The Place of the City in Environmental History

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In the last fifteen years or so, the study of urban environmental history has led to an outpouring of valuable research. Many books and articles have appeared on topics such as building technology, public works and infrastructure, environmental services, parks and greenspace, pollution and public health, energy, environmental reform and regulation, and municipal engineering. The volume of work is gratifying and adds considerably to pioneering research dating back to the 1960s, including Lewis Mumford's sweeping *The City in History* (New York, 1961), Sam Bass Warner, Jr.'s classic case study *Streetcar Suburbs* (Cambridge, MA, 1962), Carl Condit's *American Building Art* 2v. (Chicago, 1960, 1961), Nelson Blake's seminal *Water for the Cities* (Syracuse, 1956), geographer Allan R. Pred's *The Spatial Dynamics of U.S. Urban-Industrial Growth* (Cambridge, MA, 1966), John W. Reps' *The Making of Urban America* (Princeton, 1965), Roy Lubove's *Twentieth-Century Pittsburgh* (New York, 1969), Charles S. Rosenberg's *The Cholera*

Years (Chicago, 1962), and John Duffy's *A History of Public Health in New York City, 1625-1866* (New York, 1968).

For Joel A. Tarr, the leading figure in the field since the 1970s, urban environmental history is "primarily the story of how man-built or anthropogenic structures ("built environment") and technologies shape and alter the natural environment of the urban site with consequent feedback to the city itself and its populations."[1]

I would prefer a slightly broader definition in which the physical features and resources of urban sites (and regions) influence and are shaped by natural forces, growth, spatial change and development, and human action. Thus the field combines the study of the natural history of the city with the history of city building and their possible intersections.

In practice, however, urban environmental history has yet to meet the expectations of such sweeping definitions and suffers from three elemental weaknesses:

(1) The place of the city in environmental history remains largely ill-defined. The study of the urban environment has not so much been pushed to the periphery of environmental history as never truly absorbed—appended rather than integrated. Studies focused on the role of humans in the natural world rarely confront or encompass the city. For the most part, the study of the urban environment remains in the realms of urban history and the history of technology.

(2) Urban environmental history has broadened our empirical knowledge base about cities, but often suffers from limited grounding in theory. Some historical studies—but not enough—have drawn intellectual sustenance from the field of urban ecology as developed by sociologists and geographers in the early- to mid-twentieth century.

(3) The primary focus of much of the existing research has been internalist, that is, narrow and empirical rather than broad and theoretical in nature, with more attention devoted to how cities function rather than how they grow and what role cities play within the larger matrix of the physical environment.

The City and Environmental History

There is no doubt that urban historians must take a large part of the responsibility for not defining cities in adequate environmental terms or for not placing the built environment within the larger framework of the physical world. But at the same time, historians interested primarily in nature—and the place of humans in it—have often shunned the city or marginalized it in their studies.[2] A Round Table

on Environmental History in the March 1990 issue of the *Journal of American History* virtually ignored the urban environment, focusing on Donald Worster's "agroecological" perspective and responses to it, ecology, gender, culture, and "firestick" history. Those unfamiliar with Environmental History will benefit from the essays in the Round Table because they point out how intellectually exciting this field is and can become. However, while the participants[3] must be given credit for the difficult task of trying to establish definitional borders for a field which is potentially so expansive and amorphous, I hope that historians do not assume that the parameters of the field are now firmly set.

In an appendix to the anthology *The Ends of the Earth: Perspectives on Modern Environmental History* (New York, 1988), Donald Worster presented "Doing Environmental History," which in large part is a version of "Transformation of the Earth: Toward an Agroecological Perspective in History" that appeared in the *Journal of American History* Round Table discussion.[4] In attempting to develop a broad, but focused definition for the field of environmental history, Worster stated that "...environmental history is about the role and place of nature in human life." Nature is understood as the nonhuman world, "the world we have not in any primary sense created." In this definition he excluded the social environment—"the scene of humans interacting only with each other in the absence of nature"—and the built or artifactual environment—"the cluster of things that people have made and which can be so pervasive as to constitute a kind of 'second nature' around them." [5]

Admitting that the latter exclusion "may seem especially arbitrary," Worster made it just the same. He attempted to distinguish between the natural and the built environment "for it reminds us that there are different forces at work in the world and not all of them emanate from humans..." While the differentiation between the natural and the human-made is a long-standing motif, Worster justified the exclusion of the built environment from his definition of environmental history by arguing that "the built environment is wholly expressive of culture; its study is already well advanced in the history of architecture, technology, and the city" and concluded that "when we step beyond the self-reflecting world of humankind to encounter the nonhuman sphere, environmental history finds its main theme of study."[6]

Such a definition of environmental history makes several assumptions. First, it does not account for the generations-old debate about the nature of cities within an environmental context. Australian

historian Graeme Davison has written widely about the city as a natural system. As he stated:

> Few ideas have exercised as powerful an influence upon students of urban society as the organic or biological conception of the city. From Aristotle's *Politics* to the Chicago School and beyond, social theorists have likened cities to bodies or organisms; dissected them into constituent organs, such as 'heart,' 'lungs' and 'arteries'; and charted their growth and decay. These metaphors reflect a long-standing conflict in western thought. On the one hand, cities were exalted as the intelligent creation of civilized man and were sharply distinguished from the products of unreflective nature. Yet they also manifested an astonishing order within their vast complexity, and demonstrated a capacity for growth and self-regulation that resembled the working of nature itself. Akin to nature, cities nevertheless stood apart from nature, and so reflected man's own ambiguous relationship to the natural order. From time to time, the balance between these ideas—the city as man-made; the city as natural—has shifted back and forth in response to changing experiences of urban life and changing assumptions about man and his place in nature.[7]

Worster clearly falls into the camp of the city as human-made, and his "natural world" is incredibly pristine since "the role and place of nature in human life" is restricted to a limited range of experiences. For example, how can we justify as part of the *main* theme of environmental history the study of human intrusion in the natural world in the form of farming, and not in the building of a town or city? In a larger sense, how can we understand "the role and place of nature in human life" if we create an artificial physical environment devoid of human communities—including cities? Humans have not simply encountered nature as individuals, but as parts of groups, and if not in cities then in towns and villages or as members of nomadic clans regularly setting up and breaking down camps. And finally, while the built environment is expressive of culture, it is not *wholly* expressive of culture, since upon its creation it is part of the physical world, and whether we like it or not, interacts and sometimes blends with the natural world.

Excluding cities from the *main* theme of environmental history seems to be more of a rhetorical device than a well-crafted definition. From the vantage point of human history, isolating the "natural world"

in such an unnatural way denies the powerful holistic quality of environmental history which demands inclusion more than exclusion, no matter if it is "well advanced in the history of architecture, technology, and the city."

