>Oil and grease</td><td>mg/l</td><td><2</td></tr>
<tr><td>Nitrite</td><td>mg/l</td><td>Nil</td></tr>
<tr><td>Total heavy metals (as lead)</td><td>mg/l</td><td><1.5</td></tr>
<tr><td>Microscopic analysis</td><td>-</td><td>Free</td></tr>
<tr><td>E. Coli</td><td>-</td><td><100/100C.C</td></tr>
<tr><td>Pesticides</td><td>mg/l</td><td>free</td></tr>
</table>
Wastewater treatment regulations
• Minimum requirement for wastewater treatment is the primary treatment including sedimentation.
• Although, some wastewater treatment plants are using sophisticated treatment systems including primary, secondary and tertiary treatment units (e.g., disinfection, by chlorine, unit).
</td></tr>
<tr><td>Permissible Limits for Irrigation Water</td><td>
<table>
<tr><td>Classes of water</td><td>Concentration, total dissolved solids</td><td>Concentration</td></tr>
</table>
</td></tr>
</table>

	1. Class Excellent	250	175	20	4	4
	2. Class Good	250-750	175-525	20-40	4-7	4-7
	3. Class Permissible	750-2000	525-1400	40-60	7-12	7-12
	4. Class Doubtful	2000-3000	1400-2100	60-80	12-20	12-20
	5. Class Unsuitable	3000	2100	80	20	20

Wastewater Reuse Regulation

Parameter	Unit	1st group Primary treated water	2nd group Secondary treated water	3rd group Advanced treated water
BOD5	mg/l	300	40	20
COD (dichromate)	mg/l	600	80	40
TSS	mg/l	350	40	20
Oil and grease	mg/l	Not limited	10	5
Number of cells or eggs of Nimatoda	Count/l	5	1	1
E.Coli count	100/ml	Not limited	1000	100
TDS	mg/l	2500	2000	2000
Na absorption ratio	%	25	20	20
Cl-	mg/l	350	300	300
B	mg/l	5	3	3

Parameter	Unit	1st group Primary treated water	2nd group Secondary treated water	3rd group Advanced treated water
Cd	ppm	0.05	0.01	0.01
Pb	ppm	10	5	5
Cu	ppm	Not limited	0.2	0.2
Ni	ppm	0.5	0.2	0.2
Zn	ppm	Not limited	2	2
Sn	ppm	Not limited	Not limited	0.1
Cr	ppm	Not limited	Not limited	0.1
Mo	ppm	Not limited	0.01	0.01
Mn	ppm	0.2	0.2	0.2
Fe	ppm	Not limited	5	5
Co	ppm	Not limited	0.05	0.05

Jordan

Institutional Framework	Wastewater collection, transportation, treatment, disposal and reuse receive the greatest concern by the health authorities in the Ministry of Health (MOH). The MOH realizes that protection and promotion of human health of the public can't be guaranteed and safeguarded without monitoring wastewater and controlling its use. Therefore, all possible and applicable measures are enforced to prevent any illegal use of wastewater or any use of treated effluents in a manner that may endanger the public health. The Public Health Law No. 54 from 2002 is the legislative tool through which the Ministry undertakes all actions to safeguard the health of the people. Other agencies and organization, like Water Authority of Jordan and Ministry of

Environment, participate in the monitoring programs at varying levels. Details of each monitoring program are following:-

Ministry of Health (MOH)

The Ministry of Health has the most intensive and comprehensive monitoring program among other agencies. This program consists of:

1- periodic and regular health inspection of the treatment plants to make sure that no adverse health effects are resulting from any plant regardless of the owner of the plant, public or private sectors.
2- Medical health examination of the workers in the plants is conducted on regular basis to discover any symptoms or ill effects of the exposed people. Treatment of sick people is administered if deemed necessary.
3- Health education of the workers in the treatment plants as well as to the farmers and the public.
4- Sampling and testing of both raw sewage and treated effluents, with emphasis on the latter.

The results of testing are compared for compliance with the Jordanian standard No. 893/2002 for the use of treated wastewater in irrigation.

Water Authority of Jordan (WAJ)
(WAJ) owns and operates 19 treatment plants. The monitoring program, which is run by the water authority, covers these plants only. The goal of their program is to ensure that the plants are functioning well and that the treated waters meet the requirements set in the Jordanian standard for different uses. The components of their program are similar to those of MOH with respect to laboratory analysis only.
Recently (WAJ) has established the Water Reuse & Environment Unit as the permitting, monitoring and standard setting Authority in Jordan for both municipal and industrial reuse program, the unit also plays strong role in the water reuse projects and in the Environmental Impact Assessment and in the environment issues and water resources protection .

Ministry of Environment (MOE)
The monitoring program is run by the Royal Scientific Society (RSS) for the order of MOE. The reports are received by MOE and disseminated to concerned agencies for necessary action. The scope of the program and the small number of samples, which are tested, do not allow for proper assessment of the quality of wastewater. In addition, no crops are monitored.

Main Policy Issues

Ministry of Water and Irrigation, Ministry of Agriculture, Ministry of Environment, Ministry of Health are all responsible for policies and legislative framework for wastewater reuse. These policies comply with most recent standards for wastewater reuse issued in 2002 under the number : 893/2002
This Jordanian standard is purposely set to specify the conditions that the reclaimed domestic wastewater discharged from wastewater treatment plants should meet in order to be discharged or used in the various fields mentioned in this standard.

Discharge of

Parameters	Abbreviation	Unit	Allowable Limit

Water to Streams or Water Bodies

Group A			
Biological Oxygen Demand	BOD_5	mg/l	60*
Chemical Oxygen Demand	COD	mg/l	150**
Dissolved Oxygen	DO	mg/l	>1
Total suspended solids	TSS	mg/l	60**
pH	pH	mg/l	6-9
Nitrate	NO_3	mg/l	45
Total Nitrogen	T-N	mg/l	70
Escherishia Coli	*E. coli*	Most probable number or colony forming unit/100 ml	1000
Intestinal Helminthes Eggs	Intestinal Helminthes Eggs	egg/l	< or =1
Fat and grease	FOG	mg/l	8.0
Group B			
Phenol	Phenol	mg/l	<0.002
Detergent	MBAS	mg/l	25
Total Dissolved Solids	TDS	mg/l	1500
Total Phosphate	$T\text{-}PO_4$	mg/l	15
Chloride	Cl	mg/l	350
Sulfate	SO_4	mg/l	300
Bicarbonate	HCO_3	mg/l	400
Sodium	Na	mg/l	200
Magnesium	Mg	mg/l	60
Calcium	Ca	mg/l	200
Sodium Adsorption Ration	SAR	-	6.0
Aluminium	Al	mg/l	2.0
Arsenic	As	mg/l	0.05
Berelium	Be	mg/l	0.1
Copper	Cu	mg/l	0.2
Floride	F	mg/l	1.5
Iron	Fe	mg/l	5.0
Lithium	Li	mg/l	2.5
Manganese	Mn	mg/l	0.2
Molibdinum	Mo	mg/l	0.01
Nikel	Ni	mg/l	0.2
Lead	Pb	mg/l	0.2
Selenium	Se	mg/l	0.05
Cadmium	Cd	mg/l	0.01
Zinc	Zn	mg/l	5.0
Chrome	Cr	mg/l	0.02
Mercury	Hg	mg/l	0.002
Vanadium	V	mg/l	0.1
Cobalt	Co	mg/l	0.05
Boron	B	mg/l	1.0
Cyanide	CN	mg/l	0.01

* For biological Treatment Plants or Treatment plants with polishing ponds BOD_5 is considered as the filtered BOD
** For biological Treatment Plants or Treatment plants with polishing ponds the allowable limits is twice this number

Criteria for Use in Artificial Groundwater Aquifers

Parameters	Abbreviation	Unit	Allowable Limit
Group A			
Biological Oxygen Demand	BOD_5	mg/l	15
Chemical Oxygen Demand	COD	mg/l	50
Dissolved Oxygen	DO	mg/l	>2
Total suspended solids	TSS	mg/l	50
pH	pH	mg/l	6 – 9
Turbidity		NTU	2
Nitrate	NO_3	mg/l	30
Ammonia	NH_4		5.0
Total Nitrogen	T-N	mg/l	45
Escherishia Coli	*E. coli*	Most probable number or colony forming unit/100ml	<2.2
Intestinal Helminthes Eggs	Intestinal Helminthes Eggs	Egg/l	< or =1
Fat and grease	FOG	mg/l	8.0
Group B			
Phenol	Phenol	mg/l	<0.002
Detergent	MBAS	mg/l	25

