

Upconing and related downstream long-term salination and head phenomena in the Amsterdam Water Supply dunes

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ABSTRACT

Groundwater from the Amsterdam Water Supply dunes have been used for drinking water since 1853. During the first half of the 20th century severe intrusion and upconing occurred causing many of the wells to turn brackish or saline. As early as 1903, the hydrologist/director of the Amsterdam Water Supply, Pennink, predicted this, based on his unique sand-box modeling, which he finally published in 1915 as a large-size bound book in four languages showing detailed black and white photographs of the tests. These tests concerned sand-box simulation of simultaneous flow of fresh and salt water, using milk for the higher density fluid. With our current modeling tools, we can simulate his experiments, allowing to better understand his setup and even to verify our code. Pennink devoted much of his work on saltwater upconing below wells, which is so feared, especially on the way these cones form and the elevation at which saltwater enters the screen. Surprising, at least to many, is that this entry point is not necessarily the screen bottom. Measurements of the salinity distribution in salinized wells in our area confirmed this thirty years later. The cone form provides part of the explanation why short-term halting of well extraction rapidly delays salt pumping but does nothing to reduce salinization downstream of the well. Downstream salinization due to extraction was clearly shown in Penninks experiments, but is still largely unknown or ignored to date, with some consequences, for instance on the development of the head downstream of the extraction wells, long after extraction has been abandoned. The presentation will demonstrate and explain these relevant local and more widespread phenomena using both data collected over time and verification by modeling.