However, a simple modification of Worster's definition of environmental history—but more inclusive—would seem to satisfy many of the concerns stated above: "Environmental history is about the role and place of *the physical environment* in human life." The city has a place in such a definition, and as such reflects more accurately, I would argue, the essence of the field.

Social Science Theory and the Urban Environment

Rarely have historians attempted to confront the city in broad environmental terms as a way of setting context for their work or, for that matter, of shaping an incisive definition of urban environmental history. I would not deny the value of 'plowing the furrow' to produce empirically sound monographs on important topics. But in order to bring the city squarely into the *main* discourse of environmental history a broader intellectual foundation needs to be built. Fashioning macro-environmental theory to do so may be pretentious—or at least unwieldy—but deeper examination of the concepts pioneered by sociologists, geographers, and other social scientists—as William Cronon has done so expertly in *Nature's Metropolis: Chicago and the Great West* (New York, 1991)—may help to establish some useful constructs for expanding our thinking about the urban environment. Just as ecological science has influenced the study of environmental history in general, urban ecology can more deeply influence the study of the city.[8]

In a discussion several years ago about the nature of cities, Joel Tarr admonished me by saying, "Melosi, cities are not trees." But despite the remonstrance, the notion of cities as natural environments is worth exploring—even if the organic theory is vastly overstated—for no other reason than it helps us to reflect upon what place cities occupy in the physical world.

According to Graeme Davison, the idea of the city as a natural system "became the dominant paradigm among the first generation of middle-class urban investigators" (in Great Britain at least) in the late-eighteenth and early-nineteenth centuries. On one level, it reinforced the theories of laissez-faire economists and natural historians—"the chief ideologists of the commercial middle class;"

and on another it "endorsed the technocratic professionalism of sanitarians and other reformers" of a Malthusian bent.[9]

While it never gained universal appeal, the idea of the city as a natural system created graphic biological metaphors relating the structure and operation of the city to that of the human body. Such an organic theory had obvious flaws and was unfairly put to the uses of certain class interests, but it did elicit powerful images of community interdependency and the rational functioning of the city's many components.

The organic theory has found its proponents even in more modern times. In *The Urban Organism*, Spenser W. Havlick argued that a city or town is "a transformed combination of resources [land, water, air, mineral and human]" and that the major goal of urbanization is "to convert the resource base into cities." The result is the city as "a second order resource" which provides benefits to the urbanites themselves and to the region and the nation.[10]

Sociologist David Harvey agreed that an urban system is "a giant man-made resource system." Applying Marxian theory, he refined that concept by suggesting that "The growth of this man-made resource system involves the structuring and differentiation of space through the distribution of fixed capital investments."[11]

At the heart of both Havlick's and Harvey's definitions is not so much a natural environment akin to other natural systems but a construct dependent on reordering of natural resources to form a new order. While this argument goes well beyond some basic assumptions of the city as a natural system, it continues to embrace the organic nature of cities nonetheless.

City and Regional Planning professor Manuel Castells—like Harvey—placed more emphasis on human action in structuring cities, but also perceived cities as dynamic rather than static: "Cities are living systems, made, transformed and experienced by people. Urban forms and functions are produced and managed by the interaction between space and society, that is by the historical relationship between human consciousness, matter, energy and information."[12]

Ascribing to the urbanization process a defining term normally limited to natural phenomena, geographers Thomas R. Detwyler and Melvin G. Marcus viewed the city as "a relatively new kind of ecosystem on the face of the earth." Their new ecosystem has limits, however. It is an "open system"—not self-contained, not functioning independently or in isolation from the rest of the world.[13] In this usage, "ecosystem" has some descriptive power without attempting to create a strict biological model.

The views of Havlick, Harvey, Castells, and Detwyler and Marcus are all modifications of the organic theory, but still rooted in it. While the notion of a city as a human body analog is not persuasive, the idea of the city as animate—if not "natural" in the strictest sense—is essential for an understanding of urban growth and development. Cities are not static backdrops for human action, nor are they organic metaphors, but ever-mutating systems as the studies above suggest.[14]

Cities are also major modifiers of the physical environment. "Their existence," geographer Ronald J. Johnston noted, "can influence the course of basic physical processes, such as the hydraulic cycle."[15] Urbanization removes much of the filtering capacity of soil and rapidly channels precipitation into available watercourses, thus encouraging flooding. City building affects the atmosphere by increasing air-borne pollutants and also creating "heat islands" where temperatures are greater than the surrounding area. Various urban activities produce huge volumes of waste products which require complex disposal mechanisms.[16] As Detwyler and Marcus concluded, "Unfortunately, the urban ecosystem seldom treats air and water resources by riparian standards; that is, they are not returned to the ecosphere in the same condition in which they were received."[17]

Alternatively, cities have the capacity—when properly designed—to use resources more efficiently than highly decentralized populations. Concentration can be an advantage in providing services, offering social and cultural opportunities, and producing and distributing goods.

Given the contrasting perspectives on the city, a fundamental question remains: As a form of human and technological intrusion, how do we gauge the impact of city building on its surroundings? And of what significance is that to the contact of humans with the natural world?

In an attempt to understand the broad features of the urban environment, sociologists and geographers in particular, have sought to develop theories of urban ecology. The theoretical origins of the ecological approach to studying spatial and social organization can be traced to nineteenth century concepts and principles conceived by plant and animal ecologists. Urban sociology, however, was born at the University of Chicago during World War I under the leadership of Robert E. Park and Ernest Burgess and strongly influenced both sociology and geography.[18] Some refer to the Chicago School as the "subsocial school," because, as Gideon Sjoberg stated, its members had been intent upon "studying man in his temporal and spatial dimensions and explaining the resulting patterns in terms of subsocial

variables." The fundamental subsocial variable was "impersonal competition," a concept borrowed from nineteenth-century Social Darwinism and classical economics, which emphasized laissez-faire doctrine and the operation of the marketplace. Those committed to the ecological perspective of the Chicago School concentrated on factors determining urban spatial patterns and the social impact of these patterns. In this context, the spatial arrangement of cities was dependent on competitive economic and social forces. Variables such as family types and social status and problems such as crime and alcoholism, they argued, have spatial configurations within cities.[19]

After its heyday in the 1930s and early 1940s, however, the ecological approach withered. But in 1950, Amos Hawley's *Human Ecology: A Theory of Community Structure* resurrected the ecological approach in the field of sociology. Building on the work of his mentor, Roderick D. McKenzie, Hawley attempted to explain the relationship between population size and urban organizational structure. According to the theory, population growth along the periphery of an urban system will be matched by an increase in organizational functions at the core to insure stability in the expanded system. This pattern of growth produced a core city and a series of dependent suburbs.[20]

What began in sociology as an emphasis on the study of social problems in central cities led to analyses of the relationships among communities within metropolitan areas and to comparative urban research. The theoretical focus also splintered into several distinct perspectives over the years, among which an urban ecological approach appeared in various forms. Economic, technological, and socio-cultural variables received primacy in different theories. Otis Dudley Duncan and Leo Schnore, however, employed the concept of the "ecological complex" with four basic components—environment, population, social organization, and technology—which they viewed as functionally interrelated.[21]

Contention over the key variable(s) in the spatial and social development of cities was a primary factor in splintering the adherents to urban ecology. For historians simply to resurrect the most monocausal of those theories seems futile. But the notion of an "ecological complex" has merit precisely because it extends the study of urbanization beyond city walls, requiring the researcher to examine external as well as internal influences shaping growth and development.

