The New York City Water Supply: Past, Present & Future

Meeting increasing demand, promoting conservation methods and complying with new water quality standards pose special challenges for major urban water supply systems.

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The existing water supply system of the city of New York is derived from a watershed area of approximately 1,950 square miles, an area larger than the entire state of Delaware. The system consists primarily of three upland watershed supply areas: the Croton, the Catskill and the Delaware watersheds (see Figure 1).

The oldest of these three supplies, the Croton, was constructed over a period of 70 years, spanning the last six decades of the 19th century and the first decade of the 20th. This period was a time of tremendous growth not only in New York City but also in the nation as a whole. A vast, sparsely populated, relatively unexplored continent existed when the Croton system was begun. By the time its last components were finished, the United States had become a major industrial power and most of our country's frontier was gone.

Two changes in public opinion and priorities began in the 1960s that would impact water supply systems across the country for the foreseeable future. The first was the rise of the environmental movement. Seeing the results of past abuses, many people began to challenge the entire "expand forever" philosophy. The second was an increased concern for water supply safety. This concern came to fruition with the passage, in 1974, of the Safe Drinking Water Act and its subsequent reauthorization in 1986. For the first time, the United States Congress mandated nationwide quality standards for drinking water and suppliers all over the country are working hard to implement them.

The Past: The Development of the System

New York City's present water supply system was developed over the last century and a half. Prior to that, the city relied on local wells and ponds for its water, but the rapid growth of its population in the first three decades of the 19th century exhausted the capacity of these local sources. Faced with this reality, the city began the development of its Croton system in the

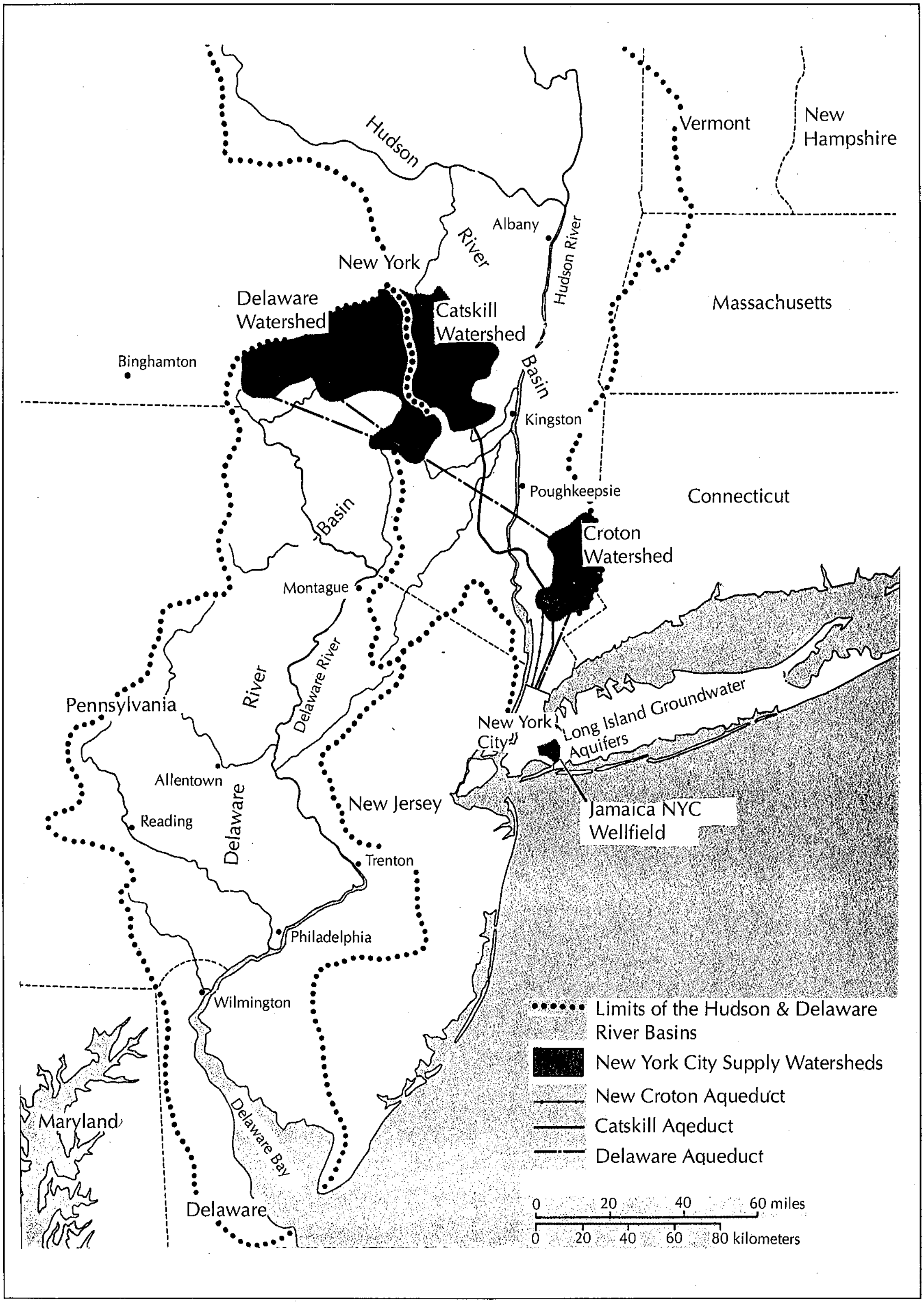

FIGURE 1. The New York City water use region.

