

# History of Distribution: From Ancient Times to Present Day

This Timeline provides a fresh look at the history of water distribution from ancient times to the present day.

Credits: This timeline was developed by a Subcommittee of the Distribution and Plant Operations Division (DPOD) of AWWA. The following members contributed to the development of the timeline:

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Sources for all information in this poster are provided on the attached page.



**American Water Works Association**

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## ANCIENT

Around 3100-1100 B.C., Mesopotamian engineers built very large weirs and diversion dams to create reservoirs and canals to carry water long distances across the flat countryside.

The Noria, or Egyptian Wheel is thought to be the first vertical water wheel in history. It dates from the early Roman Empire, around 700-600 B.C.

As recorded by the Roman Sextus Julius Frontinus, nine aqueducts were constructed and in operation prior to his appointment as Commissioner. The first aqueduct was built in 312 B.C., and several more were added over the centuries.



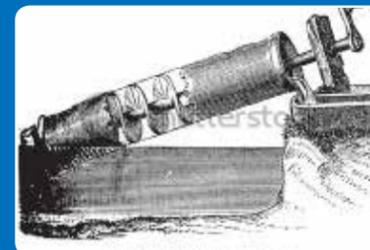
By dates 101-200 A.D., during the Han Dynasty, the Chinese used chain pumps that lifted water human foot pedaling, hydraulic waterwheels, or rotating mechanical wheels pulled by oxen.

The Minoans appear to be the first civilization to use underground clay pipes for sanitation and water supply between 2700-1401 B.C.

Around 1500 B.C., ancient Egyptians built large, flat-bottomed basins for growing crops along the riverbanks and simple sluices that diverted water into them at the peak of flood.

Constructing "qanats," slightly sloping tunnels driven into hillsides containing groundwater, probably originated in northwestern Persia (now Armenia) around 700 B.C.

In 600-501 B.C, a Greek engineer by the name of Eupalinus of Megara built the aqueduct of Samos.



Siphon Principle—Hero, a Greek who lived after 150 B.C., was the first known hydraulic engineer. He modernized the collection of water using the siphon principle.

First valves were most likely introduced sometime after 43 A.D. in Britain.



Archimedes, one of the greatest thinkers of ancient Greece, developed the Archimedes screw invention around 282-212 B.C. It was used to lift water from a lower elevation to a higher elevation by means of an internally threaded tube.



# MIDDLE AGES

During the Middle Ages (500-1500 A.D), water supply was no longer as sophisticated as before. These centuries were also known as the Dark Ages because of a lack of scientific innovations and experiments. After The Fall of The Roman Empire, enemy forces destroyed many aqueducts and distribution system structures.

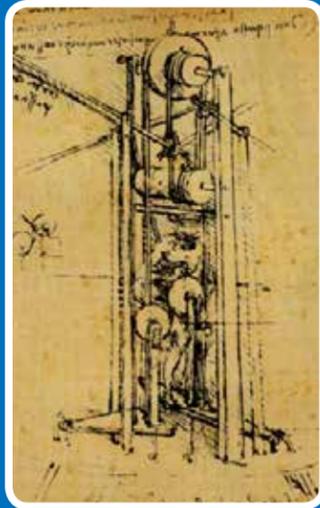
Cast iron pipe was first installed at Dillenburg Castle in Germany in 1455.

Between 1301-1400, a 5.5 km lead pipeline was installed to convey water from Tybourne Brook to London.

Incan engineers constructed a distribution system at Machu Pichu in 1450.



Leonardo da Vinci's treatise *Del moto e misura dell'acqua* summarized the state of the art of hydraulics circa 1500. He was the first recorded to observe that as a size of a conduit decreased, the velocity of flow increased.



In 1785, an engineer with the Chelsea Water Company in England, Sir Thomas Simpson, invented the bell and spigot joint, which has been used extensively ever since.

# INDUSTRIAL AGE

In 1652, Boston incorporated the country's first waterworks, formed to provide water for fire-fighting and domestic use.

The first full-scale cast iron pipe system for the distribution of water was installed in 1664 at Versailles, France.

Records indicate the first water systems in the United States were in Schafferstown, Pa., in 1746, and in the Moravian settlement that is now Bethlehem, Pa., in 1754.

In 1804, the first municipal water treatment plant, designed by Robert Thom, was built in Scotland.

Croton Aqueduct project completed, supplying water to New York City in 1842.

The first cast iron pipes were laid in the United States in Philadelphia, Pa., in 1817.



Perhaps the most important pump invention of the industrial age was the centrifugal pump invented by John Appolds in 1851.



Chicago installed one of the first steam-driven pumping systems in the mid-1860s.

In 1850, William Sewell developed the first displacement meter for measuring customer water use.

Siemens & Halske began production of the first closed-pipe current meters in 1865.



In 1882, the first Grinnell sprinkler was invented, and Grinnell systems would flourish and become widely recognized.

