



Guidelines for Reuse of Reclaimed Domestic Greywater in Peri-Urban Areas in Jordan⁴

1. Scope

These Guidelines set the conditions that reclaimed domestic greywater discharged from residential houses should meet in order to be used in restricted irrigation.

2. Standard References

- Standard Methods for the Examination of Water and Wastewater.
- Jordanian Standard Specification No. 893/2006 for Reclaimed Domestic Wastewater.
- Instructions for connecting premises to public sewer network issued by the Water Authority of Jordan in 1998.

⁴ Guidelines for Reuse of Reclaimed Domestic Greywater in Peri-Urban Areas in Jordan were proposed by the Inter-Islamic Network on Water Resources Development and Management, Amman, Jordan (INWRDAM). Submitted to the Jordan Institution for Standards and Metrology on May 2007, Hashemite Kingdom of Jordan. The Guidelines were prepared by: Engineer Zakaria Faris Tarawneh and Engineer Ahmad Ali Uleimat, of the Water Authority of Jordan. **Approved by JISM under Issue No. JS 1776: 2008.**

3. Definitions

The following definitions are used for the purpose of these Guidelines:



1. Greywater: is the wastewater collected from household activities such as dish-washing, sinks, bathing, laundry and others except the product water that contains human solid or liquid wastes known as "black water".
2. Black water: is the wastewater collected from toilets, urinary and washing of diapers or clothes that contain human feces.
3. Greywater sources: bath, sinks, laundry, ablution, kitchen, cleaning water and others.
4. Greywater separation: installation of pipes carrying only greywater outdoors.
5. Reclaimed Greywater: is greywater treated according to the conditions specified in these Guidelines provided that it is not mixed with water from other sources of lower water quality.
6. Greywater Treatment Systems: These are systems used to treat domestic greywater in order to be suitable for restricted irrigation of home gardens.
7. Disinfection: is a process for the removal or reduction of pathogenic and indicator microorganisms that can be found in the greywater by using disinfectants such as chlorine or chlorine dioxide or ultraviolet rays or ozone or any other disinfectant approved by the official parties.
8. Forages: are crops planted in order to utilize its vital aggregate (stems and roots) such as Sweet Corn, Sudan grass, Alfa Alfa and others.
9. Grains: are crops planted for its high content of carbohydrate and used in the nutrition of humans and animals and include wheat, barely, oats, corn.
10. Oils: are crops planted to produce oil such as sesame, soya bean and olives.
11. Industrial Crops: are crops used for industrial purposes such as wood trees and olive trees.
12. Cooked Vegetables: are vegetables that are usually eaten after cooking and include: eggplant, squash, beans, cauliflower, potato, okra, pees, broad beans, turnip, spinach, jew's mallow, artichoke and others.
13. Uncooked vegetables: are vegetables that can be eaten raw and include the following: tomato, cucumber, Egyptian cucumber, pepper, cabbage, onion, carrot, radish, lettuce, parsley, mint, rocket (watercress), coriander, purslane, strawberry, watermelon, cantaloupe and others.

14. Cut Flowers: are flowers of plants which are grown to be cut and taken into houses to be used for decoration in one form or another (fresh bouquets).
15. Drip Irrigation: is the delivery system of irrigation that delivers water directly to plants through pipes. Small holes or emitters control the amount of water that is released to the plant.
16. Surface Irrigation: is irrigation above the soil surface.
17. Restricted irrigation: is irrigation of all types of crops with treated greywater except vegetables and plants including edible parts that can get in direct contact with irrigation water wither these parts are eaten raw or cooked.
18. Unrestricted Irrigation: is irrigation of all types of crops.
19. Greywater Quantity: is the quantity of greywater that a family can recover, treat and use.
20. Wastewater Sewer Network: is the system of piping for the collection, transporting and discharge of wastewater that may include industrial wastewater and commercial activities to the treatment plant.
21. Storm Water Network: is the system of piping or conduits that carry and transport rainwater.
22. National Building Codes: are regulations issued by an administrative agency or a body that sets out all requirements for wastewater activities.

4. Acronyms and Symbols:

For the purpose of these Guidelines, the following acronyms mentioned in Table 5.1 are used.