1830s. In 1842, Croton water was first delivered to the city — a cause for wild municipal celebration. Yet, within a few short years, demand from a rapidly growing population exceeded reliable supply. This scenario was repeated over the next 150 years.

The main source of supply for the city today is surface water impounded in the three separate upland reservoir systems. The combined system includes 18 storage reservoirs and three controlled lakes having a total capacity of approximately 550 billion gallons. The separate collection systems were designed and built with a number of interconnections to provide operational flexibility and permit the exchange of water from one system to another. This capability mitigates the effects of localized droughts and permits full utilization of the total system capacity.

The amount of water that can be safely drawn from a watershed during the worst period in the drought of record is called the *safe (or dependable) yield*. It has been determined that the system could have furnished an average of 1,290 million gallons per day (mgd) during the drought of record in the mid-1960s. During periods of normal rainfall, watersheds supply more than the safe (or dependable) yield. Table 1 presents the safe yield and storage capacity for each of the three systems.

TABLE 1
Water System Yield & Capacity

System	Safe Yield (mgd)	Storage Capacity* (billion gallons)
Croton	240	86.6
Catskill	470	140.5
Delaware	580	320.4
Total	1,290	547.5

*Capacity above minimum operating levels.

Water is conveyed to the city from the reservoirs in the Croton, Catskill and Delaware systems by gravity through large aqueducts and balancing reservoirs. Within the city, water is distributed through two major tunnels and four distribution facilities. A third tunnel is now under construction and will supplement the two city tunnels currently in use.

Approximately 97 percent of the total water supplied is delivered by gravity; only three percent has to be pumped in order to reach the highest areas of the city. As a result, operating costs of the present system are relatively insensitive to fluctuations in the cost of electrical energy.

Even though the system was developed by the city, it is truly regional in character since it supplies water to about 60 communities in Westchester, Putnam, Orange and Ulster counties that are located within the city's watershed area and along the routes of its aqueducts. These communities presently draw approximately 125 mgd, an amount that would be sufficient to supply the combined needs of the cities of Albany, Rochester and Syracuse.

The Croton System

The Croton system consists of 12 reservoirs and three controlled lakes on the Croton River, its three branches, and on three other smaller tributaries (see Figure 2). Runoff from the Boyd's Corner and West Branch Reservoirs in the upper portion of the watershed is normally diverted to the Delaware Aqueduct. This diversion is possible because the Delaware Aqueduct passes right by the West Branch Reservoir and the hydraulic gradients at this point are equal. Water flows from the remaining upstream reservoirs through natural streams to downstream reservoirs, terminating at the New Croton Reservoir, the largest in the system. From the New Croton Reservoir, water is conveyed through the New Croton Aqueduct to Jerome Park Reservoir in the Bronx, and from there to the Central Park Reservoir in Manhattan.

Although the Croton watershed has an estimated safe yield of 240 mgd, only 140 mgd can be delivered by gravity and hydraulic pumping to the low areas of Manhattan and the Bronx. In normal years, therefore, approximately ten percent of the city's usage is supplied by the Croton system. However, by

