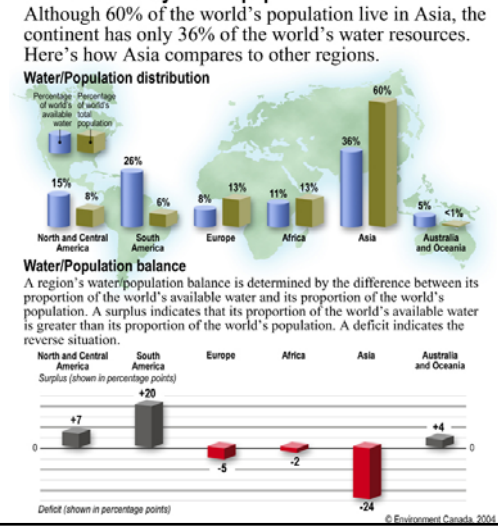
Lecture 1

Introduction to water and wastewater treatment processes

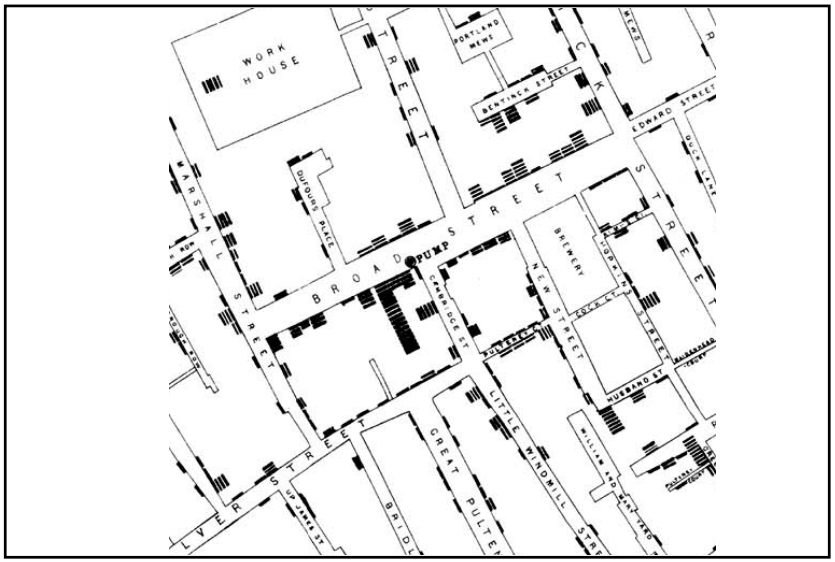


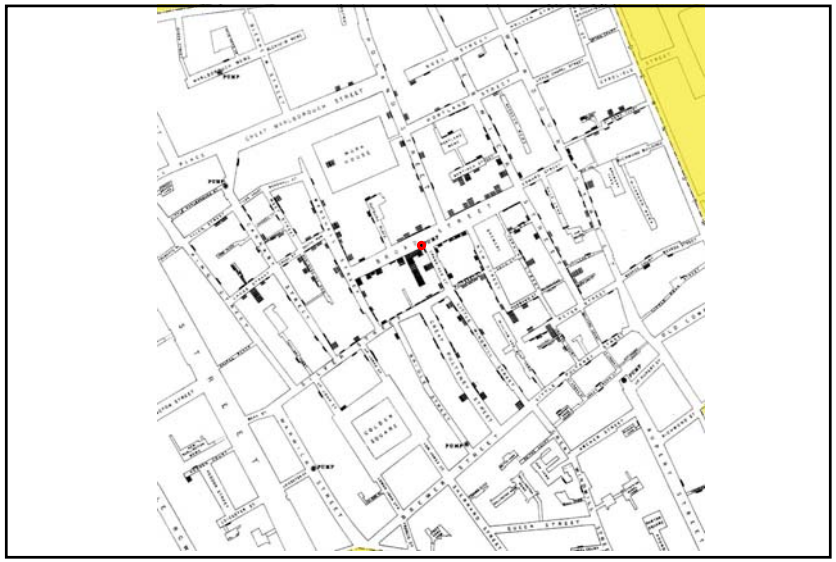
Source: Environment Canada, 2004. Water availability versus population. http://www.ec.gc.ca/water/images/info/facts/e-Water_availability.jpg. Accessed December 10, 2004.

Significant dates in public water supply

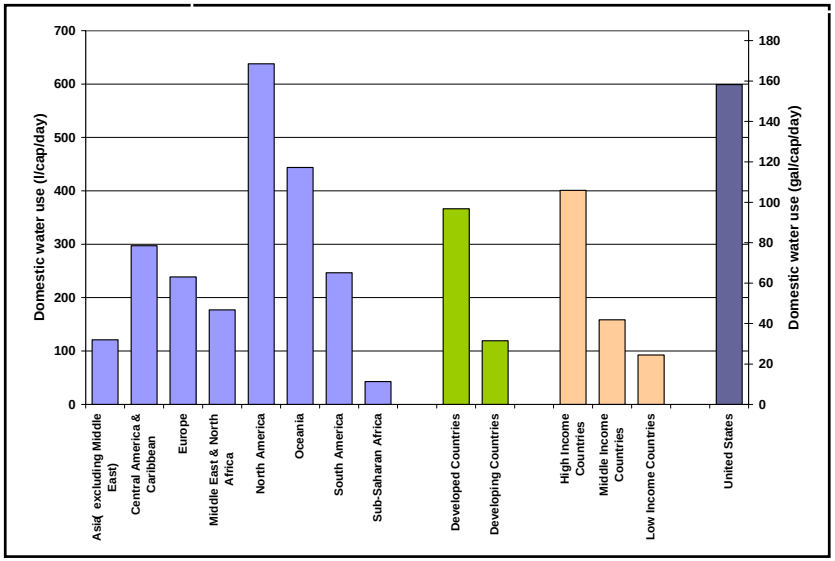
97	Inhabitants in ancient Rome use about 38 gpcd
1619	New River Company first to supply each home directly with its own water for a few hours per day
1854	John Snow establishes source of cholera epidemic in London as a contaminated supply well – first understanding of water and health
1873	Continuous supplies in general use in London
1900	Most cities have a water supply with service pipes to homes

Source: Frerichs, Ralph R., 2005. John Snow. Department of Edipdemiology, School of Public Health, University of California, Los Angeles, California. Updated January 1, 2005. Accessed January 4, 2005. http://www.ph.ucla.edu/epi/snow.html. The map is reproduced from: Snow, John, 1855. On the Mode of Communication of Cholera. John Churchill, London.

