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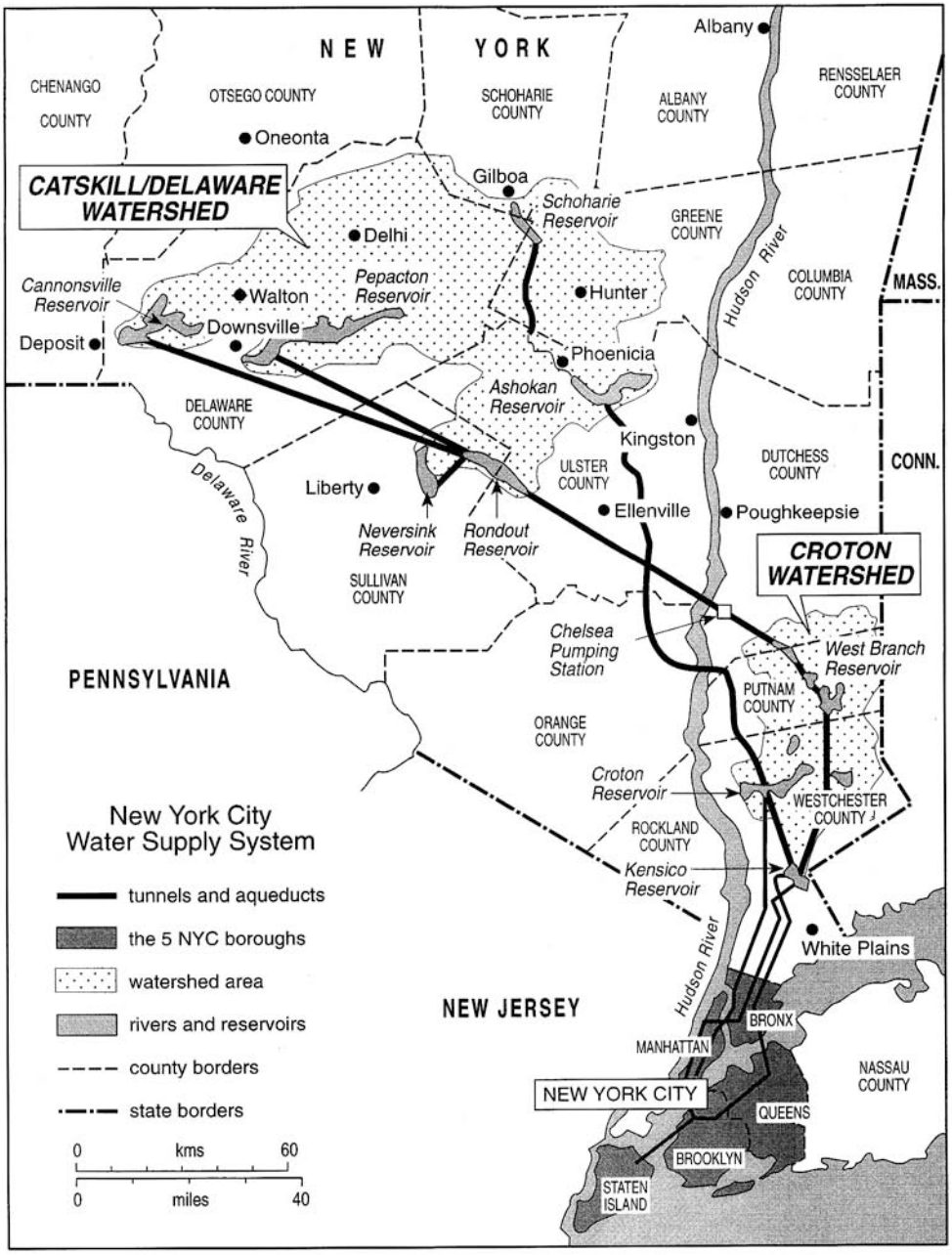
Water, Space, and Power

New York City is the most thirsty of all great cities.

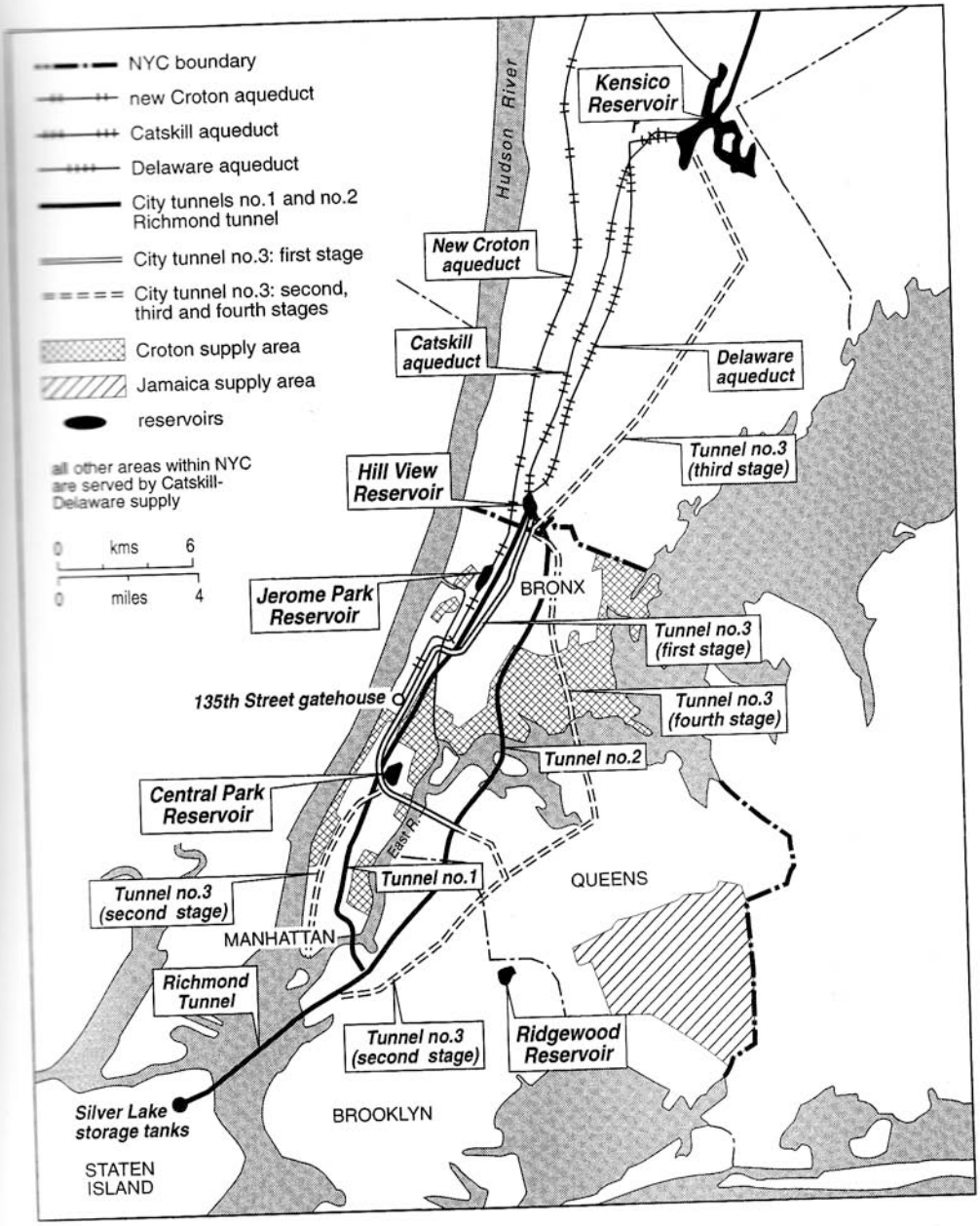
—*Jean Gottmann*[1]

The provision of water for New York City is one of the most elaborate feats of civil engineering in the history of North American urbanization. As the city grew, it extended an "ecological frontier" of water technologies deep into upstate New York. The city's modern water supply system, which has been intermittently under construction since the 1830s, now extends across the largest water catchment area in the United States, collecting water from nearly 2,000 square miles of sparsely populated mountains, lakes, and forests of the Catskill region along with the smaller and more densely populated Croton catchment in closer proximity to the city. The city's elaborate water infrastructure now includes 19 collecting reservoirs, two city water tunnels, the world's largest storage tanks, and nearly 6,000 miles of gravity-fed water mains. This vast network delivers 1.3 billion gallons of water a day to 9 million people (see figures 1.1 and 1.2).

Some sense of the scale and complexity of the water supply system can be illustrated by the city's new six-billion-dollar water tunnel, City Water Tunnel No. 3, one of the biggest civil engineering projects in America, which was conceived in 1954 and has been under construction since 1970. Although the project



1.1 The New York watershed.
Source: New York City Department of Environmental Protection.



1.2 New York City water infrastructure.
Source: New York City Department of Environmental Protection.

was halted and nearly abandoned during the city's fiscal crisis of the mid-1970s, the first section was finally opened in 1998, and the whole tunnel is expected to be completed by 2020. Beneath an inconspicuous door in Van Cortlandt Park in the Bronx lies a 250-foot shaft linked to a dazzling subterranean valve chamber over 600 feet long that connects the city to its upstate sources of water supply. This extraordinary engineering achievement has an austere, utilitarian aesthetic reminiscent of the most impressive American water technologies of the twentieth century, such as Gordon B. Kauffmann's Hoover Dam and Eero Saarinen's Watersphere. At the tunnel's official opening in August 1998, a giant fountain was activated in the Central Park Reservoir that had first been used in 1917 to celebrate the arrival of water from the Catskill Mountains.[2]

The history of cities can be read as a history of water. The historian Nelson Blake contends that "the indispensable precondition to the great growth of American cities during the nineteenth century was a recognition of the vital importance of water supply."[3] In the absence of plentiful supplies of water, cities are faced with the threats of fire, disease, social unrest, and material impoverishment. To trace the flow of water through cities is to illuminate the functioning of modern societies in all their complexity. Water is a multiple entity: it possesses its own biophysical laws and properties, but in its interaction with human societies it is simultaneously shaped by political, cultural, and scientific factors. For the historian Jean-Pierre Goubert, the modern era has seen a series of transformations in the use and meaning of water. The premodern waters of myth and salvation have been "subjugated, domesticated, mechanized and made profitable."[4] During the nineteenth century the water technology of the cities of Europe and North America evolved from an organic form, in which limited flows of water were combined with the harvesting of human wastes as fertilizers, into a modern hydrological structure in which far greater quantities of water were transported through the city in an ever more complex network of pipes and sewers. The control of water in the modern city now extends from the regional hydrological cycle to the application of plumbing technologies within the home. Water, in its multiple uses and transformations, flows between these different kinds of urban

spaces linking diverse elements such as capital markets and domestic technologies into a multitiered social reality.