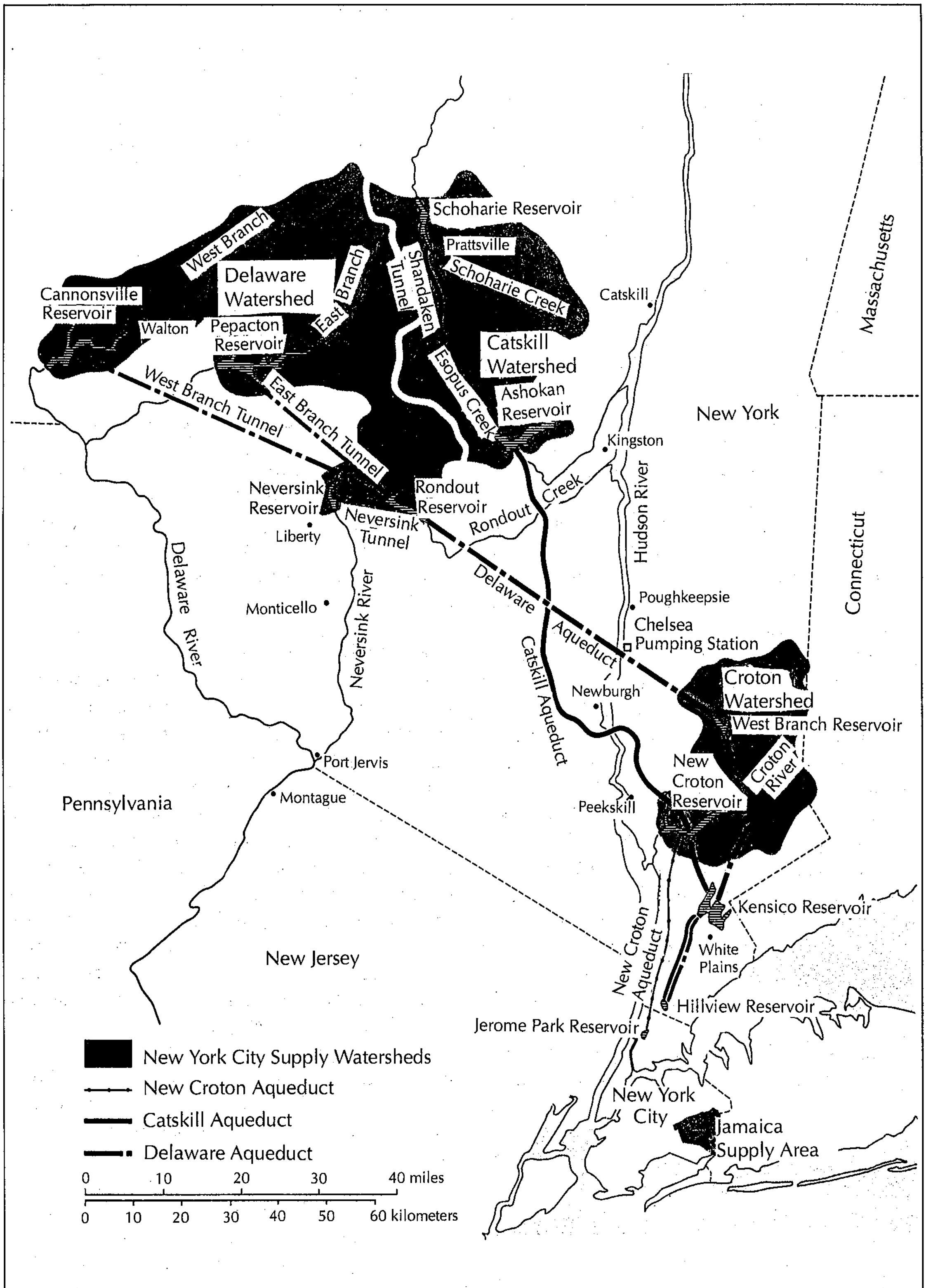

FIGURE 2. New York City's water supply system.

means of electric pumping and other distribution system manipulations, usage can be increased to about 280 to 300 mgd, approximately 25 percent of consumption, during periods of drought.

The Catskill System

The Catskill system was designed in the first decade of the 1900s, just as the Croton system was being completed. It was essentially finished in about eleven years, although a later reservoir, the Schoharie, was added in the 1920s. The scale and pace of the work dwarfed what had gone before it on the Croton system. Thousands of immigrants were recruited by contractors as they stepped ashore in this country, and were sent to work camps all along the route of the Catskill Aqueduct as well as to the construction sites of Olive Bridge and Kensico Dams. The presence of so many people in what were placid rural towns overwhelmed the resources of local law enforcement agencies and prompted the city to provide a separate police force in order to keep order. Looking back on that effort today, there is a tendency to be awe-struck by how so much was accomplished in such a short time.

All of these efforts were not universally approved. To develop the Catskill supply, the city had to displace hundreds of people whose families had, for generations, lived on land that would now be at the bottom of a reservoir. In doing so, the city often acted in a manner that was perceived as callous and high-handed by the local residents. A residue of ill will persists to this day and is one of the major obstacles that would have to be overcome if it were ever decided that additional sources were needed.

The Catskill watersheds occupy sparsely populated areas in the central and eastern portions of the Catskill Mountains and normally provide approximately 40 percent of the city's daily water supply (see Figure 2). Water in the Catskill system comes from the Esopus and Schoharie Creek watersheds, located approximately 100 miles north of lower Manhattan and 35 miles west of the Hudson River.

The Esopus Creek flows naturally into the Hudson River and drains an area of about 257 square miles. The Schoharie Creek drains into the Mohawk River from an area of 314 square miles. Most of the water from these two watershed areas is stored in the Ashokan Reservoir; the balance is stored in the Schoharie Reservoir.

The Ashokan Reservoir is formed by Olive Bridge Dam across the Esopus Creek. The Schoharie Reservoir is formed by the Gilboa Dam across Schoharie Creek at Gilboa, in Greene County, north of the Esopus Creek. The tributaries of the Schoharie Creek have their source at elevations almost 2,200 feet above sea level in the vicinities of Hunter, Windham, Prattsville and Grand Gorge in Greene, Delaware and Schoharie counties.

Water from Schoharie Reservoir is conveyed via the Esopus Creek and Shandaken Tunnel to Ashokan Reservoir where the Catskill Aqueduct begins. It is possible to divert water from the Catskill Aqueduct into the New Croton Reservoir to maximize the use of storage capacity.

The Delaware System

The Delaware is the newest, and largest, of the city's three water supply systems. It was developed over a period of 40 years, from the late 1920s to the late 1960s. Located approximately 100 miles north of lower Manhattan, it normally provides approximately 50 percent of the city's daily water supply (see Figure 2).

Three Delaware system reservoirs collect water from a sparsely populated region on the branches of the Delaware River: Cannonsville Reservoir (formed by Cannonsville Dam on the West Branch of the Delaware River); Pepacton Reservoir (formed by the Downsville Dam across the East Branch of the Delaware River); and Neversink Reservoir (formed by the Neversink Dam across the Neversink River, a tributary of the Delaware River). These reservoirs feed eastward through three separate rock tunnels — the West Delaware, East Delaware and Neversink — to Rondout Reservoir where the Delaware Aqueduct begins. Rondout Reservoir is not in the Delaware River watershed since Rondout Creek flows into the Hudson River.

