New York City Water Supply

Link to New York City DEP site on NYC water
Link to Descrition of New York City watershed agreement
Link to Maps of New York City Watershed
Similar maps on DEP server
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The New York water supply system serves Westchester County and New York City, except for Jamaica in Queens County. This system has been the purest and most bountiful supply of drinking water in the United States. It utilizes three separate systems of reservoirs which obtain water from some 2,000 square miles of watershed in upstate New York. The three systems include the Croton System, the Catskill System and the Delaware System. Generally the three elements of the New York City delivery system represent separate systems without direct inter-connections. Two tunnels City Tunnel No. 1 and No. 2 carry water from the Croton System to New York City. The Richmond Tunnel carries water from City Tunnel No. 2 to Staten Island. A new tunnel, City Tunnel No. 3, has been under construction since 1970. Most of the work in Manhattan and the Bronx has been completed. Tunneling is underway in Brooklyn and Queens.

New York City has a unique water supply system which has been the envy of the world. It was not always this way, for may years the city had many problems with its drinking water supply. Many of its citizens died or became very ill due to contaminated water. Primitive dug wells served the colony's population when it was first settled. By 1664 the population was 1,500. Waste and sewage were disposed of in pits or open dumps. This system was effective until the population density grew. Water became polluted and people started coming down with typhoid fever and intestinal diseases. By 1790, with a population of 33,000, it was clear that a central water system was needed. A large pond called the Collect Pond had been serving New Amsterdam and New York. Buckets and carts were used to draw from the pond's waters. With the increasing population growth, and the unsanitary habits of its citizens, poor taste and pollution was the result.

In 1799, the first true water supply system of New York was created by the Manhattan Company. This company was created to conduct business as a bank. Service was limited because the company's real purpose was to be a bank. The Bank of the Manhattan Company still lives as a part of Chase Manhattan Bank.

The Manhattan Company served only 2,000 homes through 25 miles of piping. This water only served the upper class and was badly served by a company that only cared to maintain the illusion of a public water service while protecting its banking operations. Anyone not fortunate enough to be connected would have to get their water the traditional way, public pumping or from people peddling water on the street. The shortage of potable water was thought by some New York residents to be behind the rise in public drunkenness, not the unsanitary ways of the citizens. The water became more and more polluted and outbreaks of disease continued to hit New York; yellow fever in 1819 and 1822, cholera in 1832 and 1834. Doctors warned that a decent water supply was essential, if the town wanted to prevent further outbreaks.

In 1835, the city voted to spend $12 million to dam the Croton River, approximately 45 miles north of Manhattan. It would then import its water by aqueduct to reservoirs from which it would be piped all over the city. The Croton system was managed according to the principle that the customers would pay the costs of its construction and operation. If a customer wanted water in their home, the Croton Aqueduct Board required payment of installation costs plus a minimum of 10 dollars a year for water rent. The Board also provided public

hydrants where water could be obtained without charge, for the less fortunate.

The Croton system was an essential part of the life support system required by the growing metropolis. Without it the city would have never grown from 300,000 in 1830 to a city of 3.5 million at the turn of the century. The introduction of the Croton water caused the ground water level to rise many feet, because the waste water was disposed of locally. Consequently the Croton Department laid 70 miles of sewers between 1850-1855. New York City once again developed a wasteful lifestyle. The Croton system was capable of delivering 30 million gallons a day, enough to meet the city's growing needs for many years. However, in a little more than a decade, consumption was threatening to exceed demand.

In 1910, New York City's population climbed to over 4.8 million. The larger population put a strain on the Croton system and the city was forced to reach out to the Catskill mountains to meet demands. The city purchased vast areas of land in the Catskill and purchased the watershed rights to many more. The Ashokan Reservoir was constructed and the water was transported to the city by a 92 mile aqueduct. The Catskill system incorporated rock-hewn tunnels, which were lined with concrete 12-15 feet in diameter and remained within the rock strata. The Catskill Tunnel 1 started from the city's Hill View Reservoir and served Manhattan and parts of Brooklyn. Tunnel 2, constructed approximately 7 years later, started at the Schoharie Reservoir. An 18 mile tunnel linked Schoharie to the Ashokan Reservoir. This tunnel served parts of the Bronx, Queens and Brooklyn. Tunnel 3 will, when finished, supplement the other tunnels, however its major function will be to permit the other two to be shut down for repairs.