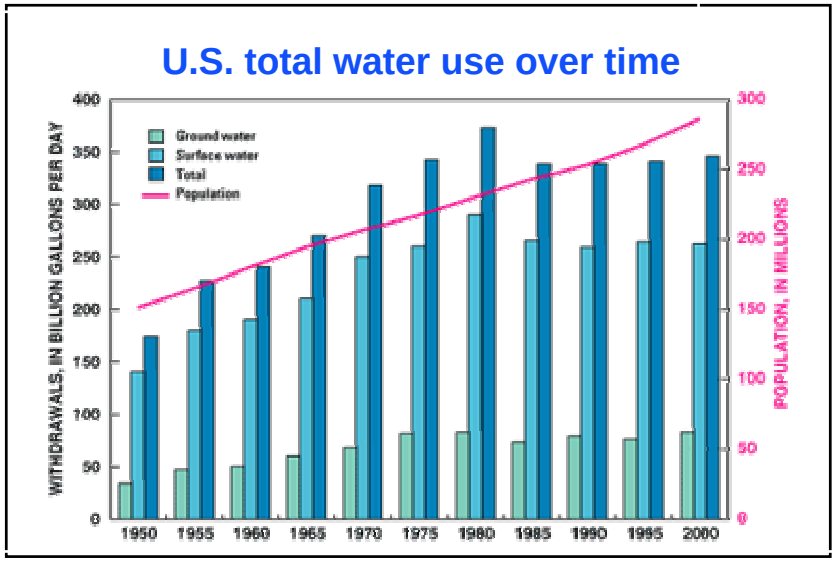




Source for both images: Frerichs, Ralph R., 2005. John Snow. Department of Edipdemiology, School of Public Health, University of California, Los Angeles, California. Updated January 1, 2005. Accessed January 4, 2005. http://www.ph.ucla.edu/epi/snow.html. The map is reproduced from: Snow, John, 1855. On the Mode of Communication of Cholera. John Churchill, London.



Based on data from: World Resources Institute, 2004. EarthTrends, The Environmental Information Portal, Water Resources and Freshwater Ecosystems, Searchable Database, http://earthtrends.wri.org/searchable_db/index.cfm?theme=2. Accessed December 10, 2004.



Source: USGS, 2004. Water Science for Schools: Trends in water use. U.S. Geological Survey, Washington, D.C. May 06, 2004. http://ga.water.usgs.gov/edu/totrendbar.html, accessed November 23, 2004. See also: Hutson, Susan S., Nancy L. Barber, Joan F. Kenny, Kristin S. Linsey, Deborah S. Lumia, and Molly A. Maupin, 2004. Estimated Use of Water in the United States in 2000. Circular 1268. U.S. Geological Survey, Reston, Virginia. May 2004. http://water.usgs.gov/pubs/circ/2004/circ1268/index.html, accessed November 23, 2004.

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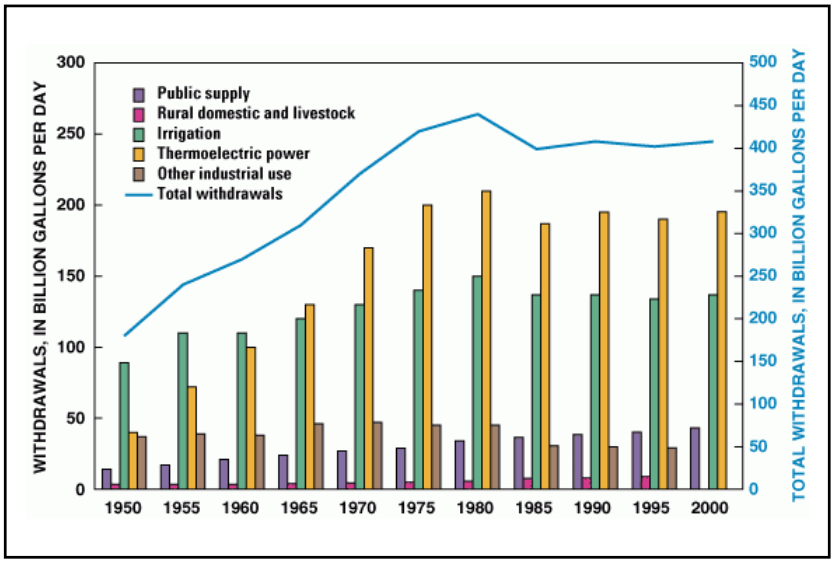
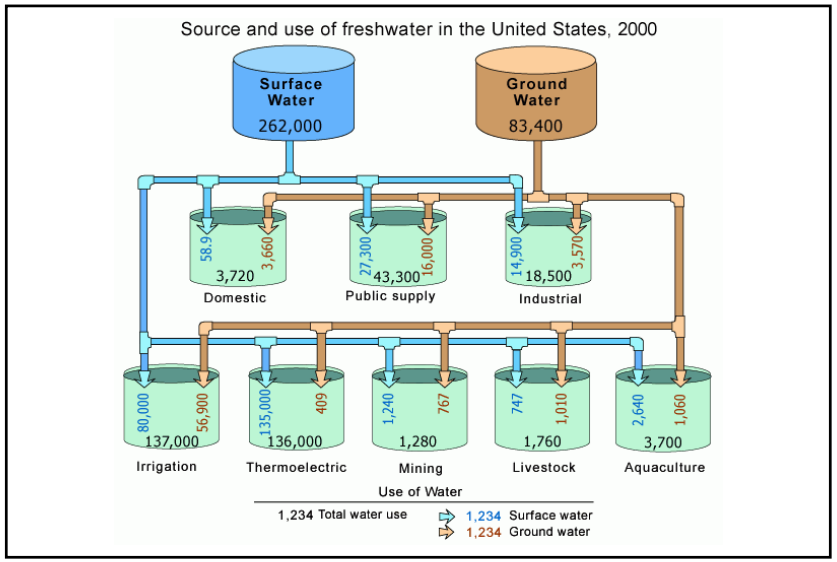
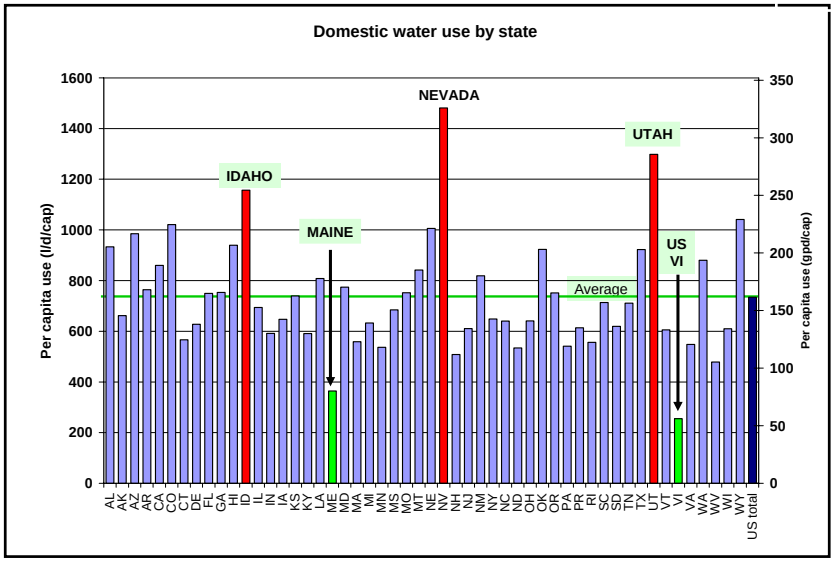




Source: USGS, 2004. Source and use of freshwater in the United States, 2000. http://ga.water.usgs.gov/edu/summary95.html. Last Modified: May 06, 2004. Accessed November 23, 2004.
See also: Hutson, Susan S., Nancy L. Barber, Joan F. Kenny, Kristin S. Linsey, Deborah S. Lumia, and Molly A. Maupin, 2004.