The story of urban water supply is a powerful element in the field of environmental history. Scholars have grappled with this dynamic from a variety of vantage points. In the American West, for example, the interaction between water and cities has become woven into a powerful narrative of the technological ingenuity behind urban growth. In New York, however, the relationship between nature and the urban landscape is far less clear. The architectural critic and landscape designer William Morrish, for example, suggests that the "dominant contextual elements of Los Angeles are not architectural, but natural." He describes how "the mountains surrounding Los Angeles are viewed as part of the formal vocabulary of the urban landscape," whereas New York, by contrast, is dominated by its architecture rather than its physical setting.[5] This chapter will show, however, that this comparison is misleading in ecological if not visual terms, since New York, like Los Angeles, is woven into its mountainous hinterland by an elaborate network of water technologies in order to transport billions of gallons of fresh water.

The landscape of upstate New York has been sculpted into a life-sustaining circulatory system through the interaction of the flow of water and the flow of money. Yet this double circulation of water and money is easily overlooked. The more distant parts of the city's watershed still resemble a Thoreauvian wilderness: one can trek through parts of the Catskill Mountains without encountering another human being. It is easy to imagine that you have entered a fragment of primal nature, but there are signs of human influence all around: the absence of large mammals; the patches of trees that have regenerated since the land was logged in the nineteenth century; and the network of paths that bear witness to many centuries of intense human activity. Most remarkable of all, however, is the fact that you are standing inside New York City's water system. The hydrological cycle of a whole region has been harnessed to provide water for a city: the rain dripping down through the leaves of hemlock trees will eventually find its way into the pipes and taps of millions of homes.

1.1 WATER AND THE NASCENT CIVIC REALM

Access to water was a constant problem for early settlers as they began to colonize the southern tip of Manhattan Island during the seventeenth century. In New Amsterdam, as the settlement was then known, there were frequent water shortages. Although many businesses and wealthier dwellings had their own wells, those without private water sources, principally the urban poor, depended on public wells, the first recorded of which was dug at what is now the intersection of Bowling Green and Broadway in 1658. The meager supplies from wells were supplemented by the collection of rainwater through the extensive use of cisterns made of masonry or wood.[6] With the growth of the city many of the wells became contaminated by privies, cesspools, and the drainage of dirty water from the streets. By the mid-eighteenth century the Swedish traveler and diarist Peter Kalm reported that even travelers' horses were reluctant to drink New York water. "There is no good water in the town itself," writes Kalm. "This want of good water is hard on strangers' horses that come to the place, for they do not like to drink the well water."[7] Records suggest that the only major source of good water remaining in the eighteenth century was derived from a spring outside the city called the Collect Pond in what is now Park Row. Water derived from the Collect Pond was sold to those who could afford it by water vendors known as "Tea-water Men." By 1785, however, the city's main source of water had degenerated into what the *New York Journal* described as "a very sink and common sewer."[8] In 1808 the city resolved to fill in the stinking Collect Pond in order to provide employment for some of the thousands of sailors and laborers thrown out of work by the Embargo Act. This early large-scale public works project reveals from the outset how political and economic factors would predominate in all discussions surrounding water supply and the construction of urban infrastructure. Rising land values merely accelerated the rate of development around the Collect Pond, and by 1815 the site had been completely filled in.[9]

Crowded, insanitary conditions in New York led to repeated epidemics of infectious disease. A series of outbreaks of yellow fever, a deadly virus carried by the mosquito *Aedes aegypti,* was recorded during the eighteenth century. Be-

tween 1791 and 1821 yellow fever epidemics became even more frequent. The most severe outbreak was recorded in 1798, when we find some of the earliest direct links made by city physicians between poor sanitation and disease. In the 1805 outbreak nearly half the city's population fled and the economic survival of the port of New York was threatened.[10] As for cholera, the great scourge of the nineteenth-century city, serious epidemics struck in 1832, 1849, 1854, 1866, and 1892 (the last major outbreak). The 1832 cholera outbreak, in which more than three thousand people died, was to prove pivotal in the early politicization of public health reform.[11] "On no former occasion," wrote the physician John W. Francis, "has New-York, frequently visited by the direful ravages of the yellow-fever, exhibited a more melancholy spectacle. Of a resident population of two hundred and twenty thousand . . . at least one-third are now dispersed in every direction."[12] Yet for Francis, as for most of his contemporaries, the cause of cholera remained inexplicable:

> It is conceded by all, that the origin of epidemic diseases is still enveloped in great obscurity; and the theories on this subject, whether referring to a distempered state of the atmosphere, to exhalations from putrid animal or vegetable matter, or to specific contagion, have been alike conjectural and unsatisfactory. The cholera, like all preceding epidemics, has exercised, but without any very useful results, the ingenuity of the speculative and philosophical observer.[13]

Francis described how cholera extended to "the innumerable circumstances connected with the economy of man in every state and condition" and attacked "rich and poor, native and stranger, young and old."[14] Despite the indiscriminate pattern of cholera morbidity across different social classes, the moralistic and superstitious responses to disease were only partially displaced by emerging concerns with urban sanitation. In the mid-nineteenth century we find a medley of perspectives on the cause of disease, combined to produce a moral geography of illness. In 1849, for example, the New York City Board of Health could confidently assert that "the general cause of the disease appears to exist in

the atmosphere" and that "the agency of various exciting causes is generally necessary to develop the disease. Among these causes the principal are the existence of filth and imperfect ventilation, irregularities and imprudencies in the mode of living, and mental disturbance."[15]

In the prebacteriological era the problem of water supply was predominantly perceived to be one of bad taste and insufficient quantity; the danger and nuisance of poor water quality was not widely linked to disease. The cholera epidemics did, however, begin to widen and intensify public debate over urban sanitation, even if the precise mechanisms of contagion were imperfectly understood.[16] Commentators such as the physician Martyn Paine noted that the prevalence of cholera was worse in Paris and Montreal than in New York and began to develop a more rigorous analysis of variations in ventilation and cleanliness that might contribute to the severity of the disease.[17] The cholera epidemics of the nineteenth century were, above all, a transitional moment in the history of capitalist urbanization, as new trade routes exposed insanitary cities to the threat of disease before there were any concomitant advances in the science of epidemiology or the practice of public health. They were, in other words, the outcome of an uneven modernity that exposed a series of political, cultural, and scientific contradictions running through urban society. While it is undoubtedly the case that changing attitudes toward public health were a significant pretext for the modernization of the city's water supply (and environmental conditions more generally), these reforming impulses belonged to a wider political and economic context for capital investment in the physical infrastructure of cities. These changes rested on an emerging commonality of interests between the power of technical elites and the economic logic behind the reordering of urban space.

The late eighteenth and early nineteenth centuries were the worst period of all in the history of the city's water supply and heralded an increasingly panicky series of investigations into alternative sources. In 1774 the city's Common Council approved a plan put forward by the Irish-born engineer Christopher Colles to build the city's first municipal waterworks using a hilltop pump from which water could flow in any direction by gravity.[18] By approving Colles's scheme, the city embarked on a completely new approach involving the con-

struction of a much more sophisticated water supply system than the existing wells and ponds. Construction began in 1774 using a steam engine designed by Colles himself, connected to a network of water pipes made from pine wood. The city financed the construction by issuing 5 percent bonds known as "water works money." In the event, the project was destroyed before its completion during the British occupation of the city in 1776. In spite of this setback, the city was slowly but inexorably widening its responsibilities for water supply. In 1792, for example, it began to use tax revenues for the digging of new wells, so that by 1809 there was a network of 249 public wells.[19]

Before any collective solution could be found for the city's water supply problem, however, there was an extraordinary historical detour created by rival attempts to control New York's banking system. In the 1790s the only banks in New York were controlled by the Federalists under Alexander Hamilton. The leading Republican, Aaron Burr, knew that his attempts to set up a rival bank would be thwarted by his political opponents in the State Legislature. Burr successfully lobbied against the construction of a public water system on the grounds that the State Legislature would be unwilling or unable to adequately finance it. In 1799 he then succeeded in passing a bill that granted a charter to a little-known water company called the Manhattan Water Company of which he was chair of the board. Hidden in the redrafted bill was a clause that allowed the company to use its surplus capital "in the purchase of public or other stock, or in any other moneyed transactions or operations."[20] Having set up the Manhattan Water Company, Burr rejected the more expensive options contained in the company's charter of diverting clean water from Westchester County and the Bronx River (which would have used up too much of the company's capital) and opted instead to drill a well adjacent to the polluted Collect Pond with cheap wooden pipes. The company never constructed the steam pump and million-gallon reservoir that it had promised the city but relied instead on horse power in combination with a small reservoir one-tenth the size, adorned with a "false front of four Doric columns supporting a recumbent figure of Oceanus."[21] As well as being of poor quality, the water was also extremely expensive at 20 dollars a year, leaving most of the city reliant on rainwater collected in rooftop cisterns or "buying an

occasional pailful from fetid wells."[22] Throughout its entire operations the Manhattan Company never laid more than twenty-five miles of water mains, but the profits were used to set up the Bank of Manhattan Company (later to become Chase Manhattan after the 1955 merger with Chase National Bank). So inadequate was the company's charter, which had been approved by the unwary State Legislature, that the city was forced to use its own revenues for flushing gutters, piping water to markets, and repairing streets after the laying of pipes. The city's attempt to buy the waterworks of the Manhattan Company in 1808 met with public indignation: not only had the company operated under the minimum legal obligations of its charter but it now stood to benefit financially from its own failure. In 1822 there was yet another serious outbreak of yellow fever and fifteen prominent physicians signed a certificate warning that the Manhattan Company's water was unfit for human consumption. By 1830 the Manhattan Company still served no more than a third of the city: the rest of the population, who now numbered over 200,000, remained dependent on polluted wells or were forced to buy water from private vendors at exorbitant prices. The "Tea-water Men" and other water vendors were earning about $275,000 a year; ships were paying $50,000 a year to have their casks filled; and fire was destroying around a quarter of a million dollars' worth of property a year.[23]

Under the twin impetus of industrialization and immigration, New York was now the largest and fastest-growing city in America. A building boom in the 1820s and 1830s spread rapidly northward from the southern tip of Manhattan Island as former residential districts became converted into more lucrative commercial and industrial premises. Beyond the business district, with its dense concentration of new urban infrastructures such as sewers and gas lighting, the rest of the city languished in a state of anarchy. In the early 1830s public interventions multiplied with the construction of a new wooden reservoir on 14th Street and the laying of extra pipes in the driest parts of the city, but these efforts amounted to little more than tinkering at the edges of the problem.

