



# **Drinking Water - Source, Transmission and Distribution (TO BE WITHDRAWN)**

**An Online Continuing Education Course for Engineers**

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# **DRINKING WATER – SOURCE, TRANSMISSION and DISTRIBUTION**

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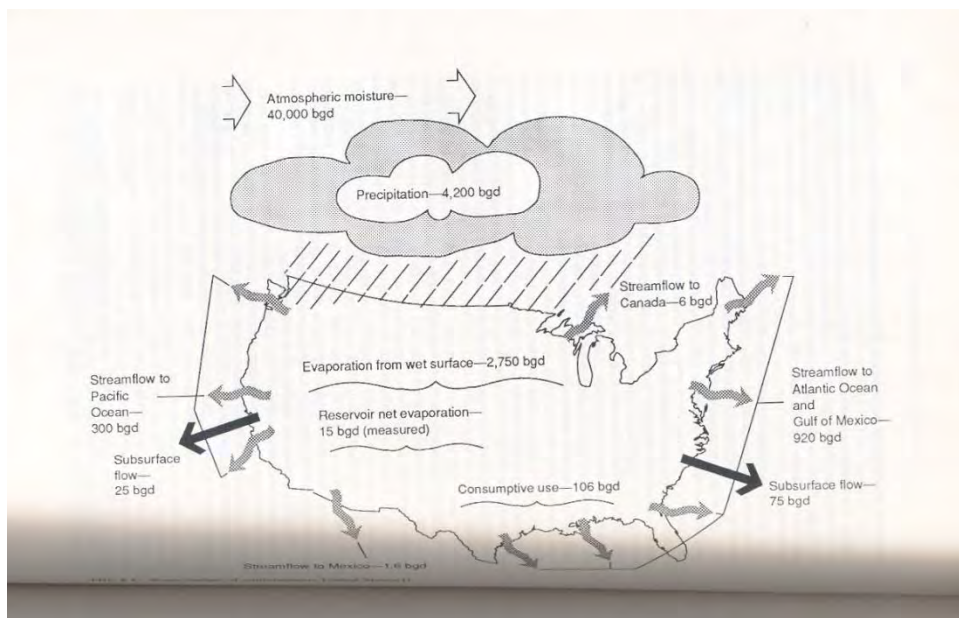
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## I. INTRODUCTION

At some time in history, water stayed in the oceans. By evaporation, moisture is transferred from the ocean surface to the atmosphere where the winds carry the moisture-laden air (water vapor) over land masses. Under certain conditions, this water vapor condenses to form clouds, which release their moisture as precipitation in the form of rain, hail, sleet, or snow. When rain falls on the earth, a part may evaporate and return immediately to the atmosphere. Precipitation in excess of the amount of evaporation requirements is available as potential source of water supply.

On the average about 40,000 billion gallons per day (BGD) of water pass over the US in the form of water vapor. Of this, approximately 4,200 BGD is precipitated as rainfall, snow, sleet or hail. The remainder continues in atmospheric suspension. Of the 4,200 BGD, two-thirds is evaporated immediately from wet surfaces or transpired by vegetation. The remaining one-third (1,400 BGD) accumulates in ground as: surface storage; flows to the oceans, the Gulf of Mexico, or across the nation's boundaries; is consumptively used; or is evaporated from reservoirs. See Figure I. 1



**Figure I. 1 Water Cycle**

As of now, only 675 BGD out of the accumulated 1,400 MGD on ground is considered available and can be developed for intensive beneficial use.

Surface water occurs in rivers, streams, lakes, swamps, marshes, and reservoirs. Stream flow varies from region to region, from season to season, and from year to year. Section II describes

the ground water as a source for drinking water supply along with other infrastructure facilities to withdraw water from these sources.

Ground water storage is considerably in excess of all artificial and natural surface storage. This enormous groundwater reserve sustains the continuing outflow of streams and lakes during prolonged periods of rains each year. The usable groundwater storage is dependant primarily on precipitation, evapotranspiration, and geologic structure. In an undeveloped groundwater basin, movement of water to lower basins, seepage from and to surface-water sources, and transpiration are dependent upon the water in storage and the rate of recharge. During periods following abundant rainfall, recharge may exceed discharge. When recharge exceeds the discharge, the amount of water available as storage in the groundwater basin increases and the water table or artesian pressure rises. When recharge ceases, storage decreases which causes water-table levels and artesian pressures to decrease. Section III describes the ground water sources together with the necessary infrastructure facilities to tap this source

Water is transported over long distances through aqueducts to locations where it is to be treated and/or used. It is then conveyed to individual users or use points through distribution networks.