Developing the Delaware system posed a new problem; one not encountered with the two earlier systems. In constructing, it the city would, for the first time, impound interstate waters. The city's efforts to use these waters resulted in a lawsuit brought by the downstream states of New Jersey, Pennsylvania and Delaware that challenged the city's plans. In 1931, the Supreme Court issued a decree apportioning the waters of the Delaware River. New York City was allowed to divert 440 mgd, but had to release sufficient water to maintain downstream flows in the Delaware River. The maximum amount the city had to release from Neversink Reservoir, the first stage of the Delaware system, regardless of the downstream flow targets, was 40 mgd.

When the Delaware system was expanded, a similar lawsuit resulted in an amended decree in 1954 that reapportioned Delaware River water. The system is operated under the terms of that decree to this day.

In 1961, another player entered the game — an Interstate-Federal Compact for the Delaware River Basin provided for the establishment of the Delaware River Basin Commission. Under the terms of this compact, the commission members (the states of New York, New Jersey, Pennsylvania and Delaware, as well as the United States Department of the Interior) could, by unanimous vote in an emergency, supersede the provisions of the 1954 Supreme Court decree.

The Effects of Drought

When the last stage of the Delaware system was designed, it was calculated that, on its completion, the total city system would provide a safe yield of 1,800 mgd. This calculation was based on the worst drought of record at the time. Unfortunately, before the system was finished in 1967, New York City and, indeed, the entire northeastern portion of the United States, suffered through a drought more severe than any previously experienced. Upon recalculation, the safe yield of the system was downgraded to 1,290 mgd — a 510 mgd reduction.

The magnitude of this reduction can be better appreciated when it is understood that it is larger than the safe yield of the entire Catskill supply (470 mgd). In 1965, at the height of the drought, it became obvious that if the city followed the terms of the 1954 decree rigidly, it would empty the Delaware reservoirs. This situation would have not only put the city at dire risk, but would also have ended all releases into the river downstream of the city's dams. The Delaware River Basin Commission responded to this situation in 1965 during the peak of the drought. The five parties of the commisision voted to supersede the provisions of the 1954 Supreme Court decree. It declared an emergency and modified the provisions of the decree. The amount the city was allowed to divert was reduced, but so was the amount it had to release downstream. In effect, the available supply was stretched out to get through the drought.

What happened during the drought left a lasting impression and a continuing dialogue was begun that continues to this day, all aimed at better managing and utilizing the water available. The decade of the 1980s, with its three droughts, led to further refinements of these efforts and it is fair to say that the system is far better prepared to weather a drought now than it was in the 1960s.

The Hudson River & The Chelsea Pump Station

Water may be pumped into the Delaware Aqueduct from the standby pump station at Chelsea, New York, which draws from the Hudson River. The Chelsea Pump Station has a capacity of 100 mgd. The second facility of its type to be situated at this location, the Chelsea Pump Station was reconstructed in 1965-66 under drought emergency circumstances and operated for approximately ten months during 1966 and 1967. It was then placed on standby status until 1981. In that year, again under drought conditions, the station was rehabilitated to full operating capacity, but the drought ended before it became necessary to place it into service.

In 1985, a recurrence of drought necessitated placing the station into service and it ran for approximately five months. In the spring of 1989, after a winter of extraordinarily low precipitation, the station was run for two weeks and was shut down when heavy rains finally came.

The Present: How the System Operates

The city's water supply is transported through an extensive system of tunnels and aqueducts (see Figure 3). Croton system water is delivered from the New Croton Reservoir by the New Croton Aqueduct to the Jerome Park Reservoir in Manhattan. From Jerome Park and Central Park Reservoirs, and from direct connection to the New Croton Aqueduct, trunk mains carry water to the service area. The Catskill and Delaware Aqueducts convey water from Ashokan Reservoir and Rondout Reservoir to Kensico Reservoir and then to Hillview Reservoir in Yonkers. Kensico serves as a balancing reservoir; Hillview serves as a distribution reservoir. Water from the Catskill and Delaware systems is mixed in the Kensico Reservoir before it is conveyed to Hillview Reservoir from which water enters City Tunnels 1 and 2. Trunk mains carry water from tunnel shafts and from the distribution facilities (Jerome Park, Central Park and Ridgewood Reservoirs and the Silver Lake Tanks) to the various service areas.

Water Distribution

The water distribution system consists of a grid network of water mains ranging in size from six to 84 inches in diameter. It contains approximately 6,000 miles of pipe, 88,000 valves and 96,000 fire hydrants.

Slightly over half of the mains in the system are unlined cast iron, the primary construction material that was used before 1930. Between 1930 and 1970, cement-lined cast iron pipe was used, comprising about 40 percent of the water main mileage. Since 1970, the installed pipe material has been cement-lined ductile iron and now comprises about six percent of the water main mileage. The city has an extensive program for the replacement of water mains and spends about $100 million per year on this effort.

