

The Bacteriological City and Its Discontents

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In the rapidly gentrifying Oderberger Straße in the Prenzlauerberg district of Berlin lies a curious building that resembles a medium-sized factory. Now a semi-derelict venue for alternative cultural events, it was until 1994 a public bath and swimming pool. The imposing *Stadtbad*, first opened in 1902, is a remnant of a distinctive phase in urban history whereby the benefits of regular washing and exercise were promoted as part of a wider attempt to improve the health and well-being of the general population.¹ The changing relationship between water and the human body in the modern city reflects a distinctive “hydrological order” characterized by the extension of complex technological networks, changing patterns of everyday life and the establishment of new modes of municipal administration. Water, like other facets of urban nature, was incorporated into an increasingly rationalized and scientifically managed urban form.

The history of urban infrastructure is now the focus of a vibrant debate that combines the established insights of urban history with emerging perspectives drawn from other fields such as architecture, critical theory and urban studies. Emphasis on the administrative, technical, and political dimensions to nineteenth-century urban reform has been supplemented by a greater concern with the micro-spaces of the modern city – in particular the body and the domestic interior – along with an expanded theoretical discussion of themes such as the ideological rationale for urban governance, the role of public works projects in the construction of a functional public realm and the social, cultural and economic implications of technological networks in urban space.²

Implicit within this current debate is a sense that a *longue durée* extending from the mid-nineteenth century until the last quarter of the twentieth century has been partially supplanted by a new set of socio-technological developments. This essay explores the movement toward a distinctive constellation of space, society, and technology that is referred to here as the “bacteriological city” in order to differentiate this historical phase from the early industrial era and also from a range of developments over the last thirty years associated with the emergence of neo-liberal ap-

proaches to public policy.³ Placing an extended period of urban history under one conceptual frame risks a degree of omission between different developments, but it does help to identify some of the commonalities and anomalies that have characterized processes of capitalist urbanization since the middle decades of the nineteenth century. This urban epoch has been variously referred to in the literature as the “hydraulic city,” the “sanitary city,” or the “modern infrastructural ideal,” but the term “bacteriological city” is deployed here to denote a distinctive set of interrelated developments ranging from science and technology to new forms of municipal administration.⁴

The term “bacteriological” is especially apposite for an exploration of the relationship between water and cities since technical and political discourses cannot be easily disentangled from advances in disease epidemiology that influenced developments in civil engineering, planning, and public health. At the same time, however, the term “bacteriological” is not intended to give undue weight to the medical or scientific dimensions to urban policy making but will be related to wider themes such as the role of urban networks in mediating the relationship between the body and the city. In exploring the development of water infrastructure this essay examines the transformation of the modern city as part of an interrelated set of developments that transcend the interventions of individual engineers, planners, or medical advocates. The relatively stable urban form that emerged out of the chaos of the nineteenth century is presented as a historical compromise that emerged in order to enable the modern city to function more effectively. Yet in circumstances where the modernization process was never fully completed – most notably in a colonial context – the underlying weaknesses of the bacteriological city as a universal ideal are sharply revealed.

Delineating the Bacteriological City

The nineteenth-century city, as the political and economic fulcrum for industrialization, posed a complicated set of dilemmas for the scope and effectiveness of modern government. A particular challenge during the first half of the nineteenth century was the marked deterioration in urban living conditions punctuated by devastating outbreaks of infectious disease. Though the public health crisis affecting rapidly growing cities was readily ascribed to atrocious physical conditions, this masked competing interpretations of the problem and the degree to which public health was conceived as part of a wider set of social and political reforms. Moralistic interpretations of ill health, for example, co-existed with a miasmatic emphasis on “mephitic exhalations” associated with the dangers of stagnant air and water. The relationship between poverty, disease and the physical environment remained a confused arena in the pre-bacteriological era in part because few professional discourses engaged with urban problems

in any systematic way that might enable the political, economic, and technical spheres to be considered in relation to one another. In any case, diseases such as cholera and typhoid threatened not just the poor but entire populations, and problems with water supply were generally conceived in terms of taste or convenience rather than outright threat.