Today, 50% of the city's water comes from the Delaware system, 40% from the Catskill system, and the remaining 10% comes from the Croton system. The city now has 19 reservoirs; the farthest is 120 miles from central Manhattan. This long travel time, which is powered by gravity, results in most of the microbes dying naturally. The water is treated with:

- chlorine to kill organisms,
- fluoride to prevent tooth decay,
- sodium hydroxide to raise pH levels, and
- orthophosphate, a substance that coats pipes, to prevent lead from leaching into the drinking water.

New York City's water, in the past, has won many awards for it's taste, and has long been toasted as "the champagne of drinking water" but today it has "lost it's sparkle." History repeats itself, is a popular expression which can certainly be used to describe the New York City Water Supply System. In several instances throughout New York's history, citizens have been inflicted with various illnesses from their public water supply and this still is the case today. However, it is no longer typhoid fever, yellow fever, or cholera but new diseases caused from microbes that cannot be killed by chlorine alone.

One bacteria invading New York City's water is E. coli, short for Escherichia coli, a bacteria that grows in the colon of humans and other animals. E. coli is not usually a health hazard in itself, but it is a measure of extent that harmful fecal matter has contaminated the water. High E. Coli counts means that it is more likely the water is also tainted with giardia and cryptosporidium or other microbes responsible for diseases such as hepatitis, and salmonella. Giardia and cryptosporidium often cause flu-like symptoms such as a fever, chronic diarrhea, or dehydration. It is particularly deadly to those with weak immune systems such as AIDS, HIV positive patients, the elderly and young babies. Increasing the chlorine doses to counter the rise in E.coli has meant 50% increases of a chemical by-product called trihalomethanes, or THM's, formed when chlorine reacts with organic matter in the water. There is evidence of a link between THM's and rectal and bladder cancer and birth defects. Also, the

city has had more fecal-waste violations than any other US city.

In 1993, the city promised the federal government that it would try to stop or slow construction in the watershed areas to preserve quality of the drinking supply. Parts of Northern Westchester and Putnam counties are now experiencing a major rise in construction. The Federal Environmental Protection Agency (EPA) insists that New York City must implement tough new regulations on land use in the watershed area. The city released a Watershed Protection Plan as one of the conditions for allowing New York City drinking water supply to remain unfiltered. Filtration involves building a giant plant where water passes through sand beds or a similar filter, like crushed anthracite coal. This process usually rids the water of parasitic microbes. The city is one of six cities in the country that is exempt from a 1986 law that requires all municipal systems to filter their water. Those other cities own either most or all of their watershed. They limit the population and do not allow sewage discharge in their watershed area.

New York City's watershed is treated differently. There are 200,000 people living within its 2000 square mile watershed area. New York City owns only about 10% of the area. There are 104 sewage plants discharging their effluent directly in the water shed area. City officials, however, have argued that the size of the city's watershed makes filtration unnecessary because pollutants are naturally dispersed.

In 1993, the EPA issued a Determination, effective until December 15, 1996, granting filtration avoidance to New York City. The city must comply with more than 150 conditions dealing mainly with increased watershed protection. Some actions that must be taken included: creating new watershed regulations, partnership programs with watershed and farming communities, upgrading of sewage treatment facilities, enforcement of water quality regulations, and land acquisition. If they do not follow this Determination the city, under the Clean Water Act, could face building a filtration plant that would cost them $3-8 billion to build and $2-4 million to maintain annually.

Currently, the city is already under a Federal Order to build a $600 million plant to filter the water from reservoirs east of the Hudson River. In early September of 1996, the city released a comprehensive water protection agreement between the city, the state, and upstate communities. This agreement will put off, until at least 2002, the federal Determination, released in 1993, which threatened the city with the prospect of having to build a costly filtration plant. This agreement will force upstate communities to abide with some new rules from the city but at the same time forces the city to spend $230 million to buy land within the watershed and $400 million to support economic development in the Catskills and to stop pollution from sewage plants and other sources. The city has taken a less harsh approach to controlling development within the watershed. Earlier methods were met with much criticism and lawsuits from watershed towns. Previously, the city acquired lands by eminent domain without consideration of the owners needs or wishes. It then relocated homes and cemeteries and flooded the abandoned towns. Now, they can only acquire land by "willing buyer, willing seller" purchases.