During the early decades of the nineteenth century we can observe the emergence of a shift in the politics of water which began to undermine the claims of private provision. This set in train a reformist urban vision based on a more so-

phisticated conception of the technical, administrative, and financial dimensions to public works. We should be careful, however, not to overstate the significance of public health concerns in relation to the broader political and economic dynamics behind the modernization of urban infrastructure. In 1798, for example, the engineer Joseph Browne had called for the extension of waterworks to new sources beyond the city's political boundaries, but the continuing intransigence of city authorities in the early nineteenth century stemmed from a reluctance to finance any program of public works that might significantly raise taxes.[24] In the meantime, however, other major American cities were busily abandoning their reliance on private water suppliers. As early as 1798, for example, Philadelphia had pioneered the development of public water supply, followed by Cincinnati in 1817.[25] Finally, in 1833, a Water Commission was appointed by New York State to undertake the first systematic study of the city's water needs, deploying the latest advances in the geological and engineering sciences. This more rigorous approach coincided with a major cholera outbreak and enabled a consensus to emerge among New York's political and business elite that a source of water from outside the city had to be found. A number of different proposals were debated at the time, including the damming of the Hudson River, the tapping of the Passaic River in New Jersey, and the construction of a canal from the Bronx River into Manhattan. After much deliberation, technical opinion agreed on a plan to divert water from the Croton River forty miles to the north of the city using a closed masonry aqueduct.[26]

How can we account for the shift in technical and political opinion that occurred in the 1830s? A first development was the increased seriousness of water-related disease outbreaks in New York at a time when new evidence from its economic rival Philadelphia revealed that the construction of an improved water supply system had successfully reduced the incidence of disease.[27] A further issue was the growing status and professionalization of engineers, who were able to convince political and economic elites that a more technically ambitious solution to the city's water problems had to be found. The city's reluctance to invest in the project on the grounds of cost was countered by new evidence collected by the state-appointed water commissioners that at least 30,000 owners of building lots

would be willing to subscribe to a new water service and easily cover its estimated construction cost of $5.4 million. Another critical factor to emerge in the 1830s was the growing extent of damage to property by fire, which threatened the city's burgeoning insurance industry. Fire damage was now costing the city more than any notional expenditure on a new water system, particularly in the wake of the "great fire" of 1835 in which 674 buildings were destroyed (figure 1.3).[28] Since directors of leading insurance companies were represented on both the state-appointed Water Commission and the city's Common Council, this must have intensified the sense of urgency to take action. There was also at this time increasingly frantic lobbying by chemical works, breweries, tanneries, distilleries, hotels, sugar refineries, and other parts of the fast-growing New York economy which relied on pure and reliable water supplies and would be ruined if the city authorities failed to take action.[29] The situation was merely exacerbated by the gathering pace of industrialization, urbanization, and the use of steam power, which accelerated the shift of industrial production to new urban centers. In the absence of a secure water supply, New York's boosters claimed, the city would lose out to its main rivals and future investment would be stymied.

In 1834 the State Legislature finally passed a law that gave the city the right to construct its first municipally owned waterworks. This proposal was then strongly approved in a citywide referendum the following year. In 1835 the city authorized an initial bond issue of over $2 million which would allow construction of the Croton Aqueduct to proceed. The first bond issue sold well in both the United States and Europe, despite the economic downturn of 1837–1843, and the city was easily able to complete the project to the satisfaction of its investors.[30] Predictably, almost all the opposition to the new water system came from uptown residents and property owners whose wells were not yet polluted, and their well-organized opposition succeeded in delaying construction for a further two years. Toward the source of the Croton River in Westchester County, residents "vigorously opposed the aqueduct, claiming it disfigured their fields and divided property."[31] For the historian Eugene Moehring, however, the successful completion of this project demonstrated how "the city had triumphed over a water shortage that had threatened its health, property, and prosperity. Despite

staggering costs and political opposition, authorities had met the crisis directly, setting an example for other towns. Problems had been legion—contract fraud, court suits, jurisdictional disputes, and pipe location, but New York overcame them."[32] The construction of the Croton Aqueduct marked a new era in North American urbanization. Had it not been built, it would have been impossible for New York City to retain its position as the largest and fastest-growing city in America.

1.2 ENGINEERING THE TECHNOLOGICAL SUBLIME

> Nothing is talked of or thought of in New York but Croton water; fountains, aqueducts, hydrants, and hose attract our attention and impede our progress through the streets. . . . Water! Water! is the universal note which is sounded through every part of the city, and infuses joy and exultation into the masses, even though they are out of spirits.
>
> —*Philip Hone*[33]

The completion of the Croton Aqueduct in 1842 was marked by the biggest public celebrations in New York City since American independence. The diarist Philip Hone recounts the five-mile-long procession as one of "perfect order and propriety," which he attributed to "the moral as well as the physical influence of water."[34] Since the writings of Vitruvius, the beauty and technical ingenuity of water-based architecture have been a recurring symbol of both prosperity and municipal independence (figure 1.4). The architectural historian Vittorio Gregotti, for example, describes how the aqueduct has, through history, created "a productive dialectics with the built fabric of the city" which has enabled "the unity of the *urbs* and the *civitas*":

> To supply water freely to a city is much more than guaranteeing a service: it represents, in an exemplary way, the collective effort to ensure the communal life of the settlement. It imposes its necessary

> geometry and reconnects city and territory, geography and settlement. . . . Necessity, ingenuity and civic virtue seem to be represented in the aqueduct by an organic synthesis.[35]

The creation of New York's water system consolidated the emergence of a more sophisticated kind of urban society within which fragmentary and parochial perspectives were superseded by a more strategic urban vision. This new outlook was reinforced by impressive engineering feats in the service of a modern metropolis. The Croton Aqueduct incorporated the latest advances in French and British engineering and also added unprecedented features of its own. The elaborate new structure excelled the Roman aqueducts in the size of its cross section and also advanced on Assyrian and Roman structures by the use of the siphon: its unique features included the low 12-foot inverted siphons at the High Bridge and the one at the Manhattan Crossing that put the water under pressure.[36] The chief engineer for the project from 1836 was John B. Jervis, who had gained extensive experience from the construction of the Erie Canal (1817–1825). Jervis was one of a number transitional engineers who played a significant role in the modernization and professionalization of engineering science in the nineteenth century.[37]

Like the Erie Canal, the Croton Aqueduct also contributed toward a new kind of mediation between technology and nature in the American landscape. The economic growth of the city was increasingly tied to a regional urban ecology within which "wild nature" would be gradually displaced by an intensely reworked landscape. With the extension of the city's ecological frontier into upstate New York, the urbanization of nature and the naturalization of the urban could advance in tandem. The construction of aqueducts, dams, and reservoirs in upstate New York marked the evolution of a new kind of technological and cultural engagement with nature. "By the middle of the nineteenth century," argues the historian David Nye, "the American sublime was no longer a copy of European theory; it had begun to develop in ways appropriate to a democratic society in the throes of rapid industrialization and geographic expansion."[38] Crucial to this emerging aesthetic sensibility was the gradual supplanting of nature-based sublimity by an emphasis on the growing scale of human artifice.

The new water infrastructures presented an architectural vision quite different from the kind of romanticized native American landscapes depicted in the contemporary art of Thomas Cole, Asher Brown Durand, and other artists associated with the Hudson River School of painting. The latest accomplishments of the engineering sciences emerged as a field in which America could rival the Old World in its Promethean transformation of nature. The vibrant combination of modernity and Arcadia presented a symbolic concretization of the pastoral landscape in the service of republican ideals. Features of the Croton Aqueduct such as the High Bridge soon became recognizable icons in the New York landscape and markers on a path to a more clearly defined sense of national identity (figure 1.5).[39]

The construction of a new water infrastructure instituted a different kind of relationship between the city and nature. At one level the improved flow of water contributed toward a democratization of nature. Fountains and other architectural features symbolized the new urban bounty of fresh water brought from upstate sources; plentiful supplies of water helped to keep streets clean and contribute toward the creation of a more "hygienic" urbanism; while the gradual diffusion of plumbing technologies within the home lessened the daily burden of fetching water from standpipes and other sources. At first, some commentators were skeptical: the lawyer and diarist George Templeton Strong feared that Croton water would be full of "tadpoles and animalculae," to say nothing of "Hibernian vagabonds" relieving themselves into the aqueduct as they toiled on the completion of the project. But within a year, Strong took delight in the new bathroom fixtures installed by his father: "I've led rather an amphibious life for the last week," he wrote, "paddling in the bathing tub every night and constantly making new discoveries in the art and mystery of ablution. A real luxury, that bathing apparatus is."[40] Water gradually entered urban consciousness in a variety of ways, some public and some private, and in time the growing use of water would be seen as an indicator of modernity.

Despite the better access to water for many ordinary New Yorkers, the political impetus behind the construction of the new water system remained firmly economic in its motivation. The historian Joanne Goldman, for example,

suggests that the Croton Aqueduct marked a dramatic departure from the starkly unequal distribution of municipal services in the past, yet this observation oversimplifies the transformation of urban infrastructure.[41] The dramatic expansion in the scale and cost of public works in nineteenth-century New York was firmly grounded in an economic logic that found powerful political advocates. If impoverished Irish and German wards had received water before the wealthy residents of the Upper West Side, this was simply an anomalous outcome of the speed with which new pipes were constructed under the more densely populated parts of lower Manhattan.[42] The modernization of nineteenth-century cities in Europe and North America was not carried out in order to improve the conditions of the poor but to enhance the economic efficiency of urban space for capital investment. In this sense, the scale of new public works and the pace of technological change masked the persistence of social and political inequalities that would not be tackled in any systematic way until many decades later.[43] Advances in public health were an ambiguous by-product of the bourgeois rationalization of cities. Whatever the complex motivations that lay behind the development of elaborate public works projects, however, they did provide thousands of laboring jobs for native and immigrant workers whose votes were integral to the growth of machine politics with the widening of the political franchise. And even if the spread of new advances in public health was initially highly uneven, it did lend a powerful legitimacy to the development of new kinds of municipal governance freed from the *noblesse oblige* of the past.

