QUALITY OF WATER AND WASTEWATER FOR URBAN AND INDUSTRIAL DEVELOPMENT

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and

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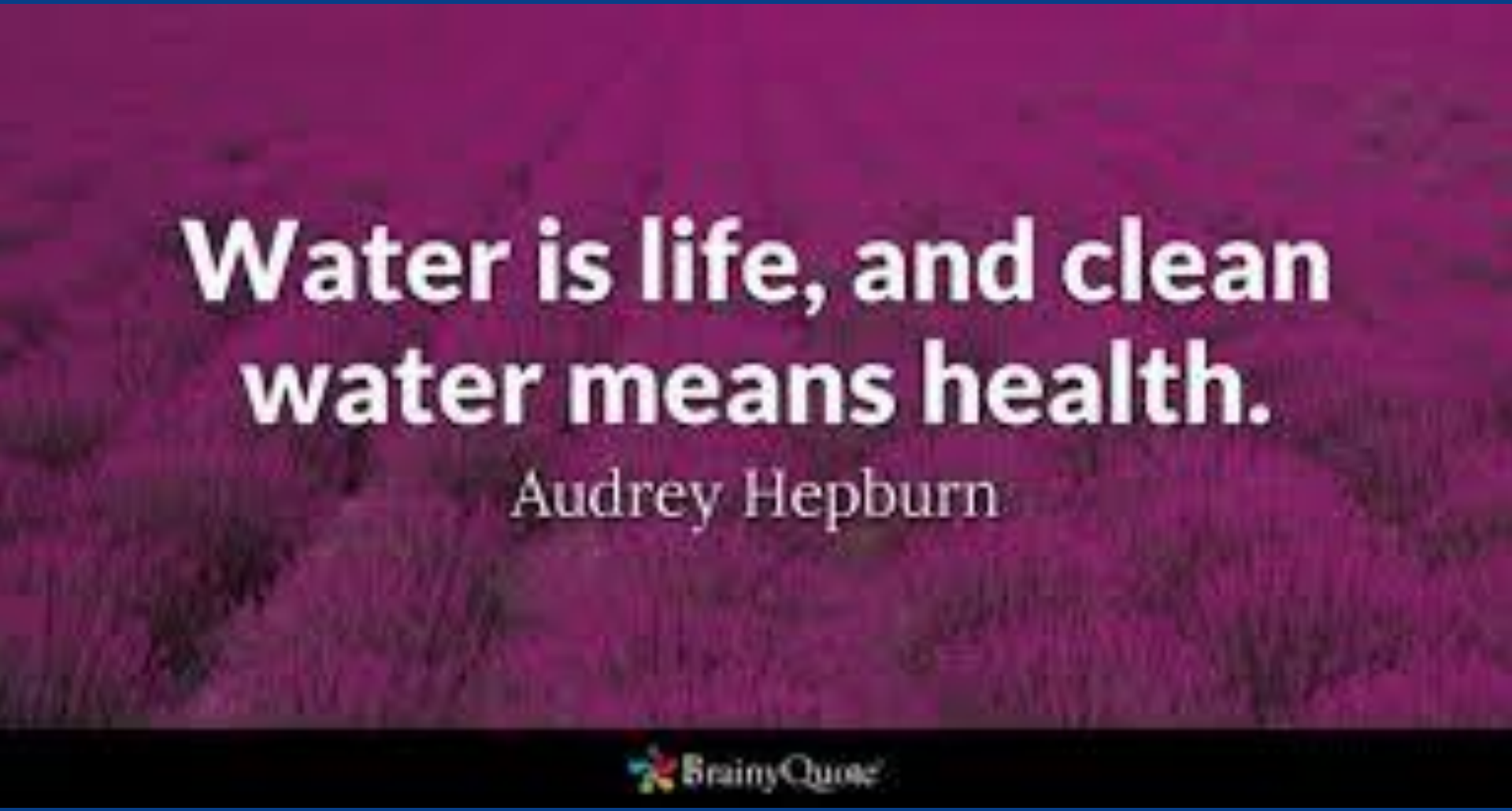
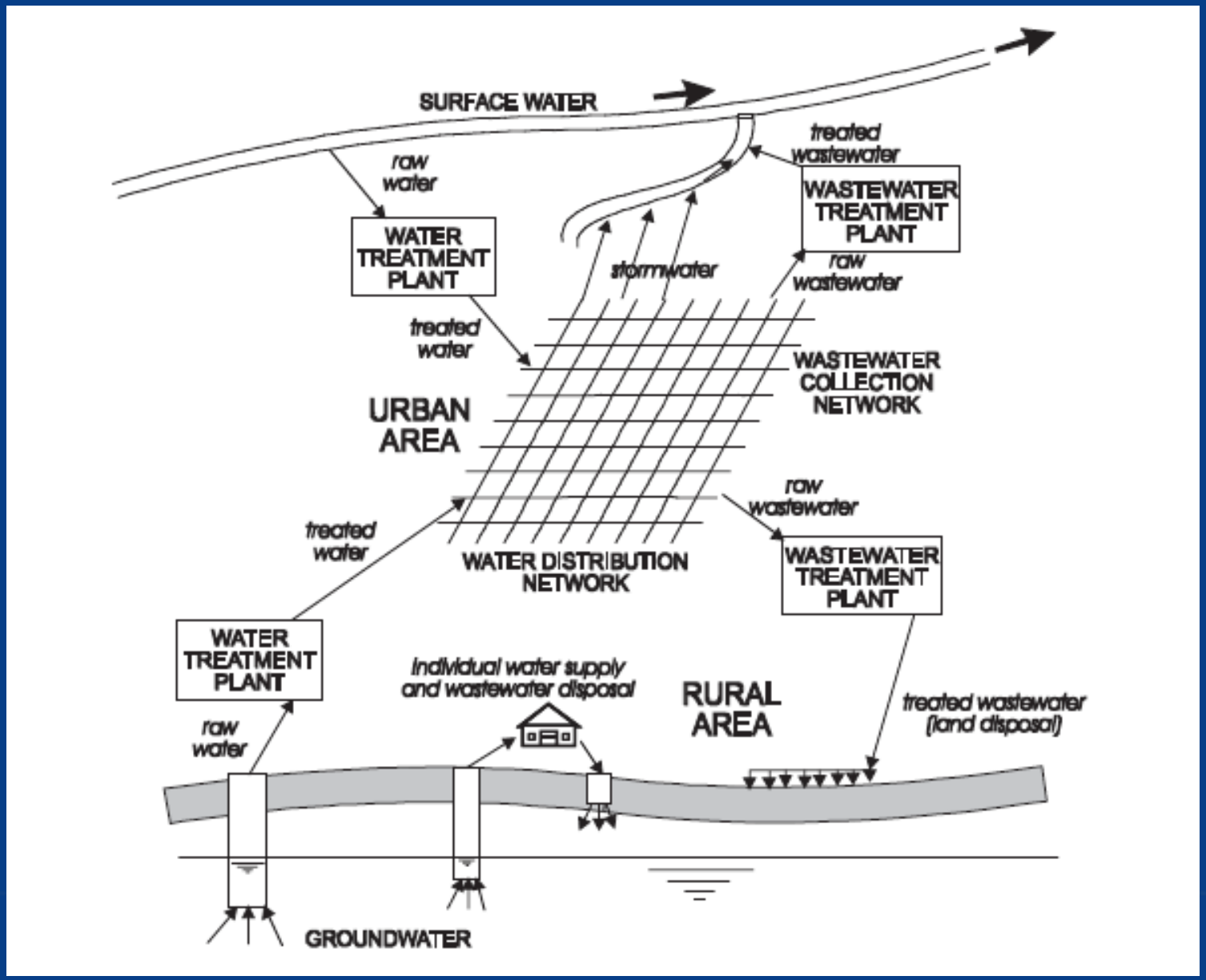
If there is magic on this planet, it is contained in water.
Loren Eiseley
BrainyQuote