Another point of contention in urban ecology has been whether or not urbanization is conducive to social organization. The work of Lewis Mumford comes to mind in this debate. While not strictly an

urban ecologist within the parameters of sociology, Mumford was and is widely read by social scientists. Sjoberg treats Mumford as "more a moralizer than a scientist," while his biographer Donald L. Miller sees an "urban historian, urban visionary."[22] Because—as Sjoberg perceptively noted—Mumford viewed the crucial problems of modern society as "products of an imbalance between nature and human culture," his works sharply condemned the modern metropolis for veering so far from the Athenian "polis." To Mary Jo Huth, Mumford and some "traditional materialists" aligned with the Chicago School, viewed the city in negative terms as "secular, impersonal, and segmental." From this perspective, urbanization is not conducive to social organization.[23] While Mumford's view of urbanization *per se* is not strictly negative—indeed his monumental work *The City in History* is a plea to bring the importance of the city into our consciousness—his critical appraisal of the "megalopolis" has influenced scores of scholars and commentators.

On the other hand, Burgess's theories, which linked social status with residential patterns, tended to emphasize order rather than the social disorganization notions ascribed to Mumford and some "traditional materialists." Burgess' "concentric zones" distributed population in a city according to economic and social status, where the inner rings of settlement were predominantly poor and the outer rings increasingly more affluent. Others discussed "sectors" which were not so much like ripples on a pond, but more like slices of a pie.[24]

While the specifics of Burgess' concentric zones may hold little interest to the environmental historian, the larger question of the capacity of cities for social organization or disorganization may be a useful tool in linking spatial and social issues in future research. Indeed, the great variety of questions raised by urban sociologists since the birth of the Chicago School offer fertile ground for historical inquiry, especially if more empirical evidence is mined to test the larger questions of urban ecology.

The 1950s also saw the ecological approach reemerging in urban geography, especially through the formulation of location theory, and through more extensive cross-disciplinary discourse with sociology. But the rejuvenated ecological approach was narrower in focus than its original incarnation, especially because of the downplay of the interrelationships of human groups and the attention given to the internal structure of cities and to land-use patterns through theories of city location.

Location theories almost began simultaneously with the formative years of the social sciences in the late-nineteenth and early-

twentieth centuries. However, the "central place theory" of German economic geographer Walter Christaller in the 1930s most strongly influenced European and American scholars. Christaller was concerned with how cities served as "central places" for tributary regions particularly with respect to commerce and trade, manufacturing, service delivery, and administrative functions. Central place theory complemented the theory of agricultural production originally developed by J.H. von Thunen and the theory of industry location found in the work of Alfred Weber.[25]

Central place theory is not particularly useful as a major organizing principle for dealing with the urban environment, because it is applicable primarily for understanding intra-urban as opposed to inter-urban systems.[26] Insofar as central place theory, in particular, and location theory, in general, helps to distinguish between development at the core as opposed to the periphery of cities, it does offer guidance for understanding urban growth.[27]

Location theory in general is likewise too myopic for balancing internal or structural change in cities with outward growth. At the same time, ecological theories that do not link social, economic, and technological forces may be rightly criticized as monocausal.

A promising body of theory which may overcome some of the shortcomings of location theory can be found in the area of systems analysis. In 1964, geographer Brian J. L. Berry published an influential article entitled, "Cities as Systems within Systems of Cities."[28] Among other things, he argued that "cities are systems susceptible of the same kinds of analysis as other systems and characterized by the same generalizations, constructs, and models." "It is clear," he added, "that cities may be considered as systems—entities comprising interacting, interdependent parts. They may be studied at a variety of levels, structural, functional, and dynamic, and they may be partitioned into a variety of subsystems."[29]

As a way of applying an ecological approach to cities, the idea of a city as a system within a system of cities offered a powerful research approach, especially for model building. But the overarching systems models which became popular in the 1960s were criticized in the 1970s as "too formal and restrictive."[30] As one social scientist argued, applying a systems approach to urban spatial structure might focus attention on the interrelationships which are most easily measured—or those which offer simplistic analogies—and fit "most conveniently" into the systems framework.[31] Since cities are strongly influenced by a range of external forces, as I stated earlier, it is best to think of them as "open systems" which departs from the kind of

thinking that would make them insular or self-contained, and will help place urbanization in the larger context of the physical environment. In trying to incorporate cities into the larger physical world, the view of cities as unique ecosystems is tempting but ultimately ahistorical. I would not be inclined to identify cities as part of the natural world, but instead to determine how they interact with, influence or modify the natural world as an animate social/spatial system.[32]

The swirl of ideas embedded in the various sociological and geographic studies since World War I cannot be expected to lead to some quick-fix unified theory easily adapted to the field of urban environmental history. However, there are several suggestive theoretical routes open to historians seeking to link the study of the natural history of the city with the history of city building.

The State of the Field

The interest in the physical city among urban historians has broadened and deepened in the last several years, but, very few of the resulting studies can claim to be essentially environmental history. Taken as a whole, the body of literature does much to inform environmental historians about urbanization, but with some exceptions, the pieces are less than the whole. As in many historical subfields, specialization continues to dominate the study of the urban environment. Much of the research on infrastructure, public works, and engineering emanates from the history of technology; the study of building technology from architectural history; interest in public health and disease from medical history; pollution regulation from law; urban reform from political history; and city growth and city services from urban history and city planning history.[33]

These contributions are significant but largely fragments of what could become more conscious efforts at a new urban environmental history, especially the kind which would link the internalist propensities of much of the existing literature with the larger role of cities in the physical environment.

It would be unfair to suggest that few, if any, important books and articles have dealt successfully with the urban environment. But what exists I would tend to call 'bridge literature'—that which is making a transition from the strictly specialized internalist studies to full-blown urban environmental history. The most prominent of that bridge literature falls into three broad—and somewhat arbitrary—categories: urban growth, infrastructure, and pollution and health.