So popular was Croton water that by 1850 New York could boast of the highest levels of per capita water consumption of any city in Europe or North America.[44] Earlier suspicions toward extensive water use were supplanted by a new enthusiasm for its diverse therapeutic and hygienic applications. Contemporary advocates of hydrotherapies such as Joel Shew saw the growing use of water as an indicator of the "general advancement of civilization" through American society.[45] Twentieth-century commentators such as Sigfried Giedion elaborated on this sense of dynamic optimism surrounding the spread of water through modern societies: "Words are too static," writes Giedion. "Only a

moving picture could portray water's advance through the organism of the city, its leap to the higher levels, its distribution to the kitchen and ultimately to the bath."[46] Water use in American society grew steadily through the installation of new water technologies such as flush toilets and fixed washbasins, which came into general use from the 1850s onward (figure 1.6). Yet the spread of plumbing technologies can be attributed to changing fashions in health and architectural design rather than simply the greater availability of running water. The new popularity of water within the home is best conceived as a "private manifestation" of the impetus for greater personal space and new standards of hygiene.[47] As the historian Alain Corbin has pointed out in a French context, the growing use of water and the concomitant emphasis on cleanliness formed part of a complex pattern of cultural changes in the pre-Pasteur era associated with sharpening social and economic differentiations.[48] Water use became entangled in wider ideological discourses surrounding the promulgation of middle-class domesticity in the face of increased social polarization in the nineteenth-century city.[49] After all, the "water revolution" was initially largely restricted to the middle classes, with most working-class tenements lacking bathing facilities until legislative changes in the early twentieth century. Only in 1870, for example, did the city finally open two free public baths after decades of debate over personal hygiene (private bathing houses had already been in operation since the eighteenth century).[50]

As for human wastes, there was little consensus over the relative advantages of water closets and earth closets until increased water use in the late nineteenth century began to overwhelm the use of facilities unconnected to the sewer system.[51] The declining use of earth closets in the cities of Europe and North America marked a transition away from the circulatory preoccupations of the organic city and the desire to use human wastes as fertilizers. As increasing quantities of water entered these self-contained sewage systems for individual dwellings, the nitrogen content began to fall. "It is now conceded," wrote the New York sanitation pioneer George Waring in 1895, "that the very small amount of manure and the very large amount of water cannot be separated at a profit."[52] With the advent of modern plumbing systems, these earlier efforts to recycle human wastes

were superseded by a new emphasis on large-scale technological systems to facilitate the flow of water through cities, which led ultimately to the development of sewage treatment works and other advanced methods of water purification and pollution control.[53] The dwindling use of privies, cesspools, and other ad hoc solutions to the problems of urban sanitation marks the decline of the "private city" where emphasis was placed on minimalist and fragmentary forms of municipal government. The widening political franchise saw new legislative efforts in 1879 and 1901 to improve the quality of tenement housing and ensure that the benefits of new plumbing technologies would be incorporated into building design. New patterns of water use became part of a wider transformation in living conditions which furthered the technical and cultural agenda of urban reformers and public health advocates as they sought to build centrally managed urban systems. For sanitary inspectors such as Robert Newman, the complexity of plumbing individual homes was a microcosm of the challenge to transform the circulatory dynamics of the entire city:

> No community and no city can preserve a wholesome condition without a supply of pure water; and an equally thorough purification from all refuse. To properly arrange this double circulation in a large house, is a matter of no trivial consideration; how much more, then, is skill, sagacity, and system, necessary for the sufficient supply and drainage of a district of an immense city like New York?[54]

By the early twentieth century the United States would be one of the best-plumbed nations in the world through the rapid diffusion of technologies such as pedestal sinks, enameled double-shell tubs, and siphonic-jet toilets.[55] An international survey of urban water consumption in the 1890s found that rates of water use in American cities were far higher than in those of continental Europe: only southern American cities such as New Orleans, with limited connections to urban water supply systems, exhibited lower rates of per capita water use than major European cities such as London, Paris, and Glasgow. We also find that New York's midcentury lead in per capita water consumption had been rapidly out-

stripped by fast-growing industrial cities such as Chicago, Pittsburgh, and Philadelphia.[56] Of course, the manufacturers of water-using technologies, plumbers, soap makers, and other industries that stood to benefit from an expanded use of water also played a role in fostering the spread of new consumption patterns: cleanliness was but one facet in the development of new cultures of retail shopping and advertising that would transform the lives of ordinary Americans.[57]

By the early 1870s a combination of droughts, low water pressure, and continuing urban growth, along with allegations of widespread graft and corruption, began to focus public attention on the need to rethink the scope and management of New York City's water supply system. As a result of the 1876 drought, for example, there was the first serious recognition that the repeated calls for water metering and repair of leaking pipes would not be sufficient to forestall serious future shortages. And by the 1880s supplies were so inadequate in the summer months that water could not be obtained from taps on the upper stories of tenement blocks. As a result of looming water shortages, a new phase of construction began for the Croton system in 1883. The New Croton Aqueduct (completed in 1890), the New Croton Dam (completed in 1907), and the Croton Falls Reservoir (completed in 1911) were the most elaborate water infrastructures ever constructed up to that time (figure 1.7). Had they not been undertaken, it might have proved catastrophic for the rapidly growing city: in 1895, for example, a severe drought had left most storage reservoirs almost empty.

By the early twentieth century the United States was the world leader in the building of dams for water supply, power, irrigation, and the control of navigation, yet as the historian Charles Weidner remarks, "most New Yorkers were too preoccupied with their city's growth to become unduly excited about their new aqueduct."[58] The New Croton Aqueduct was soon dismissed as simply one of the city's many achievements; it could hardly compare with the grandeur of other engineering projects such as John Augustus Roebling's design for the Brooklyn Bridge, which opened to international acclaim in 1883. The reconstruction of the "invisible city"—the upstate reservoirs, the underground pipe galleries, the valve chambers and other largely hidden or distant architectural

features—could no longer capture the public imagination in the way they once had. "Municipal growth, whether slow or rapid," wrote the engineer James C. Bayles, "usually occurs by stages which are scarcely perceived, or at least scarcely realized, by citizens with whom it is a matter of daily experience."[59]

The completion of the Croton system did not solve the city's water problems. As early as the 1860s there had been fears for the safety of the city's new water system as a result of human and industrial wastes entering upstate streams and reservoirs. This marked an important advance in the epidemiological understanding of waterborne disease. In 1868, for example, Dr. Elisha Harris expressed concern over the "defilement" of the Croton system with sewage. Harris wrote widely on the subject and drew attention to the latest scientific debates in Europe and the need to disinfect drinking water by boiling.[60] A survey by the New York State Board of Health in 1884 revealed that villages, farmhouses, and mills in the Croton valley were draining their sewage directly into the river and its tributaries. As a result, the State Legislature granted the State Board of Health a series of new powers to control pollution in the city's watershed, but these proved relatively ineffective. Eventually, in 1893, new legislation was introduced that proposed to eliminate pollution by the acquisition of land along the streams of the Croton watershed. Despite contemporary descriptions of the water as turbid and strong-smelling, the city's newly established bacteriological laboratory assured the public in the early 1890s that the water presented no threat to public health.[61] But expert opinion remained divided between greater watershed protection and the early introduction of new filtration technologies. In 1894, for example, the engineer and entrepreneur Arnold Ruge lobbied the city authorities to introduce the latest French and Swiss filtration technologies on the pretext that the rich were simply buying themselves out of the problem of deteriorating water quality: "The rich in this city drink spring waters, imported from other States and even from Europe, but the masses of this City—the poorer classes—are compelled to drink unfiltered, dirty and even odoros Croton water."[62] In the event, a wide range of changes were instituted, and the construction of the more distant and higher-quality Catskill system was begun, which allowed the city to avoid any

need to filter its water supplies until the dramatic reemergence of the water quality debate in the 1990s. During the first two decades of the twentieth century the emphasis on improving or protecting water quality was advanced further with a variety of initiatives. The most significant change was the use of water chlorination from 1910, which led to a sharp fall in recorded cases of typhoid and restored public confidence in the safety of the city's water.[63]

With the rising status of engineering, planning, and other new public service professions, urban management became increasingly influenced by a technical elite devoted to the rationalization of cities. In the wake of the Chicago exposition of 1893 and new developments in city planning pioneered in Sweden, Germany, and other industrialized countries, there was a strong convergence of international technical opinion around the need for more sophisticated and scientifically based modes of urban governance.[64] By the early decades of the twentieth century engineers like George T. Hammond were celebrating their role in the "wonderful growth of the urban." For Hammond, writing in 1916, there was no doubt that engineers must play a didactic role: "We are employed by the public, not only to do their work but also to lead them in technical municipal affairs. It is our duty and province to instruct as well as serve."[65] The rationalization of urban space became a kind of Taylorization transferred from the factory to the city: the creation of a scientifically organized world where Thorstein Veblen's dream of "engineers in power" might ultimately be realized.[66] It would be misleading, however, to conceive of the growing professionalization of technical opinion as constituting an undifferentiated perspective on the future of city management: important differences existed over rival technical and organizational solutions to the management of urban space.[67] Debates over technology and urban planning are best perceived as crisscrossing a complex web of evolving interests in the context of continuing elite domination of urban politics. Tensions existed between rival fractions of capital and also between different tiers of state authority as successive political machines vied for control over urban government.[68] The 1898 merger between the five boroughs expanded the scope and responsibilities of New York City's water supply system

overnight, as the Croton system began to replace inferior alternatives such as the polluted wells of Queens, Staten Island, and the Bronx, as well as Brooklyn's surface-fed Ridgewood system based in Long Island.[69] From the 1890s onward a policy consensus gradually emerged that the Croton system could not sustain any major expansion in the future and that the only solution to the city's long-term water needs would be to use the more distant sources of the Catskill Mountains.

Urban growth instituted a brutal logic of its own which necessitated a transformation of the physical landscape over a vast area, introducing forms of strategic decision making beyond the scope of existing municipal government. An emerging political ecology of power linked the city to an ever greater swath of upstate land as part of a giant metabolic urban system. In order to begin this new phase of construction, the State Legislature created a powerful new structure in 1905 called the Board of Water Supply, which institutionalized the role of engineers in municipal government. This new body had immense powers: it could take over private land for water supply; it could work in relative autonomy from elected municipal government; and, following amendments to the state constitution, its projects were not limited in cost by the requirement to restrict bond issues to a specified percentage value of city real estate.[70] Foreign observers such as the British engineer Gilbert J. Fowler were amazed at the scale of this new undertaking:

> The world has been startled by the magnitude of your water schemes. Any European city would have regarded 114 gallons *per capita* as an extravagant allowance, yet this—which is equal to a daily supply of 500,000,000 gallons—is what is now obtained from the Croton works alone, but rather than curtail that supply, or do anything which might be interpreted to favour a limited use of water for public health purposes, the authorities determined to carry out a gigantic scheme to obtain another 500,000,000 gallons of water a day, this time from the Catskill mountains. The magnitude of

> the undertaking and the aggregate cost of bringing in 1,000,000,000 gallons per day will place New York water supply in a category by itself when a history of the world's great water works comes to be written.[71]

Before New York could commence an expansion of its water supply, however, it had to overcome what Charles Weidner describes as a "scandalous prelude" created by the attempt of the Ramapo Water Company to gain control over the water resources of the Catskill Mountains in anticipation of the city's future needs.[72] In 1895 the Ramapo Water Company had successfully lobbied the State Legislature to grant it land and water rights in the Catskill Mountains. As a result, New York City came very close to losing any control over the future design or cost of its water supply system. When the nature of the Ramapo Water Company's proposals became known, a bitter public response ensued led by City Comptroller Bird S. Coler.[73] In 1901 the State Legislature repealed the company's charter, thereby freeing the city from dependence on it for the future of its water supply. For some years, however, the company continued its attempts to overturn the decision of the State Legislature. As late as 1915, for example, the US Supreme Court dismissed a suit brought by the Ramapo Water Company that sought to prevent the construction of the Ashokan Reservoir, the first of the city's reservoirs to be constructed in the Catskill Mountains.