With the development of the empirical sciences in the early decades of the nineteenth century, however, the pattern of mortality and morbidity could be conveyed far more accurately than in the past. From John Snow's classic survey of the incidence of cholera in Soho to Parent-Duchâtelet's olfactory investigations of underground Paris we find an emerging classificatory impulse toward the *terrae incognitae* of the modern city. The surveys and writings of figures such as Friedrich Engels, Henry Mayhew, Thomas Southwood Smith, and others placed the living conditions of the modern industrial city under unprecedented critical scrutiny. In so doing, the scope of modern governance was widened to include not just the "modern subject" – a new kind of urban citizen amenable to the emerging discourses of hygienism and social control – but also the recognition of governable spaces that had previously not been systematically identified. The issue of public health became an increasingly significant concern for the modern state so that the health of the population acquired a strategic importance that had previously been neglected. The development of more systematic forms of data collection and the expansion of state activity into hitherto neglected areas altered the rationale of governmental activity and introduced a range of new strategic imperatives in the face of industrialization, urbanization, and emergent forms of political agitation. With the expansion of military conscription, for example, the scale of undernourishment and ill health became more readily apparent than it had been in the past. Concerns with public health encompassed not just needs for economic efficiency but also the demographic demands of emerging nationalist ideologies. In one sense the urban population was increasingly regarded as a collective statistical entity, but in another sense the more communal sensory experience of the past was increasingly challenged by new attitudes toward privacy and social distinction. Changing attitudes toward health, hygiene, and cleanliness involved an emphasis on increasingly individualized forms of identity and a growing cultural emphasis on the redefinition of the domestic arena.⁵ The emergence of new social formations also coincided with intensified forms of spatial differentiation so that the vertical segregation of the congested pre-industrial city was increasingly superseded by the horizontal segregation of the expanding industrial metropolis.

The place of water within the nineteenth-century city reflects an ambiguity between the strategic needs of the modern state and the development of reformist dimensions to urban political discourse. The demonstration of linkages between contaminated water and ill health played a pivotal role in fostering the political demands of the burgeoning public health movement for the physical reconstruction of cities, even if the rationale for

improving water infrastructure rested on a wider set of factors at best only tangentially related to human health. Many industries in the nineteenth-century city such as chemical works, breweries, tanneries, and distilleries all relied on pure and reliable water supplies and demanded action from municipal authorities to tackle the deteriorating situation. In addition to industrial needs for water, the constant threat of fire provided a further spur to action not least because of the growing political power of the insurance industry.⁶

The rapid growth of nineteenth-century cities quickly overwhelmed the historic reliance on wells, water vendors, and other sources and led to the introduction of centralized water supply systems in, for example, Paris in 1802, London in 1808 and Berlin in 1856. Yet this shift toward more elaborate water supply systems introduced new tensions over how urban populations would bear the costs of these infrastructure projects. The transformation of the modern city would have been impossible without the innovative use of financial instruments such as municipal bonds to enable the completion of ambitious engineering projects without imposing substantial additional tax burdens. In the 1830s, for example, New York City issued bonds to enable the completion of the Croton Aqueduct to solve the city's chronic water shortages, and in the 1850s Berlin drew not just on British engineering expertise to develop its water supply but also on the financial resources of the London capital markets.⁷ Municipal bond markets weathered the economic turbulence of the 1870s and played a pivotal role in enabling the development of infrastructure networks: by 1905, for example, water works constituted the largest component of municipal debt for U.S. cities.⁸ These and other financial mechanisms channelled the flow of capital into the built environment and also underpinned the growing interconnections between urbanization and international finance.

In addition to new methods of financing public works, the reconstruction of cities also required the establishment of new policy instruments such as the power of eminent domain and other planning mechanisms that enabled a strategic urban vision to override multifarious private interests. Wealthy residents with their own wells, for example, had frequently sought to organize petitions against the development of municipal water systems that they regarded as expensive and unnecessary. Furthermore, the construction of large-scale hydraulic engineering projects required the acquisition of private lands both for the completion of new infrastructure and to protect public water systems from possible contamination with agricultural wastes or other possible sources of pollution. In the case of water, a critical trend from the middle decades of the nineteenth century onward was the replacement of inadequate private water companies by public ownership. Private companies routinely exploited their monopoly of individual supply networks by refusing to extend services to outlying districts or by making excessive charges for poor quality services. In cities such as Los Angeles and New Orleans, for example, the charters of

private water companies were revoked under public pressure to allow the development of municipal water services. In the U.S.A., some 43 percent of water works were publicly owned in 1890 compared with more than 70 per cent by the 1920s as networks expanded to include poorer or more distant neighborhoods.⁹ The trend toward the municipalization of water supply involved bringing diverse private operators under the control of the local state to produce more unified, centralized, and democratically accountable forms of service provision.¹⁰ By the 1920s and 1930s, however, the emerging bacteriological city of the late nineteenth century was metamorphosing into a fully fledged technocratic paradigm for modern governance so that political changes in the urban arena became a progenitor of wider regional and national goals for public policy. In the U.S.A., for example, the New Deal saw a vast expansion in the federal role for water management ranging from the construction of immense dams and river diversion schemes to the complex reconstruction of flood defenses.¹¹

