

The Relation of Dams and Reservoirs to the Water Supply of Southwestern California

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The utter dependence of a populated semi-arid region on an adequate water supply, though a self-evident concept, is nevertheless one which entails many unforeseen complications. The inhabitant of a humid region, accustomed to drawing his water in any desired quantity from nearby lakes and rivers, finds it difficult indeed to conceive of the problems faced by communities in southwestern California. The Los Angeles Basin alone, an area surrounded on three sides by high mountain ranges and on the fourth by the Pacific Ocean, contains over fifty per cent of the people in the state, while but seven tenths of one per cent of the state's water occurs there.

Since this South Coastal Plain, or Los Angeles Basin, is a center of population, industry, and agriculture, its water supply problem, as compared with that of neighboring districts, is unusually severe. Embracing an area of nearly 3,000 square miles, some 2,200 of which are suitable for agricultural or residential development, it is drained by the Los Angeles, San Gabriel, and Santa Ana rivers and their tributaries. There are approximately ninety cities and urban communities in the district, and nearly all the remaining land is used in the raising of citrus fruits, nuts, grapes, grains, and other agricultural products. In the region south of Los Angeles industrial development is pronounced, embracing steel mills, oil fields, and factories of various kinds. Increasing demand of these enterprises for water is naturally expected.

The improved area has the form of a gently sloping, undulatory plain, extending roughly twenty-five miles from sea-level to an elevation of nearly a thousand feet at the base of the mountains. Normal yearly rainfall on this plain is fifteen inches, though seasonal variations are common. The mountains, some of which have altitudes of ten thousand feet, receive more nearly twice that amount. Since the climate of the region is of the Mediterranean type, most of the precipitation occurs during the winter, when it is least needed for agricultural purposes. For this reason, irrigation of crops during the dry summer months is essential. Furthermore, though evenly spread through the winter and spring, the individual falls of rain are often torrential in character, their waters swelling streams to many times their normal size and quickly discharging across the plains into the ocean as waste.

The site of the Pueblo of Los Angeles was chosen largely because of the available water in the nearby Los Angeles River. This was in 1781. It is significant that but twenty years later a dam was built across the

river, diverting water for irrigation and to a lesser extent storing it for use during unusually dry seasons. For 133 years the Los Angeles River continued as the sole source of water, until a series of dry years and a rapidly increasing population forced engineers to look elsewhere for water. It was not until late in the nineteenth century that realization came to most people concerning the true nature of this river, however. It has since been stated that southern California streams "flow upside down," and recognition of this fact was one of the greatest single steps in the growing knowledge of water resources in the region. The water in these streams actually flows through and is filtered by the highly porous gravels beneath the surface. Thus, the water obtained from wells in Los Angeles was of adequate amount and superior purity.

Applications of this new concept soon came into use. It was soon obvious why the smaller streams, perennial in the mountains, disappeared beneath the surface upon reaching the floor of the Los Angeles Basin. The question immediately arose as to how this water could be saved. The answer was the construction of subsurface dams on the outwash plains of a few such streams, their effect being to bar the underground passage of the water and force it to the surface, where it could be used. The more important type of dam, however, was not man made at all, but a product of geologic activity. The mountains surrounding the plains area have been uplifted along a series of faults in comparatively recent geologic time, and have constantly contributed coarse gravels to the areas along their base. These gravels themselves have been offset by faulting or by the initial irregularities on the bedrock "basement" in such a way that individual subsurface basins were developed. In a sense, these are reservoirs formed by natural damming of the water-bearing gravels, and have been the major source of water for Los Angeles, Pasadena, and neighboring cities for many years. In addition, actual artesian areas nearer the coast were discovered.

But these new sources were foolishly and wastefully exploited. Artesian areas decreased in size from an original 375 square miles to a few dozens of square miles by 1914, while other gravel basins were so alarmingly overdrawn that ground water levels fell as much as seventy feet. Springs dried up and the waters of even the large streams sank into the gravels and disappeared. Los Angeles, realizing that stringency of water would seriously affect its growth, settled its metropolitan problem by building an aqueduct from the Owens River watershed, on the east slopes of the Sierra Nevada Mountains, 250 miles across the Mojave Desert southwestward into the Los Angeles Basin. Capable of supplying the needs of two million people, the Owens River aqueduct has five major dams and reservoirs along its length, constructed for purposes of storage, flow regulation, and power plant use. Without these structures, an aqueduct of such length would not be sufficiently flexible for practicability. At the present time, a forty-seven mile extension is being built to tap the waters of Mono Lake, thus making available enough

water to fill the aqueduct to its maximum mean capacity of approximately 300,000 acre feet per year. Two large reservoir dams and several smaller stream diversion dams are involved in this project.

Other communities met the problem in similar fashion. Though the canyons in the mountains are narrow and offer few good reservoir sites because of their steep profiles, dams were nevertheless built. The function of these structures, which are found in nearly all canyons of any importance, is twofold: first, to divert water for domestic use of the cities lying in the basin below; and second, to arrest the rapid progress of flood waters during and immediately following heavy rainstorms, allowing these waters to escape later, when they can be used. Check dams of this sort are becoming important, especially since many forest fires on the mountain slopes have increased the runoff speed.

The water supply problems of this region are by no means solved at the present time. Estimates for 1934 showed an actual overdraft on ground waters in the Los Angeles Basin amounting to nearly 166,000 acre feet per year. The larger cities of the district are meeting this situation by constructing an aqueduct from the Colorado River that will be capable of delivering over one million acre feet of water per year. Large dams are being built across the Colorado and San Gabriel rivers, the former to divert the water and the latter to form a storage reservoir. Six other dams and reservoirs are contemplated.

The agricultural districts, however, cannot afford to use such transported water for irrigation; hence they must look to more immediate sources. Studies of ground water conditions in the basin have revealed that overdraft is due to avoidable waste, rather than to lack of supply, since estimates show an excess of 400,000 acre feet over present demands. Conservation of waste waters is being carried out along several lines, the most important of which is the use of check dams in the control of floods. The flood waters are later released, as mentioned before, and spread over the gravels in the basin below, replenishing the ground water supply. Reclamation of sewage waters will eventually contribute some 100,000 acre feet of water annually, while the importance of rain falling in the basin proper is being recognized.

Similar conditions obtain in other areas of southwestern California, though a scattered population makes the situation less acute. Nevertheless, there is hardly a stream course that doesn't have at least one dam along its length, and all indications point to continued erection of more and more of these structures as the demand for water increases. Some 130 years have elapsed since the construction of that first dam across the Los Angeles River, a period during which but a single process (though with many variations) has been used to obtain water. This is simply the prevention of runoff from reaching the sea by diverting it for human uses, and as long as human uses continue to exist in southwestern California, dams and reservoirs must be an integral and essential factor.