The first part of the Catskill system, constructed between 1907 and 1917, was far bigger than the Croton system. It includes the Ashokan, Kensico, Hill View, and Silver Lake reservoirs, as well as 126 miles of aqueduct (some 18 miles of which were bored through solid rock between 200 and 750 feet under the Harlem and East rivers and the streets of Manhattan).[74] Under the McClellan Act the city sought to acquire land without a repetition of the "rapacious proceedings" that characterized the use of land in the Croton watershed, yet bitter conflict ensued over the indirect loss of earnings from destroyed businesses and undervalued property acquisitions. The development of New York's water system led to the mass displacement and destruction of many settlements across the

city's watershed. Upstate New York experienced its own water wars to rival that of the Hetch-Hetchy and Owens valleys in California.[75] In 1908, for example, Justice A. T. Clearwater publicly reprimanded the city for the betrayal of the people of Ulster County, whose land claims had been "scoffed and sneered at, derided and belittled." In the summer of 1913 a correspondent for the *Kingston Freeman* described the disappearance of the village of West Shokan to make way for the Ashokan Reservoir: "Very few buildings are left now to be burned. The trees are all cut down and the village is fading as a dream."[76]

The Ashokan Reservoir alone covers an area of 12.8 square miles, equal to the whole of Manhattan Island below 110th Street, with a capacity of over 130 billion gallons drawn from a mountainous catchment area of 257 square miles. The Catskill Aqueduct is twice as long as the greatest Roman aqueduct, being over twice the length of the two Croton aqueducts combined, and was designed by "a corps of engineers and experts unequalled in the history of engineering."[77] In 1917 Mayor George McClellan compared the construction of the Catskill Aqueduct to that of the Panama Canal. The comparison is apposite, considering the fact that the possibilities for large-scale urban reconstruction were facilitated by growing US economic and political hegemony in central and southern America at the time (see chapter 4). Urban infrastructure provided a reliable investment for new flows of capital, and continued urban growth was in turn related to vast social and environmental transformations that extended far beyond the US frontier.[78] In October 1917 the first Catskill water reached Manhattan and this event, like the completion of the Croton Aqueduct in 1842, was marked by a three-day celebration culminating in a rapturous reception in Central Park:

> At the Sheep Fold ceremony depicting American Indian tributes to "the good gift of water" a huge chorus of children and young women sang the National Anthem and the pageant was about two-thirds through when a downpour came. Strangely the rain fell just after the medicine men of the Indian Village and the priests of the ancient Orient, in compliance with the programme, had prayed for

> rain for benefit of the crops. The prayers had no sooner been uttered than the drops of water heralded the cloudburst. The children, laughing at the coincidence, scattered in all parts of the park.[79]

Almost as soon as the Catskill system had been completed in 1927, however, it became clear that an even bigger water source would be needed for the city. During the 1920s the Board of Water Supply carried out "endless investigations" of the more distant parts of the Delaware watershed.[80] In 1930, in anticipation of the city's water needs, the state of New Jersey sought an injunction in the US Supreme Court in order to prevent New York City from taking further water from the tributaries of the Delaware River (whose water supplied the needs of many New Jersey communities). In the event, the court found in the city's favor, with a decree granting the city permission to take 440 million gallons a day from the Delaware River as it passed through New York State.[81] In 1927 the city's Board of Estimate finally approved the Delaware project and authorized the issue of $64 million worth of city bonds, but the 1929 stock market crash delayed the start of construction until 1937.[82] The first phase of the Delaware system was eventually completed with a federal loan issued under the public works program of the New Deal, but the entire project was not completed until 1967 (figures 1.8 and 1.9). It is difficult to overestimate the significance of the New Deal for the modernization of the city's infrastructure: in 1940, for example, the chairman of the New York City Planning Commission, Rexford Tugwell, estimated that New Deal-funded capital improvements amounted to double what could have been achieved without federal assistance.[83] Thus the initiation of the final stage of the city's water system was enmeshed in a wider political and economic context for public works which increased the power and scope of large-scale infrastructure projects in urban policy making.

The period from the 1880s until the 1960s saw a continuous program of dam and reservoir construction for New York City. The idea that anything might restrict or impede the preeminence of New York as a world-class city proved unthinkable, and engineers were ready to provide ever more elaborate means to slake the "thirsty metropolis."[84] It would be misleading, however, to argue that

engineers and city planners uniformly supported the logic of ever greater water use: there was a parallel ascetic discourse of disdain for the profligate use of water in the post-World War II era. The city engineer Edward J. Clark, for example, publicly derided the wastage of water by lawn sprinklers and children playing with fire hydrants.[85] The serious drought of 1949–1950 not only reinforced the urgency of the need to complete the Delaware project but also heralded intense water conservation efforts for the first time. By the early 1960s a further series of droughts necessitated the pumping of extra water from the Hudson River, and serious debate ensued over the mooted construction of nuclear-powered desalination plants as the only viable long-term water strategy for the city.[86] In the summer of 1965 the engineer Abel Wolman made a pointed contrast between the apparently drought-induced plight of New York and the increasingly sophisticated water infrastructures of semiarid southern California. Wolman railed against "delayed action and failures of management" which had led to the absurdity that while "New Yorkers were watching their emptying reservoirs and hoping for rain, Californians were busy building an aqueduct that would carry water some 440 miles."[87] For Wolman, water shortages in the modern era were the outcome of political vacillation rather than climatic perturbation.

The factors that determine the long-term viability of cities and regions rest ultimately not with natural limits, which are in any case largely culturally and technically determined, but with the strategic significance of places within a wider set of social and economic dynamics. And it is precisely this interaction between regional urban systems and the changing dynamics of capitalist urbanization that was to emerge as the key dilemma for water policy making in the 1970s. The earlier symbiosis between water scarcity and the power of engineering within urban management had become trapped within an anachronistic framework unable to grapple with newly emerging realities. We now find a shift away from preoccupations with adequate supplies toward newly emerging concerns with the safety of drinking water and the maintenance of physical infrastructure. The sense of technological and administrative omnipotence that pervaded the completion of the vast Catskill and Delaware systems had begun to fade.

1.3 URBAN DECAY AND THE HIDDEN CITY

> Space as threat, as harbinger of the unseen, operates as medical and psychical metaphor for all the possible erosions of bourgeois bodily and social well-being.
>
> —*Anthony Vidler*[88]

The creation, since the nineteenth century, of large-scale technological systems for the provision of drinking water, irrigation, and power is a pivotal element in the modern impulse to rationalize nature. The integration of the hydrological cycle into the circulatory dynamics of the modern city produced not only a material transformation in the built environment but also a symbolic landscape of political and cultural power.[89] By the late 1950s it appeared that the New York metropolitan region had "developed a kind of supremacy, in politics, in economics, and possibly even in cultural activities."[90] New urban infrastructures were an integral dimension to this hypermodernization of urban form within which speed, mobility, and economic efficiency took precedence over alternative urban visions developed around more vernacular or community-based modes of urban living. From the late 1960s onward, however, America's celebration of technical progress had begun to shift decisively away from vast civil engineering structures to new advances in electronics, computing, and bioengineering.[91] The decline of the Fordist city, with its associated regional clusters of manufacturing industries, was accompanied by a reemergence of latent contradictions within the modernization of urban space. Fears of crime and social disorder associated with the chaotic and anarchic spaces of nineteenth-century urbanism began to resurface in response to the urban crises of the late 1960s and 1970s that swept through American cities. New York began to exhibit a kind of spectral urbanism in which the ghostly traces of former cycles of investment coexisted with new cycles of investment in the built environment. A crumbling mass of infrastructure from the past encircled the new architectural symbols of the city's global preeminence. The fountains of the Kensico Dam, to the north of the city in Westchester County, for

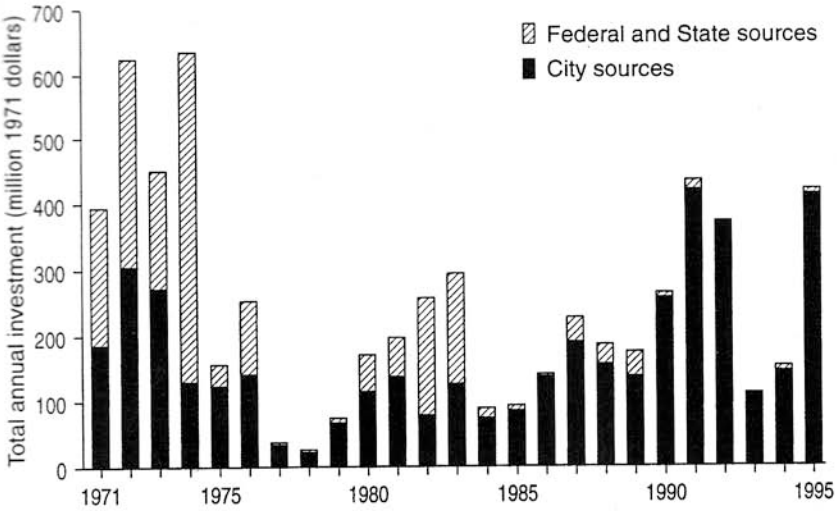
example, lay dry and neglected as a forgotten piece of the city's past, the cracked and discolored stonework covered by a patina of mold like the ruins of an ancient civilization.[92] And by 1982 the city's water commissioner, Francis X. McArdle, was warning of "decline and disintegration" for the city's water system.[93]

The shifting relationship between culture and technology in New York can be traced to identifiable changes in patterns of infrastructure investment that stem from the fluctuating economic fortunes of the city within an increasingly globalized system of capital mobility and economic production. A fundamental dynamic here is the emerging disjuncture between the mobility of capital and the extent of fixed capital represented by past investment in the built environment. In the 1830s we saw how these two dimensions were successfully combined in order to secure a degree of synergy between urban form and economic prosperity through the early development of capital markets and new administrative structures. Subsequent economic downturns in the 1850s, 1870s, and 1920s all failed to seriously undermine this relationship but led to new configurations in the role of the state for infrastructure provision in order to sustain continued urban growth. In the mid-1970s New York again faced an economic downturn. The city faced a severe fiscal crisis in 1975 derived from the cumulative impact of rapid depopulation and deindustrialization since the 1960s, which had led to a shrinking local tax base at the same time as there were demands for higher social expenditure to mitigate the social and economic impact of urban decline.[94]

The late 1960s and early 1970s saw the disintegration of any consensus over the aim and method of urban planning. This transitional period was marked by the declining power and prestige of technical and professional elites in urban government. A growing body of literature explored the hiatus between liberal and Marxian interpretations of persistent social and economic inequalities associated with the process of capitalist urbanization.[95] The perceived urban crisis of the late 1960s and 1970s shattered preconceived approaches to the management of urban space inherited from the Progressive era. The work of David Harvey, for example, provided important insights into the relationship between the partial recomposition of urban form and the spatial and sectoral switching of capital investment between different elements in the urban environment.[96] The political

and economic turmoil facing European and North American cities undermined existing conceptions of the linkages between urban form, civil society, and the technical rationalization of urban space. Under post-Fordist urbanism the secondary circuit of capital investment, which includes the built environment, had become more sharply differentiated in both spatial and sectoral terms. In the case of New York these trends have been significant in two main ways: first, there has been an ongoing crisis in the maintenance of the physical fabric of the city; and second, a decisive shift has occurred in the way capital investment is funded, with a growing dependence on socially regressive sources of revenue such as user charges. By the 1980s, however, the radical impulse behind the critique of liberal planning discourses had been supplanted by a new emphasis on the power of private capital to shape urban space. The role of planners, engineers, and public policy advocates had been increasingly eclipsed by bankers, lawyers, and bond underwriters determined to redirect urban governance toward the needs of business. The relative significance of the public city and the private city had been altered by changing patterns of investment in the built environment that have consistently favored the promotion of new opportunities for capital accumulation in the place of the now much-maligned public agenda of the New Deal era. Yet as we shall see in subsequent chapters, the public realm fostered under the New Deal was in many respects a trajectory of private aspirations that rested on sharp contradictions in the urban experience. The story of New York's water supply represents one element in this changing urban dynamic, as the existing rationale for large-scale urban policy making became progressively disengaged from the wider dynamics of urban and regional change.