Understanding how and why cities grow is the first step in shaping an understanding of the urban environment. The efforts of Eric E. Lampard to apply social science theory to the study of urban growth set an agenda for historians in the early 1960s. Lampard perceived of the city as an ecological complex—somewhat like Duncan and Schnore—of population, the physical environment, technology and social organization that could be employed to determine the "changing structure and organization" of communities. As he continued to assert throughout his career, "...the fate of urbanized areas, like that of cities, is always determined in *interaction* with the world around."[34] While Lampard contributed substantial basic research of his own, his major contribution was to conceptualize about the process of growth, coaxing others to do likewise.[35]

As Robert R. Dykstra and William Silag noted, however, "Lampard's formulation has elicited much admiration but little action...," especially with respect to comparative community histories.[36] Not only is Lampard's call conceptually ambitious, but requires demands in terms of research and documentation which most historians find daunting.

While less ambitious than Lampard's vision for the study of urban growth, Sam Bass Warner, Jr.'s *Streetcar Suburbs: The Process of Growth in Boston, 1870-1900* (Cambridge, MA, 1962) wrung an impressive amount of insight about the growth of cities out of a relatively narrow case study of suburban development in nineteenth-century Boston. Warner viewed himself—not unlike Lampard—as keeping the flame of the Chicago School as well as Lewis Mumford.[37]

In *Streetcar Suburbs*, Boston's suburban growth was accomplished through the application of efficient transportation technology, extension of other key services, and a conducive land development system. The study offers a detailed picture of the spatial patterns of residential growth and the composition of the new neighborhoods. *Streetcar Suburbs* has had a major impact on the field of urban history, especially in terms of the discourse over suburbanization and the correlation between technology and growth, but few have attempted to use Warner's insights within a broader environmental context. What sets the book apart from what came before, in my mind, is the emphasis on the *mechanism* instead of the *impulse* for growth.[38]

In addition to Warner, historical geographer Allan R. Pred has added some important detailed studies of city systems to our bibliography utilizing central place theory, such as *The Spatial Dynamics of United States Industrial Growth, 1800-1914* (Cambridge, MA, 1968),

Urban Growth and the Circulation of Information: The United States System of Cities, 1790-1840 (Cambridge, MA, 1973), and *Urban Growth and City-Systems in the United States, 1840-1860* (Cambridge, MA, 1980). But the work of historical geographers notwithstanding, Warner's methodology and Lampard's emphasis on an environmental complex have yet to be merged into a major historical study of urban growth.[39]

Because many urban environmental historians have been interested in the internal development of cities, the study of city building and infrastructure has attracted wider attention than the processes of growth. As with urban growth, many pioneering studies originated in the 1960s on topics such as architecture, planning, transportation, and economic development.[40] Roy Lubove, a trailblazer in this area in the 1960s, was so bold as to define urban history as "the process of city building over time."[41]

As a departure point, the study of urban design, building technology, and urban space is fundamental for understanding the city-building process itself. The work of Carl W. Condit is representative of those seeking to make clearer the relationship between structures and urban space. Of particular interest to Condit is the impact of technology on building design and land-use patterns, with detailed attention to materials, techniques, and styles. Such studies about the form and structure of cities provides insights about their texture.[42]

Condit's works focus on the 'vertical' quality of the city. John Reps and others interested in urban planning sometimes take more of a 'horizontal' perspective by viewing cities in terms of grids and other land-use patterns. Reps' *The Making of Urban America: A History of City Planning in the United States* (Princeton, 1965) is a classic study in that genre.[43] Complimenting both building technology and urban planning are a variety of studies on the urban landscape, including park development. For example, George F. Chadwick's *The Park and the Town: Public Landscape in the Nineteenth and Twentieth Centuries* (New York, 1966) provides a comprehensive look at park development in western civilization.[44]

Although not strictly urban history, the work of John R. Stilgoe has added a stimulating dimension to the study of the urban environment. His *Metropolitan Corridor: Railroads and the American Scene* (New Haven, CT, 1983) examines, among other things, the structures and spaces that evolved along railroad lines between 1880-1935. His interest in non-traditional spatial development interlaces some of his other studies and is a significant vantage point for studying urban land-use patterns.[45]

Attempting to grasp the city building context in broad environmental terms requires larger concepts than "building technology" or "urban landscape." The relatively recent focus on city "infrastructure" provides a more useful handle. Joel Tarr explained persuasively that infrastructure provides the vital technological "sinews" of a city: roads and bridges, water and wastewater lines, disposal facilities, power systems, communications networks, and buildings.[46]

Christine Meisner Rosen added an operational dimension to Tarr's definition by arguing that infrastructure development shared the qualities of "capital intensiveness, land extensiveness, and monopolistic production."[47] And a good summary statement is Josef W. Konvitz's notion that "Unlike public works, which it subsumes, the term 'infrastructure' is at once a description of physical assets and of their economic, social, and political role."[48]

The new "infrastructure" literature of the last ten to fifteen years has deepened our knowledge about an array of technical systems and city services which help to define the urban environment in more precise terms. The work of Tarr and others is based on extensive mining of under-utilized—but valuable—research materials such as technical journals and tracts, city plans and maps, transactions of engineering societies, and numerous government documents.[49]

Some of the best studies have used the idea of infrastructure to speculate more freely about the nature of city building in particular and urbanization in general. Josef Konvitz's *The Urban Millennium* (Carbondale, Il., 1985) is a sweeping study of city building from the Middle Ages to more recent times, with a particular emphasis on Europe. A salient feature of the book is the clear assertion that city building is an on-going process. "Nothing may look less likely to change in a radical way than the status quo in city building," he speculated, "but nothing else may be more likely." Referring to the nineteenth century as the "First Industrial Age of iron, steam, and coal" and the twentieth century (so far) as the "Second Industrial Age of glass, petroleum, and electricity," he concluded that "It will be surprising if the transition from the Second to the Third Industrial Age does not bring with it a mutation in city building as significant as the one that occurred nearly a century ago."[50]

Less certain about a major urban transformation, Christine Rosen in *The Limits of Power* (Cambridge, MA., 1986) examined the rebuilding process after fires in Chicago (1871), Boston (1872), and Baltimore (1904). Her concern was that many barriers existed to rational redevelopment of these cities after the fires, including the nature of

the real estate market, the physical and economic qualities and character of the infrastructure and its relationship to the population, and the unequal distribution of wealth and political influence limiting decision making to a few elites. Indeed, there was need for vast environmental improvements in these cities well before the fires, and the lack of attention to them helped cause the fires themselves. Since there was a failure to adapt to the myriad environmental needs of the cities, the primary focus of her study was to "explain why, at virtually every stage of growth, the achievement of these adaptations lagged significantly behind the need for adaptation."[51] The emphasis on the decision-making process in city building in this study acts as an important corrective for those who would give credit to the sheer momentum of changing economic forces or technological innovation.