Total Dissolved Solids	TDS	mg/l	1500
Total Phosphate	T- PO_4	mg/l	15
Chloride	Cl	mg/l	350
Sulfate	SO_4	mg/l	300
Bicarbonate	HCO_3	mg/l	400
Sodium	Na	mg/l	200
Magnesium	Mg	mg/l	60
Calcium	Ca	mg/l	200
Sodium Adsorption Ration	SAR	mg/l	6.0
Aluminium	Al	-	2.0
Arsenic	As	mg/l	0.05
Berelium	Be	mg/l	0.1
Copper	Cu	mg/l	0.2
Floride	F	mg/l	1.5
Iron	Fe	mg/l	5.0
Lithium	Li	mg/l	2.5
Manganese	Mn	mg/l	0.2
Molibdinum	Mo	mg/l	0.01
Nikel	Ni	mg/l	0.2
Lead	Pb	mg/l	0.2
Selenium	Se	mg/l	0.05
Cadmium	Cd	mg/l	0.01
Zinc	Zn	mg/l	5.0
Chrome	Cr	mg/l	0.02
Mercury	Hg	mg/l	0.1
Vanadium	V	mg/l	0.1
Cobalt	Co	mg/l	0.05
Boron	B	mg/l	1.0
Cyanide	CN	mg/l	0.01

Criteria for Reuse in Irrigation

Parameter	Unit	Cooked Vegetables, Parks, Playgrounds and Sides of Roads within city limits	Fruit Trees, Sides of Roads outside city limits, and landscape	Field Crops, Industrial Crops and Forest Trees
		A	B	C
Biological Oxygen Demand	mg/l	30	200	300
Chemical Oxygen Demand	mg/l	100	500	500
Dissolved Oxygen	mg/l	>2	-	-
Total suspended solids	mg/l	50	150	150
pH	unit	6-9	6-9	6-9
Turbidity	NTU	10	-	-
Nitrate	mg/l	30	45	45
Total Nitrogen	mg/l	45	70	70
Escherishia Coli	Most probable number or colony forming unit/100 ml	100	1000	-
Intestinal Helminthes Eggs	Egg/l	< or = 1	< or = 1	< or = 1

Guidelines for Reuse in Irrigation

Fat And grease	FOG	mg/l	8
Phenol	Phenol	mg/l	<0.002
Detergent	MBAS	mg/l	100
Total Dissolved Solids	TDS	mg/l	1500
Total Phosphate	T-PO_4	mg/l	30
Chloride	Cl	mg/l	400
Sulfate	SO_4	mg/l	500
Bicarbonate	HCO_3	mg/l	400
Sodium	Na	mg/l	230
Magnesium	Mg	mg/l	100
Calcium	Ca	mg/l	230
Sodium Adsorption Ration	SAR	-	9
Aluminium	Al	mg/l	5
Arsenic	As	mg/l	0.1

Berelium	Be	mg/l	0.1
Copper	Cu	mg/l	0.2
Floride	F	mg/l	1.5
Iron	Fe	mg/l	5.0
Lithium	Li	mg/l	2.5 (0.075 for citrus crops)
Manganese	Mn	mg/l	0.2
Molibdinum	Mo	mg/l	0.01
Nikel	Ni	mg/l	0.2
Lead	Pb	mg/l	5.0
Selenium	Se	mg/l	0.05
Cadmium	Cd	mg/l	0.01
Zinc	Zn	mg/l	5.0
Chrome	Cr	mg/l	0.1
Mercury	Hg	mg/l	0.002
Vanadium	V	mg/l	0.1
Cobalt	Co	mg/l	0.05
Boron	B	mg/l	1.0
Cyanide	CN	mg/l	0.01

Morocco

Current Situation

Most Moroccan towns are equipped with sewerage networks, frequently collecting also industrial effluent. The volumes of wastewater collected were estimated at 380 Mm^3/yr in 1988 and are expected to reach 700 Mm^3 in 2020. For Casablanca alone, the annual production of wastewater was estimated at 250 Mm^3 in 1991, with forecasts of around 350 Mm^3 in 2010. However, out of the 60 largest towns only 7 have a MWTP, but both their design and operation are considered insufficient. As a consequence, most of the wastewater produced by the inland towns is used to irrigate about 7,235 ha of crops after insufficient or even no treatment. A high proportion of the remaining water is discharged to the sea (Conseil Superieur de l' Eau, 1988 and 1994). The volume of wastewater available for reuse will increase with the improvement of sewerage networks. Under these conditions the share of wastewater in the overall water resource could be several percentage points higher within a few decades, especially if the wastewater of coastal towns is also recycled.

The reused water is mainly raw wastewater sometimes mixed with fresh water. The irrigated crops are mainly fodder crops (4 harvests of corn per year around Marrakech), fruit trees, cereals and produce (growing and selling vegetables to be eaten raw is prohibited). Morocco does not have yet any specific wastewater reuse regulations. Reference is usually made to the WHO recommendations. While reducing its environmental impact on the conventional receiving waters, the lack of wastewater treatment before reuse in inland cities results in adverse health impacts. Improvement in wastewater reuse methods and in the quality of reused water for irrigation is recognized as essential. In karstic areas, the infiltration of wastewater affects groundwater resources to varying degrees. Lastly, the inadequate sanitation, collection and treatment of wastewater, mostly in small towns, are often a risk to the eutrophication of dams. The discharge of raw wastewater to the sea without proper outfalls may affect the development of tourism by degrading the sanitary quality of beaches and generating unpleasant odours and aesthetics.

Institutional Framework

At institutional level, water management is a shared responsibility between the Ministry of Equipment (for resources mobilization, management and planning), the Ministry of Agriculture (which is the principal consumer and manager of the wetlands) and the Department of the Environment (which is

	responsible for the development of laws and standards with regards to discharges). The institutional framework consists of the following bodies: **Advisory authorities** – Higher Council of Water and Climate – National Council of the Environment – Prefectorial and Provincial Commissions of water **Administrative authorities** – Ministry of Health – Ministry of Equipment National Office of Drinking Water Basin Agencies Directorate of Meteorology Directorate General of Hydraulics – Ministry of Interior Directorate General of Local Communities Directorate of Control and Conceded Services Water Services – Ministry of Agriculture and Rural Development Administration of Rural Engineering Directorate of Waters and Forests Regional Offices of Agricultural Development – Ministry of Energy and Mines National Office of Electricity – Secretariat of State of the Environment – Ministry of regional planning, the water and the environment **The Ministry of the Environment (ME)** This institution is responsible for the protection of the environment in general and particularly the protection of the natural resources. This Ministry provides technical assistance in aid of the local communities for which water treatment is a principal component. **The Local Communities (CL)** The Communal Charter of September 30, 1976 assigns to Local Communities the management of public services including liquid treatment. **Ministry of the Interior** While administratively supervising the local communities, this department plays an important role regarding wastewater management through the General Directorate of the Local Communities (DGCL) and the General Directorate of Urbanism, Architecture and Regional Planning (DGUAAT). **Ministry of Public Health** It contributes to the protection of public health by preserving the hygiene of the habitat and the public health. **Ministry of Agriculture and Rural Development** With a long experience in the protection of the rural environment, particularly before the decentralisation policy is in charge of wastewater treatment and agricultural reuses through the ORMVA. **Ministry of Equipment (ME)** Being in charge by the State to manage the hydraulic sector, this department deals with questions of water treatment due to the research activities it

performs in the field of water protection and management.

Basin Agencies

Decentralized organs for water management, these agencies have obvious interactions with regards wastewater management.

National Office of Drinking Water (ONEP)

Responsible for drinking water conveyance, distribution management within the communities and monitoring of wastewater that is likely to be used for human consumption. At this moment, ONEP is also in charge of the cleaning up of certain rural centers.

Other administrative authorities

National Council of the Environment (CNE): Created in 1980, is an independent consultative authority in matters of environmental protection. It was re-energized by the creation of the Ministry of the Environment. It currently has departments at regional and local level

The Higher Council of Water Climate (CSEC): Created in 1981 by royal decision, it was institutionalised recently by a Decree and reassembles all authorities concerned with water management and the climate.

Policies

In 1995, Law No10/95 came into force and established the legal framework of the national water policy for the next decades. This law includes a series of legal instruments aiming at dealing with the problems of the deficiency of water resources, the increasing water demand, the rise of the water price and the degradation of the environment and the water recipients.

The major principles of this law are in brief the following: (a) water is a state-owned property; (b) water has an economic value and (c) the necessity to accomplish solidarity at all levels (national, regional and local) regarding water management after national dialogue.

This dialogue was materialized by the creation of three organizations, namely the Higher Council of Water and Climate (CSEC), the Basin Agencies (AdB) and the Prefectorial and Provincial Commissions of Water.