Water is life, and clean water means health.
Audrey Hepburn
BrainyQuote

WATER QUALITY

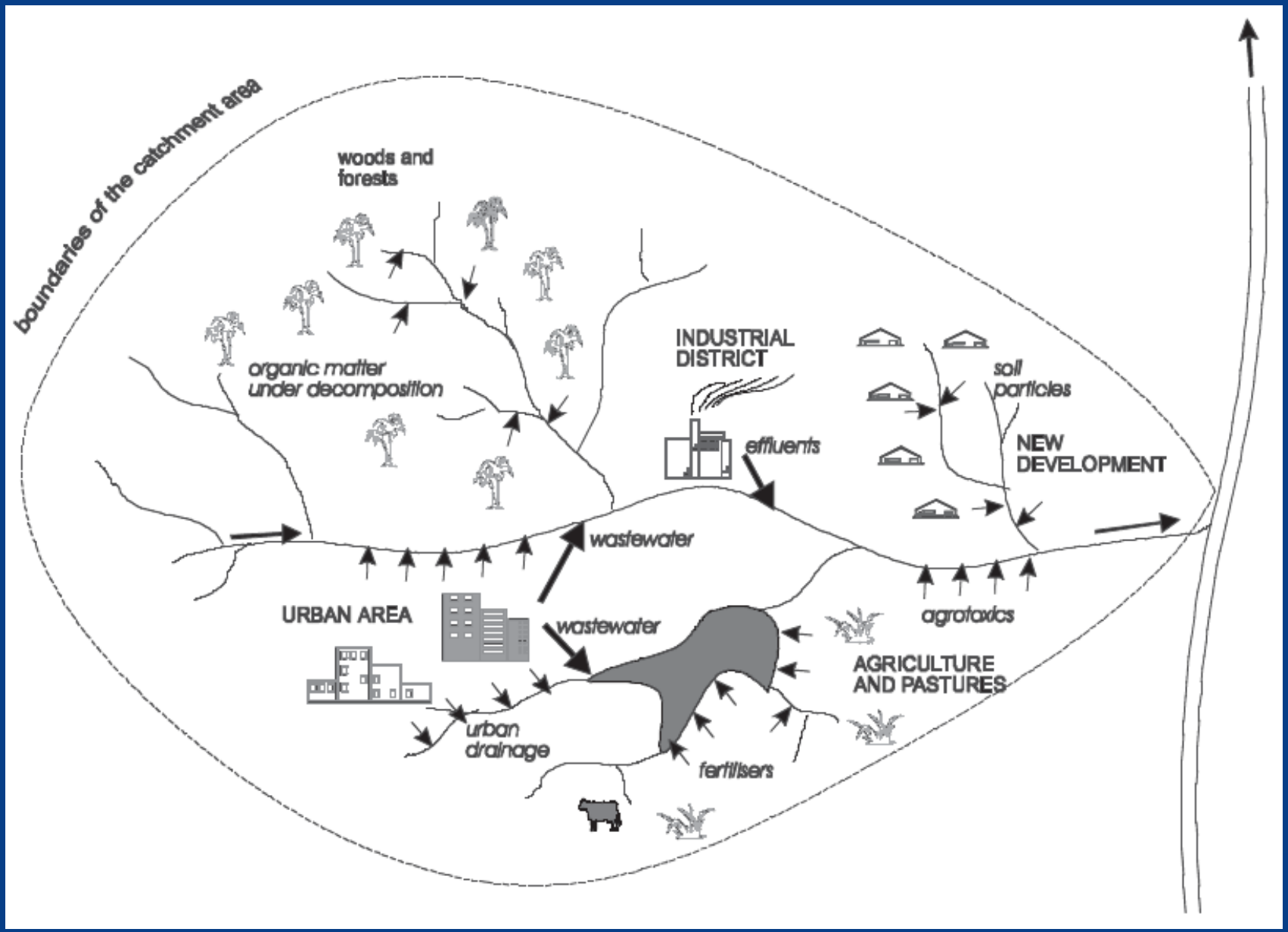
describes the chemical, physical and biological characteristics of water in terms of its suitability for a specific use