A most promising context—not a paradigm however—within which several urban historians now operate, seeks to understand the infrastructure in terms of technical networks. So far the research has concentrated on nineteenth- and twentieth-century cities, but certainly has applicability to other eras as well.[52] Growing out of a conference in Paris sponsored by Centre National de la Recherche Scientifique and the National Science Foundation in 1983, *Technology and the Rise of the Networked City in Europe and America* (Philadelphia, 1988) edited by Joel A. Tarr and Gabriel Dupuy, brought together the work of European (primarily French) and American scholars who evaluated the city in terms of the development and impact of various technical networks. In the Preface, Tarr and Dupuy noted the significance of such networks: "Technological infrastructure makes possible the existence of the modern city and provides the means for its continuing operation, but it also increases the city's vulnerability to catastrophic events such as war or natural disaster. While technology may enhance the urban quality of life, it may also be a force for deterioration and destruction of neighborhoods, as well as a hindrance to humane and rationale planning."[53]

In Spring, 1991, CNRS published the first issue of *Flux* under the editorial leadership of Gabriel Dupuy. The journal, published alternately in French and English, expanded on the ideas at the 1983 Paris conference, hoping to display in its pages the most current work dealing with technical networks. "Notions which are at present confused, like 'system effects' and 'network effects' should be clarified by articles on telecommunications or transportation," Dupuy stated. "The role played by the interconnections between networks should appear in the domain of water distribution as well as electricity."[54] Such a view of urban networks broadened the utility of the concept to

treat many dimensions of urban development and city growth, and encouraged more comparative research.[55]

The percolation of these ideas throughout Western Europe and the United States, and thus the rekindling of interest in systems theory, has resulted in some exciting new book-length studies. André E. Guillerme's *The Age of Water: The Urban Environment in the North of France, A.D. 300-1800* (College Station, TX, 1988) treats the development of "hydraulic networks" (or hydrographic systems) in French cities of the Middles Ages.[56] "Contrary to a widely held view," Guillerme argues, "this hydrographic system did not originate naturally. Its gradient, profile, and dimensions were planned and worked out over many centuries—from as early as the decline of the Roman empire—for military purposes." In time, this system assumed other roles, driving watermills, draining swamps, and serving a variety of other consumers.[57] Such a study not only illuminates a very significant pattern of urban development, but begs for comparison with other non-urban hydraulic systems, such as those described in the works of Donald Pisani, Donald Worster, Lawrence Lee, and others.

Harold L. Platt's *The Electric City: Energy and the Growth of the Chicago Area, 1880-1930* (Chicago, 1991) does for electrical power what Guillerme attempted to do for water. Platt is concerned with more than Samuel Insull's technical and economic prowess in developing an electric grid for the Chicago area. He successfully highlights the ways in which the "'invisible' world of energy that envelops us" affects the everyday life of people.[58] *The Electric City* devotes considerable space to the decision-making process that led to the power grid as well as to the impact of electricity on consumers of energy. It is this latter consideration which has often been missing from studies of the urban environment—indeed environmental history in general. Platt's work is a good example of how to treat humans as consumers of the environment, and what that may tells us about the impact of technological and economic change on cities in particular and society in general.

"Pollution studies" have offered an opportunity to examine the role of humans as consumers of the environment, and within the context of the city, have also provided a vehicle for examining the extent and nature of environmental degradation caused by population growth, technological change, and industrial production;[59] the development and effectiveness of environmental laws and regulation; the origins and impact of environmental politics and reform; and the role of key participants in changing the urban environment.

The authors in my *Pollution and Reform in American Cities, 1870-1930* (Austin, 1980) presented an array of studies on urban pollution problems—water, wastewater, air, solid waste, and noise pollution—and on the central role of municipal engineers and women reformers in the anti-pollution campaigns. Although limited chronologically and geographically, the value of such a study, and others which pre- and post-date it, was to make graphic the range of pollution problems assaulting the cities.[60]

In *Pollution and Reform*, I referred to the period between 1870 and 1930 as the genesis of an "environmental crisis in the city" brought on by the convergence of industrialization and rapid urban growth. Were I to write the book today, I would rethink the concept of a generalized environmental crisis and its timing, but I would not minimize the significance of pollution as a problem in American cities as presented by Stuart Galishoff, Joel Tarr, James McCurley, and Terry Yosie, or the importance of environmental reform in that era for setting precedence for the "quality of life" issues which are so much a part of the modern environmental movement as demonstrated by Dale Grinder, Raymond Smilor, Stanley Schultz, Clay McShane and Suellen Hoy.[61]

Unfortunately, the role of women in urban environmental reform has not moved far beyond Hoy's original work as found in "'Municipal Housekeeping': The Role of Women in Improving Urban Sanitation Practices, 1880-1917," in *Pollution and Reform*. However, the study of municipal engineering has fared better, especially since several historians have built upon the work of Tarr and Schultz and McShane's seminal article, "To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late Nineteenth-Century America." *Journal of American History* 65 (September, 1978): 389-411. One of the more recent comprehensive treatments of municipal engineering is found in Schultz's *Constructing Urban Culture: American Cities and City Planning, 1800-1920* (Philadelphia, 1989).[62]

The study of urban pollution and its ramifications has been enhanced by the rich literature in the field of the history of medicine and public health. To truly understand the quality of the urban environment, especially from the vantage point of consumers, is to understand disease transmission and epidemics, sanitation and health, and the role of doctors, sanitarians and public health officials in combatting disease and pollution. The most current bibliography of value to the environmental historian can be found in John Duffy, *The Sanitarians: A History of American Public Health* (Urbana, IL, 1990).

Despite the impressive work available on engineers and sanitarians, the study of environmental policy making in the city is in its infancy and the study of environmental regulation as it pertains to cities still lacks comprehensive treatment.[63]

However, the transition literature which I have discussed—taken as a whole—has prompted urban historians and historians of technology to view the city with different eyes. Mumford's "invisible city"—those pipes, conduits and wires creating a hydraulic, pneumatic, and electrical maze below the streets—and the buildings and bridges standing as concrete forests above the streets are not merely the products of obscure, mundane technologies or a backdrop for human action, but integral components in a dynamic environmental system. Yet for the most part, the existing historical literature—as I also have suggested— does not link cities to a world beyond its suburbs.