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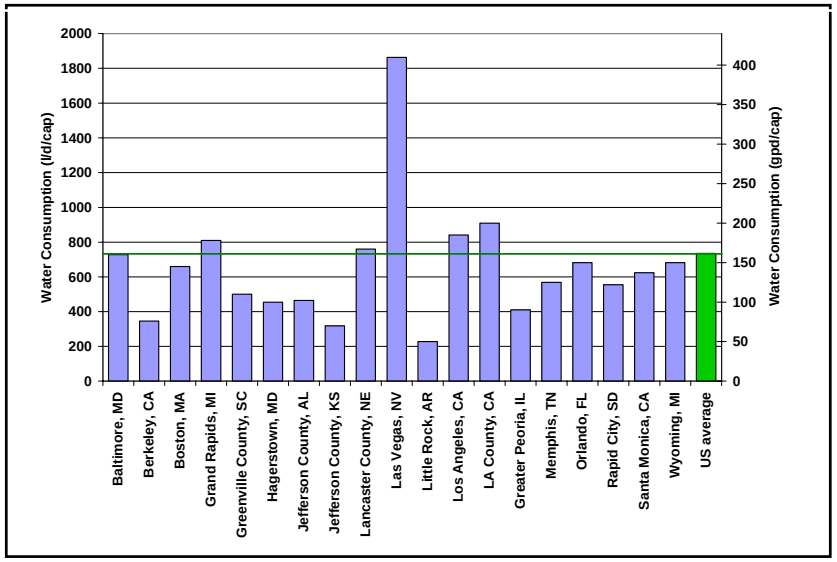


Source of data: ASCE, 1979. Design and Construction of Sanitary and Storm Sewers. American Society of Civil Engineers, New York, New York. Table 1, pp. 21-23.

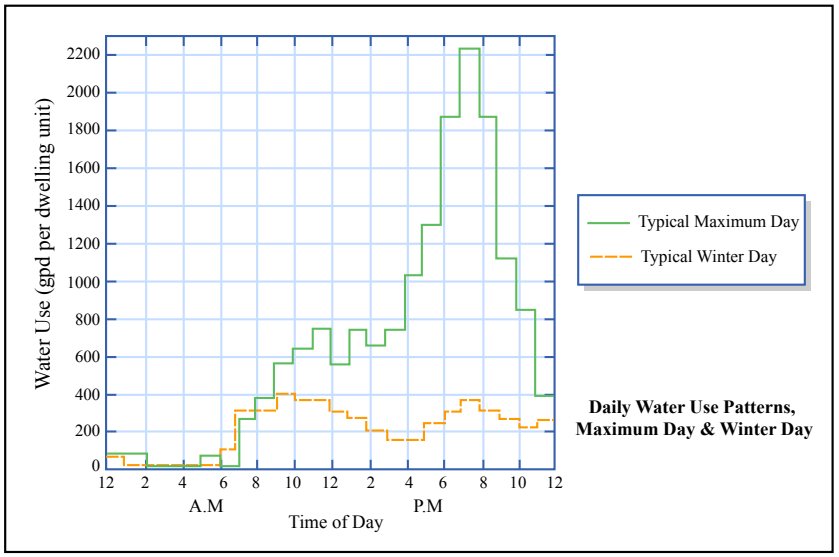
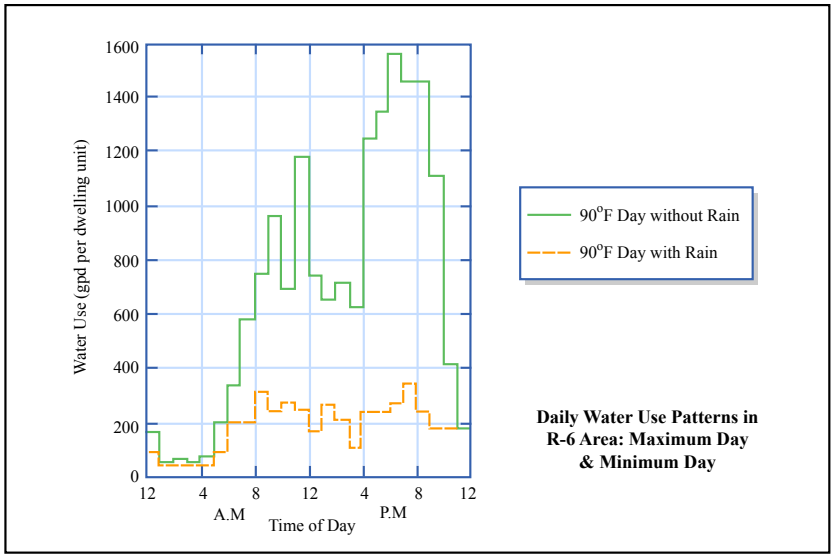


Figure by MIT OCW.



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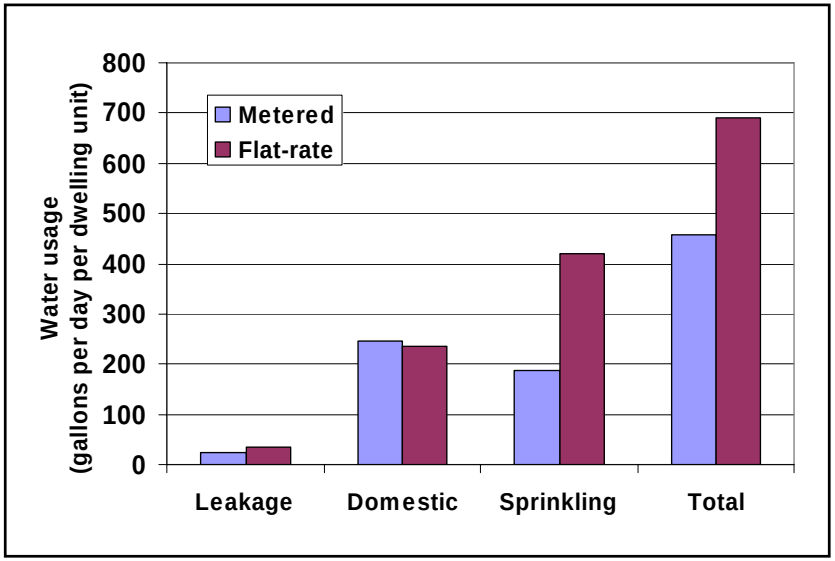
Adapted from: Viessman, W., Jr., and M. J. Hammer. *Water Supply and Pollution Control*. 7th ed. Upper Saddle River, NJ: Pearson Education, Inc., 2005.