Water pressure is regulated within a range of 35 to 60 pounds per square inch (psi) at street level. Generally, 40 psi is sufficient to supply water to the top of a five- or six-story building. About 97 percent of total system consumption is normally delivered by gravity. It is necessary to pump only the remaining three percent to areas of higher elevation to keep the pressure within this desired range. High-rise buildings, of course, have their own internal pumping systems.

The distribution system in each borough is divided into three or more zones in accordance with pressure requirements. These zones are determined chiefly by local topography. The ground elevation in the city varies from a few feet above sea level, along the waterfront, to 403 feet above sea level at Todt Hill in Staten Island. The highest ground elevations in the other boroughs are: Manhattan, 267 feet; the Bronx, 284 feet; Brooklyn, 210 feet, and Queens, 266 feet. Various facilities provide storage to meet the hourly fluctuations in demand for water throughout the city, as well as any sudden increase in draft that might arise from fire or other emergencies.

Addressing Current Water Quality Concerns

The city's supply is known for the high quality of its water. Because of its inherent quality and the long periods of detention in its reservoirs, it has not yet been necessary to filter water from the system in order to reduce bacterial content and turbidity. The only treatment procedures routinely employed are detention, screening, the addition of caustic soda for pH control, chlorination for disinfection, and fluoridation. Additions of copper sulfate for algae control and alum for turbidity control are made occasionally, as needed.

Until recently, this level of treatment had proved to be more than sufficient to maintain water quality standards throughout the entire system. Population growth and commercial and industrial development within the Croton system have caused some deterioration of its water quality. The city is currently operating a demonstration treatment facility at Jerome Park Reservoir to develop design criteria for treating Croton system water. A full-scale treatment facility, the Croton Filter Plant, is scheduled for completion in the mid-1990s.

The system has five laboratories that moni-

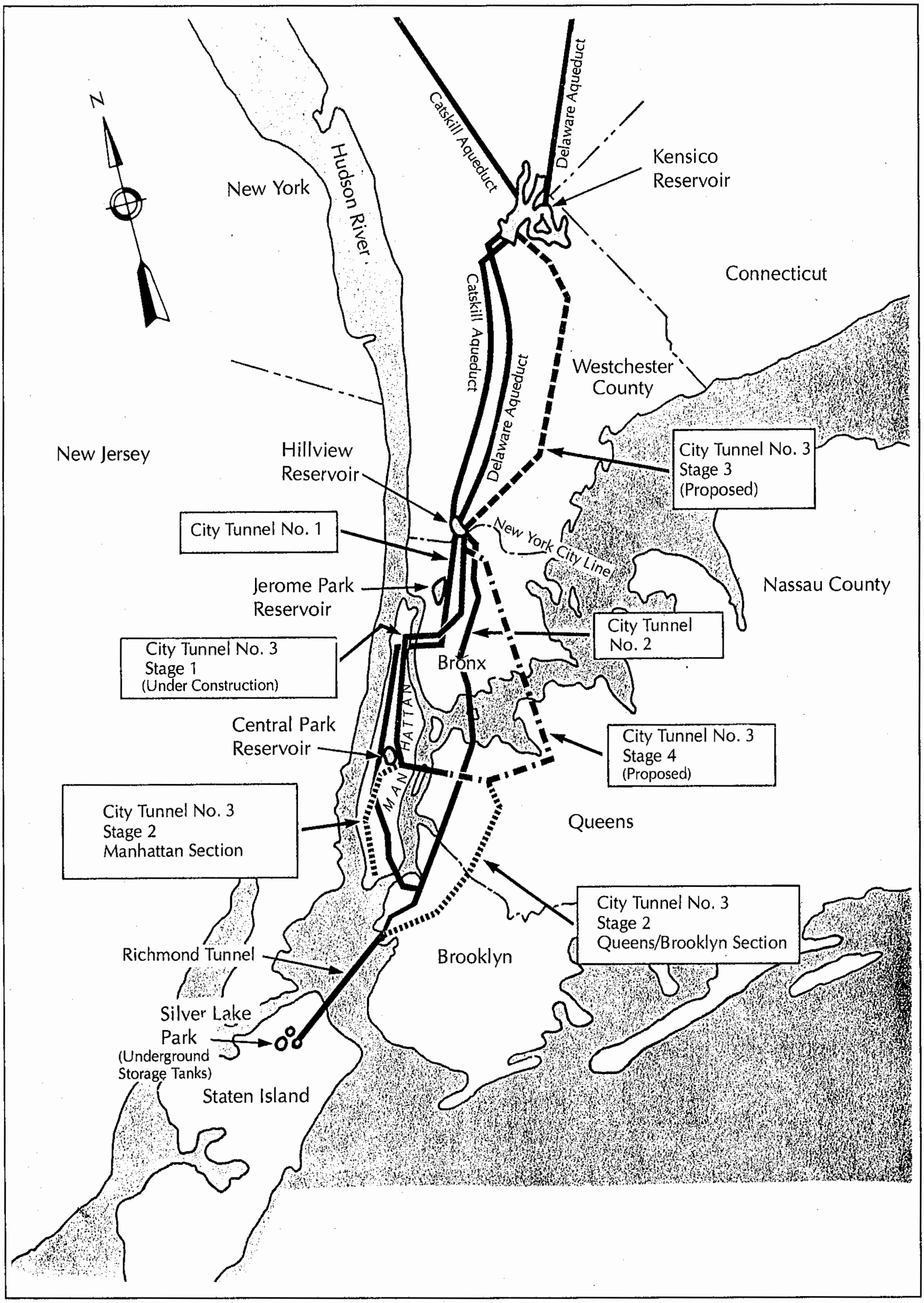

FIGURE 3. New York City's water supply transportation system.

tor water quality. They employ approximately 65 microbiologists, chemists and scientists. Over 40,000 samples per year are collected and 400,000 analyses are performed annually. Routine checks are made for 60 different substances, including heavy metals and trace organics. The monitoring program meets or exceeds federal and state requirements and has the capability to meet potentially more stringent requirements.

