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DEVELOPMENT OF GUIDELINES FOR THE ECONOMIC USE OF WATER IN THE ESCWA REGION

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I. WATER REQUIREMENTS AND STANDARDS FOR VARIOUS USES IN THE ECWA REGION

The major water uses could be calssifed into three main categories:

(a) Municipal, and domestic uses in urban and rural areas;

(b) Industrial requirements;

(c) Agricultural demands.

A. Municipal and domestic uses

The development of urabn and rural communities in any country has been closely associated with the provision of adequate water supply and sewage systems. In fact, these systems not only consititute the basis for the promotion of public health and the conservation of manpower, but they also play a significant role in economic development.

The rapid increase in population, the growth of urban areas and the steady rise in living standards have dramatically increased the per capita consumption of water.

Only 77 per cent of the urban population and 22 per cent of the rural population in the developing countries have access to reasonable water supplies. Most of them lack satisfactory sewage disposal facilities[1/].

The main issue, from an economic view point is to know the effects of the accessibility, quality and quantity of water on health.

Many human enteric parasites are transmitted though fecal contamination of water[2/]. This perpetuates many of the problems so prevalent in the developing world. Safe drinking water and safe waste disposal are necessary prerequisites for the eradication of water-borne diseases.

The international WHO standards for drinking water are listed in the following table:

1/ Saunders and Warford: "Village Water Supply: Economics and Policy", 1976.

2/ H. Dietrich and M. Handerson, WHO, Urban Water Supply Conditions and Needs in Seventy-five Developing Countries, 1963.

Table 1: <u>Standards for Drinking Water</u>

Maximum	Mean	Material or Characteristics
750 mg/l	250 mg/l	Suspended sediment
25 mg/l	5 mg/l	Turbidity
–	Tasteless	Taste
–	Colourless	Colour
1 mg/l	Less than	Br - Bromium
0.5 mg/l		
1 mg/l	0.3 mg/l	Fe - Iron
0.5 mg/l	0.1 mg/l	Mn - Manganese
15 mg/l	1 mg/l	Cu - Copper
200 mg/l	75 mg/l	Ca - Calcium
200 mg/l	50 mg/l	Mg - Magnesium
400 mg/l	200 mg/l	SO_4-Sulphate
650 mg/l	200 mg/l	Cl - Chlorine
Not less than 6.5, not more than 9.2	8.5-7.6	Ph*-Acidity or alkalinity measure
4 mg/l	3 mg/l demand	BOD-Biochemical oxygen
0.05mg/l	–	As - Arsenic
0.01mg/l	–	Cd - Cadium
0.05mg/l	–	CN
0.10mg/l	–	Pb - Lead
0001mg/l	–	Hg - Mercury
0.01mg/l	–	Se

<u>Source</u>: World Health Organization (WHO) International Standards for Drinking Water (Geneva, 1963-1971).

* Ph is the logarithm of the reciprocal of the hydrogen ion concentration.

Sedimentation, filtration and chlorination of surface water used for drinking and domestic purposes in the ECWA region are sufficient measures to render it in conformity with the WHO standards while drinkable groundwater needs only to be cholorinated. Periodic analysis of samples of water from water-supply schemes is a recommended routine.

Bicarbonate is common in groundwater. It is likely to contain more iron (Fe) than surface water. Concentrations as low as 0.3 ppm parts per million iron leaves reddish brown stains on porcelain and cloths discounting its value for household use, although it has no ill effect on the human body. Iron is removed by filtering.

Hardness of water is due to the presence of calcium, and magnesium salts in appreciable parts per million (ppm) is another source of complaint for household water consumers. In soft water they are practically absent. The degree of hardness is reported as follows:

Parts per million (ppm)	Classification
0-60	Soft
61-120	Moderately soft
121-180	Hard
more than 180	Very hard

Moderately hard water is suitable for all purposes. Hard water may be softened by a lime-soda process and zeolite or cation-exchange. The lime-soda process is employed for public and industrial supplies, while a cation-exchange is utilized for personal or domestic uses. Softening water reduces soap consumption, fuel consumption due to reduced boiler scale and plumbing maintenance expenses.