ROUTES OF WATER USE AND DISPOSAL



Source: von Sperling (2007)

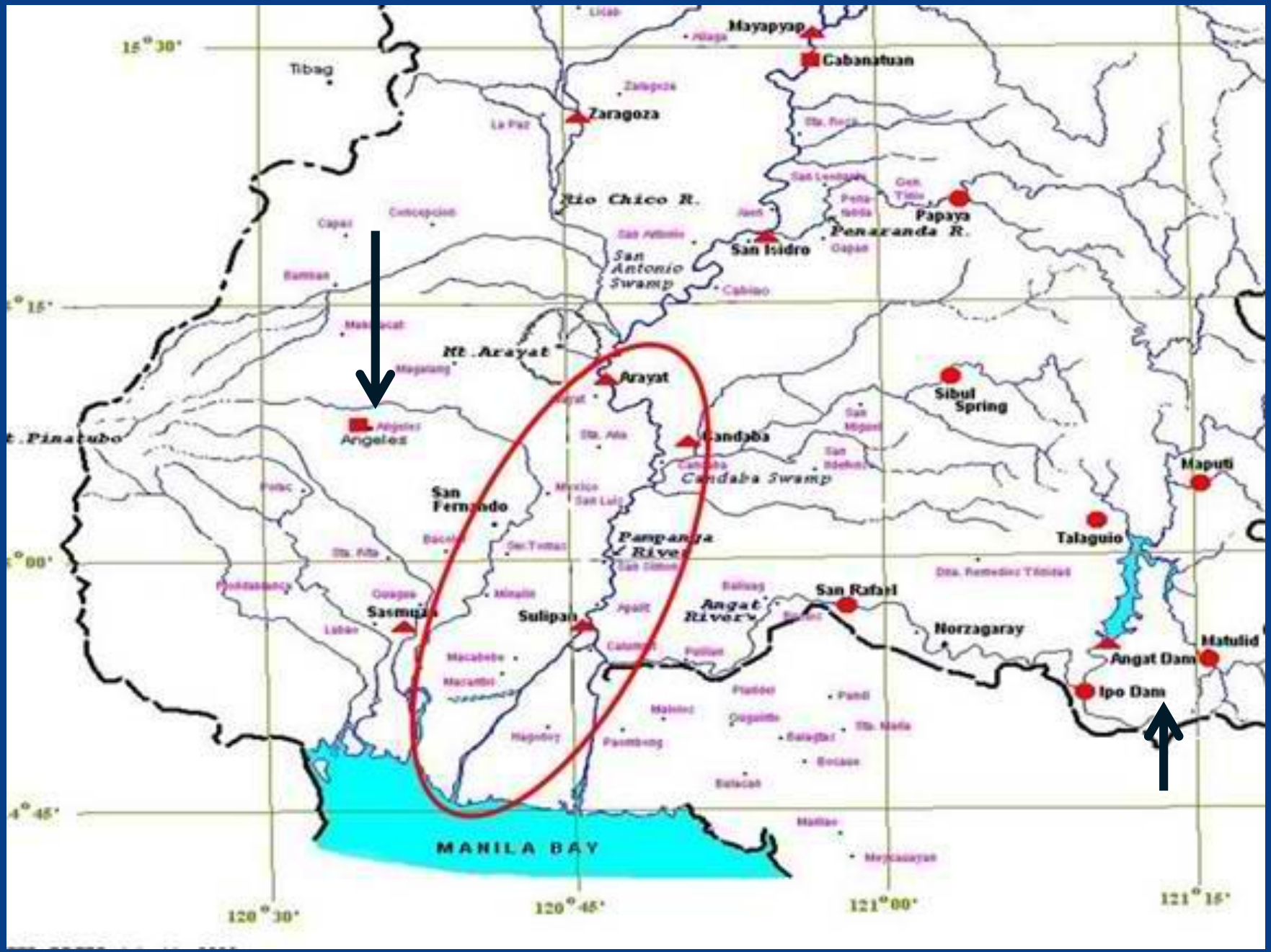
WATER QUALITY AND LAND USE IN THE CATCHMENT AREA



Source: von Sperling (2007)