Wastewater Criteria

CATEGORY	CONDITION FOR REALISATION	EXPOSED GROUPS	INTESTINAL NEMATODES [i][*] [arithmetic mean (average) of the number of eggs per liter]	FECAL COLIFORMES [geometric mean of the number per 100 ml] [ii][+]	TREATMENT PROCESS FOR WASTEWATER Capable of ensuring the required microbiological quality
A	Irrigation of cultures to be consumed raw, sport fields, parks[iii][+].	Farmers Public Consumers	Absence	≤ 1000 (d)	A series of stabilization tanks designed to obtain the desired microbiological quality or any other equivalent treatment.
B	Irrigation of cereals, industrial crops, fodder crops, pastures and tree plantations [iv][§].	Farmers	Absence	No standards is recommended	Retention in the stabilization basin for 8-10 days or any other process which allows an equivalent elimination of the helminths and the fecal coliformes.
C	Local irrigation of cultures of	None	Without object	Without object	Preliminary treatment

	category B if the farmers and public consumers are not exposed to it according to the irrigation technique, but at least primary decantation [i][*] Ascaris, Trichuris (whipworm) and Ankylostoma [ii][+] During the irrigation period [iii][+] A strict directive (<200 fecal coliformes per 100ml) is justified for lawn with which the public can have a direct contat [iv][§] In the case of fruits trees, the irrigation must be stopped two weeks before harvest and no fruit that has fall down must be collected. Irrigation by spraying is prohibited.
Quality Standards for reuse in Irrigation	

	Parameters	Limit values
	BACTERIOLOGIC PARAMETERS	
1	Fecal coliforms	1000/100 ml*
2	Salmonella	Absence in 51
3	Bacterium of cholera	Absence in 450 ml
	PARASITOLOGIC PARAMETERS	
4	Pathogenic parasites	Absence
5	Eggs, Cysts of parasites	Absence
6	Larvae of Ankylostomides	Absence
7	Fluococercaires of *Schistosoma haemotobium*	Absence
	TOXIC PARAMETERS (1)	
8	Mercury (Hg) in mg/l	0,001
9	Cadmium (Cd) in mg/l	0,01
10	Arsenic (As) in mg/l	0,1
11	Total Chrome (Cr) in mg/l	0,1
12	Lead (Pb) in mg/b	5
13	Copper (Cu) in mg/l	0,2
14	Zinc (Zn) in mg/l	2
15	Selenium (Se) in mg/l	0,02
16	Fluorine (F) in mg/l	1
17	Cyanide (Cn) in mg/l	1
18	Phenols in mg/l	3
19	Aluminum (Al) in mg/l	5
20	Beryllium (Be) in mg/l	0,1
21	Cobalt (Co) in mg/l	0,05
22	Iron (Fe) in mg/l	5
23	Lithium (Li) in mg/l	2,5
24	Manganese (Mn) in mg/l	0,2
25	Molybdenum (Mo) in mg/l	0,01
26	Nickel (Ni) in mg/l	0,2
27	Vanadium (V) in mg/l	0,1
PHYSICO-CHEMICAL PARAMETERS		
28	Total salinity (STD) mg/l	7680
	Electric Conductivity (CE) mS/cm à 25°C**	12
29	Infiltration Le SAR*** = 0 - 3 et CE = 3 - 6 et CE = 6 - 12 et CE = 12 - 20 et CE = 20 - 40 et CE =	 <0,2 <0,3 <0,5 <1,3 <3
TOXIC IONS (affecting sensible cultures)		
30	Sodium (Na)	
	.Surface Irrigation (SAR*)	9
	.Irrigation by spraying (mg/l)	69
31	Chlorine (CI)	
	.Irrigation de surface (mg/l)	350
	.Irrigation by spraying (mg/l)	105
32	Boron (B) (mg/l)	3
VARIOUS PARAMETERS (affecting sensible cultures)		
33	Temperature (°C)	35
34	pH	6,5-8,4
35	Suspended solids in mg/l Gravitational irrigation Local irrigation and irrigation by spraying	 2.000 100
36	**Nitrates** ($N\text{-}NO_3$) in mg/l	30
37	Bicarbonate (HCO_3) (Irrigation by spraying mg/l)	518
38	Sulfates (**SO^2_{-4}**) en mg/l	250

*1.000 CF/100 ml for cultures intended for raw consumption (Controls are to be performed only if the concerned water is likely to come in touch with wastewater)

	** If electric conductivity (CE) exceeds 3mS/cm, severe restrictions are applied to water when it is to be used for irrigation, but the 50% of the potential yield can be irrigated with water of 8,7 mS/cm (in the case of barley). *** SAR = Sodium absorption ratio (coefficient of sodium absorption)
Tunisia	
Current Situation	Wastewater reuse in agriculture is regulated by the 1975 Water Code (law No. 75-16 of 31 March 1975), by the 1989 Decree No. 89-1047 (28 July 1989), by the Tunisian standard for the use of treated wastewater in agriculture (NT 106- 003 of 18 May 1989), by the list of crops than can be irrigated with treated wastewater (Decision of the Minister of Agriculture of 21 June 1994) and by the list of requirements for agricultural wastewater reuse projects (Decision of 28 September 1995). They prohibit the irrigation of vegetables that might be consumed raw. Therefore, most of the recycled wastewater is used to irrigate vineyards, citrus and other trees (olives, peaches, pears, apples, pomegranates, etc.), fodder crops (alfalfa, sorghum, etc), industrial crops (cotton, tobacco, sugarbeet, etc), cereals, and golf courses (Tunis, Hammamet, Sousse, and Monastir). Some hotel gardens in Jerba and Zarzis are also irrigated with recycled wastewater. Irrigation with recycled wastewater is well established in Tunisia. A Regional Department for Agricultural Development (CRDA) supervises the operation and maintenance of the water distribution system and controls the application of the Water Code.
Institutional Frameworkl	Several ministries are responsible for water and wastewater planning, management, monitoring, and pollution control. An inventory of these agencies has been prepared to identify their mandate, responsibilities, and activities in connection with water quality. The main ministries and agencies include: • Ministry of Agriculture (MoA) • Ministry of Environment and Land Use Planning (MoELUP) a. Agence Nationale de la Protection de l'Environnement (ANPE) b. Office National de l'Assainissement (ONAS) • Ministry of Public Health (MoH) • Ministry of Industry (MoI) • Ministry of Interior (MoInt) **Ministry of Agriculture:** Responsible for all water management issues including planning, monitoring and implementing water resource allocation countrywide. The only significant responsibilities not covered by the ministry are pollution abatement and sewage treatment. The ministry carries out its work through a number of directorates. ***Direction Générale des Ressources en Eau (DGRE)***: This directorate is divided into two sub-divisions, one for surface water and another for groundwater. The responsibilities of DGRE include: • Ensure the application of laws and regulations related to pollution abatement and groundwater. • Develop research activities related to water and water quality. • Install and operate water quantity and quality networks for surface

water and groundwater.
- Conduct studies for the evaluation of water resources and their exploitation.

Direction Générale des Etudes des Travaux Hydrauliques (DGETH): This directorate is responsible for (i) the study of water quality in dams and (ii) the study, execution, construction, supervision, and operation and maintenance of irrigation and drainage infrastructure.

Direction Générale des Travaux Hydrauliques (DGTH): constructs large dams and irrigation infrastructure.

Direction Générale du Genie Rural (DGGR): produces and distributes potable water in dispersed rural areas of less than 500 inhabitants and develops irrigation projects.

Societe Nationale d'Exploitation et de Distribution des Eaux (SONEDE): An autonomous public authority that treats and distributes potable water in urban areas and large villages with more than 500 inhabitants.

Ministry of Environment and Land Use Planning (MoELUP): formulates strategies, coordinates and controls activities for the protection of nature and the environment, pollution abatement, nuisance control, and improves the quality of life. The ministry has two major general directorates:
- ***Direction Générale de l'Amenagement du Teritore (DGAT):*** identifies measures for rational land management to ensure the sustainability of natural resources and protect fragile ecosystems.
- ***Direction Générale de l'Environnement et de la Qualite de Vie (DGEQV):*** evaluates the overall environment, proposes guidelines as part of a national strategy to protect the environment, develops action plans for natural resource conservation, and reduces pollution sources.

Three autonomous organizations operate under the supervision of Ministere de l'Environnement et de l'Amenagement du Territoire (MEAT) to ensure monitoring, enforcement, pollution reduction and natural resources protection.
- ***Agence Nationale de Protection de L'Environnement (ANPE):*** executes the mandates of MEAT with respect to prevention, monitoring, enforcement and public awareness. ANPE manages the environmental impact assessment system and monitors industrial discharge and treatment units. The mandate has been broadened to include the reparation of ecological damage and the execution of a national solid waste management program.
- ***Office National de l'Assainissement (ONAS):*** monitors treated and discharged wastewater quality and ensures environmental protection. Manages sewage collection, treatment and disposal in urban agglomerations, and industrial and tourism zones.
- ***Le Centre International des Technologies de l'Environnement de Tunis (CITET):*** undertakes capacity building as well as research, development and adaptation of technology and new innovations. At

	present CITET has broadened its activities to include: training, technical assistance, information and documentation, and the provision of laboratory testing for governmental organizations and the private sector such as ONAS, ANPE and industries. **Ministry of Public Health (*Direction Générale de L'Hygienne du Milieu et de la Protection de l'Environnement - DHMPE):*** evaluates and monitors technical assistance, education, public awareness and research. It is also responsible for supervising the hygiene of public places (restaurants, hospitals, etc.) and controlling wastewater discharge from treatment plants. **Ministry of Industry:** participates in elaborating government strategies for pollution abatement and environmental protection. **Ministry of the Interior - *Direction Générale des Collectivités Publiques Locales (DGCPL):*** responsible for (i) the national program for environmental protection and (ii) the legal and regulatory framework for the environment and sanitation. In addition to the ministries responsible for water and wastewater management, there are several consultative institutions including: • ***Commission for Public Hydraulic Domain*** • ***National Comity for Water*** • ***National Commission for Environment*** • ***National Commission for Sustainable Development*** • ***National Commission for Conservation of Water and Soil.*** At the national level, a number of institutions have responsibilities with respect to water quality and the abatement of hydraulic pollution. These institutions are: ***Commissariat Régional au Développement Agricole (CRDA):*** assumes, at the regional level, the responsibilities of the Ministry of Agriculture with respect to the protection and preservation of hydraulic resources. The CRDA is assisted by the following institutions: • Le Comité Consultatif • Les Groupements Régionaux de la Conservation des Eaux et Sols • Les Associations de la Conservation des Eaux et Sols.
Regulatory Framework	In 1975 Tunisia developed the water code Le Code des Eaux under Law No. 75. This code includes several articles related to the protection and preservation of surface and groundwater as well as water reuse for agricultural purposes. Other laws and decrees that address pollution and water resources protection have also been issued and include: • Decree No. 79-768 (1979) regulating the connection and discharge of wastewater effluents into the public sewer system. • Decree No. 85–56 (1985) regulating the discharge of wastewater into the environment.