The average daily world consumption of water per capita is 80 liters according to WHO statistics. This average increases with the rise of living standards and the development of the town. Cities with over (100) thousand population in the U.S.A., for example, are designed on the basis of a daily consumption of (600) liters of water per capita including industrial uses.

B. Industrial uses

Industries consumes huge quantities of water which could be classifed into three interreleted general calsses as follows:

1. Water entering into the formation of the final industrial product forming an important part of it;

2. Water used in industries for cooling, removal of impurities and preparation of solutions;

3. Water used to dilute and remove industrial debris.

Industry consumes most of the water supply in advanced industrialized countries with agriculture a close second. Some wastewater can be treated and reused but with the present rate of growth, reduction in the total water required for industry is not a possibility. Industrialization increases urbanization thus increasing the demand on water supplies for domestic and municipal use.

In group 1 member Countries of the ECWA region, the extensive development of oil fields during the last twenty five years, with the essential urbanization associated with it created a high demand on water for industrialization and urbanization. For this reasons, desalination was resorted to as a valuable supplemental source.

Some industries require more water than others. Table 2 below lists water requirements for a large number of industries.

Table 2: Water Requirements for a Large Number of Various Industries

Inudstry	Water Usage in Cubic Meters
One ton of Petroleum	10
" ton of Canned vegetable	0.04
" ton of Paper	199.0
" " " Wool textile	600.0
" " " Cement	4.50
" " " Steel	150.0
" " " Nitrogen fertilizers	600.0
" " " Sulpher mining	11.0
" " " Artificial rubber	2,100.0
One ton of Aluminium	200.0
" " " Artificial silk	2,660.0
" " " Fibber threads	5,600.0
" " " Cotton textile	260.0
" " " Sugar	200--400

Source: Al-Sahhaf, Mehdi, "Water Resources in Iraq, and Their Protection From Pollution", Baghdad, Ministry of Guidance, 1976, p.156.

Steel production and synthetic rubber use water mainly for cooling. If the purpose is cooling it is relatively easy to retrieve most of the water used for this purpose but not without the expense of investment in cooling tanks, towers and pumping.

Water and waste treatment is freeing increasing amounts of water for use and reuse as more is learned about water quality and how to adjust fresh water of low quality (having a high mineral or organic content) for different uses. New and better treatment methods are evolving every year. Demineralization is likely to carry the burden of water improvement for some time.

Sample standard specifications of water used for different industries are presented in Table 3 below:

Table 3: Sample Standard Specifications for Water for Various Industries

Industry	Material	Percentage
Textile	Fe	Not more than 0.3 mg/1
	Mn	" " " 1.0 mg/1
	Cu	" " " 0.5 mg/1
	Dissolved solids	" " " 150 mg/1
	Suspended solids	" " " 1000 mg/1
	$CaCO_3$	" " " 120 mg/1
	Ph	Not less than 6, not more than 8

Table 3: (Cont'd)

Industry	Material	Percentage
Chemical industries	Fe	Not more than 5 mg/1
	Mn	" " " 2 mg/1
	Ca	" " " 200 mg/1
	Mg	" " " 100 mg/1
	HCO_3	" " " 600 mg/1
	SO_4	" " " 850 mg/1
	Dissolved solids	" " " 2500 mg/1
	Chlorides	" " " 500 mg/1
	Suspended sediments	" " " 10,000 mg/1
	$CaCO_3$	" " " 1000 mg/1
	Alkali	" " " 500 mg/1
	Ph	Not less than 5.5, not more than 9
Petrochemical industries	Ca	Not more than 220 mg/1
	SiO_3	" " " 50 mg/1
	Fe	" " " 15 mg/1
	Mg	" " " 85 mg/1
	K+Na	" " " 230 mg/1
	HCO_3(Bicarbonates)	" " " 480 mg/1
	SO_4	" " " 570 mg/1
	Chlorides	" " " 1600 mg/1
	NO_3	" " " 8 mg/1
	F	" " " 1.2 mg/1
	Deissolved salts	" " " 3500 mg/1
	Suspended sediments	" " " 500 mg/1
	$CaCO_3$	" " " 900 mg/1
	Ph	Not less than 6, not more than 9
Food and canning industries	$CaCO_3$	Not more than 300 mg/1
	Ph	" " " 8.5
	Ca	" " " 120 mg/1
	Chlorides	" " " 300 mg/1
	SO_4	" " " 250 mg/1
	Fe	" " " 0.4 mg/1
	Mg	" " " 0.2 mg/1
	SiO_4	" " " 50 mg/1
	NO_3	" " " 45 mg/1
	Dissolved salts	" " " 550 mg/1
	Suspended sediments	" " " 12 mg/1
Paper industry	Suspended sediments	Not more than 500 mg/1
	Fe	" " " 0.5 mg/1
	Chlorides	" " " 1000 mg/1
	Dissolved salte	" " " 1080 mg/1
	$CaCO_3$	" " " 475 mg/1
	Ph	Between 4.6 - 9.4