MAP of PAMPANGA RIVER BASIN

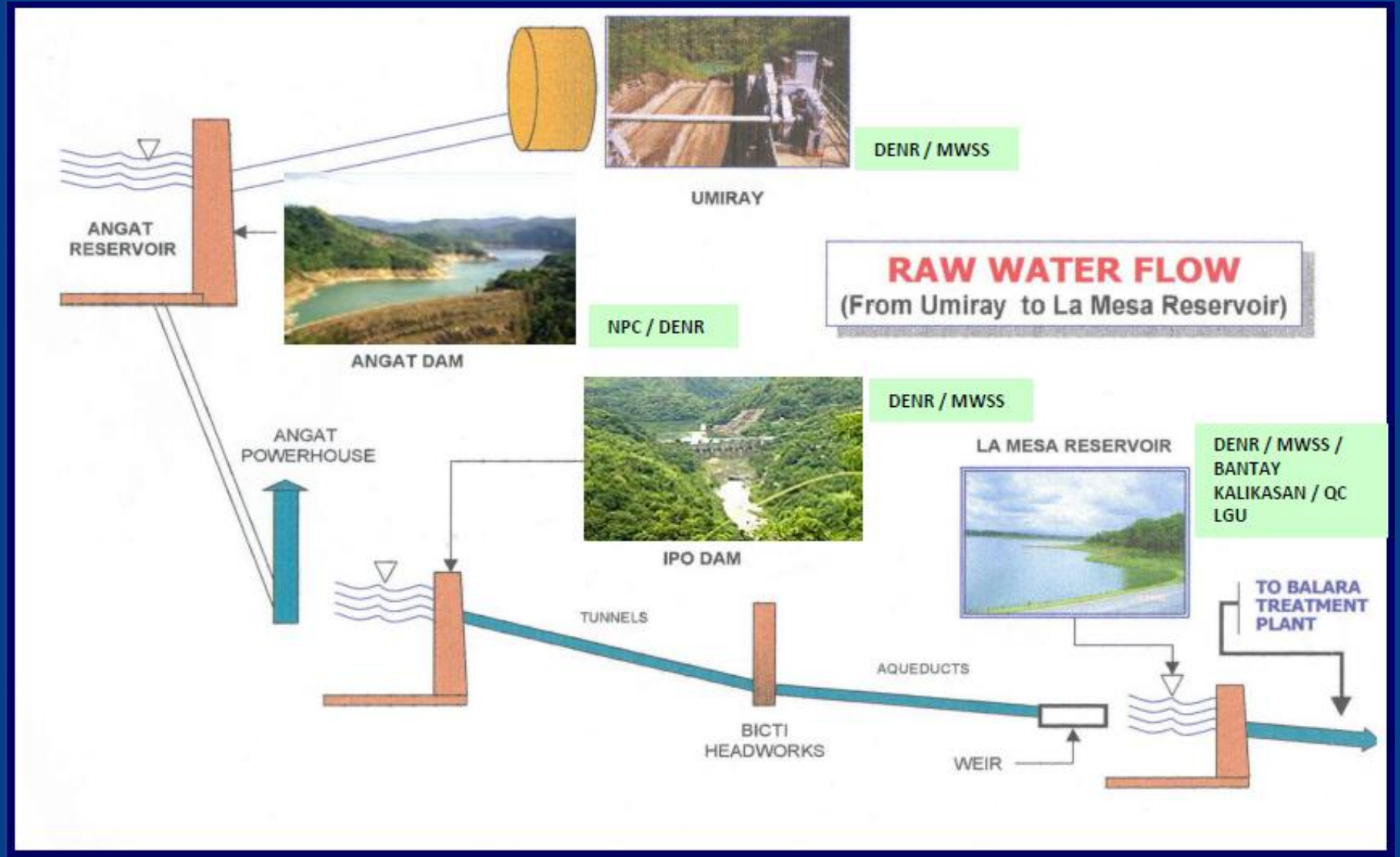
WATER SOURCE MAP for PAMPANGA



PAMPANGA RIVER (Mt. Arayat in background)

Photo of Alfred Malaza

WATERSHED MGT. PROTECTION



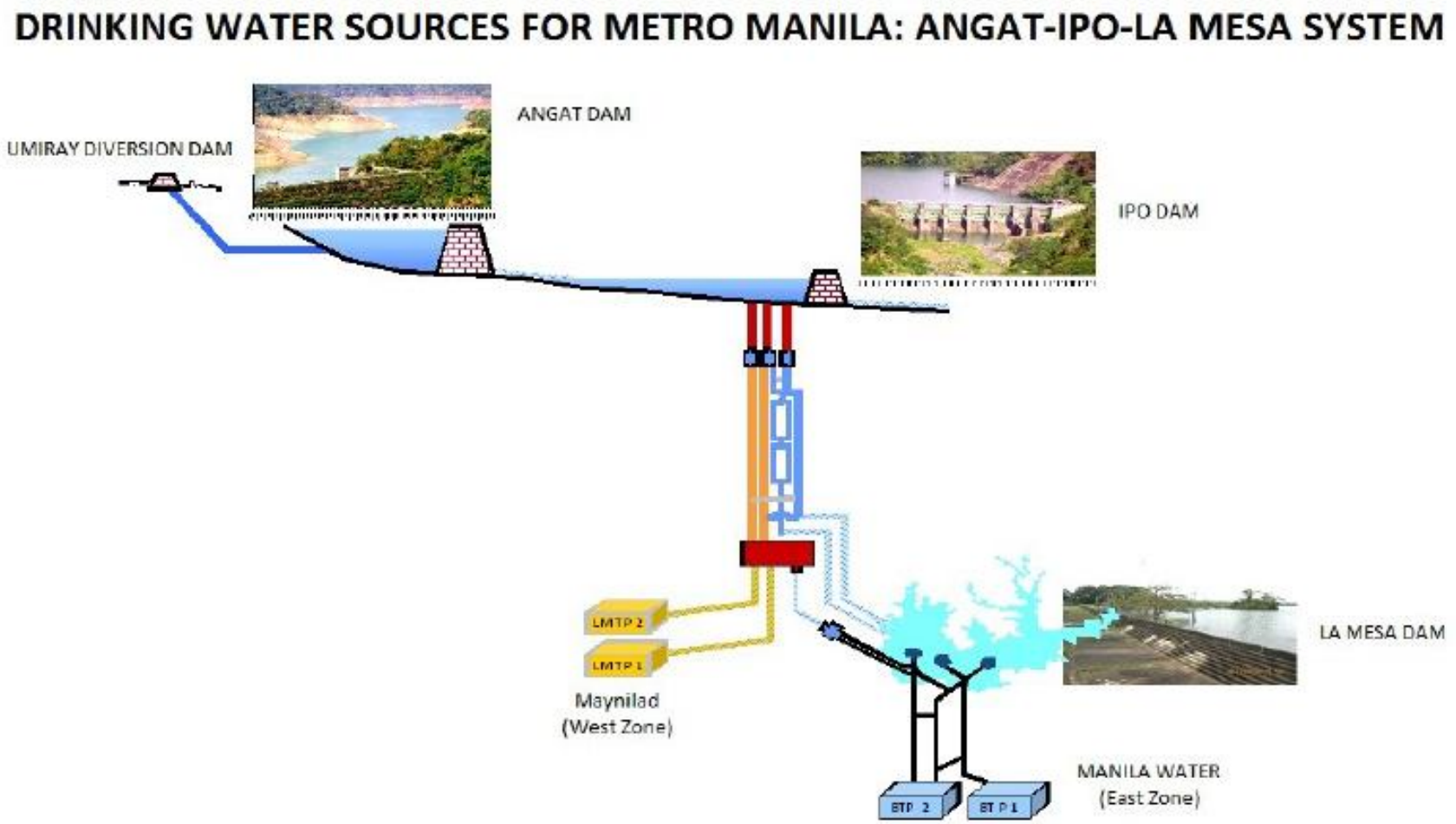
PART I.