In addition to the monitoring program, watershed inspectors maintain constant surveillance of the watersheds. To further ensure high water quality, the system includes real estate adjacent to its reservoirs that has been acquired to prevent potential water contamination from sewage that would be produced if these areas were developed, and to control access to the reservoirs.

The Future: Where to Go From Here?

The frontier is gone. The potential for developing major new sources of supply is limited. The easiest supplies to develop have already been developed. New ones will be far more costly to bring on-line than those that exist now, both economically and environmentally. This reality leads to an inevitable conclusion: conservation must become the keystone in any new water supply construction program.

Concurrently, we must take much better care of what we have. America is a young country and we are only now seriously facing up to the hard task of reconstructing the great systems left to us by our predecessors. New York City is facing up to that task with an ambitious ten-year program that is estimated to cost approximately $8.5 billion (see Table 2). This sum, huge as it is, does not include the cost of developing any major new supplies or the cost of having to filter the Catskill and Delaware supplies. Two landmark actions were taken by the city to address these concerns.

Municipal Water Finance Authority

In 1984 the New York state legislature passed the New York City Water Finance Authority Act and a complementary law that created a public benefit corporation, the New York City Water Board. These laws were passed in order to achieve three main goals:

- To allow the city to sell revenue bonds to finance system improvements — something forbidden to cities by the New York State Constitution.
- To allow development of a modern accounting system that would clearly delineate the expenditures and revenues associated with the city's water and wastewater systems and that would set rates so that the revenues are sufficient to pay for the expenditures.
- To develop a long-range Capital Improvement Program, as shown in Table 2, to ensure the continued viability of the city's water supply and wastewater facilities. The amounts shown in Table 2 for New Source Development are for design and mid-term type projects, not for developing major new water sources.

Mayor's Intergovernmental Task Force

With New York City facing its second serious drought in five years, Mayor Koch, in July of 1985, formed an Intergovernmental Task Force to review the city's water supply system and make recommendations for its future needs. The task force was comprised of members from the United States Army Corps of Engineers; the United States Geological Survey; the New York State Departments of Health, Environmental Conservation, and State; the New York State Water Resources Planning Council; the various counties that surround the city; and, a number of city agencies.

The task force issued two interim reports. The first, "Increasing Supply, Controlling Demand," was released in February 1986. The second, "Managing for the Present, Planning for the Future," was released in December 1987.[1,2]

The report, "Increasing Supply, Controlling Demand," recommended:

"First, it is clearly necessary to study demand further and to refine projections for

TABLE 2
Capital Improvement Program

System Funds	(thousands) 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
Water Supply & Transmission											
Tunnel 3 Stage I	$ 11,091	$ 14,403	$ 5,060	$ 340	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 30,894
Tunnel 3 Stage II	52,292	31,760	34,867	157,997	458,426	278,014	120,004	0	95,002	0	1,228,362
Tunnel 3 Stage III	0	0	0	0	10,468	0	0	0	0	0	10,468
Tunnel 1 Reconstruction	0	0	0	0	0	0	0	0	0	1,070	1,070
Misc. Expenditures	0	0	1,600	0	0	0	0	0	0	0	1,600
Subtotal	63,383	46,163	41,527	158,337	468,894	278,014	120,004	0	95,002	1,070	1,272,394
Water Distribution											
Croton Watershed Dam Safety Program	13,340	0	45,980	100,760	5,611	0	0	0	0	0	165,691
Croton Filter Project	3,306	9,999	0	225,939	0	27,680	0	22,467	0	0	289,391
Trunk & Distribution Main Extension	15,487	187,671	11,160	71,133	31,973	31,282	38,680	38,632	5,652	0	431,670
Trunk & Distribution Main Replacement	94,655	72,903	115,687	252,038	158,309	77,246	136,480	137,657	142,428	141,934	1,329,337
New Source Development	0	7,184	0	0	21,842	0	415,483	0	0	0	444,509
Upstate Improvements	2,822	4,570	6,367	17,160	21,627	6,617	3,480	17,168	3,727	3,856	87,394
Misc. Expenditures	7,335	1,207	0	0	0	0	2,714	0	0	0	11,256
Subtotal	136,945	283,534	179,194	667,030	239,362	142,825	596,837	215,924	151,807	145,790	2,759,248
Sewers											
Sewer System Extensions	70,555	45,377	44,271	60,252	57,962	51,070	50,000	53,977	46,958	30,470	510,892
Chronic Malfunction & Emergency Replacement	57,024	54,447	62,208	66,757	70,000	75,000	80,000	85,000	90,000	95,000	735,436
Programmatic Replacement	26,394	23,142	15,579	18,048	37,368	31,312	33,353	29,382	16,854	32,400	263,832
Replacement or Augmentation to Existing System	36,260	37,258	26,347	33,934	35,761	0	27,102	10,000	10,000	10,000	226,662
Program Response to Legal Mandates	7,813	29,351	16,405	6,667	11,750	18,104	0	2,000	0	1,000	93,090
Subtotal	198,046	189,575	164,810	185,658	212,841	175,486	190,455	180,359	163,812	168,870	1,829,912
Water Pollution Control											
Consent Decree Construction & Upgrading	41,046	2,205	42,102	135,530	119,440	112,000	112,000	0	0	0	564,323
Sludge Disposal	14,526	10,701	6,270	3,000	9,000	0	0	0	0	0	43,497
Plant Stabilization	1,650	1,100	1,749	1,799	33,499	22,100	21,800	0	0	0	83,697
Water Quality Mandates	24,423	10,740	23,000	318,100	19,500	281,301	246,000	69,999	10,000	0	1,003,063
Misc. Upgrading & Reconstruction	39,082	33,233	50,234	56,453	60,433	62,876	53,478	56,651	40,308	36,668	489,416
Subtotal	120,727	57,979	123,355	514,882	241,872	478,277	433,278	126,650	50,308	36,668	2,183,996
Equipment	13,387	9,482	22,867	7,209	4,780	5,019	5,268	5,531	5,807	6,097	85,447
Total System Funds	532,488	586,733	531,753	1,533,116	1,167,749	1,079,621	1,345,842	528,464	466,736	358,495	8,130,997
State & Federal Funds											
Water Pollution Control											
Consent Decree Construction & Upgrading	137,767	12,494	254,000	0	0	0	0	0	0	0	404,261
Total State & Federal Funds	137,767	12,494	254,000	0	0	0	0	0	0	0	404,261
	(thousands) 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	Total
Total Funds All Sources	670,255	599,227	785,753	1,533,116	1,167,749	1,079,621	1,345,842	528,464	466,736	358,495	8,535,258