Table 5.1: Acronyms and Symbols

Characteristics	Symbol
Aluminum	Al
Arsenic	As
Beryllium	Be
Bicarbonate	HCO ₃
Biochemical oxygen demand (Five Day)	BOD ₅
Boron	B

Characteristics	Symbol
Cadmium	Cd
Calcium	Ca
Chemical oxygen demand	COD
Chloride	Cl
Chromium	Cr
Cobalt	Co
Copper	Cu
Cyanide	CN
Dissolved oxygen	DO
Escherichia Coli	E.coli
Fat, Oil and Grease	FOG
Fluorine	F
Iron	Fe
Lead	Pb
Lithium	Li
Magnesium	Mg
Manganese	Mn
Mercury	Hg
Methylene Blue Active Substance	MBAS
Molybdenum	Mo
Most probable number	MPN
Negative logarithm of H ⁺ concentration	pH
Neuflumeter Turbidity Unit	NTU
Nickel	Ni
Nitrate	NO ₃
Selenium	Se
Sodium	Na
Sodium adsorption ratio	SAR
Sulphate	SO ₄
Total Dissolved Solids	TDS
Total Nitrogen	T-N

Characteristics	Symbol
Phosphate	P (as PO ₄)
Total Suspended Solids	TSS
Vanadium	V
Zinc	Zn
Silver	Ag
Barium	Ba

5. Greywater Sources

Greywater is collected separately from sewage flow that originates from domestic uses such as, washing machine, bathtub, shower or sink, kitchen sink and dishwasher.

6. Collecting Greywater

1. Construct a separate internal network for greywater system independent of black water and also a piping system for treated greywater or a feeding by gravity system to be used directly on site.
2. Greywater may be collected by putting a bucket under the sink and then carrying the bucket of greywater outside to the point of use and treatment.

7. Greywater Treatment Systems

The greywater treatment system should have the following components:

1. The conveyance portion of the greywater system consists of pipes and valves that are needed to allow the discharge of the greywater when the system is under maintenance or the greywater is not needed or not working to the sewer system.
2. Appropriate drip irrigation system to distribute the reclaimed greywater through a network.
3. A pump is needed to pump the greywater at some point of the system if it is not possible to make use of feeding by gravity.

8. General Requirements

8.1. Health and Safety Requirements

Domestic wastewater discharged to a sewer system represents the health conditions of each family living that area. In fact, greywater can contain different types of

organisms that are found in black water and may transfer diseases to human beings and present health risk. To avoid these conditions, the following requirements should be taken into consideration:

1. Designing appropriate greywater system according to the estimation of greywater from each household.
2. Greywater should not be stored before or after treatment more than 24 hours.
3. Greywater system must be maintained and operated by a well trained person.
4. Fresh water should be used from time to time to minimize build up of negative effects on soil properties and drip irrigation system.
5. Spray irrigation is prohibited.
6. Avoid direct contact with greywater.
7. Avoid inhalation of spray coming from greywater.
8. Do not use greywater for washing or bathing.
9. It is not allowed to discharge greywater through storm drainage network.
10. The greywater system should be operated and maintained in a well programmed manner.
11. Do not construct the greywater pipes near drinking water pipes to avoid cross contamination.
12. Greywater should not be used in a manner that may result in a direct contact with vegetables or plants eaten raw.
13. Greywater should be used on the site where it is generated household (property boundary).
14. It is advisable to construct the irrigation pipes below the soil to minimize odor problems coming from the greywater.
15. Avoid using greywater if there is a family member with an infectious health conditions.
16. Avoid using greywater discharged or mixed with washing diapers.
17. Avoid using hazardous chemicals in washing activities discharged to greywater system.
18. Avoid making pools resulting from greywater reuse activities.
19. The property area to be irrigated should be suitable to the generated greywater quantity on a daily basis.



8.2. Environmental Impact Considerations

Domestic reuse of greywater will help the environment by reducing demand on higher quality water and will minimize pressure on water resources with respect to quantity and quality conditions.

A. Greywater may be affected by the following conditions:

1. Shortage of natural water resources in the area.
2. Water quantity supplied to consumers is reduced.
3. Drinking water supplied to consumers through intermittent water supply system (weekly basis).
4. Available land area (sufficient irrigation area).
5. The willingness of the household to deal and manage its greywater system.
6. Cases where it is difficult to install and separate greywater from black water.
7. Inappropriate soil conditions.
8. The climate is not suitable for reuse activities at certain times of the year.
9. The possibility of greywater separation affecting local sewer operation.
10. The laws, regulations and systems applied in the country.
11. Health conditions of household.
12. No or low economic feasibility for the household.
13. High cost of purchasing, installing and maintaining greywater system components.
14. Absence of a qualified person in the family to deal and manage the greywater system.

B. Minimizing negative effects on the environment:

The effect of greywater reuse activities can be minimized through meeting the following requirements:

1. Greywater must be used on site at a household garden and it should not run off out of the owner property.
2. It is advisable to use detergents that are friendly to the environment.
3. Reduce flow of fat, oil and grease from kitchen to greywater system.
4. Greywater should not be discharged into storm drainage system.

9. Guidelines Requirements

1. Greywater should be completely separated from black water.
2. Must be possible to divert greywater to the normal wastewater drain system if the greywater system is closed down.
3. Must use pipes specified for carrying greywater and should be color coded to avoid mixing and cross contamination with drinking water system.
4. Official party monitoring greywater systems should consider the criteria in Tables 5.2, 5.3, 5.4A and 5.4B for the purpose of evaluating the quality of reclaimed greywater for restricted irrigation uses as mentioned in these Guidelines.