<table>
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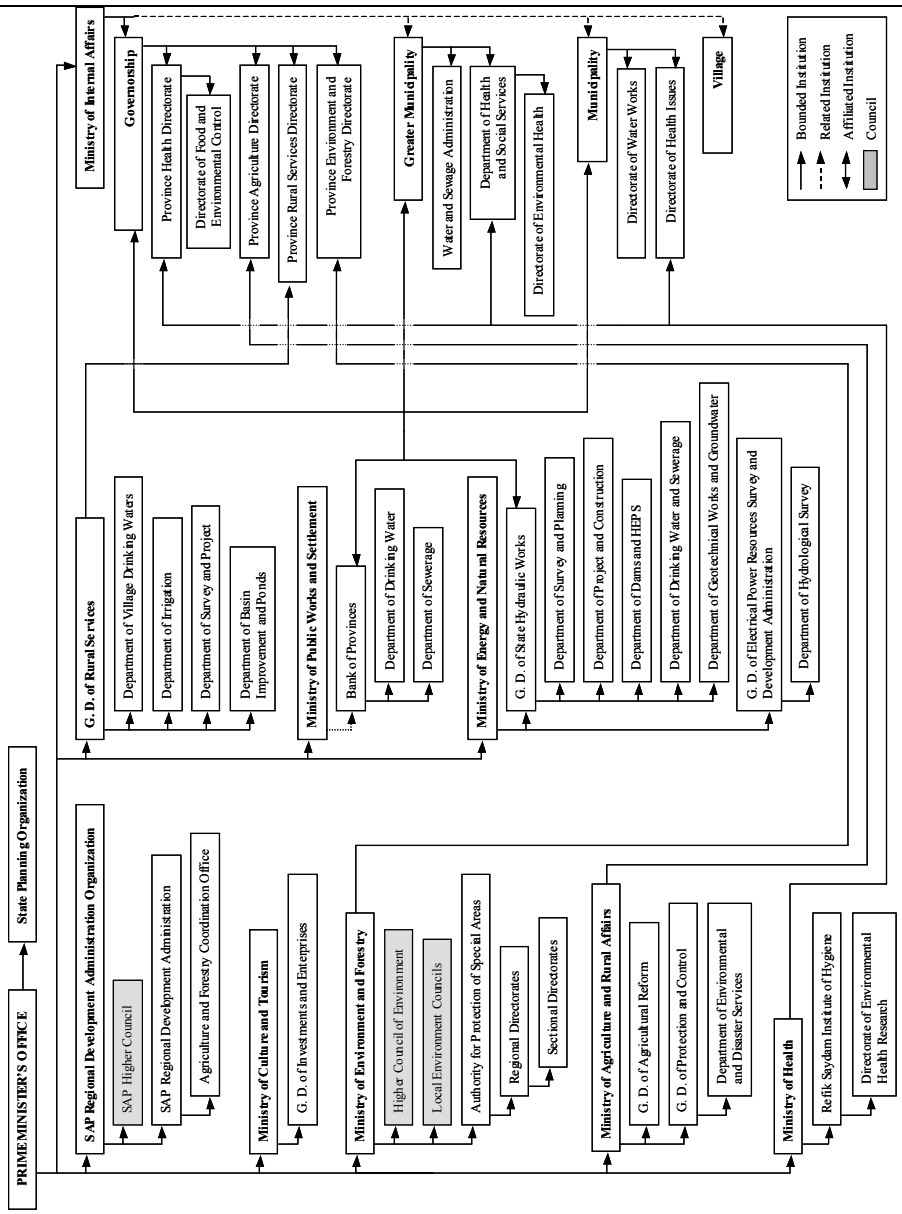
Decree No. 89–1047 (1989) modified by decree No. 93–2447 (1993) identifying conditions for the reutilization of treated wastewater for irrigation.
Decree No. 91-362 (1991) requesting the preparation of environmental impact assessment studies as a prerequisite to obtaining a license for the construction of industrial, agricultural and commercial establishments.
Law No. 92-115 (1992) regulating industrial activities and discharge.
Ministerial Decree (1995) relating the modalities and specific conditions for the reuse of treated wastewater for irrigation.

In addition, the Tunisian government has issued a number of standards related to water quality:

N.T 09.14 (1987) – quality of potable water.
N.T 09.13 (1983) – quality of surface water that can be used as a source for potable water.
N.T 106.03 (1989) – standards for the reuse of treated wastewater for irrigation purposes.
N.T 106.02 (1989) – standards for the discharge of treated wastewater.

</td></tr>
<tr><td>Irrigation Standards (N.T 106.03 (1989))</td><td>
<table>
<tr><td>Parameters (a)</td><td>Maximum allowed concentration</td></tr>
<tr><td>pH</td><td>6.5 - 8.5</td></tr>
<tr><td>Electrical conductivity (EC) (µS/cm)</td><td>7000</td></tr>
<tr><td>Chemical oxygen demand (COD)</td><td>90 (b), (c)</td></tr>
<tr><td>Biochemical oxygen demand (BOD5)</td><td>30 (b), (c)</td></tr>
<tr><td>Suspended solids (SS)</td><td>30 (c)</td></tr>
<tr><td>Chloride (Cl)</td><td>2000</td></tr>
<tr><td>Fluoride (F)</td><td>3</td></tr>
<tr><td>Halogenated hydrocarbons</td><td>0.001</td></tr>
<tr><td>Arsenic (As)</td><td>0.1</td></tr>
<tr><td>Boron (B)</td><td>3</td></tr>
<tr><td>Cadmium (Cd)</td><td>0.01</td></tr>
<tr><td>Cobalt (Co)</td><td>0.1</td></tr>
<tr><td>Chromium (Cr)</td><td>0.1</td></tr>
<tr><td>Copper (Cu)</td><td>0.5</td></tr>
<tr><td>Iron (Fe)</td><td>5</td></tr>
<tr><td>Manganese (Mn)</td><td>0.5</td></tr>
<tr><td>Mercury (Hg)</td><td>0.001</td></tr>
<tr><td>Nickel (Ni)</td><td>0.2</td></tr>
<tr><td>Lead (Pb)</td><td>1</td></tr>
<tr><td>Selenium (Se)</td><td>0.05</td></tr>
<tr><td>Zinc (Zn)</td><td>5</td></tr>
<tr><td>Intestinal nematodes (arithmetic mean no. of eggs per litre)</td><td>< 1</td></tr>
</table>
</td></tr>
<tr><td>Discharge of Treated Wastewater N.T 106.02 (1989)</td><td></td></tr>
<tr><td colspan="2">Turkey</td></tr>
<tr><td>Current Situation</td><td>The use of reused water for irrigation in Turkey is mainly due to the scarcity of water resources and inefficient water resource management, both of which are exacerbated by growing population, economic conditions and increasing urbanization.
Although, domestic wastewater should not be used directly without proper</td></tr>
</table>

	treatment, it contains nutrients, which are essential for plant growth and can be used after treatment as a water resource in a more convenient way. Especially in arid summer times in which irrigation activities should be increased for agricultural production, it can be said that wastewater is reused for irrigation in some cases. As a result the concentration of nitrogen, phosphorus, salinity, biodegradable organic materials, trace elements may depict subsequent increases in the agricultural production areas if wastewater not treated properly. Boron is another parameter which should be given special emphasize since, high boron loaded characteristic of the water source, since accumulation of boron in such a heavy soil due to irrigation will lead to sharp decrease in agricultural productivity. Technical regulations and constraints for the use of wastewater effluents for agricultural purposes, with reference to Water Pollution Control Regulations are used in Turkey. In addition to the regulations there are other criteria included, regarding the classification of the waters to be used for irrigation, maximum allowable heavy metal and toxic elements concentrations as well as the mass limits for application of these pollutants in terms of unit agricultural areas.
Institutional Framework	The Turkish institutional framework for water, wastewater and agricultural irrigation is summarised in the following figure. In this figure the ministries and organisations, their related, affiliated, and bounded institutions and units are given. Their relationships are indicated. The major aspects of the framework are explained below.