the city's future needs. An historical analysis of consumption as it relates to such factors as resident population, jobs, and the number of housing units should be developed. From this point forward, the city should monitor every aspect of demand on the water system not only to provide better data about future needs, but also to develop water-saving strategies.

"Second, the city should take every reasonable measure to control and contain water demand including metering and rate setting, leak detection and leak prevention, public awareness campaigns and school curricula, recycling and the use of groundwater for nonpotable purposes, and refitting buildings with lowflow, water-conserving fixtures. In the next decade every avenue of water conservation must be fully explored.

"Third, the city must acknowledge that, even with the best efforts at controlling demand, a supplemental supply of an additional 200 million to 300 mgd will be needed before the end of the century. The planning and development of this supply should proceed immediately and not await the results of the proposed demand study.

"Fourth, the city must prepare for the possibility that a much larger water development project, yielding 400 million to 1.2 billion gallons per day, will be needed in the long term. To lay the groundwork for such a large-scale development, the city should begin immediately to assess and select the most likely options, refining water yield, cost, time, and engineering estimates for projects such as the Hudson River High-flow Skimming Project, a reservoir system in the Upper Hudson Basin, or a system of canals and tunnels carrying water from the Great Lakes. The city should also do further study of the potential for recharging Long Island aquifers with reservoir water, and using the aquifer supply during droughts.

"To be successful, this comprehensive, long-term effort will require the dedication of additional resources to perform a consumption study, to develop water-saving strategies and conservation programs, and to evaluate potential water supply projects. The urgency and the momentum of the recent drought should not be lost as the reservoir levels return to normal. The city faces a very serious long-term water supply problem. If water demand continues on its current track, the city will be using 800 mgd more water in 2030 than it is using now. It must plan today to control this demand and to provide additional supply for it."

The report, "Managing for the Present, Planning for the Future," gave a detailed description of the actions taken in the period between the issuance of the two interim reports. In the section entitled, 'Summary and Next Steps,' it stated:

"This section provides a summary of the report, and describes the next steps that the Task Force believes should be taken in 1988 and subsequent planning periods.

"The Task Force organized its work during 1986-87 on the management and planning of New York City's regional water supply system through seven committees: Conservation, Demand, Groundwater, Hudson River, Long-Range Planning, Metering, and Water Quality and Watershed Management. Each of these committees focused on aspects of water demand and supply for the system. The work of the Demand, Metering, and Conservation Committees is described in Section 3, Demand Management and Conservation; and the work of the Water Quality and Watershed Management, Hudson River, Groundwater, and Long-Range Planning Committees is described in Section 4, Supply Potentials. The observations and recommendations presented are those that the committees submitted to the whole Task Force, and are in the form approved by the Task Force as its best response to Mayor Koch's charge to the group.

"The recommendations relating to Demand Management and Conservation focus on: monitoring the recently begun system demand study; the detailed implementation of the city's new metering program; and the implementation and improvement of the range of conservation measures now in place and proposed. The recommendations relating to Supply Potentials focus on: improvements in the watershed management system, including water quality concerns; detailed investigation of additional withdrawals from the Hudson River in the general area of the Chelsea station, to prepare for the possibility that additional medium-term supply will be required; designs for more in-depth analyses of the possibility of using Brooklyn/Queens groundwater as a medium-term source; and, for more substantial long-term supply, should this be required, study of a Hudson River Basin project with or without flow augmentation.