The development of the bacteriological city required the introduction of new forms of technical and managerial expertise in urban government. The replacement of miscellaneous administrative bodies such as parishes and vestries with more centralized approaches to urban management necessitated the expansion of state bureaucracies so that the development of cities became an interrelated facet of the growing political power of the nation state. Yet the relationship between technical knowledge and municipal reform remained a complex arena where rival technological solutions to the problems of urban sanitation became repeatedly entwined in political conflicts over the autonomy of professional expertise in urban policy: engineers, for instance, frequently expressed their frustration at the fiscal and political barriers to the completion of their work – a sentiment which finds its clearest expression in the ambivalence of colonial urban administrations toward the latest advances in engineering science. In the British colonies, for example, the so-called Manchester doctrine of minimal financial support ensured that comprehensive engineering solutions to problems of ill health and insalubrious urban conditions would never be implemented.¹² In the case of nineteenth-century Bombay, there were decades of discussions among engineers, physicians, and colonial administrators but little progress toward an integrated sanitation system was ever achieved. By the 1860s the situation was becoming critical as the city's economic boom encouraged vast waves of migration and intense overcrowding. In 1863 the leading British civil engineer, Robert Rawlinson, called for a modern sewer system to be constructed in Bombay "according to true scientific principles."¹³ Yet in a colonial context these advocates for urban improvement operated within a political arena where the nascent forms of citizenship and political reform enjoyed in Europe or North America had only limited significance. The emerging bacteriological city was a technical adjunct to capitalist urbanization, yet its full realization was in conflict with the marginal status of the colonial city so

that moralistic and “neo-miasmatic” discourses persisted in preference to any universalist response to the modernization of urban infrastructure. Bombay, like many other colonial cities, experienced a catastrophic decline in urban environmental conditions culminating in an outbreak of bubonic plague in 1896 that was to last more than fifteen years and cause immense economic disruption and loss of life.¹⁴

The emergence of more systematic approaches to the understanding of disease, poverty, and urban labor markets contributed toward a rationalization of urban policy so that new analytical methods could be applied to public administration. Changing conceptions of disease epidemiology played a critical role within this transition by introducing a collective conception of human health that began to displace the earlier holistic emphasis on the susceptibilities of individuals or the miasmatic focus on physical attributes of cities such as drainage or ventilation.¹⁵ It is in this context that public health advocates such as Rudolf Virchow and Robert Koch sought to use scientific advances – albeit within a positivist frame – as a means to underpin political demands for social reform that extended far beyond a purely utilitarian or technical agenda. Yet the prevailing view of public health, epitomized by Chadwickian sanitationism, rested on a restricted conception of urban reform as the modernization of urban infrastructure rather than any wider critique of the process of capitalist urbanization itself.¹⁶ In broad terms we can conceive of the modernization of industrial cities as a shift from the “private city” to the “public city” whereby fragmentary, piecemeal, and highly localized solutions to the problems of water and sanitation were superseded by the promotion of more complex kinds of coordination between political and economic interests. This transition was in fact a double movement so that public activities such as washing were increasingly restricted to the private sphere whereas privately organized access to potable water or sanitation was gradually incorporated into a centralized, networked and municipally controlled metropolitan form.

Fractured Modernities

The hydrological transformation of the nineteenth-century city involved the gradual displacement of the “organic city” with its emphasis on the utilization of human wastes for agriculture. Yet elements of this earlier phase persisted into the second half of the nineteenth century before the epidemiological advances of the 1880s assured the ascendancy of contagionist ideas in public health thinking.¹⁷ In the pre-bacteriological age, for example, it was far easier for figures such as Justus von Liebig and Edwin Chadwick to argue for a continuation in the agricultural uses of human waste and elaborate on complex schemes for the diversion of new sewer outlets to farms in the vicinity of the city.¹⁸ Yet their cyclical conception of a rational urban order, founded on organicist and utilitarian concep-

tions of nature, conflicted with the underlying dynamics of the capitalist city and the development of a cultural appropriation of nature rooted in leisure rather than the needs of agriculture. The growing popularity of washing, for example, began to threaten the sanitary arrangements of the pre-industrial city by flooding cesspits and diluting the nitrogen content of human manure at the same time as the production of artificial fertilizers was becoming more widespread.¹⁹