The altered political and economic circumstances for urban policy making in the 1970s were to have a profound impact on urban infrastructure. In the early 1970s, in the years preceding the 1975 fiscal crisis, we find higher levels of investment than in any subsequent period, marked by a predominance of federal and New York State sources of funding (figure 1.10). The 1975 fiscal crisis brought about a virtual collapse in capital investment: the period between 1975 and 1990 effectively represented a disinvestment in physical infrastructure, with levels of expenditure falling below that required to maintain the value of the city's capital



1.10 Changing levels and sources of capital investment in the New York City water and sewer system, 1971–1995.
Source: New York City Record, New York City Office of the Comptroller and New York City Office of Management and Budget.

stock. In the wake of the 1975 fiscal crisis New York City found itself shut out of the municipal bond market. As a consequence, by the late 1970s the city was completely reliant on grants from the federal government and New York State for its capital budget.[97] The "hidden city," represented by the vast networks of pipes, tunnels, bridges, and other basic elements in an urban infrastructural palimpsest, bore the brunt of a reallocation of resources away from long-term capital investment in urban infrastructure.

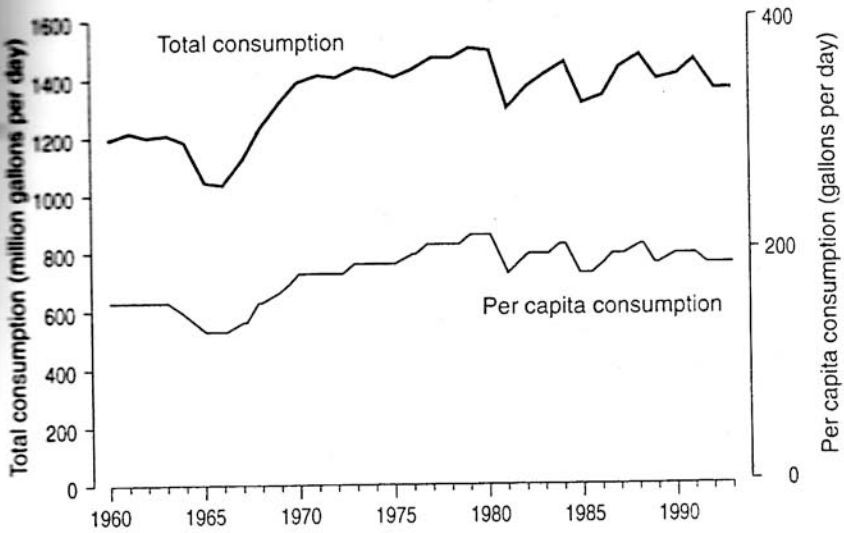
In the early 1980s there was a modest recovery aided by a new input of federal funding, but by the mid-1980s the level of capital investment had again begun to falter: between 1977 and 1985 the overall contribution of federal expenditure to the city's budget fell sharply from 19 percent to 9 percent.[98] Since the end of the 1980s there has been a major expansion in capital investment from city sources, with renewed levels of investment in the 1990s derived from a fundamental reconfiguration in the arrangements for capital funding through an increased reliance on municipal bond markets. Yet despite the increased level of capital investment, the city has still not reached the level of investment of the pre-fiscal crisis era. Furthermore, current levels of investment are not adequate to prevent a further deterioration in the city's infrastructure. The median age of water mains and sewers continues to rise, resulting in a gradual yet inexorable increase in numbers of water main breaks. Over half of the city's water mains consist of unlined cast iron laid before 1930, whereas only 9 percent are composed of more flexible ductile iron laid after 1970, which is less likely to crack under stress. By the year 2020 more than 35 percent of the city's water mains will be over 100 years old, and the city will face severe difficulty in maintaining its infrastructure without punitive increases in water and sewer fees.[99] The consequences of dilapidated infrastructure are that nearly 5 percent of the city's water supply is estimated to be lost through leaks, undermining efforts to conserve water, and the city is repeatedly faced with expensive pipe failures, in some instances involving substantial flooding of the subway system and extensive road collapses costing many millions of dollars to repair.[100]

With the sharp decline in federal and New York State funding for water supply, the city has become increasingly reliant on just two sources of money:

user charges for water and sewer services, and the issue of municipal bonds specifically for the water and sewer system. The increasing reliance on revenue financing from water and sewer fees to support capital investment mirrors similar developments in a number of larger US cities including Boston, Chicago, Philadelphia, and Detroit. Reluctance to raise property taxes since the 1970s has contributed to a rise in water and sewer fees of nearly 200 percent between 1987 and 1994.[101] By the late 1990s nearly a quarter of the city's water bills were in arrears, leading to the enactment of new regulations giving the city the right to shut off water supply to individual buildings: a threat that now hangs over much of the city's poorest multioccupancy low-income housing.[102] The background to this change can be traced to new funding arrangements set up under Mayor Edward I. Koch in 1985 with the creation of two quasi-autonomous city agencies, the New York City Municipal Water Finance Authority and the New York City Water Board, in order to relieve some pressure on the city's capital budget. The Municipal Water Finance Authority borrows money for capital projects by selling bonds backed by water and sewer fees. The Water Board then sets water and sewer rates at whatever level is necessary to pay back the bonds and run the water supply system.[103] In addition to political pressures to hold down property taxes, a number of other factors have contributed to the sharp rise in water and sewer fees since the late 1980s: the increasing costs of running the water supply system; a continued decline in federal and New York State sources of funding (especially since the election of the second Reagan administration in 1984); the unwillingness of voters to approve additional construction bond issues (epitomized by the heavily defeated proposal for an environmental bond issue in 1989); and increasing debt service on newly issued revenue bonds. In poorer parts of the city, rising water charges during the 1990s have begun to threaten the economic viability of low-cost housing in the multioccupancy private rented sector (a threat that has also been recognized in other American cities such as Denver, Detroit, and Los Angeles).[104] What is certain is that the era of cheap unlimited water use is over. In the wake of further droughts in the 1980s, and the gradual introduction of water metering since 1988, the relationship between the city and its water supply system has fundamentally altered. The prospect of a new phase of expansion in the city's

water infrastructure to tap still more remote sources in upstate New York has been tempered by a new kind of fiscal and environmental austerity in water use. Available evidence suggests that water use has indeed stabilized since the 1980s after decades of rapid growth (figure 1.11).[105]

In 1993 the city's newly elected Republican mayor, Rudolph W. Giuliani, marked a decisive move toward greater fiscal austerity and a shift toward greater reliance on the private sector for the provision of municipal services. Within two years Giuliani announced his intention to sell off the entire water system to the New York City Water Board, which currently leases the system from the city. Giuliani argued that this transaction would allow the city to do a number of things: pay off old bonds (to allow new borrowing); write off unrecoverable taxes; and release $1 billion over the next four years for urgent capital projects, enabling the city to exceed its current borrowing limit. The Water Board would fund the sale by issuing $2.5 billion in new water and sewer bonds with a debt service of some $2 billion, equivalent to around $65 million a year over a 30-year period. Giuliani's proposed sale of the water system led to fierce competition among Wall Street bond underwriters to win the $1.5 million in fees for managing the sale of the city's water assets.[106] However, this attempt to find a short-term solution to the city's budget deficit was blocked by City Comptroller Alan Hevesi, thereby exposing deep divisions in city water policy. Comptroller Hevesi castigated the proposed sale of valuable city assets in order to reduce the current budget deficit as a "fiscal gimmick" with deleterious long-term consequences for the city.[107] Hevesi argued that the loss of the water and sewer system would accelerate the erosion of the city's control of its watershed, making it easier for the state governor to change the composition of the city's Water Board in favor of upstate development interests (the seven members are currently appointed by the city's mayor). A succession of legal battles upheld these concerns and ruled against Giuliani, in a significant reverse for the neoliberal impetus toward the privatization of public services in American cities.[108] As a consequence of these political struggles over the control of public assets, the New York water system has emerged as a significant bulwark for the continuing importance of democratic accountability and regional coordination in the delivery of public services.



1.11 Changing levels of citywide and per capita water consumption in New York, 1960–1993.
Source: New York City Department of City Planning, with additional data adapted from R. Cropf, "Water Resources," in C. Brecher and R. D. Horton, eds., *Setting Municipal Priorities 1990* (London and New York: New York University Press, 1989), pp. 173–197.