In Turkey, Prime Minister's Office (PMO) holds the top of the institutional framework tree. The framework consists of ministries, organizations, general directorates and special boards. The major ministries related with water, wastewater and agricultural irrigation and their responsibilities could be summarized as follows: The Ministry of Health (MoH) has the responsibility of performing analysis related to water quality. The Ministry of Public Works and Settlement (MoPWS) is in charge of financing water and wastewater infrastructures and giving technical support. The Ministry of Energy and Natural Resources (MoENR) is in charge of investigating, planning and management of water resources for irrigation, community water supply and energy production. The Ministry of Environment and Forestry (MoEF) sets relevant standards for environmental pollution control, carries out inspection of pollution sources and routinely monitors the quality of water resources. The Ministry of Agriculture and Rural Affairs (MoARA) has the responsibility of determining and implementing plans and policies on agriculture and agricultural irrigation. The Ministry of Internal Affairs (MoI) is responsible for the administrative management. The State Planning

Organization (SPO) prepares national development plans and programmes, and coordinates financial support for investments. The Turkish laws and regulations related with wastewater treatment, disposal and reuse are summarised here:

Year	Establishment	Law/Regulation/Bulletin
1983	MoEF	Environment Law
1988	MoEF	Water Pollution Control Regulation (WPCR)
1989	MoEF	WPCR Administration Aspects Bulletin
1989	MoEF	WPCR Toxic and Hazardous Substances in Water Bulletin
1991	MoEF	WPCR Technical Aspects Bulletin
1995	MoARA	Aquatic Products Regulation
2001	MoEF	Environmental Inspection Regulation
2002	MoEF	Environmental Impact Assessment Regulation

Discharge Standards of Domestic Wastewaters to Receiving Bodies

Class 1 – Pollution load: 5-60 kg/day BOD, Population < 1000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	180	120
SS	mg/l	70	45
pH		6-9	6-9

Class 2 – Pollution load: 60-600 kg/day BOD, Population: 1000-10000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	160	110
SS	mg/l	60	30
pH		6-9	6-9

Class 3 – Pollution load > 600 kg/day BOD, Population > 10000

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	50	45
COD	mg/l	140	100
SS	mg/l	45	30
pH		6-9	6-9

Class 4 – For domestic wastewater treatment plants treating with stabilization ponds (independent of population)

Parameter	Unit	Composite sample (2 hrs)	Composite sample (24 hrs)
BOD_5	mg/l	75	50
COD	mg/l	150	100
SS	mg/l	200	150
pH		6-9	6-9

Irrigation Water Quality Parameters

Quality Criteria	***Irrigation Water Class***				
	I. Class (very good)	II. Class (good)	III. Class (usable)	IV. Class (usable with caution)	V. Class (detrimental, unusable)
EC25 x 106	0 – 250	250 – 750	750–2000	2000-3000	> 3000
Variable Sodium Percentage (%Na)	< 20	20 – 40	40 – 60	60 – 80	> 80
Sodium Adsorption Ratio (SAR)	< 10	10 – 18	18 – 26	> 26	
Sodium Carbonate Residue (RSC), meq/l mg/l	> 1.25 < 66	1.25 – 2.5 66 – 133	> 2.5 > 133		
Chloride (Cl-), meq/l mg/l	0 – 4 0 – 142	4 – 7 142 – 249	7 – 12 249 – 426	12 – 20 426 – 710	> 20 > 710
Sulphate (SO_4-), meq/l mg/l	0 – 4 0 – 192	4 – 7 192 – 336	7 – 12 336 – 575	12 – 20 575 – 960	> 20 > 960
Total salt concentration (mg/l)	0 – 175	175 – 525	525–1400	1400-2100	> 2100
Boron concentration (mg/l)	0 – 0.5	0.5 – 1.12	1.12 – 2	> 2	
Irrigation water class	C_1S_1	C_1S_2, C_2S_2,	C_1S_3,C_2S_3,	C_1S_4,C_2S_4,	

			C_2S_1	C_3S_3,C_3S_2, C_3S_1	C_3S_4,C_4S_4, C_4S_3,C_4S_2, C_4S_1	
	NO_3- or NH^4+, mg/l	0 – 5	5 – 10	10 – 30	30 – 50	> 50
	Fecal Coliforms** (per 100ml)	0 – 2	2 – 20	20 – 100	100 – 1000	> 1000
	BOD5 (mg/l)	0 – 25	25 – 50	50 – 100	100 – 200	> 200
	Suspended Solid Matter (mg/l)	20	30	45	60	> 100
	pH	6.6 – 8.5	6.5 – 8.5	6.5 – 8.5	6.5 – 9	< 6 or >9
	Temperature	30	30	35	40	> 40

Maximum Concentration of Heavy Metal & Toxic Elements for Irrigation Water

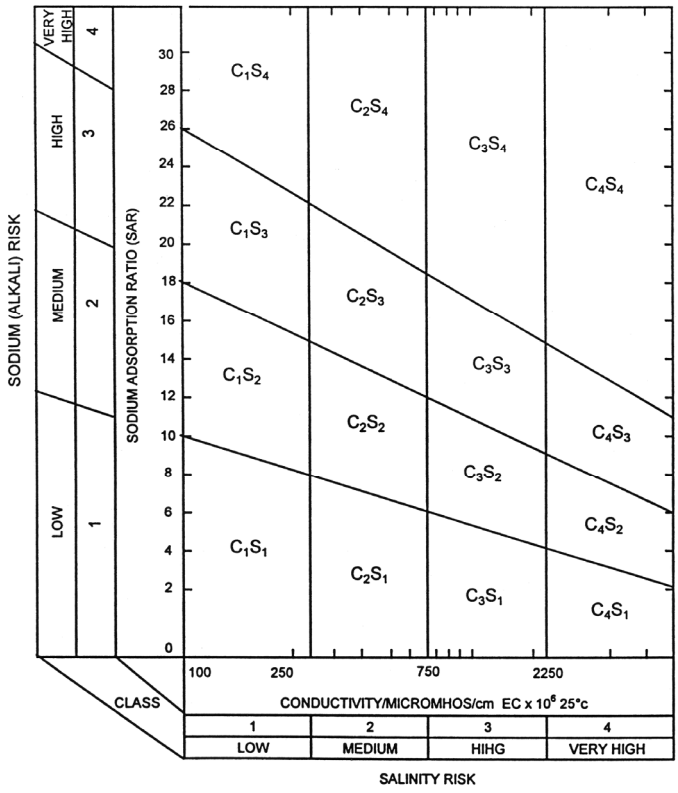
Elements	Maximum total amounts per unit area, kg/ha	Permissible maximum concentrations	
		Limits for continuous irrigation under all soil conditions, mg/1	Limits for irrigation for less than 24 years on clayey soils with pH value 6.0-8.5, mg/1
Aluminium (Al)	4600	5.0	20.0
Arsenic (As)	90	0.1	2.0
Berlyllium (Be)	90	0.1	0.5
Boron (B)	680	-[3]	2.0
Cadmium (Cd)	9	0.01	0.05
Chrome (Cr)	90	0.1	1.0
Cobalt (Co)	45	0.05	5.0
Copper (Cu)	190	0.2	5.0
Fluorine (F)	920	1.0	15.0
Iron (Fe)	4600	5.0	20.0
Lead (Pb)	4600	5.0	10.0
Lithium (Li)[1]	-	2.5	2.5
Manganese (Mn)	920	0.2	10.0
Molybdenum (Mo)	9	0.01	0.05[2]
Nickel (Ni)	920	0.2	2.0
Selenium (Se)	16	0.02	0.02
Vanadium (V)	-	0.1	1.0
Zinc (Zn)	1840	2.0	10.0

[1] 0.075 mg/1 for citrus
[2] Concentration allowed only for acidic-clayey soils with high iron content

Irrigation Water Classification

Irrigation water class	Boron concentration in irrigation water (mg/1)		
	Sensitive crops [1] (mg/1)	Fairly sensitive crops [2] (mg/l)	Resistant crops [3] (mg/l)
I	less than 0.33	less than 0.67	less than 1.0
II	0.33-0.67	0.67-1.33	1.00-2.00
III	0.67-1.00	1.33-2.00	2.00-3.00
IV	1.00-1.25	2.00-2.50	3.00-3.75
V	more than 1.25	more than 2.50	more than 3.75

[1] : Example: walnut, lemon, fig, apple, grape and green beans
[2] : Example: wheat, barley, maize, oat, olive, cotton
[3] : Example: sugar beet, clover, broad beans, onion, cos lettuce, carrot