Table 3: (Cont'd)

Industry	Material	Percentage	
Cement industry	$CaCO_3$	Not more than 240	mg/1
	Hardness	" " " 500	mg/1
	Fe	" " " 1.8	mg/1
	Mn	" " " 5	
	Ph	Not less than 6.9, not more than 8.8	
	Dissolved salts	1120	mg/1
	Suspended sediments	200	mg/1
	SO_4	235	mg/1
	Chlorides	100	mg/1

Source: National Technical Advisory Committee, report on "water quality criteria" submitted to the Secretary of Interior, Washington D.C., 1968.

See Also: Al-Sahhaf, Mehdi, "Water Resources in Iraq, and Their Protection From Pollution", Baghdad, Ministry of Guidance, 1976, pp. 170-172.

C. Agricultural uses

Water requirements for irrigation and agriculture form the largest portion of water used in arid and semi-arid regions of the ECWA Countries, (Group II and III).

The water requirements for agricultural crops in Iraq, which are about the same all over the two groups of the ECWA regions, are as follows:

Winter crops: One cubic metre per second for every (1,500) hactars all through the winter season.

Summer crops: One cubic metre per second for every (750) hactars all through the summer season.

Gardens: One cubic metre per second for every (1,000) hactars all through the year.

Cotton and Rice: One cubic metre per second for every (500) hacter all through the growing season.

The above-mentioned water requirements represent the average present agricultural water use in Iraq, covering the consumptive use of plants, conveyance losses through irrigation systems, unavoidable field water losses, including deep percolation, (depending on the employed field irrigation method, soil characteristics, depth of water table and climatic conditions), plus the leaching requirements.

In the ECWA member Countries belonging to Group I, the agricultural water needs are about twice as much due to intense heat, low precipitation, higher evaporation rates and unfavourable soil conditions. Expressed in terms of depths of water per unit area, the total water requirement per unit area for winter cultivation in Iraq is considered as 1.2 metre for the entire winter season, while it is estimated to amount from between 2.4 metres to 2.5 metres of water depth per unit area in Kuwait, Qatar, and Saudi Arabia.1/.

No accurate statistics regarding water consumption by cattle and other animals in the ECWA region is available. Rough estimates of the water consumption by camels, sheep and goats are as follows:

One sheep	average daily consumption of water	5 - 6 liters
One goat	" " " " "	5 - 6 liters
One camel	" " " " "	25 - 30 liters

Table 4 presents some established standards for irrigation water quality.

Table 4: Standards for Irrigation Water

Water class	Electrical conductivity EC X 10^6	Salt content total ppm	Sodium percentage of total salt	Boron ppm
1	0-1000	0-700	60	0.0-0.5
2	1000-3000	700-2000	60-75	0.5-2.0
3	over 3000	over 2000	75	over 2.0

Source: Israelson and Hansen, Irrigation Principles and Practices, New York, John Wiley, 1962. p.226

Class (1): is considered excellent to good, suitable for most plants under most conditions.

Class (2): waters are mentioned as good to injurious for more sensitive plants.

Class (3): considered by the laboratory unsatisfactory for most crops and unsuitable under most conditions.

If the salts present are largely sulphates, the values for salt content in each class can be raised 50 percent.

The following standards are established for fisheries and fish breeding:

1/ Kashif Alghita, Bakir, Ahmad, "Hydrology and its Applictions" Mosul University Publishing House, 1982, pp. 368-372.