Besides concerns about the quality of water being supplied to New York City, there is also concern about the quantity of water available. New York City residents use about 1,500 million gallons per day. The three water systems can supply a maximum of 1,850 gallons per day. The safe yield of the system, that is the amount of water that can be produced during a period of drought, is 1,226 million gallons per day. Thus, New York City cannot expand its water use or tolerate a break in one of the aqueducts supplying water to the city.

Appendix: Following are more detailed descriptions of each of the three systems supplying water to New York City and Westchester County.

The Croton System

The Croton System is the oldest controlling flow from 12 reservoirs and five lakes which covers about 370 square miles of the Croton River Drainage Basin. The average yield of the system is 300 million gallons per day (MGD). The safe yield is 246 MGD.

The Catskill System

The Catskill System consists of two reservoirs, the Ashokan and the Schoharie. The Ashokan Reservoir impounds water from 247 square miles of the drainage basin of the Esopus Creek which drains into the Hudson River. Water from the Ashokan Reservoir is fed into the Catskill Aqueduct and delivered to the Kensico reservoir or the Hillview Reservoir. The Schoharie Reservoir impounds water from the 314 square mile drainage basin of the Schoharie Creek which drains into the Mohawk River. Water from the Schoharie Reservoir is delivered to the Esopus Creek Basin via the Shandanken Tunnel which drains into a branch of the Esopus Creek and thence by open stream to the Ashokan Reservoir.

The Ashokan and Schoharie Reservoirs drain into the Catskill Aqueduct with a capacity of 550 MGD as it drains into Kensico Reservoir. The portion of the aqueduct between the Kensico and Hillview Reservoirs has a capacity of 880 MGD.

The Delaware System

The Delaware System consists of three reservoirs located in the Delaware River Basin, the Canonsville, Pepacton and Neversink Reservoirs, and the Rondout Reservoir on Rondout Creek in the Hudson River Basin. Water is delivered via separate tunnels from Cannonsville, Pepacton and Neversink Reservoirs to Rondout Reservoir and from there through the Delaware Aquduct to the Kensico Reservoir. The Delaware Aqueduct intercepts the Croton System at the West Branch Reservoir. The Cannonsville Reservoir receives water from the 450 square mile watershed of the West Branch of the Delaware River. The Pepacton Reseroin receives water from the 372 square mile watershed of the East Branch of the Delaware River. The Neversink Reservoir receives water from the 93 square mile watershed of the Neversink River. The Rondout Reservoir receives water from the 95 sqare mile watershed of the Rondout River and serves as a collecting reservoir for the water from the three other reservoirs in the Delaware system. The safe yield of the entire Delaware water system is 610 MGD. Water from the Rondout Reservoir travels through the Delaware Aqueduct to the West Branch Reservoir in the Croton System. Water from the Pepacton and Neversink Tunnels is also used to produce hydroelectricity.