DRINKING/POTABLE WATER

DRINKING WATER QUALITY

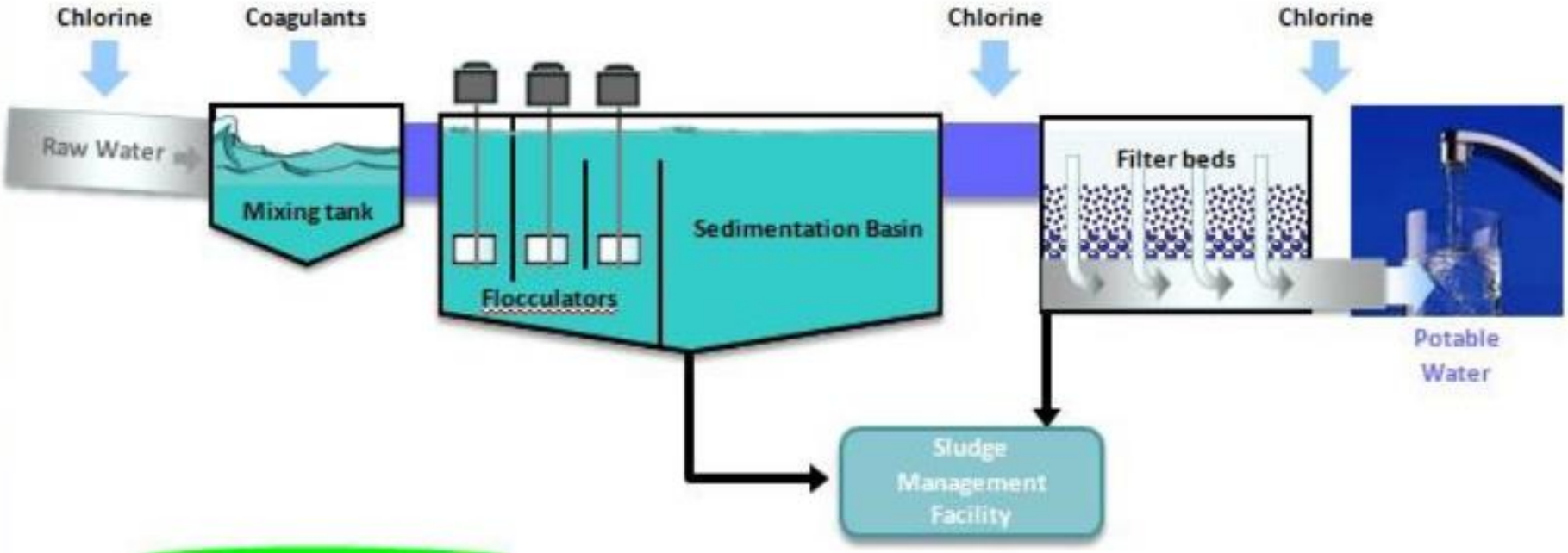
Water, the most abundant compound on earth, is essential for life. Unfortunately, it is becoming more difficult to provide potable water to the rapidly expanding human population due to depletion of water sources and increasing pollution.

MUNICIPAL/CITY WATER PURIFICATION



Water Treatment Process at the Balara Plants

PRE-CHLORINATION	COAGULATION	FLOCCULATION	SEDIMENTATION	INTERMEDIATE CHLORINATION	FILTRATION	POST CHLORINATION
Removal of algae and improves coagulation	Addition of chemicals with rapid mixing for suspended particles to form small flocs	Slow agitation or mixing to form fewer but bigger floc particles	Settling of floc particles by gravity	Further removal of algae before filtration	Filtering of remaining suspended particles	Disinfection or removal of disease causing organisms



DRINKING WATER STANDARDS

Department of Health

DOH AO No. 2017-0010

Philippine National Standards for Drinking Water (PNSDW):

- Microbiological
- Inorganic
- Organic includes disinfectant by-products
- Radioactive

Re: Administrative Order No. 2017-0010

I. Mandatory Parameters	PNSDW Max. Allowable Level
1. Arsenic (mg/L)	0.01
2. Cadmium (mg/L)	0.003
3. Lead (mg/L)	0.01
4. Nitrate (mg/L)	50
5. Color Apparent (CU)	10
6. Turbidity (NTU)	5
7. pH	6.5-8.5
8.Total Dissolved Solids (mg/L)	600
9. Disinfection residual	
Residual Chlorine (mg/L)	0.3-1.5
Chlorine Dioxide (mg/L)	0.2-0.4

DRINKING WATER STANDARDS

2. Chemical and Physical Quality

2.5 Minimum Frequency of Sampling

The minimum frequency of sampling for drinking water supply systems for physical and chemical analysis is provided in **Table 2**.