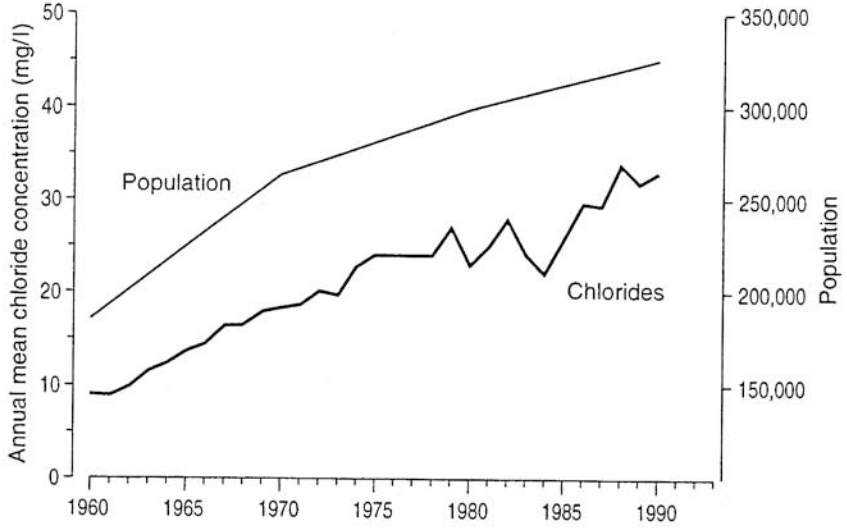
1.4 PARANOID URBANISM

> The disconnection from our places of service is furthered by growing doubts about the sustainability of America's technological achievements. Our water, which we once saluted for its unrivalled purity and propitiated with splendid water towers and graceful dams, now seems to contain the specter of lurking microbes and toxins.
>
> —*Thomas H. Garver*[109]

The maintenance of physical infrastructure represents only one side to the city's water crisis. The other dimension is provided by declining public confidence in the safety of the drinking water: a situation unprecedented since the typhoid scares of the prechlorination era in the early twentieth century. By the early 1990s the safety of New York water had become the most contentious environmental issue in the city. In the early 1960s, by contrast, commentators on the extension of the Delaware system, then under construction, had actually suggested that the quality of water from the new Cannonsville Reservoir was "uneconomically" good: it was argued that the city should have looked to cheaper but inferior sources such as filtered water from the Hudson River.[110] The most distinctive feature of New York's water supply system over the last century has been the extraordinarily high quality of its unfiltered mountain water. In November 1991, for example, a *New York Times* article eulogized the city's water as a "great municipal blessing" and proudly noted that Fortnum and Mason's tea department in London would use only the purest water available: New York tap water.[111] A few days later, however, an irate letter to the editor of the *New York Times* from Assemblyman John Ravitz sought to draw public attention to dangerously low reservoir levels and a significant decline in the quality of the older Croton water system.[112] When the water supply system was originally constructed the city's watershed was remote and sparsely populated, but upstate development pressures have now thrown the long-term security of the city's water system into doubt. Water quality in the Croton system nearest to the city, which supplies around 10 percent of

the city's water, has been steadily deteriorating since the early 1960s.[113] The concentration of the indicator pollutant chloride has risen from 8.8 mg/l in 1960 to 33.2 mg/l in 1990, an increase of 265 percent, in comparison with average concentrations of 8.5 mg/l in 1990 in the more distant and sparsely populated Catskill-Delaware system (figure 1.12).[114] Another key indicator of declining water quality is the presence of the fecal coliform bacterium *Escherichia coli,* which was detected in the summer of 1993 in the Chelsea and Lower East Side districts of Manhattan served by part of the Croton system. In the ensuing public health alert the city advised households in affected areas of the city to boil their water, which was accompanied by a sharp rise in sales of bottled water across the city as a whole (figure 1.13).[115]

Bottled water consumption in New York City has grown rapidly in response to skillful marketing of mineral waters as part of the rise of "health consumerism" coupled with increased anxiety over water quality in the 1990s.[116] But these trends are not explicable simply in terms of elite marketing: water quality has entered the wider arena of risk and uncertainty in public policy making, in consequence of an erosion of trust between citizens and the executive authorities of the state.[117] The very idea of safe public water supply has become a fantastical notion in the popular imagination. Sales of bottled water across the US have tripled during the 1990s despite evidence that public supplies are often of superior quality. Indeed, New York saw one of the fastest-growing markets for bottled water *before* the public health alerts of the 1990s.[118] We can identify a connection here in which the development pressures in the city's watershed lead to declining water quality while the polarization of incomes and lifestyles contribute to the increased consumption of elite consumer goods. A degraded public water supply system now operates in combination with increasing access to private sources of drinking water by the better-off, in a dangerous reversion to nineteenth-century patterns of service provision. The increasing use of bottled water by the rich also presents a bizarre inversion of the contemporary picture in developing countries, where the poor rely on expensive water vendors whereas the middle classes are connected to cheaper sources of piped water.



1.12 Changes in mean annual chloride concentration and population in the Croton watershed, 1960–1990.
Source: New York City Department of Environmental Protection.

1.13 The Giuliani administration has been periodically overwhelmed by the city's water crisis (*Village Voice*, 11 July 1995).
Source: Courtesy of Steve Brodner.

The most immediate problem facing New York's water quality has been quite specific: it is only in the smaller Croton system that a measurable deterioration in water quality has actually presented any threat to public health. Nine of the Croton system's 12 reservoirs are now overloaded with phosphates from inadequate sewer systems, and since 1990 the entire Croton system has been repeatedly closed due to summer algal growth.[119] Nonepidemic strains of cholera, as well as *Giardia* and *Cryptosporidium,* have also been detected in the city's reservoirs. Yet the picture of declining water quality is not as straightforward as it may appear: the increasing sophistication of environmental monitoring over the last twenty years has revealed the extent of previously undetected and largely unknown threats to public health such as new chemical compounds, *Cryptosporidium,* and other pathogenic organisms at the limit of detection.[120] The threat of *Cryptosporidium* raises three particularly perplexing issues for environmental regulation: the health uncertainties form part of a wider sense of public unease with the regulatory capacities of modern government; the risk lies at the edge of scientific knowledge (the organism was not recognized as a cause of human disease before the mid-1970s); and the contamination cannot be simply prevented by technological means through the filtering of public water supplies (as the Milwaukee outbreak of 1994 revealed).[121] The complexity of environmental regulation has also been intensified by the proliferation of so-called non-point sources of pollution, making individual polluters much harder to identify.

The background to the current escalation in political conflict over water quality can be traced to a tightening of federal water quality standards since 1989. As a result of these new standards the federal Environmental Protection Agency issued the city a deadline to prevent further deterioration in water quality for the Catskill-Delaware system by 2002 or be forced to undertake a massive program of filtration, at a cost of some $8 billion for the entire water supply.[122] Major engineering companies have been lobbying for this lucrative contract, which marks, for the private sector, a significant extension to potential investment opportunities in municipal service provision.[123] The new federal demands for technological improvements to water infrastructure have contributed to a market-led process of

"ecological modernization" in which increasingly large shares of the city's capital budget are devoted to meeting ever higher environmental standards. The combination of higher charges with the extension of water metering to the poorest parts of the city is set to exacerbate the socially regressive impact of new patterns of capital investment, and even environmentalists have balked at the scale of this expenditure which threatens to undermine public support for environmental quality.[124]

The dilemma facing the city is whether filtration can be avoided for the Catskill-Delaware system without undermining regional development for some of the poorest communities in upstate New York.[125] As for the smaller Croton watershed to the east of the Hudson River, the political prospects of regulating what is now an affluent commuter belt have steadily deteriorated, with new pro-development groups emerging such as the Alliance for Watershed and Water Development that seek an end to current watershed regulations and promote filtration for the city's water.[126] Putnam County, located just 30 miles north of the city in the heart of the Croton watershed, is now the fastest-growing county in the state, with a stream of new developments under way for luxury homes, golf courses, offices, hotels, and shopping malls.[127] A number of these pro-development groups have been revealed to be significant contributors to the 1994 election campaign fund of Governor George Pataki, who has emerged as the most powerful political player in the drafting of new regulations for development in the city's watershed.[128] Although the battle to protect water quality in the Croton watershed has now almost certainly been lost, the future of the other 90 percent of the city's water system remains open to question. The water quality chemist Gerald Iwan, taking a historical view of developments, argues that the city faces a stark choice between "a future of complete dependence on treatment technology and associated economic and technical responsibilities of unimaginable magnitude" or a policy of enhanced watershed protection in order to maintain "cost-effective, high-quality drinking water without the complexities of superfluous treatment technology and source quality degradation."[129] The future of the city's water supply presents a microcosm of the whole gamut of challenges facing the future of environmental regulation given the declining significance of municipal

governance in urban planning. The choice among different options remains delicately balanced, and as the city's power to shape developments has waned a new phase in the political ecology of urban water supply has begun to emerge.

The 1990s have seen an intensification of efforts by the city to protect its water supply, but the logistical problems are formidable. The watershed police—a designated branch of the New York City Police Department—were originally set up to protect upstate communities from workers involved in the construction of the city's water system and to prevent damage to city-owned property. Only during wartime, in response to fears of sabotage, have there ever been extensive efforts to guard the whole of the city's upstate network of aqueducts, dams, and reservoirs. For much of the postwar period, only a handful of police officers have been assigned to protect 2,000 square miles of watershed from many thousands of potential sources of pollution (figure 1.14).[130] There is a long-standing sense of regulatory ineffectiveness: the thirty-year period from 1960 to 1990 saw no prosecutions of water polluters despite evidence of declining water quality.[131] The lack of effective regulation in the city's watershed can be attributed to an ethos of regulatory laissez-faire shared by city-based engineers and upstate development interests.[132] Studies of environmental regulation have often revealed how technological solutions are favored by business interests and government agencies alike because they avoid reliance on politically contentious attempts to control individual polluters. And it is this question of the appropriate extent of urban authority over rural land use that is now at the heart of the regulatory dilemma facing the future of the city's water supply system.

The year 1990 saw the first efforts to revise the city's watershed rules since 1953. These new watershed protection rules address more recent threats such as pesticides, herbicides, and other toxins absent from the earlier regulations. However, the new watershed protection rules have been greatly weakened under political pressure from upstate interests and the Republican-controlled New York State Senate in Albany. A particular barrier to effective regulation of water quality is that the city owns less than four percent of the land in its watershed, far lower than the rate for other US cities such as Boston and Portland, Oregon, for example, which also rely on unfiltered water supplies.[133] The 1993 proposal by the city

to buy 80,000 more acres of watershed land has run into repeated political and fiscal obstacles. The period since 1993 has seen a stark polarization between city and upstate interests, with the perceived regulatory interference in the watershed being met by a growing mobilization of property rights activists (with links to well-established groups in the Adirondack Mountains further north) and increasingly sophisticated antiregulation lobbies such as the Coalition of Watershed Towns. The possibilities for environmental regulation have been undermined by a deep-rooted ideological and cultural divide between urban environmental activists and rural upstate communities resenting outside interference in land use planning. Since the early 1990s the regulatory role of city and state authorities has come under sustained political attack from upstate communities and development interests in the watershed who demand less regulation, and also from the increasingly well-organized and vociferous city-based environmental groups who demand greater regulation and control of the city's watershed.