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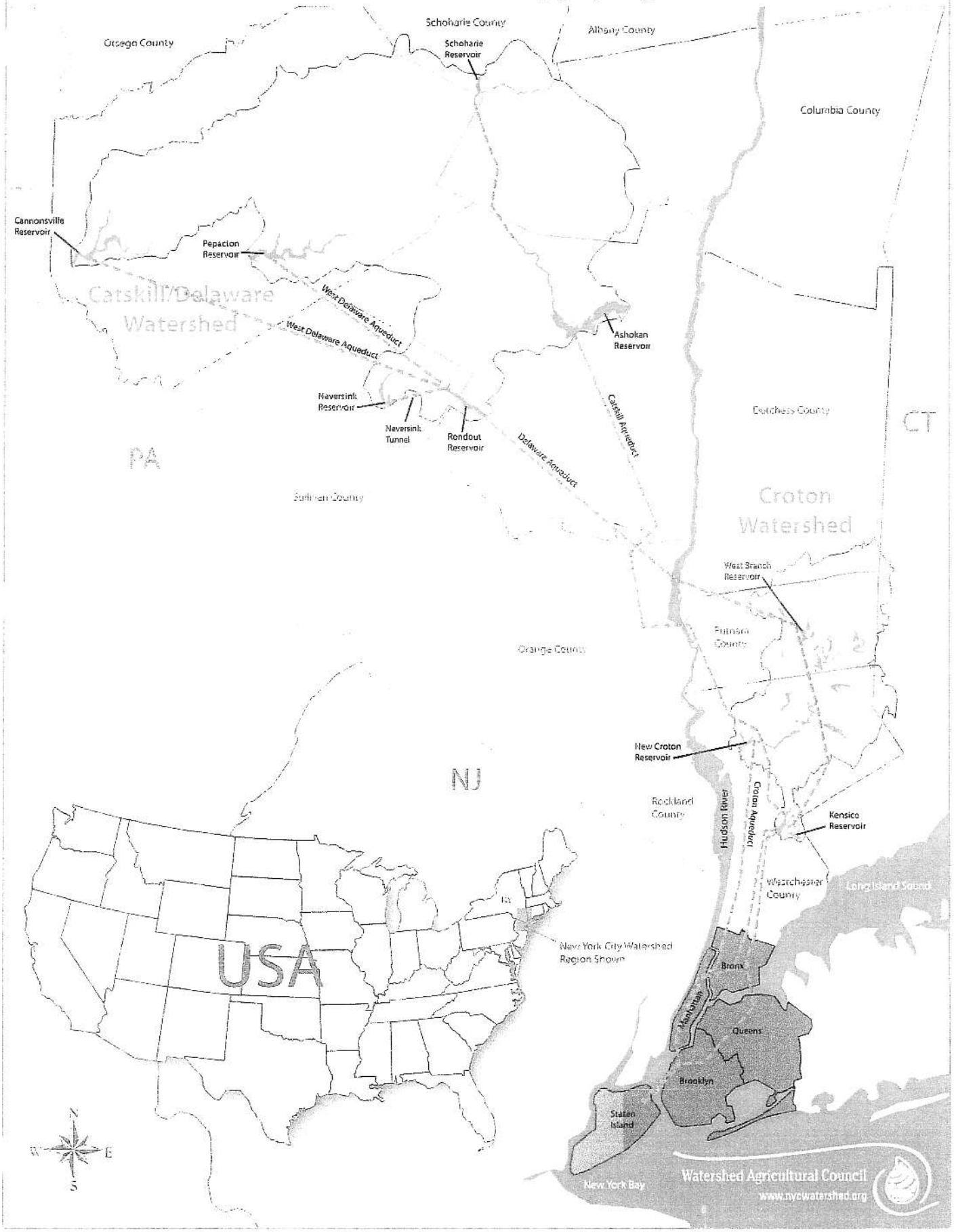
The NYC Water Supply System



Watersheds & Working Landscapes: The NYC Water Supply System

What are watersheds?

- The land area that sheds all of its surface water into a common body of water (such as a stream, river, lake, reservoir) is called a watershed.
- Every body of water has its own watershed.
- All of the earth's land drains into some body of water ... therefore we all live in a watershed.

What is the NYC water supply system?

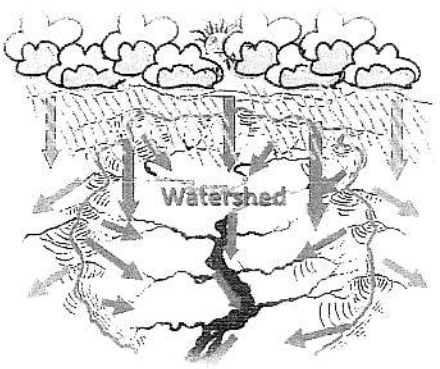
- NYC's water supply comes from reservoirs within watersheds in upstate NY - the older Croton Watershed and the newer Catskill/Delaware Watersheds.
- 19 reservoirs and 3 lakes supplies 8 million NYC residents and visitors and 1 million more upstate with 1+ billion gallons of water per day.
- Thousands of people in dozens of communities were forced to move to make way for the City's 13 collecting reservoirs and buffer zones.
- The water travels up to 125 miles through large underground tunnels and aqueducts to reach NYC.
- On average 90% of NYC's water is supplied by the Catskill/Delaware Watersheds which are currently unfiltered.