Irrigation water classification diagram

United States of America	
Official name	EPA/625/R-04/108 Guidelines for Water Reuse
Area of reference	U.S. Environmental Protection Agency Municipal Support Division Office of Wastewater Management Office of Water Washington, DC
Scope	Regulations refer to actual rules that have been enacted and are enforceable by government agencies. Guidelines, on the other hand, are not enforceable but can be used in the development of a reuse program. Currently, there are no federal regulations directly governing water reuse practices in the U.S. Water reuse regulations and guidelines have, however, been developed by many individual states. As of November 2002, 25 states had adopted regulations regarding the reuse of reclaimed water, 16 states had guidelines or design standards, and 9 states had no regulations or guidelines. In states with no specific regulations or guidelines on water reclamation and reuse, programs may still be permitted on a case-by-case basis. Regulations and guidelines vary considerably from state to state. States such as Arizona, California, Colorado, Florida, Georgia, Hawaii, Massachusetts, Nevada, New Jersey, New Mexico, North Carolina, Ohio, Oregon, Texas, Utah, Washington, and Wyoming have developed regulations or guidelines that strongly encourage water reuse as a water resources conservation strategy.These states have developed comprehensive regulations or guidelines specifying water quality requirements, treatment processes, or both, for the full spectrum of reuse applications. The objective in these states is to derive the maximum resource benefits of the reclaimed water while protecting the environment and public health. Other states have developed water reuse regulations with the primary intent of providing a disposal alternative to discharge to surface waters, without considering the management of reclaimed water as a resource. This section provides an inventory of the various state water reuse regulations throughout the U.S. and updates recommended guidelines that may aid in the development of more comprehensive state or even federal standards for water reuse.
Monitoring scope	Current regulations and guidelines may be divided into the following reuse categories: • Unrestricted urban reuse – irrigation of areas in which public access is not restricted, such as parks, playgrounds, school yards, and residences; toilet flushing, air conditioning, fire protection, construction, ornamental fountains, and aesthetic impoundments. • Restricted urban reuse – irrigation of areas in which public access can be controlled, such as golf courses, cemeteries, and highway medians. • Agricultural reuse on food crops – irrigation of food crops which are intended for direct human consumption, often further classified as to whether the food crop is to be processed or consumed raw. • Agricultural reuse on non-food crops – irrigation of fodder, fiber, and seed crops, pasture land, commercial nurseries, and sod farms. • Unrestricted recreational reuse – an impoundment of water in which no limitations are imposed on body-contact water

recreation activities.

- Restricted recreational reuse – an impoundment of reclaimed water in which recreation is limited to fishing, boating, and other non-contact recreational activities.
- Environmental reuse – reclaimed water used to create manmade wetlands, enhance natural wetlands, and sustain or augment stream flows.
- Industrial reuse – reclaimed water used in industrial facilities primarily for cooling system make-up water, boiler-feed water, process water, and general washdown.
- Groundwater recharge – using infiltration basins, percolation ponds, or injection wells to recharge aquifers.
- Indirect potable reuse – the intentional discharge of highly treated reclaimed water into surface waters or groundwater that are or will be used as a source of potable water.

States with regulations or guidelines pertaining to the use of reclaimed water for the following unrestricted urban reuse categories are:

- Toilet Flushing – Arizona, California, Florida, Hawaii, Massachusetts, New Jersey, North Carolina, Texas, Utah, and Washington
- Fire Protection – Arizona, California, Florida, Hawaii, New Jersey, North Carolina, Texas, Utah, and Washington
- Construction Purposes – Arizona, California, Florida, Hawaii, New Jersey, North Carolina, Oregon, Utah, and Washington
- Landscape or Aesthetic Impoundments – Arizona, California, Colorado, Florida, Hawaii, Nevada, New Jersey, North Carolina, Oregon, Texas, and Washington
- Street Cleaning – Arizona, California, Florida, Hawaii, North Carolina, and Washington

Unrestricted Urban Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Oxidized, coagulated, filtered, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized, coagulated, filtered, and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	5.0 mg/l	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg)	2 NTU (Avg)	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg)
	5 NTU (Max)	5 NTU (Max)					5 NTU (Max)
Coliform	**Fecal**	**Total**	**Fecal**	**Fecal**	**Fecal**	**Fecal**	**Total**
	None detectable (Avg)	2.2/100 ml (Avg)	75% of samples below detection	2.2/100 ml (Avg)	2.2/100 ml (Avg)	20/100 ml (Avg)	2.2/100 ml (Avg)
	23/100 ml (Max)	23/100 ml (Max in 30 days)	25/100 ml (Max)	23/100 ml (Max in 30 days)	23/100 ml (Max)	75/100 ml (Max)	23/100 ml (Max)

[1] NS - Not specified by state regulations

Overview on Existing Regulations for Treated Wastewater Reuse purposes

Restricted Urban Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment and disinfection	Secondary – 23, oxidized, and disinfected	Secondary treatment, filtration, and high-level disinfection	Oxidized and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	20 mg/l	30 mg/l
TSS	NS	NS	5 mg/l	NS	NS	NS	30 mg/l
Turbidity	NS	NS	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	200/100 ml (Avg)	23/100 ml (Avg)	75% of samples below detection	23/100 ml (Avg)	23/100 ml (Avg)	200/100 ml (Avg)	23/100 ml (Avg)
	800/100 ml (Max)	240/100 ml (Max in 30 days)	25/100 ml (Max)	200/100 ml (Max)	240/100 ml (Max)	800/100 ml (Max)	240/100 ml (Max)

[1] NS - Not specified by state regulations

Agricultural Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment and disinfection	Secondary-23, Oxidized, and disinfected	Secondary treatment, basic disinfection	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS [1]	Oxidized and disinfected
BOD_5	NS	NS	20 mg/l $CBOD_5$	NS	30 mg/l	5 mg/l	30 mg/l
TSS	NS	NS	20 mg/l	NS	NS	NS	30 mg/l
Turbidity	NS	NS	NS	2 NTU (Max)	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	Fecal	Total	Fecal	Fecal	Fecal	Fecal	Total
	200/100 ml (Avg)	23/100 ml (Avg)	200/100 ml (Avg)	2.2/100 ml (Avg)	200/100 ml (Avg)	20/100 ml (Avg)	23/100 ml (Avg)
	800/100 ml (Max)	240/100 ml (Max in 30 days)	800/100 ml (Max)	23/100 ml (Max)	400/100 ml (Max)	75/100 ml (Max)	240/100 ml (Max)

[1] NS - Not specified by state regulations

Unrestricted Recreational Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [1]	Oxidized, coagulated, clarified, filtered, and disinfected	NR	NR	Secondary treatment and disinfection	NS	Oxidized, coagulated, filtered, and disinfected
BOD_5	NR	NS[2]	NR	NR	30 mg/l	5 mg/l	30 mg/l
TSS	NR	NS	NR	NR	NS	NS	30 mg/l
Turbidity	NR	2 NTU (Avg) 5 NTU (Max)	NR	NR	NS	3 NTU	2 NTU (Avg) 5 NTU (Max)
Coliform	NR	Total 2.2/100 ml (Avg) 23/100 ml (Max in 30 days)	NR	NR	Fecal 2.2/100 ml (Avg) 23/100 ml (Max)	Fecal 20/100 ml (Avg) 75/100 ml (Max)	Fecal 2.2/100 ml (Avg) 23/100 ml (Max)

(1) NR - Not regulated by the state
(2) NS - Not specified by state regulations

Restricted Recreational Reuse

	Arizona	California	Florida	Hawaii	Nevada	Texas	Washington
Treatment	Secondary treatment, filtration, and disinfection	Secondary-23, oxidized, and disinfected	NR [1]	Oxidized, filtered, and disinfected	Secondary treatment and disinfection	NS	Oxidized and disinfected
BOD_5	NS[2]	NS	NR	NS	30 mg/l	20 mg/l	30 mg/l
TSS	NS	NS	NR	NS	NS	NS	30 mg/l
Turbidity	2 NTU (Avg) 5 NTU (Max)	NS	NR	2 NTU (Max)	NS	NS	2 NTU (Avg) 5 NTU (Max)
Coliform	Fecal None detectable (Avg) 23/100 ml (Max)	Total 2.2/100 ml (Avg) 23/100 ml (Max in 30 days)	NR	Fecal 2.2/100 ml (Avg) 23/100 ml (Max)	Fecal 200/100 ml (Avg) 23/100 ml (Max)	Fecal 200/100 ml (Avg) 800/100 ml (Max)	Total 2.2/100 ml (Avg) 23/100 ml (Max)

(1) NR - Not regulated by the state
(2) NS - Not specified by state regulations

Groundwater Recharge

	Arizona	California[2]	Florida	Hawaii	Nevada	Texas	Washington
Treatment	NR [3]	Case-by-case basis	Secondary treatment and basic disinfection	Case-by-case basis	NR	NR	Oxidized, coagulated, filtered, and disinfected
BOD_5	NR		NS[4]		NR	NR	5 mg/l
TSS	NR		10.0 mg/l		NR	NR	5 mg/l
Turbidity	NR		NS		NR	NR	2 NTU (Avg)
							5 NTU (Max)
Coliform	NR		NS		NR	NR	**Total**
							2.2/100 ml (Avg)
							23/100 ml (Max)
Total Nitrogen	NR		12 mg/l		NR	NR	NS