Data from: Linaweaver, F. P., Jr., J. C. Geyer, and J. B. Wolff, 1967. A Study of Residential Water Use, A Report Prepared for the Technical Studies Program of the Federal Housing Administration, Department of Housing and Urban Development. Department of Environmental Engineering Science, The Johns Hopkins University, Baltimore, Maryland.

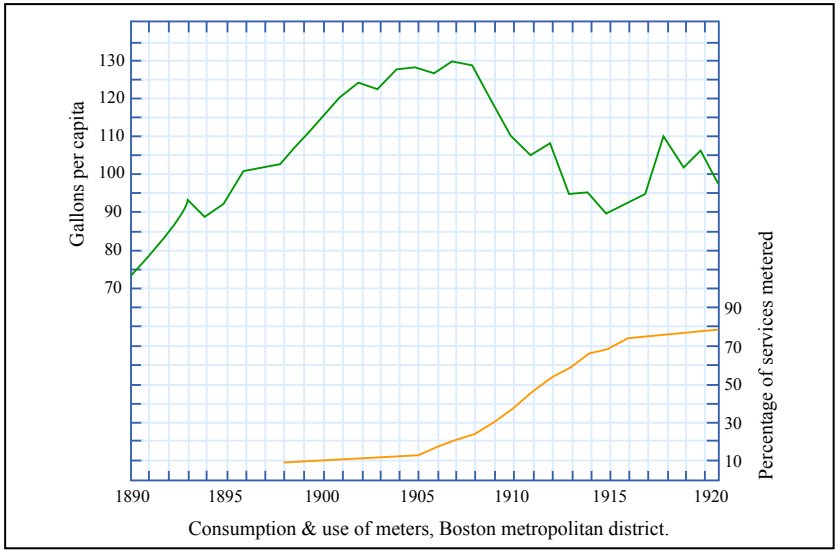
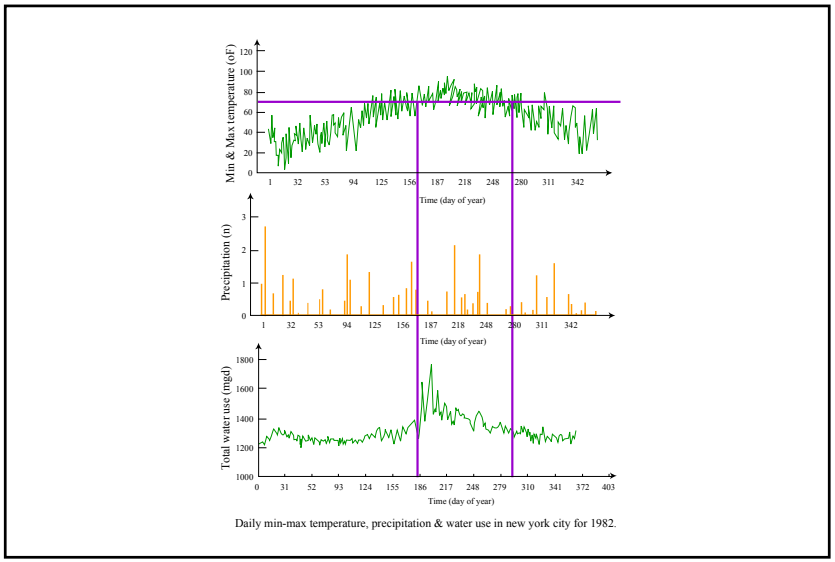


Figure by MIT OCW.

Adapted from: Turneaure, F. E., H. L. Russell, and M. S. Nichols. *Public Water Supplies: Requirements, Resources, and the Construction of Works*. New York, NY: John Wiley & Sons, 1940.



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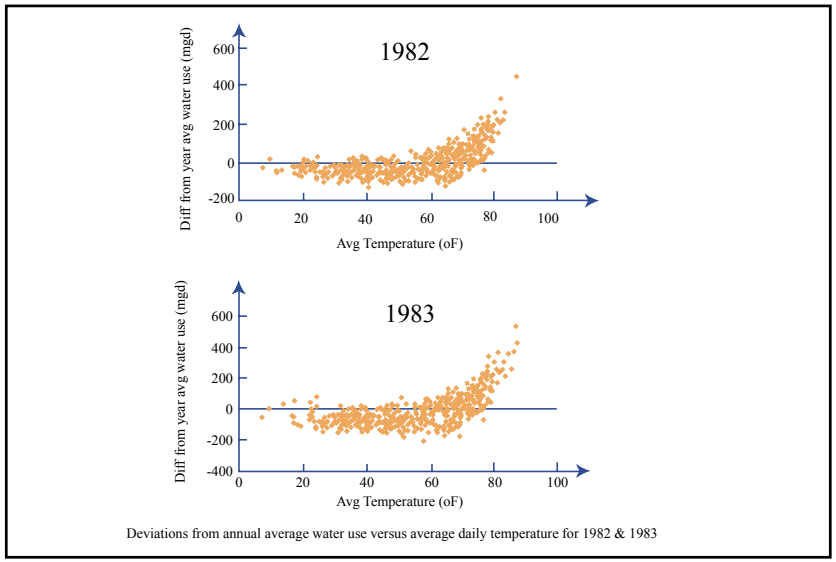
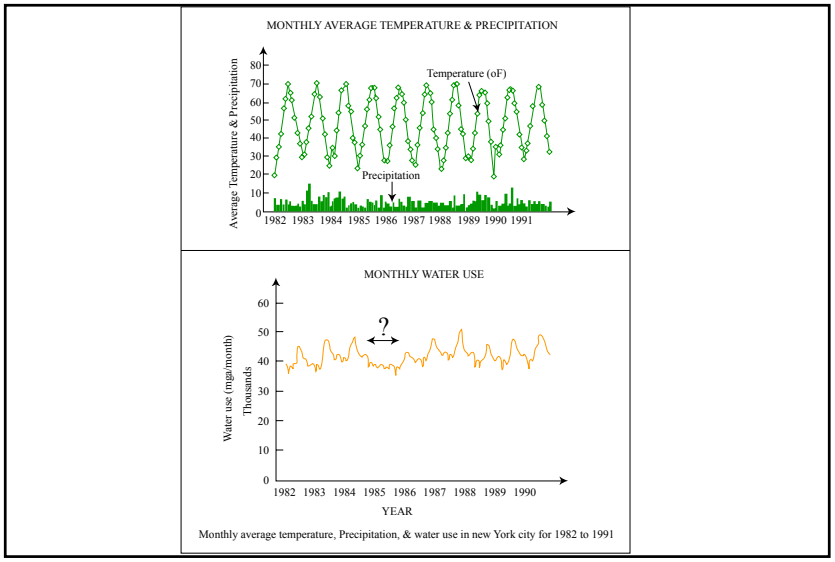


Figure by MIT OCW.