What are working landscapes?

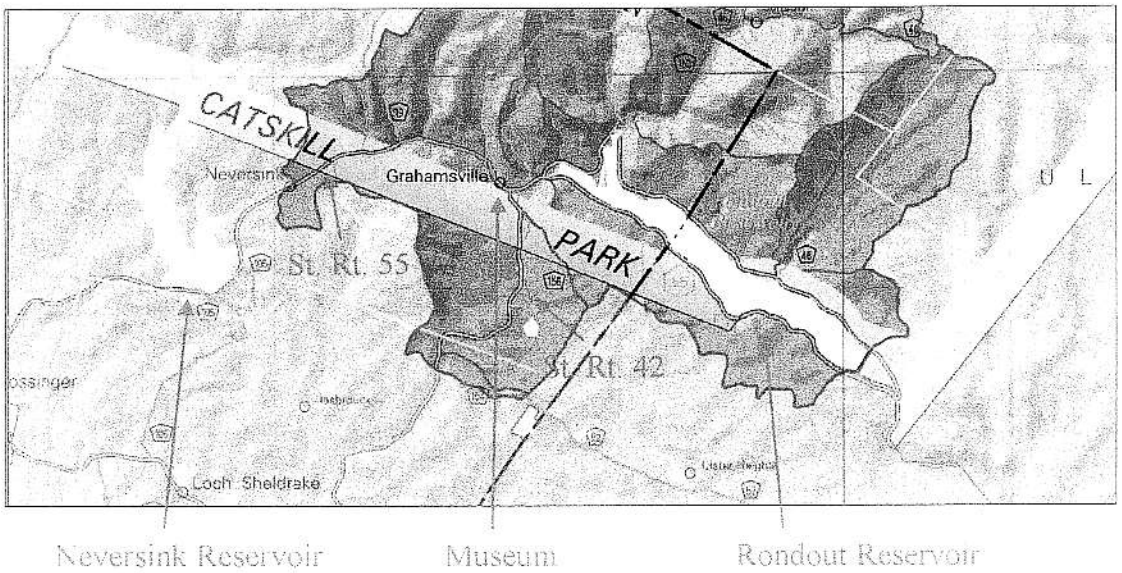
- A working landscape is a landscape which can support and balance a variety of economic, ecological, and social needs by taking into account the residents who live/work in the landscape as well as non-residents who rely on the land for goods and services.
- Approximately 75% of the NYC watershed landscape is forestland and farmland covers 7-10%. The remainder is developed.
- 71% of the NYC water supply watersheds are privately owned. 17% is owned by NYS (Catskill Forest Preserve) and NYC owns 12% (reservoirs, buffer lands, recreational lands).
- 250,000+ people live in the NYC Watersheds, most of them in the Croton Watershed, in suburban Westchester and Putnam Counties.
- NYC works in partnership with upstate watershed consituents to protect and preserve water quality in the watersheds through well managed forestland and farmland - working landscapes.

Why are working landscapes important for watershed protection?

- Well-managed farms and working forests are a preferred land use for watershed protection.
- A "working" landscape provides multiple benefits:
  - jobs
  - food
  - wood products
  - safe drinking water
  - rural character
  - recreation & tourism opportunities
  - biodiversity
  - community economic viability
  - open space



Rondout and Neversink Reservoirs



Neversink Reservoir

Construction Began: 1941
Construction Completed: 1953 Filling began on June 4, 1953 and it took two years to completely fill.

S.A. Healy Company from Chicago, Illinois constructed the reservoir and dam. The dam's cut off wall is eight feet wide at the bottom, four feet wide at the top and 166 feet tall. The earthen structure containing the cut off wall is 1500 feet wide at the base, 60 feet wide at the top, 200 feet high, and 2800 feet long. The dam is made up of seven and one half MILLION cubic yards of compacted soil and one million cubic yards of rock.

The reservoir is five miles long and one half mile wide. It holds 35 billion gallons of water.