Table 2. Minimum Frequency of Sampling for Drinking-Water Supply Systems for Physical and Chemical Analysis

Source and mode of Supply	Minimum Frequency of Sampling
a. Level I	Once a year
b. Level II	
c. Level III	
d. Emergency Supplies of Drinking Water	
e. Water Refilling Stations	Twice a year
f. Water Vending Machines	

WATER QUALITY MONITORING & SURVEILLANCE

Water Supply IRR - Sanitation Code of the Phils.

- Service providers – have the legal duty to ensure that the quality of water supplied does not fall below the standards at any given time (Manila Water / Maynilad Water/water districts/ coops)

- LGU - quality and sufficiency - establish a monitoring & surveillance framework and system guidelines to ensure that drinking water quality conforms with the Standards (both private & public)

- *LOCAL* Water Quality Monitoring Committee *Metro Manila Drinking Water Quality Monitoring Committee (MMDWQMC)*

WATER QUALITY MONITORING & SURVEILLANCE

MWSS Privatization (1997)

- Creation of MWSS Regulatory Office

  ROLE:

  - determine Manila Water / Maynilad Water level of service in providing water supply that complies at all times with PNSDW

  - Independent regulator - independent reassurance that human health is safeguarded through the provision by the Concessionaires of SAFE and POTABLE public water supplies of a quality acceptable to the customers *(random sampling)*

THE MWSS REGULATORY OFFICE

Monitoring Functions of MWSS-RO

- **Technical Regulation Area:** to monitor Capital Investments and Assets of the concessionaires; to monitor concessionaires' compliance on drinking water and wastewater
- **Customer Service Area:** to monitor customers' complaints and concerns
- **Financial Service Area:** to monitor income and expenses of the concessionaires as to prudence and efficiency; to evaluate water rates/tariff as to its reasonability
- **Legal Area:** to render legal opinion and review contracts concerning customers and concessionaires

Re: Administrative Order No. 2017-0010

Population Served	Minimum Frequency of Sampling for Total Coliform and Thermotolerant Coliform/E. coli	Minimum Frequenct of Sampling for Heterothrophic Plate Count (HPC)
Less than 5,000	2 samples monthly	2 samples monthly
5,000 - 100,000	1 sample per 5,000 population + 2 additional samples monthly	1 sample per 5,000 population + 2 additional samples monthly
More than 100,000	1 sample per 10,000 population + 12 additional samples monthly	Required at least 40% of the sampling points
Note: collection of samples should be spread out within a month		

COLIFORM

A type of bacteria. The presence of coliform-group bacteria is an indication of possible pathogenic bacteriological contamination. The human intestinal tract is one of the main habitats of coliform bacteria.

DRINKING WATER QUALITY: ISSUES AND CONCERNS

RECOMMENDATIONS

- Existing policies on the quality of drinking water and monitoring procedures must be reviewed and harmonized for all WSPs including water districts, bottled drinking water manufacturers, refilling stations and small bottlers.
- DOH should be empowered, in terms of budget, structure and equipment, to effectively monitor and enforce compliance with quality guidelines, including monitoring of refilling stations and all bottled water manufacturers.

Source: del Rosario, E.J. (2013)

DRINKING WATER QUALITY: ISSUES AND CONCERNS

RECOMMENDATIONS (continued)

- Policies for recognition (more accurate term than accreditation) of water testing laboratories by DOH should be updated and should include laboratory space requirement and qualifications of persons certifying reports of analyses and evaluating laboratories.
- The Philippine government should strive to strengthen the regulation of water service providers to ensure that the standards for good quality drinking water are met and sustained.

DRINKING WATER QUALITY: ISSUES AND CONCERNS

RECOMMENDATIONS (continued)

- For bottled water the National Reference Laboratory (East Avenue Medical Center) should include proficiency testing for physico-chemical parameters.
- Currently proficiency tests are done only for microbiological analysis, being the critical parameter for water potability.
- Strict monitoring by the DOH must be enforced especially of refilling stations which do “bottling” of water.

LONG-TERM CONSUMPTION OF LOW MINERAL WATER (WHO REPORT)

Consequences

- Direct effects on the intestinal mucous membrane, metabolism and mineral homeostasis or other body functions.
- mineral and water metabolism in the body compromised- electrolyte imbalance
- Practically zero calcium and magnesium intake. - increased morbidity and mortality from cardiovascular disease (CVD)

GUIDELINE VALUES FOR DEMINERALIZED WATER (WHO, 1980)

Water quality parameter	PNSDW	Tap Water	Demineralised water- refilling	WHO guide value – demineralised water
Total dissolved solids (TDS)	500 mg/l	105 mg/l (ave.)	As low as 1mg/l	Min- 100 mg/l; Max- 250 to 500 mg/l
Hardness ($CaCO_3$)	250 mg/l	59 mg/l	< 10 mg/l	HCO_3 ion- 30 mg/l; Ca- 30 mg/l

ANALYSIS OF BOTTLED WATER SAMPLES AT UPLB

Bottled water samples sold at UP Los Baños campus met the physical and chemical standards for drinking water of both WHO and PNSDW but failed to meet safety standards. The samples were positive for total and fecal coliform bacteria.