Adapted from: Protopapas, A., S. Katchamart, and A. Platonova. "Weather effects on daily water use in New York City." *Journal of Hydrologic Engineering, ASCE* 5, no. 3 (July 2000): 332-338.



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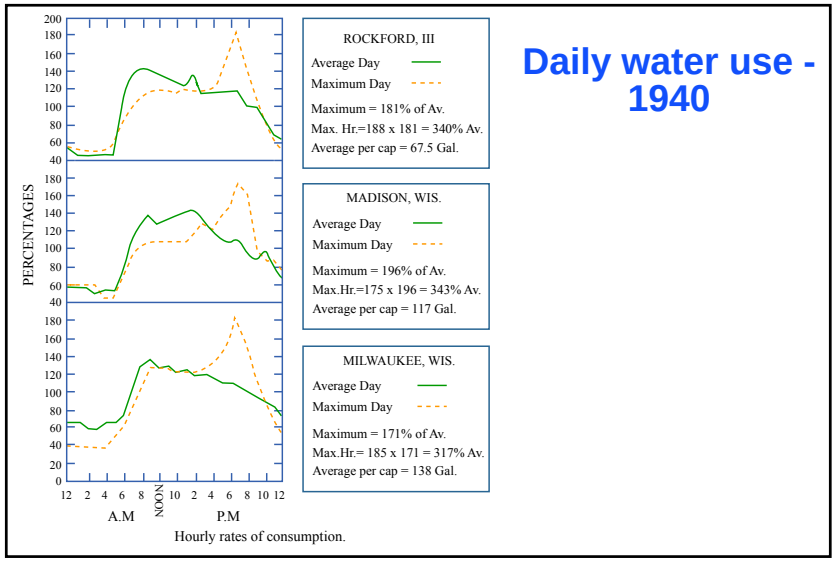

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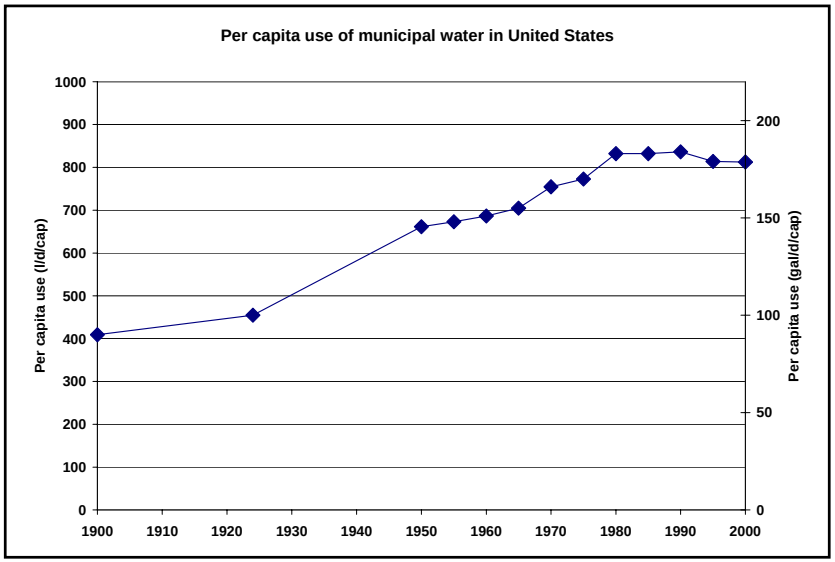
Based on U.S. Geological Survey. Estimated Use of Water in United States, Circulars 115, 398, 456, 556, 676, 765, 1001, 1004, 1081, 1200, 1268. Data for 1900 and 1924 from: Linaweaver, F. P., Jr., J. C. Geyer, and J. B. Wolff, 1967. A Study of Residential Water Use, A Report Prepared for the Technical Studies Program of the Federal Housing Administration, Department of Housing and Urban Development. Department of Environmental Engineering Science, The Johns Hopkins University, Baltimore, Maryland.



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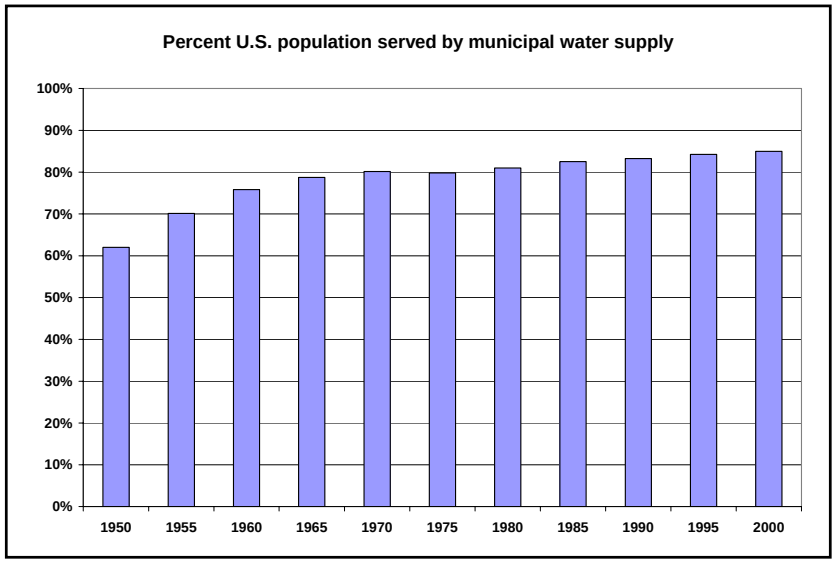
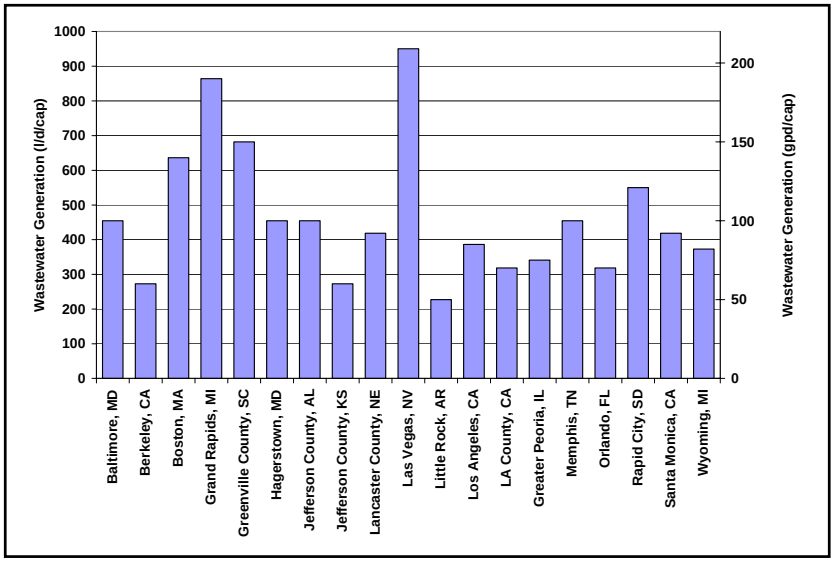
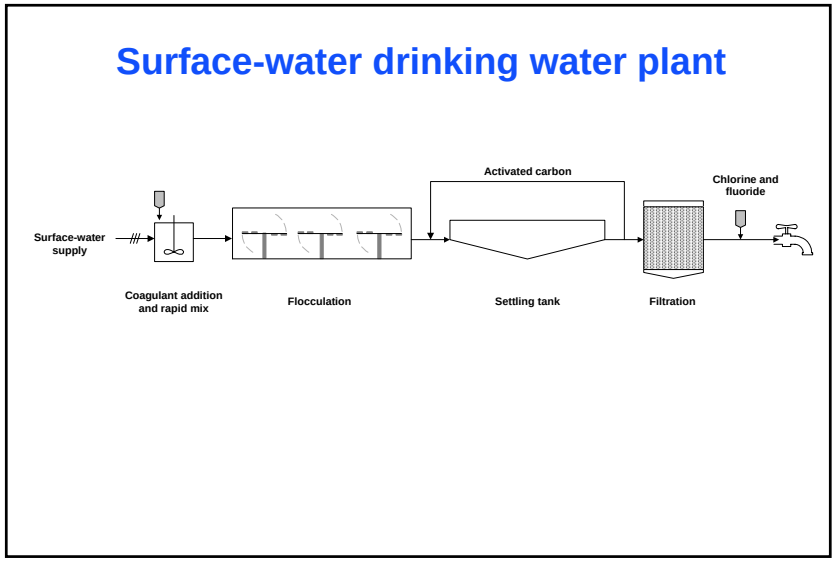