Patrick Geddes, who through his seminars in Edinburgh helped to train urbanists of many disciplines from Western Europe and the United States (Lewis Mumford among them), introduced the ecological view to the emerging field of urban planning at the turn of the century. According to Brian Berry and Frank Horton, Geddes emphasized the organic approach to city planning, "the harmonious relationships between city and region, between city and environment, and of land uses within cities, as well as the role of planning to achieve harmony where it did not exist."[64]

In some ways William Cronon embraces Geddes' spirit—the harmony of city and region, city and environment—as a construct for *Nature's Metropolis*. The book treats the relationship between Chicago and the West. "My contention," Cronon stated, "is that no city played a more important role in shaping the landscape and economy of the midcontinent during the second half of the nineteenth century than Chicago. Conversely, one cannot understand the growth of Chicago without understanding its special relationship to the vast region lying to its west."[65]

Cronon's view is decidedly from the inside looking out—examining commodity flows in order to demonstrate the development of an integrated economy in the United States "that bound city and country into a powerful national and international market that forever altered human relationships to the American land."[66] And while this prime focus leaves little time for the internalist themes so well developed in other studies, Cronon's recognition that "Americans have long tended to see city and country as separate places, more isolated from each other than connected" and that that schism is

reflected in historical scholarship, may be the most important statement of the book.[67]

As my essay strongly suggests, I share Cronon's view. What remains to be done is: First, broaden the work of the internalist scholars to extend the study of growth, infrastructure, and pollution well beyond the city limits, and second, coax the scholars of humans and the natural world into the cities. The intellectual rewards for such a venture will be well worth the trip.

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1 Letter, Joel A. Tarr to Martin V. Melosi, Sept. 6, 1992.

2 In "American Environmental History: The Development of a New Historical Field," *Pacific Historical Review* 54 (August, 1985): 297-335. Richard White noted that "In most of the literature discussed [in the essay] urban environmental issues have received little attention, yet in many ways both modern environmentalism and the economic influences shaping the environment flow from urban sources." See p. 330.

3 Alfred Crosby, Richard White, Carolyn Merchant, William Cronon, and Stephen Pyne.

4 Since *Ends of the Earth* was published in 1988, I assume that "Doing Environmental History" was written before "Transformation of the Earth," but I do not know that for a fact.

5 In "Transformation of the Earth" on page 1089, the reference to the "built environment" is replaced by the "technological environment, the cluster of things that people have made, which can be so pervasive as to constitute a kind of 'second nature' around them..."

6 Worster, ed., *End of the Earth*, pp. 292-93.

7 Graeme Davison, "The City as a Natural System: Theories of Urban Society in Early Nineteenth-Century Britain," in Derek Fraser and Anthony Sutcliffe, eds., *The Pursuit of Urban History* (London, 1983), p. 349.

8 This is not to suggest that social science theory should be accepted uncritically or without modification, or that urban environmental historians have ignored it altogether in the past. For example, Christine Rosen's *The Limits of Power: Great Fires and the Process of City Growth in America* (Cambridge, MA, 1986), makes excellent use of David Harvey's model for capital investment in urban infrastructure. Joel Tarr's work draws heavily on decision-making theory and modeling dealing with the application of technology to city development.

9 Davison, "The City as a Natural System," p. 366.

10 Havlick, *The Urban Organism* (New York, 1974), p. 12.

11 David Harvey, *Social Justice and the City* (Baltimore, 1973), p. 309.

12 Manuel Castells, *The City and the Grassroots: A Cross-Cultural Theory of Urban Social Movements* (London, 1983), p. xv.

13 Thomas R. Detwyler and Melvin G. Marcus, eds., *Urbanization and Environment: The Physical Geography of the City* (Belmont, CA, 1972), p. 10.

14 See Kevin Lynch, *The Image of the City* (Cambridge, MA, 1960); Hans Blumenfeld, "Continuity and Change in Urban Form," in Larry S. Bourne, ed., *Internal Structure of the City: Readings on Urban Form, Growth, and Policy* (New York, 1982). p. 51.

15 Ronald J. Johnston, *The American Urban System: A Geographic Perspective* (New York, 1982), pp. 304-05.

16 Ibid., p. 305.

17 Detwyler and Marcus, eds., *Urbanization and Environment*, p. 21. See also Robert Detweiler, Jon N. Sutherland, and Michael S. Wertman, *Environmental Decay in Its Historical Context* (Glenview, IL, 1973), pp. 87-88.

18 Brian J.L. Berry and John D. Kasarda, *Contemporary Urban Ecology* (New York, 1977), p. 3.

19 Gideon Sjoberg, "Theory and Research in Urban Sociology," in Philip M. Hauser and Leo F. Schnore, eds., *The Study of Urbanization* (New York, 1965), pp. 164-65. See also Mary Jo Huth, *The Urban Habitat: Past, Present, and Future* (Chicago, 1970), pp. 5-7.

20 Mckenzie introduced the theory of "ecological expansion" to the field of human ecology in the 1930s. According to John Kasarda, the theory stipulates that "population growth in peripheral areas of a system will be matched with an increase in organizational functions in its nucleus to insure integration and coordination of activities and relationships throughout the expanded system." For cities this implies that outward growth would occur without loss of contact with the core of settlement. See John D. Kasarda, "The Theory of Ecological Expansion: An Empirical Test," *Social Forces* 51 (December, 1972), p. 165.

21 Sjoberg, "Theory and Research in Urban Sociology," pp. 165-75; Huth, *The Urban Habitat: Past, Present, and Future*, pp. 5-7.

22 Ibid., p. 169; Donald L. Miller, "Lewis Mumford: Urban Historian, Urban Visionary," *Journal of Urban History* 18 ((May, 1992): 280.

23 Huth, *The Urban Habitat*, pp. 5-7; Sjoberg, "Theory and Research in Urban Sociology," p. 169.

24 See Huth, *The Urban Habitat*, pp. 5-7.

25 Berry and Kasarda, *Contemporary Urban Ecology*, pp. 3-4, 7-8, 12, 16, 195-97. See also Brian J.L. Berry and Frank E. Horton, *Geographic Perspectives on Urban Systems* (Englewood Cliffs, NJ, 1970), pp. 2-4, 17, 170-75; Ray M. Northam, *Urban Geography* (New York, 1975), pp. 121-41.

26 Central place theory "outlines the logic of systems of central places, focusing particularly upon the numbers, sizes, activities, and spatial distribution of such places and their associated regions." See "Central Place," *International Encyclopedia of the Social Sciences* v. 2 (New York, 1968), p. 365-70. See also Keith O. Beavon, *Central Place Theory: A Reinterpretation* (London, 1977), pp. 2, 139-42; Harold Carter, *The Study of Urban Geography* (London, 1981; rev. ed.), pp. 60-74, 138; Raymond L. Fales and Leon N. Moses, "Land-Use Theory and the Spatial Structure of the Nineteenth-Century City," *Papers of the Regional Science Association* 28 (1972): 49, 51, 53; Brian J. L. Berry, "Internal Structure of the City," in Kent P. Schwirian, *Comparative Urban Structures: Studies in the Ecology of Cities* (Lexington, MA, 1974), p. 227.

27 Theories of ecological expansion and segmental growth help to focus on the relationship between technology and the organization of cities. Ecological expansion was meant to explain the relationship between population size and urban organizational structure. According to the theory, population growth along the periphery of an urban area will be matched with an increase in organizational functions at the core to insure stability in the expanded system. This pattern of growth produces a core city and a series of dependent suburbs. Technology, especially in the form of modern transportation, becomes a key variable in this theory because it reduces "the friction of space," which allows the core to retain control over its periphery.