The first automatic fire sprinklers were developed by Henry Parmalee in 1874.

# MODERN AGE

One of the most innovative inventions of the 19th century was the Herschel Standard Venturi, which was developed by Clemens Herschel and introduced in 1887.

The first compound meter, which contained a low-flow displacement meter and a high-flow turbine unit, was patented by J.A. Tilden in 1903.

The first standardization of cast iron water pipes in Britain occurred in 1917 with the publishing of British Standard 78.

There was a large water supply project completed during WWII Colorado—Big Thompson Project from 1938-1957.

J.M. Crom developed the first successful prestressed concrete tank in 1942.

PVC pipe was first developed in Germany in the 1930s, and it was introduced in the United States in the 1950s.



Polyethylene encasement of iron pipes was first developed in 1951 to mitigate the effects of corrosive soils on metal pipes. In the mid 1960s the use of polyethylene pipe was developed and used for the first time in water distribution.

A new trenchless technology, horizontal directional drill, was first used in the water industry in late 80's-early 1990s. This method allowed pipe installs without digging up the ground.



By 2001, more than 90 percent of the U.S. population is served by community water systems.

Present day

J.A. Tilden received the first patent for a disc meter in 1892, and a conical disc meter was sold by G.A. Bassett in that same year.

The first use of cement-mortar lining of pipes took place in Charleston, S.C., in 1922.

Chicago installed its first electric centrifugal pumps in 1910.

Concrete cylinder pipe was introduced in the early 1940s.

Ductile iron pipe became available in 1948.

The first commercial hydraulic analysis software was developed by the Datics Corporation in 1957.

Water quality modeling was introduced in the 1980s as well as leak detection technology to prevent loss of water in the systems.



In 1943, Camp summarized the state-of-the-art of manual hydraulic analysis for networks and noted that better field data were more important than theoretical calculations.

President Franklin D. Roosevelt speaks at the dedication of Hoover Dam, which sits astride the Colorado River in Black Canyon, Nevada in 1935.

The McIlroy Network Analyzer was used by utilities from the early 1950s through the early 1970s to simulate water flow.

In the 1970s, bolted steel tanks with factory applied coatings became available.

A new method called fusible PVC first was developed and used in the early 1990s. This option allowed for fast installations of pipe for water distribution without using traditional methods to join the pipes together.



A key meeting in 1991, sponsored by USEPA and AWWA, brought together investigators in water quality modeling and led to USEPA's development of a distribution water quality model.



**To learn more about the awesome history of water distribution, check out these sources:**

**Web-based Sources:**

1. [http://history-world.org/ancient\\_civilization.htm](http://history-world.org/ancient_civilization.htm)
2. <http://mygeologypage.ucdavis.edu/cowen/~GEL115/115CH17oldirrigation.html>
3. <http://www1.chapman.edu/~bidmead/G-Meg.htm>
4. [http://www.eternaegypt.org/EternalEgyptWebsiteWeb/HomeServlet?ee\\_website\\_action\\_key=action.display.story&story\\_id=16&language\\_id=1](http://www.eternaegypt.org/EternalEgyptWebsiteWeb/HomeServlet?ee_website_action_key=action.display.story&story_id=16&language_id=1)
5. [http://www.nesc.wvu.edu/ndwc/articles/ot/sp01/history\\_distribution.html](http://www.nesc.wvu.edu/ndwc/articles/ot/sp01/history_distribution.html)
6. <http://www.ancientgreece.com/s/History/>
7. <http://www.waterencyclopedia.com/Tw-Z/Water-works-Ancient.html>
8. <http://www.historywiz.com/minoanplumbingandheating.html>
9. <http://www.ancientgreece.com/s/History/>
10. <http://www.crystalinks.com/greekscience.html>
11. <http://www.romanaqueducts.info>
12. <http://www.waterencyclopedia.com/Tw-Z/Water-works-Ancient.html>
13. <http://www.ancientindia.co.uk/indus/homemain.html>
14. [http://www.associatedcontent.com/article/64541/indus\\_valley\\_how\\_they\\_managed\\_their.html?cat=37](http://www.associatedcontent.com/article/64541/indus_valley_how_they_managed_their.html?cat=37)
15. <http://www.chaos.umd.edu/history/ancient1.html>
16. <http://www.china.org.cn/english/RS/42078.htm>
17. [http://www.aboutxinjiang.com/Travel/content/2006-06/09/content\\_290.htm](http://www.aboutxinjiang.com/Travel/content/2006-06/09/content_290.htm)
18. <http://www.lost-civilizations.net/mayan-history.html>
19. <http://www.waterhistory.org/histories/aguadas/>
20. [https://kb.osu.edu/dspace/bitstream/handle/1811/34703/OS\\_ENG\\_v13\\_i07\\_012.pdf?sequence=3](https://kb.osu.edu/dspace/bitstream/handle/1811/34703/OS_ENG_v13_i07_012.pdf?sequence=3)
21. <http://www.library.thinkquest.org/C004587/tools/Biography/bio13.html>
22. <http://www.soe.uoguelph.ca/webfiles/wjames/homepage/Professional/Heros.html>
23. [http://www.phillyh2o.org/backpages/PMA\\_TEXT.htm](http://www.phillyh2o.org/backpages/PMA_TEXT.htm)
24. <http://www.bifwater.com/comprofile.htm>
25. <http://www.nfpa.org/itemDetail.asp?categoryID=500&itemID=18020&URL=About%20Us/Overview/History>
26. <http://firesafelife.com/history-automatic-sprinkler-protection-part-3-henry-parmelee.html>
27. [http://www.firehydrant.org/pictures/hydrant\\_history.html](http://www.firehydrant.org/pictures/hydrant_history.html)
28. <http://www.firehydrant.org/collector/willis01.html>
29. <http://ebooks.library.cornell.edu/cgi/t/text/pageviewer-idx?c=manu;cc=manu;rgn=full%20text;idno=manu0008-7;didno=manu0008-7;view=image;seq=0168;node=manu0008-7%3A44>
30. [www.acipco.com/international/pipeand\\_fittings/ductileiron/history.cfm](http://www.acipco.com/international/pipeand_fittings/ductileiron/history.cfm)
31. [www.kennedyvalve.com/fire-hydrants.html](http://www.kennedyvalve.com/fire-hydrants.html)
32. [www.firehydrant.org/info/hist-fp.html](http://www.firehydrant.org/info/hist-fp.html)
33. [http://www.phillyh2o.org/backpages/MSB\\_Water.htm#06](http://www.phillyh2o.org/backpages/MSB_Water.htm#06)
34. [http://en.wikipedia.org/wiki/World\\_War\\_II#Background](http://en.wikipedia.org/wiki/World_War_II#Background)
35. <http://www.undergroundssolutions.com/articles/PipeRehab.pdf>
36. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA367236>