Source of data: ASCE, 1979. Design and Construction of Sanitary and Storm Sewers. American Society of Civil Engineers, New York, New York. Table 1, pp. 21-23.

Chattahoochee Water Treatment Plant – Intake Structure

Courtesy of Joe Lin. Used with permission.

Chemical Addition / Disinfection

Alum: Promote flocculation

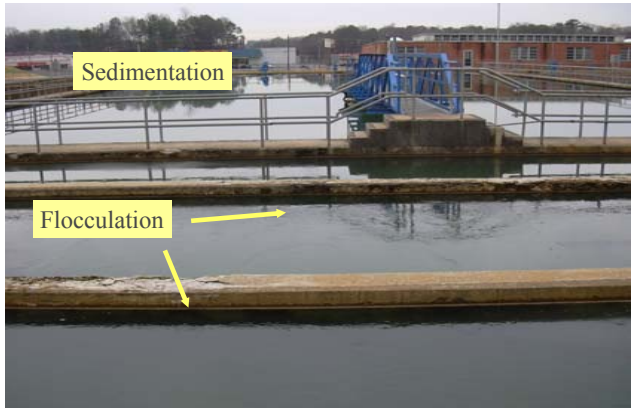
Sodium Hypochlorite: Disinfection

Courtesy of Joe Lin. Used with permission.

Chemical mixing

Courtesy of Joe Lin. Used with permission.

Flocculation / Sedimentation



Courtesy of Joe Lin. Used with permission.

Flocculation tank

Courtesy of Joe Lin. Used with permission.

Sedimentation tank (clarifier)

Courtesy of Joe Lin. Used with permission.

Sedimentation tank collection troughs

Courtesy of Joe Lin. Used with permission.

Filtration

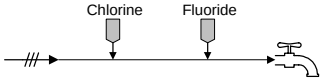
Courtesy of Joe Lin. Used with permission.

Post-Treatment Chemical Addition

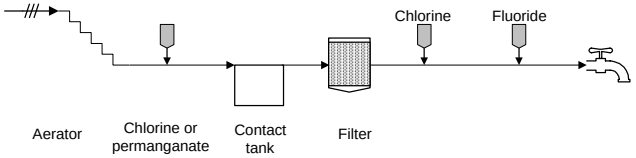
Fluoride: To prevent tooth decay
Lime: To raise the pH
Phosphoric acid: To prevent corrosion of piping in the distribution system
Sodium hypochlorite: To maintain disinfection residual in distribution system