(1) All state requirements are for groundwater recharge via rapid-rate application systems. Additional regulations for recharge of potable aquifers are contained in Section 4.1.1.10 and Appendix A.
(2) Groundwater recharge in California and Hawaii is determined on a case-by-case basis
(3) NR - Not regulated by the state
(4) NS - Not specified by state regulations

Australia	
Official name	National Guidelines for Water Recycling: Managing Health and Environmental Risks
In force since	November 2006
Involved Administrative Bodies	Natural Resource Management Ministerial Council Environment Protection and Heritage Council Australian Health Ministers' Conference
Scope	This document — the National Water Quality Management Strategy (NWQMS) *National Guidelines for Water Recycling: Managing Health and Environmental Risks* — is an authoritative reference for the supply, use and regulation of recycled water schemes. Through recycling, various water sources that have traditionally been wasted, such as stormwater, sewage effluent and greywater can become a valuable resource. This document provides guidance on how such recycling can be safely and sustainably achieved. It focuses on uses such as agriculture, fire control, municipal, residential and commercial property, and industry. Publication of these guidelines is timely, because pressure on freshwater supplies is increasing in many cities and regional areas of Australia, due to widespread drought and movement of population to large centres near capital cities. In recent years, several reports have suggested that we need to use water more efficiently; for example, by reusing water that has traditionally been seen as wastewater (SECITA 2002, Rathjen et al 2003, AATSE 2004). In response to this situation, the Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council developed these national guidelines on water recycling, under the auspices of the NWQMS. These guidelines overcome some of the deficiencies of related publications. For example, they are more comprehensive than the *NWQMS Guidelines for Sewerage Systems, Use of Reclaimed Water* (NHMRC and ARMCANZ 2000) and provide a consistent approach, whereas the guidelines developed by individual state and territory governments vary in their approach. An important feature of these guidelines is that they use a risk management framework, rather than simply relying on post-treatment testing as the basis for managing recycled water schemes. When recycling water, it is essential to protect the health of both the public and the environment, and a risk management approach is the best way to achieve this. This type of approach been used in the food industry for many years, through application of the hazard analysis and critical control point (HACCP) system. More recently it has been adopted in the water industry; for example in the latest edition of the *Australian Drinking Water Guidelines* (NHMRC-NRMMC 2004) and of the World Health Organization's *Guidelines for Drinking-water Quality* (WHO 2004). The risk management framework used in these guidelines is based on the framework detailed in the *Australian Drinking Water Guidelines* (NHMRC-NRMMC 2004). As the framework is generic it can be applied to any system that is recycling water. The framework involves identifying and managing risks in a proactive way, rather than simply

	reacting when problems arise. The first step is to look at hazards in the recycled water that could potentially affect human or environmental health (ie 'What might happen and how it might occur?'). The next step is to estimate the risk from each hazard by assessing the likelihood that the event will happen and the consequences if it did (ie 'How likely is it that it will happen, and how serious will it be if it does?'). After characterising the risks, preventive measures to control hazards are then identified (ie 'What can we do about it?'). The approach also includes monitoring to ensure that the preventive measures operate effectively, and verification to ensure that the management system consistently provides recycled water of a quality that is fit for its intended use. The risk management framework comprises 12 elements that fall into four main categories: • commitment to responsible use and management of recycled water • system analysis and management • supporting requirements (eg employee training, community involvement, research and development, validation, and documentation and reporting systems) • review (eg evaluation and audit processes). The 12 elements are related, and all need to be implemented for the risk management approach to be successful. An important feature of the approach is that multiple barriers are used to control hazards, meaning that if one measure fails, other measures continue to provide control. For example, in a scheme to irrigate commercial crops with recycled water from a major metropolitan sewage treatment plant, preventive measures designed to protect human health might include restrictions on the type of waste entering the plant, a range of treatment processes, crossconnection control at all irrigation sites and an education program on irrigation practices for those using the water or working on the scheme. Also essential to the approach are critical control points; that is, activities, procedures or processes where control can be applied, and that are essential for either preventing or reducing to acceptable levels those hazards that represent high risks. These guidelines should always be implemented in collaboration with relevant authorities such as those for protection of health and the environment. The guidelines consider management of risks to human health and environmental health, and focus on two specific situations — water recycled from a centralised sewage treatment plant and from greywater. The approach is to identify major health risks and the preventive measures needed to reduce those risks to an acceptably low level. Sources of recycled water such as sewage and greywater can contain a wide range of agents that pose risks to human health, including pathogenic (disease-causing) microorganisms and chemicals. Microbial hazards include bacteria, viruses, protozoa and, to a lesser extent, helminths. Chemical hazards include inorganic and organic chemicals, pesticides, potential endocrine disruptors, pharmaceuticals and disinfection byproducts. For human health, the main focus is on microbial hazards, although chemicals must also be considered, with some emerging areas of concern with long-term exposure to low levels of chemicals. For the environment, chemical hazards pose a greater risk

	than microbial hazards, although there are emerging areas of concern with respect to microbial hazards, such as transfer of antibiotic-resistant bacteria through waste going into the environment. In managing risks to human health it is necessary to determine acceptable or tolerable risk, set health-based targets and assess risks. These guidelines use disability adjusted life years (DALYs) to convert the likelihood of infection or illness into burdens of disease, and set a tolerable risk as 10–6 DALYs per person per year. The tolerable risk is then used to set health-based targets that, if met, will ensure that the risk remains below 10–6 DALYs per person per year. In identifying hazards, it is impractical to set human health-based targets for all microorganisms that might be present in a source of recycled water; therefore, the guidelines specify the use of reference pathogens instead — *Campylobacter* for bacteria, rotavirus and adenovirus for viruses, and C*ryptosporidium parvum* for protozoa and helminths. Dose–response information obtained from investigations of outbreaks or experimental human-feeding studies can be used to determine how exposure to a particular dose of a hazard relates to incidence or likelihood of illness. In considering exposure, both intended and unintended uses need to be considered. Unintended uses can be deliberate (eg filling a swimming pool with recycled water) or accidental (eg mistakenly cross-connecting water supplies). Similarly, in characterising risk, both maximum risk (ie risk in the absence of preventive measures) and residual risk (ie risk that remains after consideration of existing preventive measures) need to be taken into account. In managing risks to the environment from recycled water, the aims are to safeguard the welfare of future generations, provide for equity within and between generations, protect biological diversity and maintain essential ecological processes and life-support systems. In place of DALYS and health-based targets, environmental guideline values are used; these are guideline values related to impacts on specific endpoints or receptors within the environment. Examples of endpoints include specific grasses, native tree species or soil types in the area where the recycled water is to be used. The process used to assess environmental risks is to first identify water sources, uses, users and routes of exposure. Following this, the recycled water system and water quality data are assessed; and finally, hazards are identified and the overall risk assessed. As with health risks, assessing risks to the environment involves consideration of both maximum and residual risk. However, in the case of the environment, there is also an initial screening-level risk assessment, which might involve, for example, comparing hazard concentrations in the recycled water with known guideline values for hazards in the recycled water. In developing these guidelines, nine environmental hazards were identified that should be priorities for assessing the environmental risk associated with specific uses of recycled water (eg including agricultural, municipal, residential and fire control). The nine hazards are boron, cadmium, chlorine disinfection residuals, hydraulic loading (water), nitrogen, phosphorus, salinity, chloride and sodium. A

	screening-level risk assessment identified a further nine hazards associated with use of recycled water for environmental allocation for water bodies — ammonia, aluminium, arsenic, copper, lead, mercury, nickel, surfactants (ie linear alkylbenzene sulfonates and alcohol ethoxylated surfactants) and zinc. Preventive measures to protect human and environmental health include preventing hazards from entering recycled water, removing them using treatment processes, and reducing exposure, either by using preventive measures at the site of use or by restricting uses of the recycled water. For example, treatment processes used before recycling can reduce the concentration of both microbial and chemical contaminants. Monitoring is essential to determine baseline data (ie 'Where are we now?'), to validate systems (ie 'Will it work?'), for operational purposes (ie 'Is it working now?') and to verify that the processes used in recycling are effective (ie 'Did it work?'). All types of monitoring should be used in relation to both human and environmental health risks. For human health risks, validation monitoring is essential because of the magnitude of potential health risks from use of recycled water. This means that log reductions assured by designers and manufacturers of treatment systems, or by user group representatives, cannot be assumed to be valid — some objective empirical evidence of the log reductions is required. The precise nature of the evidence depends on the nature of the barriers. For environmental health risks, two major factors influence monitoring requirements — the size of the recycled water scheme and the level of risk being managed. Generally, the larger the recycled water system, the more endpoints are potentially affected, and the greater the extent of monitoring needed. However, monitoring will also be influenced by the level of risk, which depends on the specific recycled water, and the preventive measures used to minimise the risks associated with that system. Consultation and communication (covered in Chapter 6) form part of the risk management framework. These aspects are particularly important in water recycling, where a number of proposed schemes in Australia and overseas have failed or been drastically altered because of a lack of stakeholder support. Many different factors affect acceptance of water recycling, ranging from disgust and cost to sociodemographic factors. However, there are also many factors that may make the community more likely to accept a water recycling scheme, such as minimal human contact, clear protection of public health and the environment, and confidence in local management of public utilities and technologies. Research has also identified features needed for a successful communication strategy, a range of possible methods for engaging stakeholders at the planning and operation stages of a water recycling scheme, and ideas for managing communication in a crisis. These guidelines represent a first stage in developing information for water recycling in Australia. They do not deal specifically with recycling of water from industrial and commercial sources because such waters can have very specific characteristics relating to quality, variability and quantity. However, the generic approach described here can be applied to these sources. Other aspects not covered by this

	document are the use of recycling to reduce the amount of wastewater and stormwater discharged into environments such as oceans and rivers, and the subject of water allocations (including environmental flows).