Table 5: Standards of Suitable Waters for Fish Breeding

Material	Percentage
PH	Not less than 6.5 and not more than 9.0
Temperature	Does not exceed the water in the hotest summer months by more than 3 degrees centigrades
Disolved oxygen	Not more than 6 mg/litre
Turbidity	Not more than 25 mg/litre
Petroleum	zero
Radio activity	zero

Source: Al-Sahhaf, Mehdi, Pollution Control and Water Resources in Iraq, Al-Hurriyah Printing House, Baghdad, 1976, p. 168.

The FAO standards for waters suitable for agriculture which seems to be very strict and waters suitable for domestic animals are presented in Tables 6 to 8.

Table 6: Water Standards for Agriculture (FAO)

Matter or characteristic	Percentage
Color	Colorless
Taste and Oder	Tasteless and Odorless
PH	Not less than 6 or more than 8.5
Total soluble inorganic matter	500 mg per litre
Total organic soluble matter	
$<$ 1 mg/l	Andrine
$<$ 17 mg/l	Eldrine
$<$ 17 mg/l	Di-eldrine
$<$ 42 mg/l	DDT
Turbidity	Free
Toxic Matter As	Not more than 0.05 mg/l
Br	Not more than 1.0 mg/l
Pb	Not more than 0.05 mg/l
Ag	Not more than 0.05 mg/l
Fe	Not more than 0.30 mg/l
Zn	Not more than 5.00 mg/l

Source: Al-Sahhaf, Mehdi, Pollution Control and Water Resources in Iraq, Al-Hurriyah Printing House, Baghdad, 1976, p. 169.

Table 7 shows somewhat detailed standards for surface waters suitable for agriculture.

Table 7: Classes of Surface Water According to Their Suitability to Agriculture

Class	Total soluble salts (mg/l)	Electrical conductivity EC in Micromhos/cm	Agriculture use
1. Suitalbe for all crops under all soil conditions	0-500	0.75	All crops(Beans, radish, peas, apples, oranges, etc.)
2. Crops relatively tolerable to salinity with good drainage	500-1000	0.75-1.5	(Wheat, barley, rice, maize, tomato, vegetable, Olive, Cabbage, etc.)
3. Crops tolerable to salinity with adequate drainage and soil care	1000-2000	1.5-3	(Cotton, Palm trees, Beet, etc.)
4. Some crops with adequate soil drainage	2000-5000	3-7.5	(Palm trees, alfalfa, salt grasses, etc.)
5. Not suitable for any crop	Over 5000	Over 7.	
Ph	5.5-8.5	temperature 12.8° 29.3°	

Source: National Technical Advisory Committee, Report on Water Quality Criteria submitted to the Secretary of Interior. Washington D.C., 1968. p. 170.

See also: Al-Sahhaf, Mehdi, Pollution control and Water Resources in Iraq, Baghdad, Al-Hurriyah Printing House, 1976, p. 173.

Almost all surface water in rivers and streams and most of the mined groundwater and springwater throughout the ESCWA region are suitable for agriculture and up to standard.

Re-use of agricultural drainage water and groundwater containing more than 3000 ppm soluble salts is feasible after mixing it with fresh water of higher quality.

Disposal of wastewater due to the previously discussed water uses-urban, industrial and agricultural necessitates the construction of adequate sewage disposal systems, terminated with sewage treatment plants. The treatment and removal of industrial debris; and the construction of appropriate drainage systems and outfalls in agricultural areas, when necessary, are essential.

Negligence of adopting such proper measures would lead to serious health hazards, pollution and quality degradation of water sources and the ruin of cultivable areas due to waterlogging and salt accumulation problems.

The wastewater disposal and treatment projects are extremely costly. A substantial portion of the capital investment and operation and maintenance costs could be recovered, however, through a carefully planned pricing and tarrif policy, the resale of treated sewage waste sludge as fertilizers and the re-use of drainage water after mixing it with appropriate amounts of fresh water.

It may be concluded that the growing population and steady development of the ESCWA region place higher demands on suitable water supplies year after year.

Desalination and domestic and/or public effluents re-use projects have to carry the burden, for many years to come, in Group 1 and 2 member Countries, the Sinai Peninsula and Matruh and Red-Sea Provinces in Egypt.

Engineering and agronomic measures in Group 3 ESCWA member Countries, can meet the required water demands through careful planning.