Ground-water drinking water treatment plants

Disinfection and fluoridation

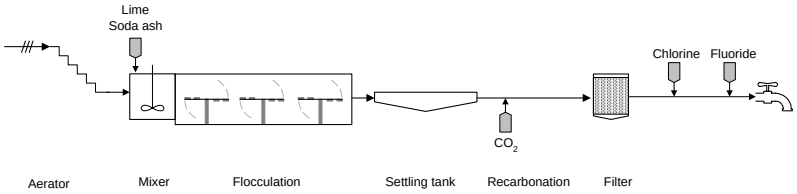


Iron and manganese removal

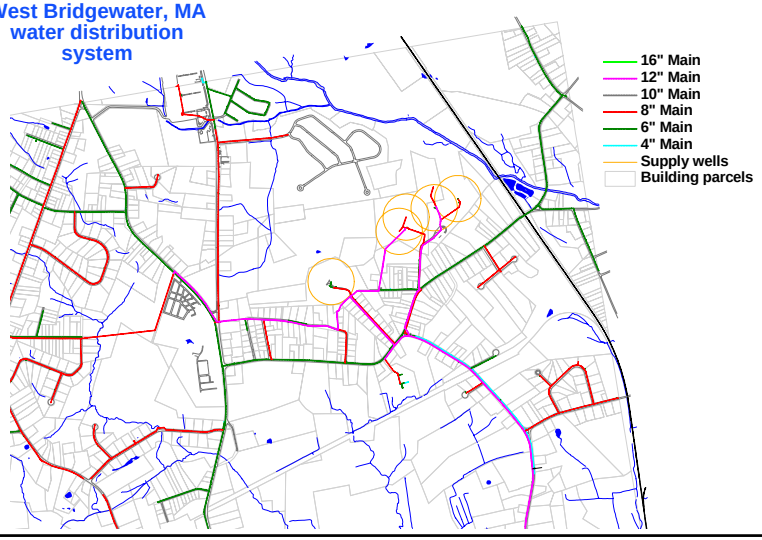


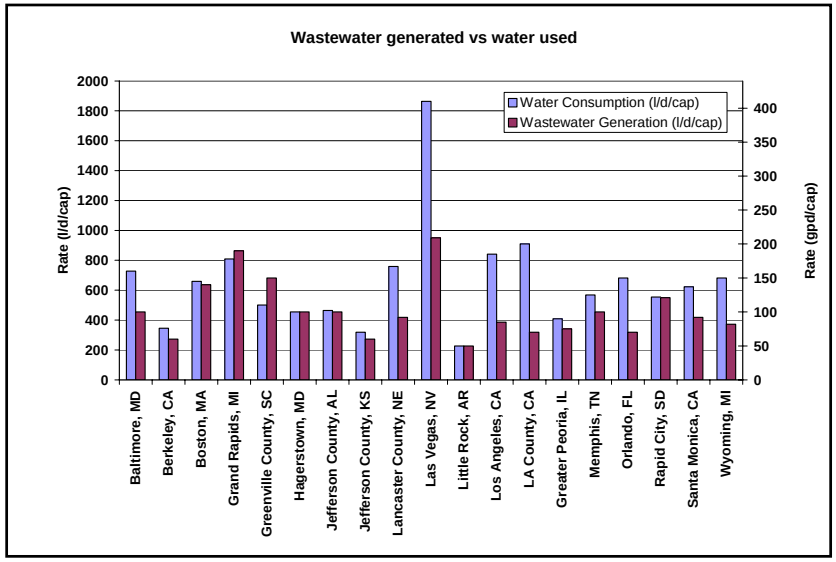
Ground-water drinking water treatment plants

Softening



West Bridgewater, MA water distribution system





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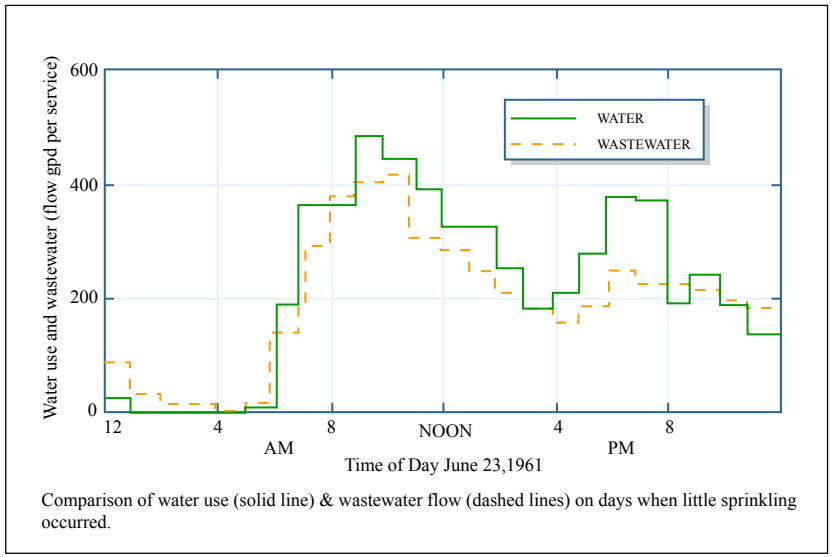
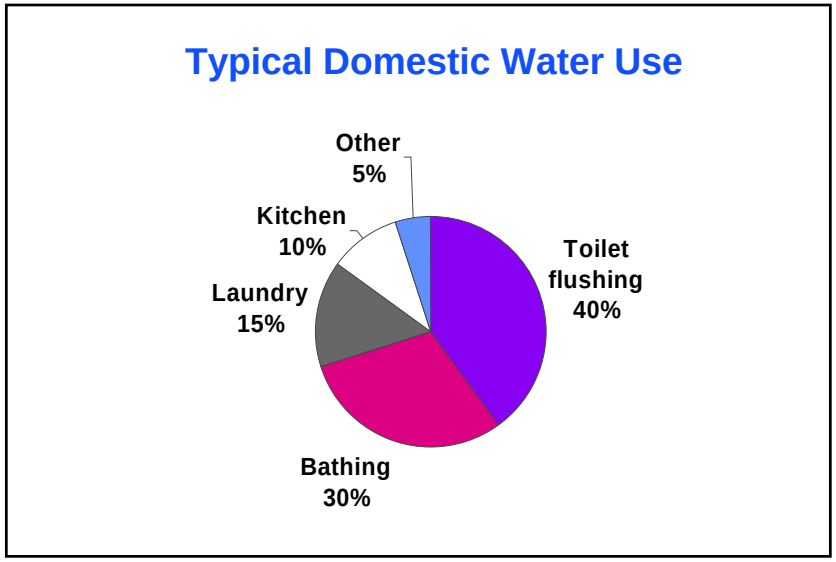


Comparison of water use (solid line) & wastewater flow (dashed lines) on days when little sprinkling occurred.

Figure by MIT OCW.

Adapted from: Viessman, W., Jr., and M. J. Hammer. *Water Supply and Pollution Control*. 7th ed. Upper Saddle River, NJ: Pearson Education, Inc., 2005.



Data from: Droste, R. L., 1997. *Theory and Practice of Water and Wastewater Treatment.* John Wiley & Sons, Hoboken, New Jersey.

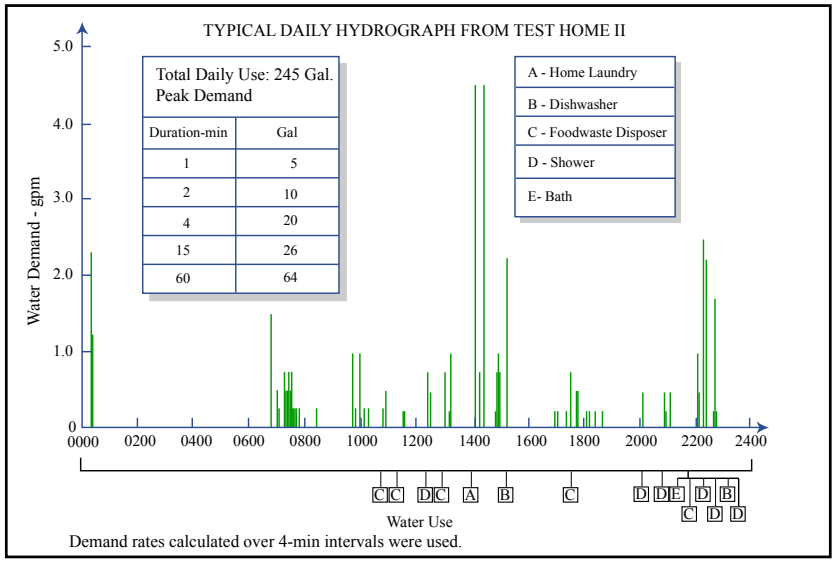


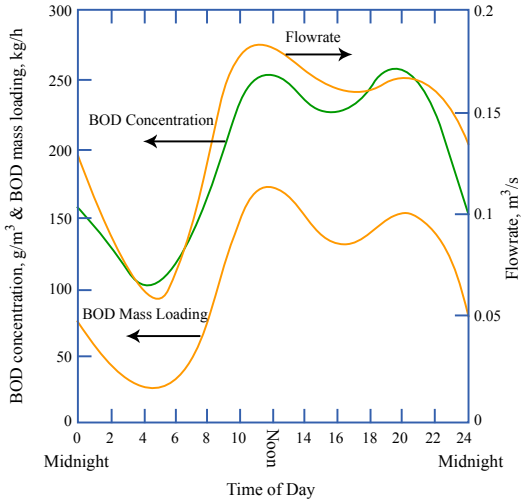
Figure by MIT OCW.

