POTABLE WATER

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Contents

Summary

Potable water plays a vital role in human society. The sources of water supply, both surface and groundwater, are analyzed in order to explain their importance for the needs of modern cities. The urban water uses are divided essentially into residential, commercial, public and industrial use.

The last part of the chapter explores the impacts caused by the urban use of the water. It is clear that urban life itself presents a pollution source that must be carefully controlled in order to achieve better environmental standards.

The various methods available for the treating and disposing of treated sewerage in natural receiving water bodies are outlined.

1. Potable Water Supply

For providing water of drinking quality in sufficient quantity for an urban population sources have to be mobilized from elsewhere, since in the immediate vicinity of the city limits only a limited supply of river, lake or underground water may be present. A number

of potential sources are discussed below.

1.1. Sources of Water Supply

Water is necessary for the health of the human beings and of the ecological system and constitutes an important element of many activities, both recreational and economic.

The quality of urban life depends on a sufficient supply of potable water. Water covers approximately 70 percent of the surface of the earth. Of this vast quantity, some 97 percent consists of sea water, which is not suitable for direct use for urban purposes. Nearly the total amount of the remaining three percent of sweet water is present in the form of solid ice in the glaciers or exists as groundwater deep underground. Therefore much of the fresh water is not directly accessible for human needs, resulting that only 0.3 percent of the sweet water is directly usable and is constituted of surface water in rivers and lakes.

Water resources for urban supply can be divided into two principal categories: surface water and groundwater.

Surface water. Surface water represents an easily accessible source of water. It can be divided into the following categories: *springs; streams and rivers;* and *lakes and reservoirs*:

Springs constitute the natural outlets of groundwater, that appear when the *piezometric* line intersects the surface of the ground. Generally, springs provide water of good quality and for this reason they are always utilized for urban water supply, when available. Even if spring water is of a better quality than water from other sources, if is often insufficient for complying with urban requirements, especially for highly industrialized countries.

Streams and rivers represent the more readily available sources of surface water. If the discharge during the dry season is much greater than the needed quantity of water, it would represent a very inexpensive resource, otherwise, as is more generally the case, water storage arrangements must be made to bridge the periods of low discharge with water drawn from storage reservoirs.

Pollution due to natural processes and anthropogenic causes renders the water of streams and rivers unsafe so that it needs some preliminary treatment in order to make it safe for drinking purposes. Therefore it is always better to withdraw water indirectly, from bored water-wells situated along the sides of streams and rivers. The reason for this is that the filtered water has endured a natural process of treatment, due to its passage through the porous medium. However, river water always requires some treatment to be rendered drinkable.

Lakes constitute a water resource that naturally, without anthropogenic pollution, presents good qualitative characteristics. They can be natural or created artificially in the form of reservoirs by means of dams made by human beings. The latter are realized in order to control and to manage the water availability for more or less long periods of

time, storing it during periods of surplus for the periods of scarcity. Water from lakes is generally easy to be abstracted and not difficult to render drinkable. Cities in the proximity of rivers and lakes cause the quality of water to get worse, and it is therefore necessary to apply more intensive treatment for ensuring its potability. The withdrawal works from lakes must be located sufficient distances away from their perimeters to guarantee that the water derived from them is not excessively turbid or subject to large temperature changes.

Groundwater, derived from the infiltration of meteoric water through geological formations, constitutes the other main water resource category. The quality of these waters depends firstly on the nature of the geological formations in which they are contained, and on the time of residence underground. The withdrawal process for these waters requires the construction of infiltration galleries or bored water-wells.

In nature, alluvial aquifers constitute the more important sources of groundwater. These are found mainly in the vicinity of rivers, lakes and seas. The water withdrawn from these aquifers is generally easy to withdraw and usually fit for potable supplies.

There are cases in which water resources can be considered being a blend between surface and ground water sources, such as in the case of wells that collect water from rivers or lakes in the vicinity. In this way it is possible to make the treatment of water less expensive, since the water already received a certain degree of purification arising from the infiltration process. In the same way water obtained from recharging groundwater aquifers can be considered a mixture between surface and ground water.

1.2. Issues on Water Resources and Supply

Natural resources, particularly water, will in future years have to make provision to cater for the growth of the population. Furthermore, global climate change may negatively affect the availability and adequacy of water resources. The changing of the climate of the planet Earth, the uncertainty of the hydrological cycle, together with the excessive exploitation of natural resources and the high cost necessary for utilizing additional surface water resources makes it necessary to seek innovative water resources.

The excessive exploitation of the aquifers that becomes necessary in order to face the increasing water demand, can produce a lowering of the piezometric level, the intrusion of polluting sources and, in the coastal zones, the penetration of the salt wedge inside the aquifer. The intrusion of marine waters therefore can surely compromise also the primary sources of fresh water supply for potable use.

The water stored in reservoirs upstream of dams has also been reduced due to many problems, such as the deposition of sediment in the lake and due to the requirements recently recommended for environmental preservation purposes. For the above reasons the search for alternative supply sources has become necessary, such as desalination of saline waters and their re-use.

Limitless amounts of salt water are available in coastal zones. The cost of desalination depends on the amount of salt that is necessary to be removed, and becomes less expensive if the process starts with brackish water and need not be confined to obtaining potable water. However the cost of utilizing this resource remains high although in the last thirty years great progress has been made with this technique.