Table 5.2: Guideline limits for properties and criterion for reclaimed greywater to be reused for restricted irrigationⁱ

Parameters	Abbreviation	Unit	Allowable Limit
Biological Oxygen Demand	BOD5	mg/l	300
Chemical Oxygen Demand	COD	mg/l	500
Dissolved Oxygen	DO	mg/l	>2
Total suspended solids	TSS	mg/l	200
pH	pH	mg/l	6-9
Nitrate	NO3	mg/l	50
Total Nitrogen	T-N	mg/l	45
Turbidity		NTU	25

Table 5.3: Guideline limits for properties and criterion of biological and microbiological for reclaimed greywater to be reused for restricted irrigation

Parameters	Abbreviation	unit	Allowable limit
Escherishia Coli	E. coli	Most probable number or colony forming unit/100 ml	***** [*]
Intestinal Helminthes Eggs	Intestinal Helminthes Eggs	egg/l	< or =1

^{*} Not applicable for restricted irrigation

Table 5.4-A: Guideline limits for properties and criterion for reuse in restricted in irrigation

Parameters	Abbreviation	Unit	Allowable Limit
Phenol	Phenol	mg/l	0.05
Detergent	MBAS	mg/l	25
Total Dissolved Solids	TDS	mg/l	1500
Total Phosphate	T-PO4	mg/l	15

ⁱ These guidelines are based on results of monitoring of greywater systems installed by INWRDAM in the Karak Governorate conducted by the Water Authority of Jordan over the past three years. Recommended biological parameters are based on average treated greywater quality of more than 64 analyzed greywater samples.

Parameters	Abbreviation	Unit	Allowable Limit
Chloride	Cl	mg/l	350
Sulfate	SO ₄	mg/l	500
Bicarbonate	HCO ₃	mg/l	400
Ammonium	NH ₄	mg/l	5.0
Sodium	Na	mg/l	230
Magnesium	Mg	mg/l	100
Calcium	Ca	mg/l	230
Sodium Adsorption Ration	SAR	-	9

Table 5.4-B: Guideline limits for heavy metals and trace elements for reuse in restricted in irrigation

Parameters	Abbreviation	Unit	Allowable Limit
Cyanide	CN	mg/l	0.05
Barium	Ba	mg/l	0.1
Aluminium	Al	mg/l	1.0
Arsenic	As	mg/l	<0.005
Berelium	Be	mg/l	0.1
Copper	Cu	mg/l	1.0
Floride	F	mg/l	1.5
Iron	Fe	mg/l	2.0
Lithium	Li	mg/l	2.5
Manganese	Mn	mg/l	0.1
Molibdinum	Mo	mg/l	0.01
Nikel	Ni	mg/l	1.0
Lead	Pb	mg/l	0.1
Selenium	Se	mg/l	<0.005
Cadmium	Cd	mg/l	0.01
Zinc	Zn	mg/l	2.0
Chrome	Cr	mg/l	0.1
Mercury	Hg	mg/l	<0.004
Vanadium	V	mg/l	<0.03

Parameters	Abbreviation	Unit	Allowable Limit
Cobalt	Co	mg/l	0.05
Boron	B	mg/l	1.0

10. Quality Monitoring

1. The responsible party for constructing the greywater system and the owner must ensure that the greywater system is working in an efficient manner so that the reclaimed greywater quality complies with the conditions stated in these Guidelines.
2. In case of sampling, the collecting, preserving, transporting and analyzing of greywater samples will be as stated in the "Guideline Methods for the Examination of Water and Wastewater issued by APHA" and the Federal American Association for Water Research and Pollution Control and any of its amendments or any other approved method if it is not mentioned in the above mentioned reference.

11. Evaluation Mechanism

For the purpose of evaluating the quality of reclaimed greywater to be used for restricted irrigation, the responsible party should ensure that the reclaimed water quality is safe. This can be achieved on routine basis through conducting training courses for operating and maintaining the greywater system to have an efficient system.

12. References

1. Standard Methods for the Examination of Water and Wastewater, APHA.
2. Jordanian Standard Reclaimed Domestic Wastewater No. (893/2006).
3. Irrigation with Reclaimed Municipal Wastewater, A guidance Manual, Stuart Pettygrove et al., 1984.
4. Health Guidelines for the use of Wastewater in Agriculture and Aquaculture, WHO, 1989.
5. Irrigation Guidelines for Water in Jordan GTZ/JVA, 2006.
6. Web site (www.inwrdam.org).
7. Web site (www.csbe.org).
8. Web site (www.umassdroughinfo.org).
9. Valelitt, Greywater Guidelines (Tucson: Water Conservation Alliance of southern Arizona-2002).
10. Summary of water quality for samples collected from Karak Area. (December 2006-March 2007).
11. Revision of health conditions for the reuse of greywater (WHO/CEHA, Amman, Jordan, 2004)