Adapted from: Anderson, J. S., and K. S. Watson. "Patterns of household usage." *Journal American Water Works Association* 59, no. 10 (October 1967): 1228-1237.

Pollutants in domestic wastewater

	High strength	Medium strength	Low strength
TSS, Total suspended solids (mg/L)	120	210	400
BOD, 5-day biochemical oxygen demand (mg/L)	110	190	350
Ammonia nitrogen (mg/L as N)	12	25	45
Organic nitrogen (mg/L as N)	8	15	25
Total phosphorus (mg/L)	4	7	12
Oil and grease (mg/L)	50	90	100
Total coliform bacteria (number/100 ml)	$10^6 – 10^8$	$10^7 – 10^9$	$10^7 - 10^{10}$
Fecal coliform bacteria (number/100 ml)	$10^3 – 10^5$	$10^4 – 10^6$	$10^5 - 10^8$
Cryptosporidium oocysts (number/100 ml)	0.1 - 1	0.1 - 10	0.1 – 100
Giardia lamblia cysts (number/100 ml)	0.1 – 10	0.1 - 100	0.1 - 1000

Based on Metcalf & Eddy Inc., G. Tchobanoglous, F. L. Burton, and H. D. Stensel, editors, 2003. Wastewater Engineering: Treatment and Reuse, Fourth Edition. McGraw-Hill, New York. Table 3-15, pg. 186.

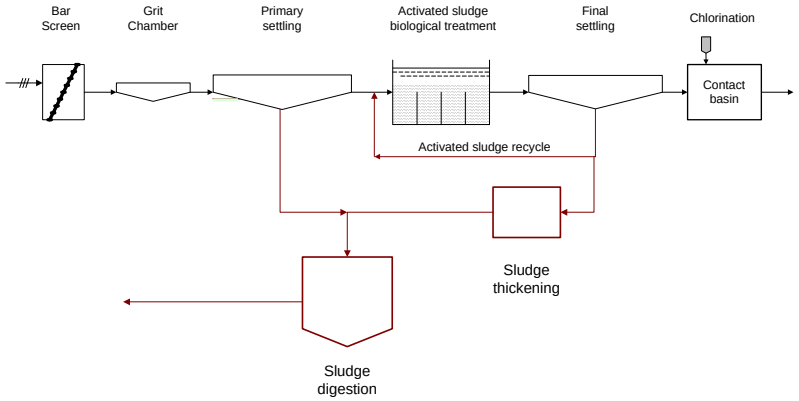


Typical hourly variations in flow & strength of domestic wastewater.

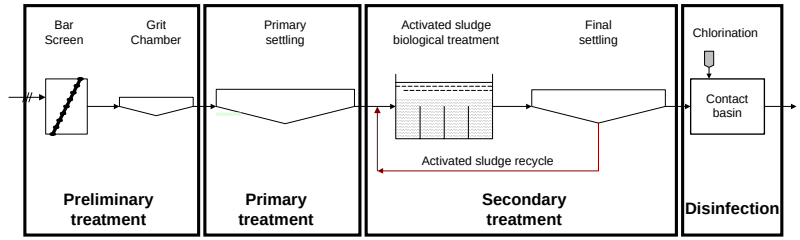
Figure by MIT OCW.

Adapted from: G. Tchobanoglous, F. L. Burton, and H. D. Stensel. *Wastewater Engineering: Treatment and Reuse*. 4th ed. Metcalf & Eddy Inc., New York, NY: McGraw-Hill, 2003.

Typical wastewater treatment plant

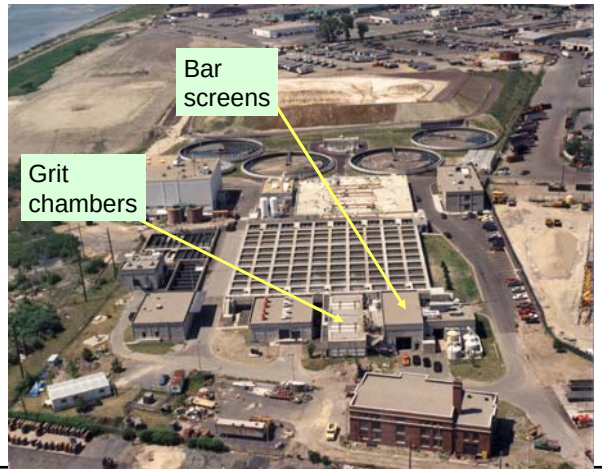


Typical wastewater treatment plant



Can also have tertiary treatment to remove nutrients and other pollutants

Lynn, MA wastewater treatment plant



Bar screens

Bar screens

Traveling screen

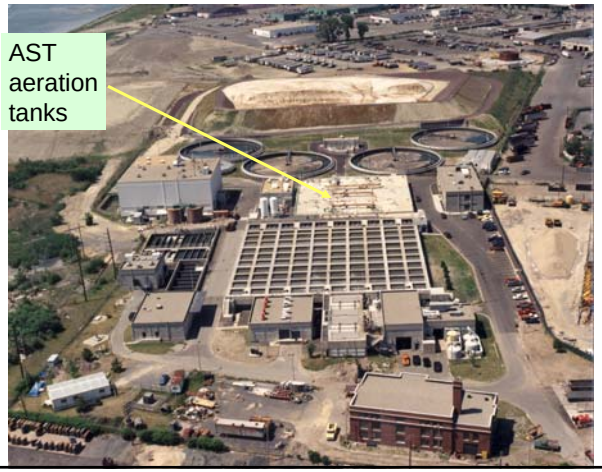
Lynn, MA wastewater treatment plant

Primary clarifiers

Primary clarifiers – sludge scrapers

Primary clarifiers – effluent wier

Lynn, MA wastewater treatment plant



Activated sludge aeration tank

Lynn, MA wastewater treatment plant

Secondary clarifiers

Lynn, MA wastewater treatment plant

Chlorine contract chambers

Virtual tours of wastewater plants

Englewood, Colorado –
http://www.englewoodgov.org/wwtp/

Lynn, Massachusetts –
http://members.aol.com/erikschiff/prelim.htm

Lexington, Kentucky –
http://www.lfucg.com/sewers/TBTour.asp