Source: Barrion et al. (2012)

MICROBIAL ANALYSIS OF SOME BOTTLED AND TAP WATER SAMPLES FROM CEBU CITY

The results indicated the presence of bacteria in both bottled and tap water samples. Many bottles of water samples from one brand were positive for heterothrophic bacteria. Tap water samples were positive for E. coli, thermotolerant coliforms, total coliforms and other bacteria.

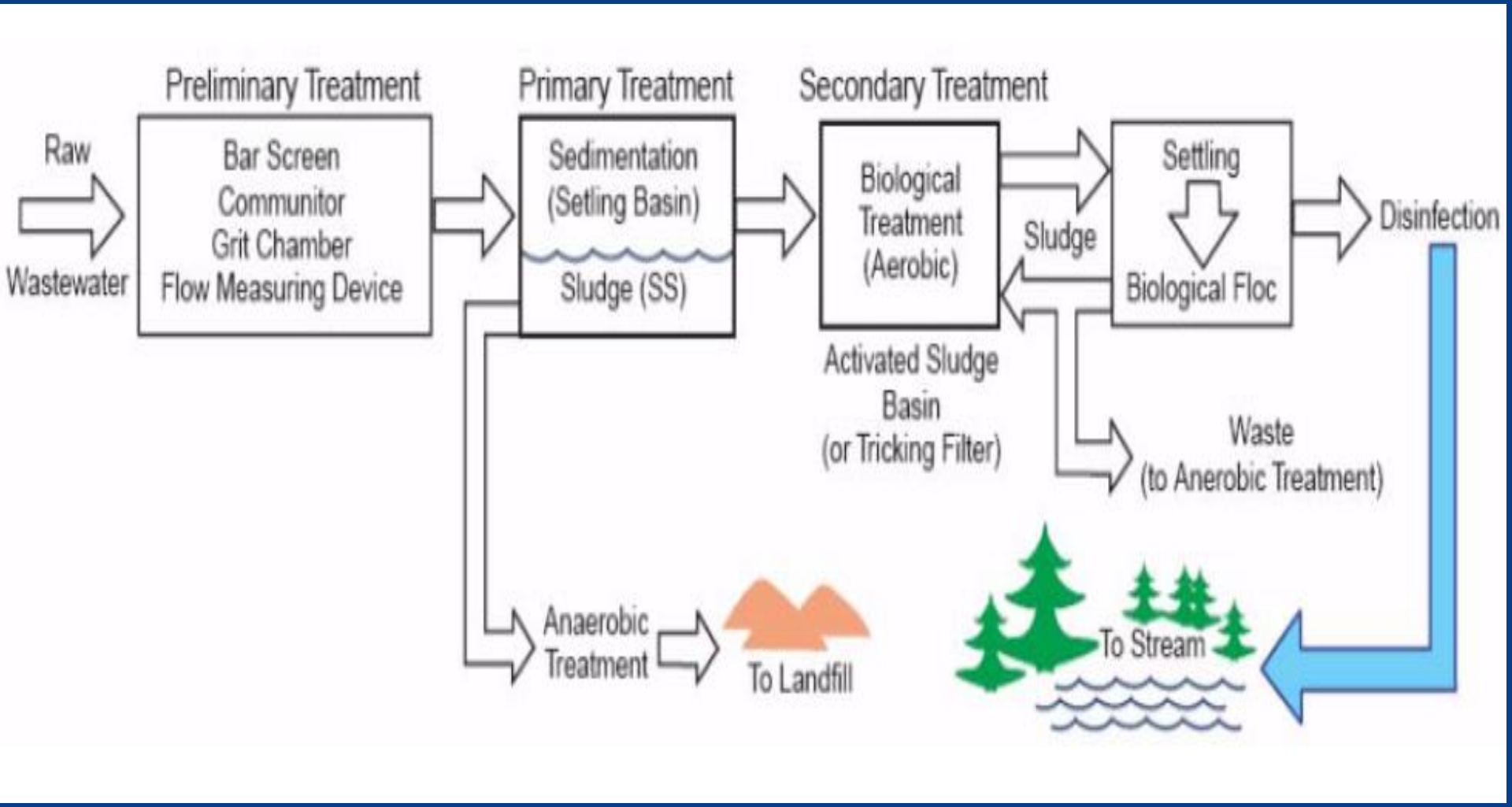
Source: B. Ybanez (2014)

PART II.

WASTEWATER

Wastewater is part of water supply to the community, industry/manufacturing, agriculture, etc. which has been mixed with suspended or dissolved solid, and usually contains pollutants.

SCHEME OF TYPICAL WASTEWATER TREATMENT FACILITY



Source: Health Manual, (2009)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

Parameter	Description
TOTAL SOLIDS	*Organic and inorganic; suspended and dissolved; settleable*
• *Suspended*	• Part of organic and inorganic solids that are non-filterable
• *Fixed*	• Mineral compounds not oxidizable by heat, inert, which are part of the suspended solids
• *Volatile*	• Organic compounds, oxidisable by heat, which are part of the suspended solids
• *Dissolved*	• Part of organic and inorganic solids that are filterable. Normally considered having a dimension less than 10^{-3} µm.
• *Fixed*	• Mineral compounds of the dissolved solids.
• *Volatile*	• Organic compounds of the dissolved solids.
• *Settleable*	• Part of organic and inorganic solids that settle in 1 hour in an Imhoff cone. Approximate indication of the settling in a sedimentation tank

Source: von Sperling (2007)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

…continued

Parameter	Description
ORGANIC MATTER	*Heterogeneous mixture of various organic compounds. Main components: proteins, carbohydrates and lipids.*
Indirect determination	
• BOD_5	• Biochemical Oxygen Demand. Measured at 5 days and 20°C. Associated with the biodegradable fraction of carbonaceous organic compounds. Measure of the oxygen consumed after 5 days by the microorganisms in the biochemical stabilisation of the organic matter.
• *COD*	• Chemical Oxygen Demand. Represents the quantity of oxygen required to chemically stabilise the carbonaceous organic matter. Uses strong oxidising agents under acidic conditions.

