

# Hydraulics in the Golden Age of Sanitary Engineering: The Life of Allen Hazen

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Allen Hazen (1869-1930) is perhaps best known for the friction loss formula which bears his name. However, in his career as a researcher and consulting engineer, he built on the work of Darcy and others to address a wide array of fundamental problems in applied hydraulics, producing a treatise on sedimentation (1904), a book of hydraulic tables for pipe flow and flow over weirs (1905), the introduction of the use of probability in defining a reservoir's safe yield (1913), and even the development of the probability paper familiar to hydraulic engineers today.

Hazen was born on August 28, 1869, and raised on the family farm on the banks of the Connecticut River. He completed studies at the local district school at the age of 12, rather than the customary 16, and received his Bachelor of Science degree in June of 1885 from the New Hampshire College of Agriculture and Mechanical Arts, just a few months shy of his 16<sup>th</sup> birthday. During a special one-year program at M.I.T. which he completed in 1888, he became acquainted with fellow students Edwin O. Jordan, George W. Fuller, and George C. Whipple, the latter two of whom would become his consulting partners later in their careers. Following that program, Hazen joined the Lawrence Experiment Station, Lawrence, MA. During his tenure there from 1888-1893, he focused on the hydraulics and engineering of filters for water purification. One paper from this period identified two parameters which are still commonly used to describe silica sand grains for use in water treatment filters: effective size and uniformity coefficient.

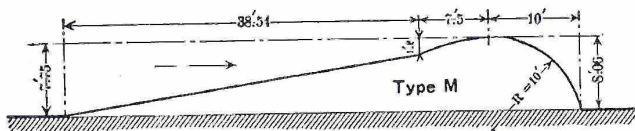


Hazen spent eight months abroad in 1894, gathering data on water supplies in Europe, and soon after started a consulting practice to bring the advances he had observed back to the U.S. The Hazen-Williams formula for friction loss in closed conduits, still a mainstay for water resources engineers, was proposed by Hazen and Gardner S. Williams in 1902. This empirical formula freed the engineer from the need to compute an iterative solution for many problems typically encountered

in waterworks. In 1905, Williams and Hazen produced their *Hydraulic Tables*, which contained solutions to the Hazen-Williams equation for everything from small wrought-iron pipe to 21 ft. aqueducts, as well as weir discharges for a variety of geometries using Bazin's formula. As an additional computational aid, they also created a hydraulic slide rule. Later in his career, Hazen turned his attention to statistical analysis of floods, and produced his final major work, *Flood Flows*, shortly before his death in 1930. While he may in general be best

## WEIR DISCHARGE,

### COMPLEX WEIRS.



remembered for the Hazen-Williams equation, he might be best known in New York City for a 1904 letter in which he recommended that the City's Croton water supply be filtered. Today, design is underway on a 290 mgd filtration facility for the Croton supply, scheduled for completion in 2007.