The re-use of treated water is nowadays considered to be a new and unconventional water resource that can be used as a supplement to the more traditional water resources. Since the beginning of the 1980's there has been a progressive increase in the use of treated water, especially for irrigation and industrial purposes. The use of such water is becoming more and more customary, having however still to overcome the social resistance for its use as potable water, together with some problems of a more technical nature, such as micro-biological sources of pollution.

It is estimated that about fifty percent of the supply for domestic use is recycled into agriculture, and that the re-use of treated water can comply with about eleven percent of the water demand for the countries affected by global climate change (GCC), and fourteen percent of the demands in the field of agriculture, and that it can save up to fifteen percent of the groundwater that is being withdrawn in the world.

2. Urban Water Use

The urban water demand can be satisfied directly from the surface and groundwater resources (for example wells for urban irrigation), or can be achieved by means of aqueduct systems that connect the sources to the city center. This may involve tunnels, pipelines and pumping stations, which is dealt with elsewhere.

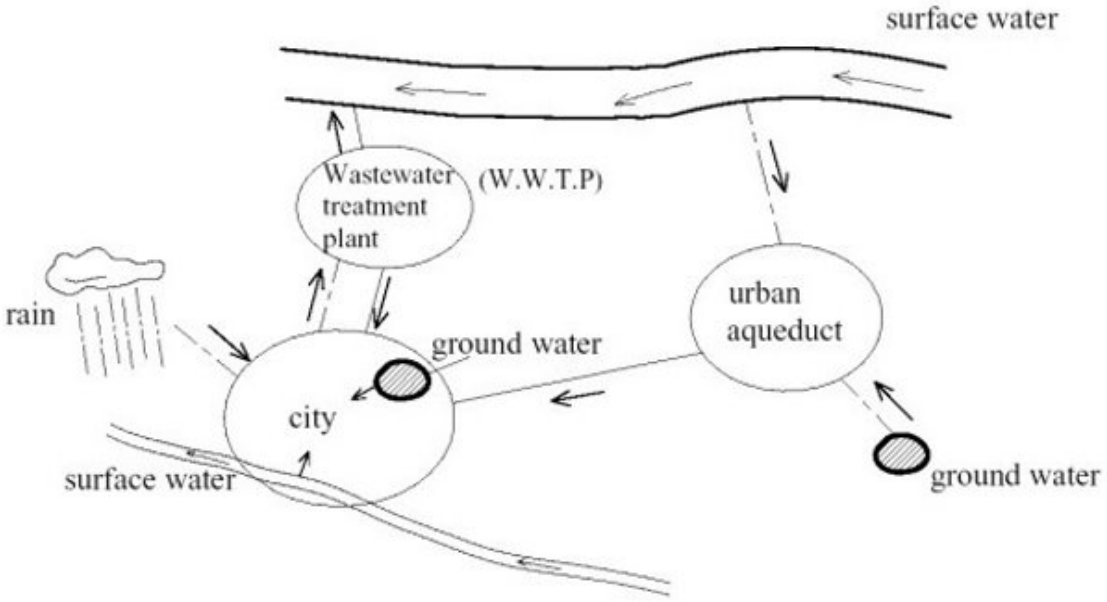

Figure 1: Diagrammatic Illustration of an Urban Water Supply Scheme

With a system of the public type remote from the supply sources, the water must be transported towards the city and there distributed in order to satisfy the needs of the city and the industrial users. The entire hydraulic works involved in the transport and the distribution of urban water constitutes a water supply system. Generally there is a single system for both domestic, commercial and industrial urban uses. This is because, if the industrial zone is located in the proximity of the city center there is no advantage to having two separate aqueducts.

The city distribution networks can be of various types, the most common ones being the looped system, the branched system and systems of the combined type. Essentially, the choice between one type or another is dictated by the lay-out of the city, although the first type is preferable because it can easily solve eventual problems that may arise in some branch of the distribution network. These types of structural and operational problems are dealt with in another chapter.

2.1. Use of Potable Water

Water use varies enormously from country to country and from city to city. In fact it essentially depends on the climate, which makes water more necessary where it is warm and dry. It also depends on the environmental impact and on the population, that is from the point of view of the social level and the economic state of the consumers, and from the degree of industrialization, since industries usually demand a great amount of water.

The use of water can be subdivided into two categories: "*instream*" use and "*offstream*" use. The former includes the production of hydropower, catering for recreation, and the provision of fish and wildlife habitats. For instream use, the water has not been captured from outside surface- or ground water resources. The latter use on the contrary comprises the withdrawal of water from outside sources, to be used for a variety of purposes, ranging from domestic use to the removal of wastes from homes and factories, and the irrigation of crops.

Once arrived at the city distribution network, the water has several destinations, depending on its intended use. The use for domestic purposes comprises all the household activities that demand water, that means drinking, washing, cooking, flushing toilets, laundering, and the irrigation of the garden. This use can be defined as the residential use. Besides this use, there are the uses for commercial-type activities, concerning the water requirements of hotels, lodgings, restaurants and all other commercial assets, as well as use for the irrigation of cultivated fields assigned to recreational activities, such as parks or golf courses.

Moreover, water is often used inside the city by industries that uses the resource for production processes and for cooling purposes. Generally, however, these industrial activities use water derived in an independent way from pools, or taken directly from surface or groundwater, at least for their process requirements. The use of urban water must finally satisfy the public requirements of the public for the fire hydrant service, for the washing of roads, the irrigation of municipal parks, the fountains and public swimming pools.

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