By contrast, the theory of segmental growth posits that the number of segmental units in an area increases as a function of population distribution, given that the friction of space is high, that is, no efficient means of transportation (or communications for that matter) exists. In this case, growth occurs primarily through increases in population density, not expansion. See Kasarda, "The Theory of Ecological Expansion: An Empirical Test," pp. 165-75; Stephen D. Webb, "Segmental Urban Growth: Some Cross-National Evidence," *Sociology and Social Research* 58 (July, 1974): 387-91. See also Johnston, *The American Urban System*, pp. 327, 332; Mark LaGory, "Twentieth Century Urban Growth: An Ecological Approach, *Sociological Focus* 12 (August, 1979): 187; Amos H. Hawley, *Human Ecology: A Theory of Community Structure* (New York, 1950), pp. 402-03; James L. Spates and John J. Macionis, *The Sociology of Cities* (Belmont, CA., 1987), pp. 160-61; Hall H. Winsborough, "City Growth and City Structure," *Journal of Regional Science* 4 (1962): 48; Alan Walter Steiss, *Urban Systems Dynamics* (Lexington, MASS., 1974), 221; Richard A. Walker, "The Transformation of Urban Structure in the Nineteenth Century and the Beginnings of Suburbanization," in Kevin R. Cox, ed., *Urbanization and Conflict in Market Societies* (Chicago, 1978), p. 167; D. I. Scargill, *The Form of Cities* (New York, 1979), p. 12.

28 Brian J. L. Berry, "Cities as Systems within Systems of Cities," *Regional Science Association Papers* 13 (1964): 147-163. For a general discussion of systems analysis, see Anatol Rapoport, "General Systems Theory," *International Encyclopedia of the Social Sciences* v. 15 (1968), pp. 452-58.

29 Berry, "Cities as Systems within Systems of Cities," pp. 158, 160-61.

30 Bourne, ed., *Internal Structure of the City*, p. 29. See also Seymour J. Mandelbaum, "Thinking About Cities as Systems: Reflections on the History of an Idea," *Journal of Urban History* 11 (February, 1985): 139-50.

31 Ibid., pp. 29-35.

[32] For a more detailed discussion of cities as systems, see Martin V. Melosi, "Cities, Technical Systems and the Environment," *Environmental History Review* 14 (Spring/Summer, 1990): 45-64.

[33] For a range of bibliographic references, see Howard Gillette, Jr. and Zane L. Miller, *American Urbanism: A Historiographical Review* (New York, 1987); Eugene P. Moehring, "Public Works and Urban History: Recent Trends and New Directions," *Essays in Public Works History* 13 (August, 1982): 1-60; Suellen M. Hoy and Michael C. Robinson, eds. and comps., *Public Works History in the United States: A Guide to the Literature* (Nashville, 1982); Joel A. Tarr, "The Evolution of Urban Infrastructure in the Nineteenth and Twentieth Centuries," in Royce Hanson, ed., *Evolution of the Urban Infrastructure* (Washington, D.C., 1984), pp. 4-60; Josef W. Konvitz, Mark H. Rose and Joel A. Tarr, "Technology and the City," *Technology and Culture* 31 (April, 1990): 284-94; Martin V. Melosi, "A Bibliography of Urban Pollution Problems," in Melosi, ed., *Pollution and Reform in American Cities, 1870-1930* (Austin, 1980), pp. 199-212; Melosi, "Urban Pollution: Historical Perspective Needed," *Environmental Review* 3 (Spring, 1979): 37-45; Melosi, "The Urban Physical Environment and the Historian: Prospects for Research, Teaching and Public Policy," *Journal of American Culture* 3 (Fall, 1980): 526—40. See also the excellent bibliographies in the *Urban History Newsletter* and the bibliographic material provided by the Society for American City and Regional Planning History.

Most of these references reflect a major emphasis on North American topics. Part of the reason is that American scholars, until recently, have played a major role in the study of the urban environment. However, the contribution of Europeans to the field has been growing steadily, building on the major contributions of Fernand Braudel and the *Annales* school and the work of various European social scientists and engineers. The appearance in 1990 of *Flux*, a journal sponsored by the Centre National de la Recherche Scientifique in Paris and edited by Gabriel Dupuy, is helping to broaden the discourse on the urban environment to include important studies on the development of urban networks and systems throughout the world. *Flux* also regularly provides scholarly articles, abstracts, and bibliographic references.

Interest in the urban environment is less well developed in other parts of the world, but significant research on Asian, South American, and Australian cities is currently underway. For example, see Dan H. Coward, *Out of Sight: Sydney's Environmental History, 1851-1981 (Sydney, 1988);* Lionel Frost, *The New Urban Frontier: Urbanization and City Building in Australasia and the American West Before 1910* (Sydney, 1991).

[34] Eric E. Lampard, "The Nature of Urbanization," in Fraser and Sutcliffe, eds., *The Pursuit of Urban History*, p. 51.

[35] Among his voluminous work, some of the most useful for understanding Lampard's general views on urbanization include "American Historians and the Study of Urbanization," *American Historical Review* 67 (October, 1961): 49-61; "Urbanization and Social Change: On Broadening the Scope and Relevance of Urban History," in Oscar Handlin and John Burchard, eds., *The Historian and the City* (Cambridge, MA, 1963), pp. 225-47; "Historical Aspects of Urbanization," in Philip M. Hauser and Leo F. Schnore, eds., *The Study of Urbanization* (New York, 1965), pp. 519-54; and "The Evolving System of Cities in the United States: Urbanization and Economic Development," in Harvey S. Perloff and Lowdon W. Wingo, Jr., eds., *Issues in Urban Economics* (Baltimore, 1968), pp. 81-139. See also Bruce Stave, "In Pursuit of Urban History: Conversations with Myself and Others—A View from the United States," in Fraser and Sutcliffe, eds., *The Pursuit of Urban History*, p. 411; Leonard Wallock, "Work and the Workplace in the City: Toward a Synthesis of the 'New' Labor and Urban History," in Gillette and Miller, ed., *American Urbanism*, p. 75.

[36] Dykstra and Silag, "Doing Local History: Monographic Approaches to the Smaller Community," in Gillette and Miller, eds., *American Urbanism*, p. 294.

[37] See Bruce Stave, "A Conversation with Sam Bass Warner, Jr.," *Journal of Urban History* 1 (November, 1974): 89.

[38] See Edward K. Muller, "From Waterfront to Metropolitan Region: The Geographical Development of American Cities," in Gillette and Miller, eds., *American Urbanism*, pp. 106-07.

[39] For a useful piece on urban growth, see Louis P. Cain, "William Dean's Theory of Urban Growth: Chicago's Commerce and Industry, 1854-1871," *Journal of Economic History* 45 (June, 1985): 241-49.