Treatment processes and on-site controls for designated uses of recycled water from treated sewage:

Log reduction targets (V, P, B)[a]	Indicative treatment process	Log reductions achievable by treatment (V, P, B)	On-site preventive measures	Exposure reduction[b]	Water quality objectives[c]
Use — Dual reticulation, toilet flushing, washing machines, garden use					
6.5 5.0 5.0	Advanced treatment required, such as: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	6.5 5.0 5.0	Strengthened cross-connection controls required including ongoing education of householders and plumbers		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • E. coli <1 per 100 mL
Use — Dual reticulation — outdoor use only or indoor use only					
6.0 4.5 5.0	Advanced treatment required; for example: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	6.0 4.5 5.0	Strengthened cross-connection controls required, including ongoing education of householders and plumbers		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • E. coli <1 per 100 mL
Municipal use — open spaces, sports grounds, golf courses, dust suppression, etc or unrestricted access and application					
5.0 3.5 4.0	Advanced treatment required; for example: • secondary, coagulation, filtration and disinfection • secondary, membrane filtration, UV light	5.0 3.5 4.0	No specific measures		• To be determined on case-by-case basis depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • E. coli <1 per 100 mL
Municipal use, with restricted access and application					
	• Secondary treatment with disinfection	2.0–3.0 1.0 >6.0	Restrict public access during irrigation and one of the following: • no access after irrigation, until dry (1– 4 hours) • minimum 25–30 m buffer to nearest point of public access • spray drift control; for example, through low-throw sprinklers (180° inward throw), vegetation screening, or anemometer switching	2.0 1.0 1.0 1.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • Disinfectant residual (eg minimum chlorine residual) or UV dosee • E. coli <100 cfu/100 mL
Municipal use, with enhanced restrictions on access and application					
	• Secondary treatment with >25 days lagoon detention or primary treatment with >50 days lagoon detention • Secondary treatment	1.0–3.0 1.0–3.0 3.0–4.0 0.5–2.0 0.5–1.0 1.0–3.0	Restrict public access during irrigation and combinations of: • no access after irrigation, until dry (1–4 hours) • minimum 25–30 m buffer to nearest point of public access • spray drift control, eg through low throw sprinklers (180° inward throw), vegetation screening, or anemometer switching	2.0 1.0 1.0 1.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • E. coli <1000 cfu/100 mL (disinfection may be required to achieve this concentration)
Landscape irrigation — trees, shrubs, public gardens, etc					
5.0 3.5 4.0	Secondary treatment or primary treatment with lagoon detention	0.5–2.0 0.5–2.0 1.0–3.0	Combinations of: • microspray • drip irrigation • no public access	 2.0 4.0 3.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • E. coli <1000 cfu/100 mL (if not disinfected)

Commercial food crops consumed raw or unprocessed					
6.0 5.0 5.0	Advanced treatment to achieve total pathogen removal required (eg secondary, filtration and disinfection)	6.0 5.0 5.0	• None required, although pathogen reduction will occur between harvesting and sale • The recycled water can be used for all crop applications, including spray irrigation of salad crops	0.5 V, B	• To be determined on case-by-case basis, depending on technologies • Could include turbidity criteria for filtration, disinfectant Ct or dose (UV) • E. coli <1 per 100 mL
Commercial food crops					
6.0 5.0 5.0	Secondary treatment with >25 days lagoon detention and disinfection	3.0–4.0 2.0–4.0 >6.0	Consumers • Crops with limited or no ground contact and eaten raw (eg tomatoes, capsicums) — drip irrigation and no harvest of wet or dropped produce • Crops with ground contact with skins removed before consumption (eg watermelons) — if spray irrigation, minimum 2 days between final irrigation and harvest • Pathogen reduction between harvesting and sale *Public in vicinity of irrigation area*[5] • No access and drip or subsurface irrigation • No access during irrigation and if spray irrigation, minimum 25–30 m buffer distance between irrigation area and nearest public access point	 3.0 3.0–4.0 0.5/day V, B 6.0 4.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • Disinfectant residual (eg minimum chlorine residual) or UV dosee • E. coli <100 cfu/100 mL
Commercial food crops					
6.0 5.0 5.0	Secondary treatment with disinfection	2.0–3.0 1.0 >6.0	Consumers • Above-ground crops with subsurface irrigation • Crops with no ground contact and skins removed before consumption (eg citrus, nuts) – no harvest of wet or dropped produce – if spray irrigation, minimum 2 days between final irrigation and harvest • Pathogen reduction between harvesting and sale *Public in vicinity of irrigation area*[f] • No access and drip or subsurface irrigation • No access during irrigation and if spray irrigation, minimum 25–30 m buffer distance between irrigation area and nearest public access point	 4.0 4.0 0.5/day V, B 6.0 4.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • Disinfectant residual (eg minimum chlorine residual) or UV dosee • E. coli <100 cfu/100 mL
Commercial food crops					
6.0 5.0 5.0	Secondary treatment or primary treatment with lagoon detention	0.5–1.0 0.5–2.0 1.0–3.0	Consumers • Crops with no ground contact and heavily processed (eg grapes for wine production, cereals) • Crops cooked/processed before consumption (eg potatoes, beetroot) • no harvest of wet or dropped produce consumption (eg citrus, nuts) – no spray irrigation • Crops with no ground contact and skin removed before • Raised crops (eg apples, apricots, grapes) – drip irrigation and no harvest	 5.0–6.0 5.0–6.0 6.0 5.0	• BOD <20 mg/Ld • SS <30 mg/ Ld • E. coli <1000 cfu/100 mL

			of wet, dropped produce • Pathogen reduction between harvesting and sale *Public in vicinity of irrigation area*[e] • No access and drip irrigation • No access during irrigation and, if spray irrigation, minimum 25–30 m buffer distance between irrigation area and nearest public access point, and spray drift control (eg through part circle sprinklers with 180° inward throw, vegetation screening, or anemometer switching) or • Extended buffer distances to >50 m	0.5/day V, B 6.0 5.0	
Nonfood crops — trees, turf, woodlots, flowers					
5.0 3.5 4.0	Secondary treatment or primary treatment with lagoon detention	0.5–1.0 0.5–2.0 1.0–3.0	Public in vicinity of irrigation area • No access and drip irrigation • No access during irrigation and, if spray irrigation, minimum 25–30 m buffer distance between irrigation area and nearest point of public access, and spray drift control (eg through part cycle sprinklers with 180° inward throw, vegetation screening, or anemometer switching) or • Extended buffer distances to >50 m	 6.0 5.0	• E. coli <10 000 cfu/100 mL

B = enteric bacteria; BOD = biochemical oxygen demand; cfu = colony forming unit; Ct = disinfectant concentration × time; P = enteric protozoa; SS =suspended solid; V = enteric virus;
UV = ultraviolet
a Log reduction targets are minimum reductions required from raw sewage based on 95th percentiles from Table 3.7.
b Exposure reductions are those achievable by on-site measures as listed in Table 3.3.
c Water quality objectives represent medians for numbers of E. coli and means for other parameters.
d BOD and SS are an indication of secondary treatment effectiveness.
e Aim is to demonstrate reliability of disinfection and ability to consistently achieve microbial quality
f Log reductions for public in the vicinity of commercial food crop irrigation areas should comply with total log reductions required for municipal use.

China

Official name: GB/T18920-2002, GB/T18921-2002, GB3838-2002

Policy Issues

	Scenic impoundments, lakes		Urban reuse			Surface water standard
Parameter [mg · L^{-1}]	Restricted reuse	Unrestricted reuse	Toilet flushing	Irrigation of green	Washing purpose	III (f. lakes)
BOD5	< 6	< 6	< 10	< 20	< 10	< 4
TDS			< 1500	< 1000	< 1000	n. r.
Turbidity [NTU]	n. r.	< 5	< 5	< 20	< 5	n. r.
TP-P	0.5	0.5	n. r.	n. r.	n. r.	0.05
TN	15	15	n. r.	n. r.	n. r.	1.0
NH4-N	< 5	< 5	< 10	< 20	< 10	< 1
Fecal coliform [< counts / 100 ml]	10,000	500	3	3	3	10000
Residual chlorine			> 1 mg/l after 30 min, > 0,2 mg/l at point of use			n. r.
Color [m^{-1}]	30	30	30	30	30	n. r.