Source: von Sperling (2007)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

…continued

Parameter	Description
ORGANIC MATTER	*Heterogeneous mixture of various organic compounds. Main components: proteins, carbohydrates and lipids.*
• *Ultimate BOD*	• Ultimate Biochemical Oxygen Demand. Represents the total oxygen consumed at the end of several days, by the microorganisms in the biochemical stabilisation of the organic matter
Direct determination • *TOC*	• Total Organic Carbon. Direct measure of the carbonaceous organic matter. Determined through the conversion of organic carbon into carbon dioxide.

Source: von Sperling (2007)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

…continued

Parameter	Description
TOTAL NITROGEN	*Total nitrogen includes organic nitrogen, ammonia, nitrite and nitrate. It is an essential nutrient for microorganisms' growth in biological wastewater treatment. Organic nitrogen and ammonia together are called Total Kjeldahl Nitrogen (TKN).*
• *Organic Nitrogen*	• Nitrogen in the form of proteins, aminoacids and urea.
• *Ammonia*	• Produced in the first stage of the decomposition of organic nitrogen.
• *Nitrite*	• Intermediate stage in the oxidation of ammonia. Practically absent in raw sewage.
• *Nitrate*	• Final product in the oxidation of ammonia. Practically absent in raw sewage.

Source: von Sperling (2007)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

…continued

Parameter	Description
TOTAL PHOSPHORUS	*Total phosphorus exists in organic and inorganic forms. It is an essential nutrient in biological wastewater treatment.*
• *Organic phosphorus*	• Combined with organic matter
• *Inorganic phosphorus*	• Orthophosphates and polyphosphates

Source: von Sperling (2007)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

…continued

Parameter	Description
pH	*Indicator of the acidic or alkaline conditions of the wastewater. A solution is neutral at pH 7. biological oxidation processes normally tend to reduce the pH.*
ALKALINITY	*Indicator of the buffer capacity of the medium (resistance to variations in pH). Caused by the presence of bicarbonate, carbonate and hydroxyl ions.*

Source: von Sperling (2007)

WASTEWATER TREATMENT STANDARDS

Characteristics of discharge	unit	Average 30-day concentration	Average 7-day concentration
BOD_5	mg/L	30	45
TSS	Mg/L	30	45
pH	pH units	Within the range 6-9 always	
$CBOD_5$	Mg/L	25	40

Source: F. Rabah (2010)

MAIN CHEMICAL CHARACTERISTICS OF DOMESTIC SEWAGE

...continued

Parameter	Description
CHLORIDES	*Originating from drinking water and human and industrial wastes.*
OILS AND GREASE	*Fraction of organic matter which is soluble in hexane. In domestic sewage, the sources are oils and fats used in food.*

Source: von Sperling (2007)

ASSOCIATION BETWEEN WATER USE AND QUALITY REQUIREMENTS

...continued

General Use	Specific Use	Required Quality
Industrial Supply	Water incorporated into the product (e.g. food, drinks, medicines)	– Free from chemical substances harmful to health – Free from organisms harmful to health – Aesthetically pleasant (low turbidity, colour, taste and odour; absence of macro-organisms)
	Water that enters into contact with the product	– Variable with the product
	Water that does not enter into contact with the product (e.g. refrigeration units, boilers)	– Low hardness – Low aggressiveness

Source: von Sperling (2007)

ASSOCIATION BETWEEN WATER USE AND QUALITY REQUIREMENTS

…continued

General Use	Specific Use	Required Quality
Irrigation	Horticulture, products ingested raw or with skin	– Free from chemical substances harmful to health – Free from organisms harmful to health – Non-excessive salinity
	Other plantations	– Free from chemical substances harmful to the soil and plantations – Non-excessive salinity

Source: von Sperling (2007)

ASSOCIATION BETWEEN WATER USE AND QUALITY REQUIREMENTS

...continued

General Use	Specific Use	Required Quality
Animal water supply	--	– Free from chemical substances harmful to animals health – Free from organisms harmful to animals health
Preservation of aquatic life	--	– Variable with the environmental requirements of the aquatic species to be preserved

Source: von Sperling (2007)

ASSOCIATION BETWEEN WATER USE AND QUALITY REQUIREMENTS

...continued

General Use	Specific Use	Required Quality
Aquaculture	Animal breeding	– Free from chemical substances harmful to animals, workers and consumers health – Free from organisms harmful to animals, workers and consumers health – Availability of nutrients
	Vegetable growing	– Free from chemical substances toxic to vegetables and consumers – Availability of nutrients

Source: von Sperling (2007)

ASSOCIATION BETWEEN WATER USE AND QUALITY REQUIREMENTS

...continued

General Use	Specific Use	Required Quality
Recreation and leisure	Primary contact (direct contact with the liquid medium – bathing; e.g.: swimming, water-skiing, surfing	– Free from chemical substances harmful to health – Free from organisms harmful to health – Low levels of suspended solids and oils and grease
	Secondary contact (without direct contact with the liquid medium; e.g.: leisure navigation, fishing, contemplative viewing	– Pleasant appearance

Source: von Sperling (2007)


DATA
IS LIKE
WATER
NEGLECT ITS
QUALITY
AND FEAR THE
INDIGESTION
Adrien Saint, Marketing World Explorer

THANK YOU
for your attention

Sunset view – Sun Moon Beach Resort
(Bagac, Bataan)