[40] See Wallock, "Work and the Workplace in the City," p. 75.

[41] See Lubove, "The Urbanization Process: An Approach to Historical Research," *Journal of the American Institute of Planning* 33 (January, 1967): 33-39. See also Lubove, "Social History and the History of Landscape Architecture," *Journal of Social History* 9 (Winter, 1975): 268-75; Lubove, *Twentieth Century Pittsburgh* (New York, 1969).

[42] See Carl W. Condit, *The Rise of the Skyscraper* (Chicago, 1952); *American Building Art* 2v. (New York, 1960, 1961); *American Building* (Chicago, 1967); *Chicago 1910-1929: Building, Planning and Urban Technology* (Chicago, 1973); *Chicago, 1930-1970* (Chicago, 1974); *The Port of New York* (Chicago, 1980).

See also Konvitz, Rose, and Tarr, "Technology and the City," p. 289; Moehring, "Public Works and Urban History," pp. 31-33.

43 See also Eugenie Ladner Birch, "Design, Process, and Institutions: Planning in Urban History," pp. 135-54 and Richard Longstreth, "Architecture and the City," pp. 155-94, in Gillette and Miller, eds., *American Urbanism*, pp. 155-94.

44 See David Schuyler, *The New Urban Landscape: The Redefinition of City Form in Nineteenth-Century America* (Baltimore, 1986); Edward Relph, *The Modern Urban Landscape* (Baltimore, 1987).

45 See also *Common Landscape of America, 1580 to 1845* (New Haven, CT, 1982); *Borderland: Origins of the American Suburb, 1820-1939* (New Haven, CT, 1988).

46 Joel A. Tarr and Gabriel Dupuy, eds., *Technology and the Rise of the Networked City in Europe and America* (Philadelphia, 1988), p.xiii. For more on the development of Tarr's work, see Bruce M. Stave, "A Conversation with Joel A. Tarr: Urban History and Policy," *Journal of Urban History 9* (February, 1983): 195-232. For infrastructure bibliography, see also Joel A. Tarr and Josef W. Konvitz, "Patterns in the Development of the Urban Infrastructure," Gillette and Miller, eds., *American Urbanism*, pp. 195-226; "Infrastructure and Urban Growth in the Nineteenth Century," *Essays in Public Works History* 14 (December, 1985): 1-85.

47 Christine Meisner Rosen, "Infrastructural Improvement in Nineteenth-Century Cities: A Conceptual Framework and Cases," *Journal of Urban History* 12 (May, 1986): 222-23.

48 Josef Konvitz, *The Urban Millennium: The City Building Process from the Early Middle Ages to the Present* (Carbondale, IL, 1985), p. 131.

49 The Public Works Historical Society has played a major role in promoting such studies through its own publications, such as the *Essays in Public Works* series and the recent *Water and the City: The Next Century* (Chicago, 1991) edited by Howard Rosen and Ann Durkin Keating, as well as through development of numerous programs at professional meetings."Public Works History" is often used to describe the interest in the urban infrastructure, but "public works" tends to exclude privately developed structures, technologies, and systems which fit more comfortably under the heading of "infrastructure" when defined broadly to include social, political and economic factors. For example, see David T. Beito and Bruce Smith, "The Formation of Urban Infrastructure Through Nongovernmental Planning: The Private Places of St. Louis, 1869-1920," *Journal of Urban History* 16 (May, 1990): 263-303.

50 Konvitz, *The Urban Millennium*, p. 188.

51 Rosen, *The Limits of Power*, pp. 4-5.

52 This is the point made in new research on seventeenth- and eighteenth-century Philadelphia by Michal A. McMahon.

53 Tarr and Dupuy, eds., *Technology and the Rise of the Networked City in Europe and America*, p. xiii. See also Eugene P. Moehring, "The Networked City: A Euro-American View: Review Essay," *Journal of Urban History* 17 (November, 1990): 88-97.

54 "Foreward," *Flux* 1 (Spring, 1990): 3. See also issues of *Planning Perspectives: An International Journal of History, Planning and the Environment*, edited by Gordon E. Cherry and Anthony R. Sutcliffe, and published in London.

55 The premier issue of *The Journal of Urban Technology* was published in Fall, 1992 in New York. It may prove to be an important companion to *Flux*.

56 This is a translation of *Les Temps de l'eau: La cite', l'eau et les techniques* published by Vallon in Paris in 1983.

57 Guillerme, *The Age of Water*, p. ix.

58 Platt, *The Electric City*, p. xv.

59 On industrialization, see Theodore L. Steinberg, "An Ecological Perspective on the Origins of Industrialization," *Environmental Review* 10 (Winter, 1986): 261-76. William R. TeBrake has written an excellent article which deals with air pollution problems before the industrial era entitled "Air Pollution and Fuel Crises in Preindustrial London, 1250-1650," *Technology and Culture* 16 (1975): 337-59.

60 Some of the best-known pioneering studies include Nelson M. Blake, *Water for the Cities: A History of the Urban Water Supply Problem in the United States* (Syracuse, 1956); many articles by Joel A. Tarr such as (with F.C. McMichael) "Historical Decisions about Wastewater Technology, 1800-1932," *Journal of Water Resources Planning and Management* 103 (May, 1977): 47-61; Jon A. Peterson, "The Impact of Sanitary Reform Upon American Urban Planning, 1840-1890," *Journal of Social History* 13 (Fall, 1979): 83-103; Martin V. Melosi, *Garbage in the Cities: Refuse, Reform and the Environment, 1880-1980* (College Station, TX, 1981); and *History of Public Works in the United States, 1776-1976*

(Chicago, 1976), edited by Ellis C. Armstrong, Michael Robinson, and Suellen Hoy. For more bibliographic references, see endnote 32.

61 See Jon Peterson, "Environment and Technology in the Great City Era of American History," *Journal of Urban History* 8 (May, 1982): 343-54.

62 The discussion of the development of urban sanitary services has attracted increasing attention from historians. Maureen Ogle, among others, has questioned the functionalist interpretation which suggests that service development correlates with population growth or the application of new technologies. For example, see "Redefining 'Public' Water Supplies, 1870-1890: A Study of Three Iowa Cities," *Annals of Iowa* 50 (Summer, 1990): 507-30. See also Alan I. Marcus, *Plagues of Strangers: Social Groups and the Origins of City Services in Cincinnati, 1819-1870* (Columbus, 1991).

63 Much of the best historical research on environmental regulation and legislation can be found in law reviews such as *Ecology Law Quarterly*. See Kermit Hall, *A Comprehensive Bibliography of American Constitutional and Legal History* 5v. (New York, 1984).

64 Berry and Horton, *Geographic Perspectives on urban Systems*, p. 10.

65 Cronon, *Nature's Metropolis*, p. xiii.

66 Ibid., p. xiv.

67 Ibid.