Selection of an aqueduct type depends on such factors as topography, head availability, climate, construction practices, economics, and water quality protection. Aqueducts may include or be solely composed of open channels, pipe lines, or tunnels. Open channels convey water under conditions of atmospheric pressure. If the channel is supported on or above the ground, it is called a *flume*. Open channels may be covered or open and may take on variety of shapes. Open channels may be lined to reduce the resistance to flow, minimize seepage, and lower maintenance costs. Where it is not practical or economical to lay a pipeline on the surface or provide an open trench for underground installation, a tunnel is selected. Tunnels are well suited to mountain or river crossing and may be operated as open channels or under pressure. Section IV explains the transport of water from the source to treatment and/or consumer along with other ancillaries such as gate valves, check valves, air-release valves, drains, surge control equipment, expansion joints, insulation joints, manholes, and pumping stations etc.

Section V describes the distribution system in detail. The distribution system is generally the major investment of municipal waterworks. Distribution systems can be considered to consist of both storage facilities and service lines. Distribution reservoirs are used to provide storage to meet fluctuations in use, to provide storage for fire-fighting use, and to stabilize pressures in the distribution system. The reservoir should be located as close to the center of use as possible.

Service lines are pipes, including accessories, which carry water from the main to the building or property being served. Most service lines are tapped directly to the main. Service pipes should be sized such that the utility's design pressure is maintained at the customer's property for the desired flows. Excessive flow velocities must be avoided.

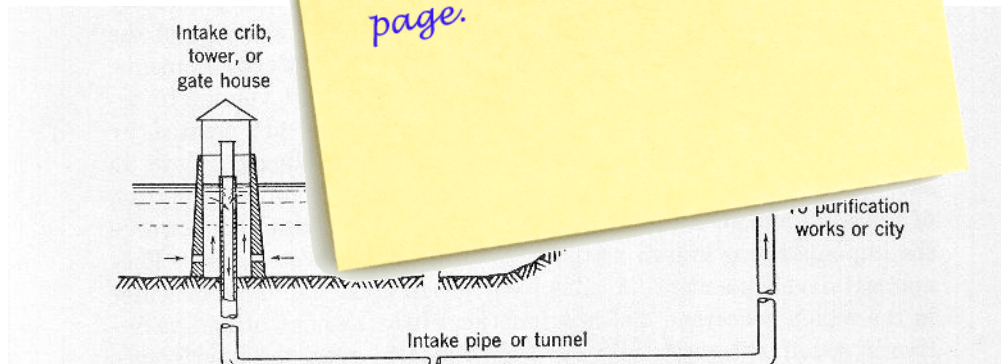
## II. SURFACE WATER

**II.1. Source** – Sources of surface water may be classified as follows:

- a. Streams, natural ponds, and lakes with adequate capacity for continuous draft.
- b. Streams with adequate flood flow, for intermittent, seasonal, or selective draft of clean flood waters, and their storage in reservoirs adjacent to the streams, or otherwise readily accessible from it.
- c. Streams with inadequate dry-weather flow but adequate annual flow, by continuous draft made possible through storage of the necessary proportion of flows in excess of daily use in an impounding reservoir created by a dam built across the stream valley.

The quantities that can be conserved in a reservoir depend with the size of the catchment area (water shed) and the amount of water precipitated and that lost by evapotranspiration.

Communities situated on streams may obtain their supplies from these sources by continuous draft. If the stream flows are sufficient at all seasons of the year to meet the requirements of the community, the works for such supplies include a dam or weir to create a reservoir, and an intake tower, (2) an intake pipe or tunnel, and (3) a distribution system. Figure II.1 is an intake arrangement for continuous draft.



**Figure II.1 Intake Arrangement for Continuous Draft**

On small streams an intake or diversion dam may have to be constructed to create sufficient depth of water to submerge the intake pipe and protect it against ice. The annual discharge of a stream or river must equal or exceed the demands of the community they are to serve. If their flows during the dry portions of the year falls short of concurrent municipal requirements, their