"The Task Force has found that, because of the future effects of metering, conservation programs, demand growth in the city and among outside users, and the longer-term potential of changes in safe yield, the optimal package of management and development measures is not now known. However, the Task Force is convinced that the right course for the city is to pursue aggressively the management and planning measures recommended in this report. This course of action will enable the city, as the nature and extent of demands on the system become clear, to implement in a phased, efficient manner the appropriate range of management and development measures, including the continuation and strengthening of conservation measures now in place.

"The Task Force also observes that many of the management, planning, and development measures discussed in this report will take years to complete. For example, the new demand study is scheduled to last nearly six years; the implementation of metering in the city will take ten years; the detailed studies needed to decide on possible mid-term sources such as Hudson River withdrawals will take substantial periods of time. The completion of these and other tasks requires a strong commitment to effective planning over a long period both by the city and by intergovernmental forums such as the Task Force.

"In responding to the recommendations of the Task Force, insofar as supply is concerned, the city has prepared a request for proposal (RFP) whose scope includes the detailed studies required to determine the feasibility of two types of Hudson River projects: an expanded Chelsea-type facility and a larger facility having a capacity of 400 to 1,200 mgd. Eight proposers have survived the first screening and they will be submitting formal proposals by September 26, 1989.

"From the eight, three [in actuality four] finalists will be selected. These finalists will submit detailed proposals, including cost proposals, later this fall. It is anticipated that a contract will be signed with the successful proposer by the spring of 1990 and that work will start shortly thereafter."

It must be noted that current projections indicate that the contract will be signed this fall. Since the second interim report was issued, work has continued and the task force is expected to release its final report later in 1991. This report will give direction to the city's water supply program for the next several decades.

Addressing New Water Quality Control Standards

Concurrent with addressing a capital improvement plan and a demand management and supply augmentation study program, the city is also focusing on water quality issues and the possible need to filter its Catskill and Delaware supplies.

When the Safe Drinking Water Act was reauthorized in 1986, Congress directed the United States Environmental Protection Agency (EPA) to develop and promulgate a series of new regulations aimed at improving the quality of the nation's drinking water. Three of those rules seriously impact New York City:

- The Surface Water Treatment Rule (SWTR) issued in 1989.
- The Lead and Copper Rule issued in June 1991.

• The Disinfection By-Products Rule, scheduled to be released in 1992.

The SWTR sets criteria a supply must meet in order to avoid filtration. New York City believes it can meet these criteria. However, the State Department of Health, the prime agent in New York State with responsibility for implementing the provisions of the SWTR, has recently issued a draft proposal that would use SWTR criteria only for the next fifteen years and would mandate universal filtration by the year 2005. The city has opposed such a requirement, believing that it would drain money away from a recently approved water quality enhancement program aimed at protecting its watersheds. Should that opportunity be lost now, it will be gone for good. To the inevitable question of, "Why not do both?," there is a simple answer — money. It is estimated that a full scale plant, or plants, that would filter the Catskill and Delaware supplies will cost the city from $3 to $5 billion. Providing the resources to do this, while at the same time meeting its other obligations, will almost certainly preclude any large scale expenditures to acquire additional watershed lands or to purchase conservation easements for them.

The Lead and Copper Rule, while not as costly as the SWTR to implement, will bring with it large costs and problems of its own. In New York City's case, most of the corrosion control strategies proposed involve actions that could upset the delicate chemical and microbiological balance of the water in its distribution system. Caution must be the watchword here and the city is currently testing a number of corrosion-inhibiting compounds.

Another component of the Lead and Copper Rule will be a requirement to develop a lead service line replacement program if corrosion control does not reduce lead content to the levels required by the rule. It is estimated that it would cost approximately $500 million to replace every lead service line in the city, so effective corrosion control is vital.

The Disinfection By-Products Rule will, finally, determine the long-term viability of operating the New York City system as an unfiltered supply. In 1989, the United States EPA issued a draft proposal, the "Strawman Rule," to generate discussion. It is clear from reading this rule, and from discussions with staff and officials involved in the process of implementing it, that there will be at least a 50 percent reduction in the standard for total trihalomethanes (TTHMs) and that standards will be set for many compounds not currently regulated. Conformance to this rule would constrain the use of chlorine as a disinfectant.

Therefore, a situation is created where a SWTR primarily concerned with biological safety compels improving disinfection efficiency and increasing chlorine residuals; a Lead and Copper Rule compels increasing water pH to reduce corrosivity, a step that will have the two-fold effect of increasing TTHM production while at the same time reducing disinfection efficiency; and, a Disinfection By-Products Rule that will severely limit the use of chlorine as a primary disinfecting agent.

Conclusion

Will it be possible to walk the fine line between these constraints, furnish high quality water and remain an unfiltered supply? It is possible, and the effort may be well worth it. A situation exists where there is a last opportunity to retain a protected watershed, but time is running out. The next five to ten years will be crucial. If a well-protected watershed is acquired, it most probably will be preserved regardless of what additional treatment requirements may be imposed in the distant future. However, if a requirement for filtering by a fixed date is set now that opportunity will almost certainly be lost.

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