**Non-Web based Sources:**

1. DIPRA, 2003, Ductile Iron Pipe, DIP-GEN 3-03, DIPRA, Birmingham, Al.
2. DIPRA, 1978, Handbook Ductile Iron Pipe, Birmingham, AL.
3. Mays, L.W., 2000, Water Distribution Systems Handbook, McGraw-Hill, New York.
4. Rouse, H. and Ince, S. 1980, History of Hydraulics, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
5. Sanks, R.L. 2005. "Water Transport", in "Water Storage, Transport, and Distribution," edited by Yutaka Takahasi in Encyclopedia of Life Support Systems (EOLSS). Developed under the auspices of the UNESCO, EOLSS Publishers, Oxford, UK.
6. Baker M.N., Taras M.J., 1981, The quest for pure water – The history of the twentieth century, volume I and II, Denver: AWWA
7. EPA, 2000, The history of drinking water treatment, Environmental Protection Agency, Office of Water (4606), Fact Sheet EPA-816-F-00-006, United States
8. Troesken, Werner. The Great Lead Water Pipe Disaster. Cambridge, MA: MIT Press; 2006
9. "Glass-Lined Iron Water Pipes." Journal: The Manufacturer and Builder, Vol.8, Issue 7 (July 1876) on Making of America website, Cornell University
10. Adams, L.A., "Stave Pipe – Its Economic Design and the Economy of Its Use," Trans. Am. Soc. Civ. Eng., Vol. 41, p.25, 1899
11. A Century of Innovation: Twenty Engineering Achievements that Transformed our Lives, George Constable and Bob Somerville, The National Academies Press, 2003
12. Engineering News Record, 1957. Computer Firm Sells Pipeline Net Analysis. Engineering
13. News-Record, p. 66.
14. ISO, Fier Suppression Rating Schedule, ISO, Jersey City, NJ.
15. Martin, D.W. & Peters, G., 1963. The Application of Newton's Method to Network Analysis by Digital Computer. Jour. of the Inst. of Water Engrs., 17:115.
16. Mays, L.W., 2000, Water Distribution Systems Handbook, McGraw-Hill, New York.
17. Ormsbee, L. (2006) "The History of Water Distribution Network Analysis: The Computer Age," WDSA Conference, Cincinnati, Oh.
18. Uni-Bell, 2001. Handbook of PVC Pipe, Uni-Bell PVC Pipe Assn., Dallas.
19. Walski, T.M. et al, 2003. Advanced Water Distribution Modeling and Management, Haestad Press, Waterbury, Conn.
20. Walski, T.M., 2006, "Water Distribution System Analysis before Digital Computers," WDSA Conference, Cincinnati, Oh.
21. Walski, Thomas M., "A History of Water Distribution," Journal AWWA, March 2006, p.112