Rondout Reservoir

Construction Began: 1937, Construction Completed: 1951

The Rondout Reservoir is the key structure in the Delaware System. It is the receiving basin for the three other Delaware system reservoirs – the Cannonsville, Pepacton and Neversink Reservoirs, and also houses the control works that regulate all water entering the Delaware Aqueduct. **The Rondout Reservoir can hold 50 BILLION gallons of water.**

Because of excessive ground water, the dam required a concrete core to prevent leakage. A series of connected caissons made from heavily reinforced concrete make up the concrete core. Using diesel powered earth moving construction equipment, workers compacted earth and earth materials around the core.

What is a caisson? A watertight chamber used to carry out construction work under water.

The name of this dam changed from Lackawack (after the town located there), to Merriman after the death of Thaddeus Merriman, the Chief Engineer from 1922 to 1933.

Water Use Calculation

NYC Environmental Protection

Record how much water you use in one week. Use this information to answer the questions on the other side. Note that all measurements are approximate. Make a checkmark every time you do each activity.

SUN	MON	TUES	WED	THURS	FRI	SAT	Weekly Total
							How many showers did you take? _____ How long are your showers? _____ How many baths? _____

A non-water- saving showerhead uses **5 gallons** per minute. Water conserving showerheads use **2 gallons** per minute. A full tub uses **36 gallons**.

SUN	MON	TUES	WED	THURS	FRI	SAT	Weekly Total
							How many times did you flush the toilet? _____

Most toilets use **5 gallons** a flush. Water-saving, high efficiency, toilets use **1.28 gallons** per flush.

SUN	MON	TUES	WED	THURS	FRI	SAT	Weekly Total
							How many times did you brush your teeth? _____

Brushing your teeth with the water running uses about **4 gallons**. Turning the water off when you're not rinsing uses less than a quarter or **.25 gallons.**

SUN	MON	TUES	WED	THURS	FRI	SAT	Weekly Total
							How many times did you wash your hands or face? _____

Washing your hands or face with the water running uses about **4 gallons**. Turning the water off saves 3 gallons, using only **1 gallon** each time you wash up.

SUN	MON	TUES	WED	THURS	FRI	SAT	Weekly Total
							How many times did you do the dishes? _____

Washing dishes with the water running uses about **15 gallons** in 5 minutes. Filling the sink/ washing dishes without water running uses only **5 gallons.**

Using the information from your weekly water use report card on the other side, figure out how much water you use on average every day.

Multiply the *number of showers you took* _____ by the *number of minutes per shower*_____ by the *amount of water your showerhead uses per minute* _____ ***(5 or 2 gallons)*** = _____ **gallons.**
Multiply the *number of baths you took* _____ by ***36 gallons*** = _____ **gallons.** ***Add*** your shower and bath totals = _____ **gallons.**
Divide by 7 and put your answer in the box to the right.

Average daily bath/shower water use:

gallons

Multiply the *number of times you flushed the toilet* _____ by the *amount of water your toilet uses with each flush* _____ **(5 or 1.28 gallons)** = _____ **gallons.**
Divide by 7 and put your answer in the box to the right.

Average daily toilet water use:

gallons

Multiply the *number of times you brushed your teeth* _____ by the *amount of water you used with each brushing* _____ **(4 or .25 gallons)** = _____ **gallons.**
Divide by 7 and put your answer in the box to the right.

Average daily teeth-brushing water use:

gallons

Multiply the *number of times you washed your hands or face* _____ by the *amount of water you used with each washing* _____ **(4 or 1 gallons)** = _____ **gallons.**
Divide by 7 and put your answer in the box to the right.

Average daily hand/face washing water use:

gallons

Multiply the *number of times you did the dishes* _____ by the *amount of water you used* _____ **(15 or 5 gallons)** = _____ **gallons.**
Divide by 7 and put your answer in the box to the right.

Average daily dishwashing water use:

gallons

Add your average daily totals to find out approximately how much water you use every day at home.

Total Average daily water use:

gallons

Is your average daily total more or less than the New York City average of 75 gallons a day? _____

Is it more or less than the Canadian average of 50-60 gallons a day? _____

What are some ways to reduce your water consumption?

_____

_____

_____

_____