Under the watershed protection plan of 1997, the city has been forced to finance extensive economic development programs for the watershed communities over a period of fifteen years in exchange for greater cooperation in the prevention of water pollution. A different pattern of environmental regulation has emerged with the creation of novel institutional structures such as the Catskill Watershed Corporation and the Watershed Protection and Partnership Council, representing both city and upstate interests. In the place of a relatively centralized, ossified, and nonparticipatory regulatory system, the watershed is now overseen by a complex and dynamic jigsaw puzzle of different interest groups ranging from upstate lumber companies to city-based ecologists.[134] Yet behind this apparent opening out of environmental policy making, a more fundamental shift has occurred: the city has found its power diminished in relation to a broad coalition of forces ranging from agricultural interests to speculative real estate with a common interest in relaxing land use controls across the city's watershed. The diverse fractions of capital represented in the Watershed Protection and Partnership Council have successfully coalesced around a regional antiregulatory agenda capable of dominating political debate over the future of the city's water supply. New pat-

terms of governance at a regional level have led to a historical shift in power away from the city-based traditions rooted in the municipal managerialist approaches of the past, with the regional dimensions to regulatory planning now extensively challenged by the upsurge of grassroots property rights activism. A variety of piecemeal and experimental interventions have emerged from the disintegration of a relatively stable mode of environmental regulation that had dominated regional water resources management since the nineteenth century. By 1999 there were already signs that the new watershed agreement had come under strain, with a further relaxation of controls on the use of crucial wetlands that act as natural buffers to minimize the contamination of streams and rivers. Powerful upstate real estate developers had also begun to mount a series of legal challenges to the new watershed protection rules using nineteenth-century state property laws. By the spring of 2000 the city had managed to acquire just 17 acres out of the 1,000 acres identified around the Kensico Reservoir in the heart of the fast-growing White Plains region as crucial for the protection of the water supply en route to the city.[135]

At the beginning of the twenty-first century the city is faced with an intensifying conflict between the short-term profitability of capital speculation and the long-term ecological viability of its watershed. The protracted negotiations between the city and its rural watershed in the context of global forces affecting the fiscal and political autonomy of the city reflect a new complexity in the political dynamics of urban water supply. It is now widely acknowledged that technocratic approaches to urban management, which reached their zenith in the late 1950s and 1960s, could never satisfactorily handle the complexity of democratic public participation. Yet the emergence of new institutional structures has become dangerously dislocated from the core decision-making processes that shape the development of urban space. In effect, wider public participation in decision making has been chimerical because legislative and regulatory agendas continue to shore up the regional needs of political and economic elites, as reflected in the growing power of upstate development interests over weakened urban government.

1.5 HYDROLOGICAL TRANSFORMATIONS

The water supply of New York has passed through a series of transformations since the early seventeenth century. The first period, lasting from the founding of the original settlement in 1626 until 1658, was marked by a reliance on natural water sources and private wells. A second phase, from 1658 until 1774, saw an expanding network of public wells within a context of steadily declining water quality. A third interval, from 1774 to 1830, was dominated by a series of ill-fated private interventions including the role of the infamous Manhattan Company. This chaotic urban scene was characterized by repeated outbreaks of disease, uncontrollable fires, and escalating economic disruption. A fourth phase, from 1837 to 1911, saw the construction and expansion of the Croton system as the city's first comprehensive public water supply. The modernization of the city's water system was marked by a series of advances spanning the bacteriological, technical, and administrative dimensions to water resources management, which mirrored developments elsewhere in Europe and North America at this time. A fifth period, between 1907 and 1967, marked the completion of the Catskill-Delaware system and an expanded role for municipal government in the management of regional water resources. This was the zenith of the technical management of urban space, with maximum power and autonomy for government agencies reached under the New Deal era. The most recent phase, extending from the late 1960s until the present time, has been characterized by a series of complex challenges to existing patterns of water provision. Regional economic change and new patterns of sociospatial restructuring have contributed to the emergence of a series of major policy dilemmas in the fields of capital investment and water quality.

The period between the completion of the Croton Aqueduct in 1842 and the city's fiscal crisis of 1975 marks a phase of remarkable stability in the history of New York's water supply. The nineteenth century saw a decisive shift from private to public water provision in order to allow new levels of efficiency and coordination. A series of tensions were played out not only between public and private interests but also among disparate bodies of technical expertise and rival political machines. During the twentieth century some of these disputes were re-

solved with a move toward the greater consolidation of fragmentary interventions to form powerful regional systems of management and control. This implied a partial waning of local democratic input, as technical elites emerged to design and operate vast public works systems. The creation of semiautonomous government structures fiscally and politically insulated from local electorates marks a smaller-scale precursor to the powerful regionally based federal agencies of the New Deal such as the Tennessee Valley Authority. The dams, reservoirs, and other large-scale infrastructure projects of the New Deal era have been widely interpreted as the epitome of American modernism. The combination of a utilitarian aesthetic in the International Style with a functional commitment to the rationalization of regional water resources became a symbol of a new kind of public landscape. These "democratic pyramids," to use Lewis Mumford's phrase, represent a unique conjunction of technology, nature, and public policy making, but their physical longevity belies the fragility of the cultural and political circumstances that facilitated their construction.[136] With the fading of the New Deal ethos in the 1970s, a new set of political, economic, and cultural developments began to shape the evolution of regional water policy. Recent changes are distinctive in a number of respects: the emergence of new sources of environmental risk such as cryptosporidiosis; the development of greater degrees of public skepticism toward technical and scientific expertise; the weakening of city power in relation to regional political developments; and above all, the intensity of the neoliberal challenge to the fiscal autonomy and ideological legitimacy of an effectively regulated and adequately funded public water system.

For over 140 years New York City successfully provided cheap, plentiful, and high-quality water to its citizens, on the basis of a settled relationship between water technologies and the "democratic urban landscape"; yet this historic achievement is now thrown into doubt by a series of political and economic developments beyond the reach of any regulatory or democratic structures yet devised. Some urban scholars have argued that social and economic developments since the 1970s have lessened any technical link between capital and urban form: the connection between urban morphology and economic function has become weakened.[137] In the case of water supply, however,

this claim is problematic because of the continuing functional dimensions to urban space. The ongoing construction of the city's third water tunnel, for example, suggests that the material determinants of urban form may conform to a deeper logic than the more ephemeral political and cultural shifts surrounding the construction and design of real estate and other speculative elements in the built environment. Still, even if the technical dimensions to the design of urban space retain a high degree of continuity, the pressures to transfer public assets into the private sector have become immense.

During the 1990s the privatization of urban water systems gathered global momentum. In 1997, for example, the *Financial Times* proclaimed, "Water is the last frontier in privatisation around the world."[138] The sale of public water systems not only flows from the fiscal weakness of municipal authorities worldwide but has also been pushed by national governments in order to bolster foreign currency reserves and find favor with international financial institutions. The global marketization of water has not been without high-profile protests, as grassroots campaigns in Argentina (Tucumán province), Bolivia (La Paz and El Alto), Manila, and Barcelona attest.[139] While the New York case did not lead to mass protests, there is little doubt that the city's water supply has been politicized to a greater degree than at any time since the failure of the Manhattan Company in the early nineteenth century. What we are seeing in New York is a protracted process of reshaping the role of the municipal government in urban water supply. In effect, a hollowing out of government arising from a combination of fiscal and ideological pressures is leading to a polarization in the public policy debate between demands for water quality protection, advanced principally by urban environmentalists, and a coalition of antiregulation upstate interests, whose rhetoric is rooted in a legacy of land use conflict in the city's watershed.[140] The future form of environmental management is emerging as a politically contested reconfiguration of public policy, in this instance centered on a redefinition of the administrative powers of city government. At the heart of the debate over environmental management in the city lies a tension between market-led development pressures and the administrative jurisdiction of municipal authorities. The blocked sale of the city's water system in 1997 suggests that a stable new configuration of power

between capital and municipal governance has yet to be determined. Beyond the international political and economic exigencies that have driven recent developments in water policy, there is still considerable scope for contestation and debate. If filtration of the city's entire water system does eventually occur at some point in the twenty-first century, historians of the future may well comment on the remarkable persistence of this particular fragment of engineered nature.

The extensive dam- and reservoir-building program undertaken by New York City caused wide-ranging disruption to the communities of the Croton and Catskill watersheds, yet the extending ecological frontier of the city enabled a new kind of mediation between nature and society that was of inestimable benefit to millions of people. Municipal-led policy interventions under the auspices of technological modernism have often had deleterious environmental consequences, as the highway-spliced inner-city neighborhoods of postwar New York attest (see chapter 3). Yet to dispense with the role of government altogether as part of an ecological critique of the institutional basis to Western modernity risks the effective abandonment of any practical means for implementing environmental regulation. This political and ecological dilemma is heightened by the global dimensions to environmental change, which are driven by the relative absence of any form of effective international economic regulation in the face of unprecedented capital mobility. The fact that global climate change may affect the hydrological conditions for New York's water supply in the future illustrates this profound uncertainty.[141]

Some recent critical interventions under the auspices of the postmodernity debate have tended to denigrate or least display profound ambivalence toward the regulatory role of government in modern societies. The demise of the nation-state is both predicted and welcomed as part of a new fluidity in cultural and economic life. "On the ethical front," writes the anthropologist Arjun Appadurai, "I am increasingly inclined to see most modern governmental apparatuses as inclined to self-perpetuation, bloat, violence, and corruption."[142] This kind of anti-statist or even conspiratorial sentiment is a recurring motif in environmental histories that are critical of urban demands on rural water resources. In an American context, for example, the water wars of the Midwest and southern California

have proved a fertile ground for what we might term antimodern interpretations of large-scale state-directed water projects.[143] What is often missing from these accounts, however, is a fuller picture of the impact of the modernization of water infrastructures on the everyday lives of urban citizens. The provision of water remains a collective service, even if the public-private distinction has become sharper in recent years and even if the very word "public" misleadingly elides dominant economic, political, and cultural developments to the exclusion of more marginal voices. Water is a collectivity in a metabolic sense because urban life depends on its supply, but decisions over water policy have never been open to much in the way of public deliberation or debate. The most promising solution to environmental degradation may lie in the development of a more sophisticated public sphere through which new forms of democratic decision making can emerge in preference to any lurch toward the ecological Hobbesianism of greater control, which may prove in any case to be fiscally and ideologically untenable.

The role of strong advocacy groups and an informed and active citizenry emerge as crucial in any effort to protect the environmental advances of the past. Yet the post-New Deal environmentalist agenda harbors innate weaknesses: its individualist and consumer rights-based orientation serves to deflect attention from more widely conceived regulatory goals in the public interest which extend to the sphere of production as well as consumption (a dilemma we return to in chapter 5). Similarly, the degree of indifference on the part of city-based water quality advocacy groups to the economic viability of low-income upstate rural communities is testament to wider class-based tensions in the American environmental movement, which serve to strengthen the hand of capital in the dismantling of the public sphere. This political dilemma is heightened by the socially regressive consequences of market-led ecological modernization, epitomized by spiraling water charges, that threaten to fragment the political strength of any cross-class environmental alliances in the city.

This chapter has explored the evolving interaction between water and the dynamics of capitalist urbanization. We have seen how the creation of urban infrastructure has been essential to the economic viability of New York City and at the same time has fostered possibilities for new kinds of mediations between na-

ture and society. The period from the 1840s until the 1970s marked a *longue durée* in the history of the city's water marked by a high degree of political and organizational continuity in spite of rapid urban growth and far-reaching technological change. The partial unraveling of existing relationships between water and urban form since the 1970s reveals the fragile and contradictory dimensions to the built environment within the ongoing process of capitalist urbanization. A precarious balance among disparate political, economic, and cultural understandings of urban water supply systems has begun to disintegrate. The creation of metropolitan nature necessitated immense technical and organizational ingenuity in order to link the hydrological cycle of upstate New York to a multiplicity of private spaces within the city. The experience of the last twenty years has revealed how the prospect of a disintegrating and contaminated water system has exposed deep anxieties over the state of the public realm.