The increasing quantities of human waste being discharged into rivers – either directly or through connections to the sewer system – provoked widespread opposition from agricultural, industrial, and fishing interests dependent on clean water as well as “river fanatics” who insisted on using rivers for drinking water.²⁰ In the wake of the Hamburg cholera outbreak of 1892, in which nearly 10,000 people died, there was a ferocious standoff between the miasmatic theories of Max von Pettenkofer and his allies, which found favor with the ruling elites, and the contagionist arguments of Robert Koch who emphatically blamed the contamination of water supply for the spread of cholera and called on the German authorities to take decisive action. Pettenkofer denied that drinking water was involved in the spread of disease and insisted instead that the “cholera miasma” originated from localized changes in groundwater levels. In contrast, Koch demanded that the structure of municipal government be altered so that the implementation of public health measures such as the regular monitoring of drinking water quality became an integral and continuous aspect of governmental activities.²¹ The gradual acceptance of contagionist conceptions of disease epidemiology undermined the last vestiges of an organic conception of the modern metropolis and rendered human feces not only a focus of abjection but also a source of danger to public health. In Paris, for example, new legislation in 1894 made the connection of individual dwellings to the main drainage system mandatory as the introduction of *tout-à-l’égout* replaced the complicated and increasingly unworkable sanitary arrangements of the Haussmann era.²² Yet throughout much of the global South this last phase in the modernization of water infrastructure remains only partially completed: in many cities, for example, neither comprehensive sewer systems nor waste water treatment works were ever introduced, and even in Europe and North America the deficiencies of existing water treatment systems have been the focus of new waves of legislation and political contestation since the 1980s.

The spread of these technological networks and new plumbing innovations within the home remained highly uneven in different national and cultural contexts and was largely restricted to middle-class households until the wider diffusion of prosperity during the twentieth century: the general introduction of water closets, for example, was limited before the 1880s and bathrooms only became a standard domestic fixture after 1914.²³ When the historian Patrick Joyce refers to the sanitary or hydraulic city as “a dominant social imaginary of the city” he presents a highly general-

ized interpretation of a medley of different developments: the differential experience of the modern city is obscured by an abstract account of the governmental strategies of political liberalism.²⁴ Used in a neo-Foucauldian context by Joyce and others, the term “liberalism” denotes the attempt to regulate human behavior through indirect means rather than through more direct forms of state intervention: the growing popularity of new plumbing technologies exemplifies this dynamic by inculcating new washing habits through the co-evolution of society and technological networks.²⁵ Yet we could argue à la Joyce that the colonial city – with its indirect modes of governmentality – marks the acme of a political strategy to govern through the complex appropriation of existing power structures and social mores in order to combine fiscal austerity with various forms of ideological legitimation.²⁶ Joyce is also right to highlight not just the technical and governmental parallels between what he terms “colonial and metropolitan governmentality” but also the derogatory hierarchies of human worth that were applied both to the slum dwellers of Europe and the native populations of colonial cities. What he describes as “dislocated liberalism” usefully captures the sense of a governmental regime at the margins of its own internal logic in a colonial context where the political and economic exigencies of rapid urbanization could not be masked by any nationalist appeal to modernization and in which cities would emerge as the loci for nascent independence movements.²⁷

Until recently the lagging levels of connection to modern water supply and sanitation systems in the cities of the global South were widely perceived as a temporary phenomenon to be overcome through ambitious efforts at urban planning and reconstruction. In reality, of course, the technocratic ideal that drove the development of the bacteriological city conflicted with the political and economic dynamics behind capitalist urbanization: a tension that was largely masked within the metropolitan core of Europe and North America but which was clearly manifest within colonial cities from the outset. Far from a singular modernity, the development of urban technological networks since the nineteenth century has generated a diversity of urban forms ranging from the fully connected metropolis of the Fordist era to an array of hybrid entities incorporating a palimpsest of different socio-technological arrangements. The contemporary transition away from the bacteriological city can only be fully appreciated in the context of the innate weaknesses within this centralized technological model. In the last thirty years the municipal dominance in urban water provision has come under pressure from a number of different quarters: the anomalies within the universalist ideal, where it has been only partially implemented, have been exposed through the so-called “brown agenda” and demands to extend global access to water and sanitation; the integrated model of service provision has been extensively fractured through the splintering and disaggregation of technical networks to produce new inequalities; expert-led approaches to civil engineering and urban planning have been

extensively challenged by an emphasis on expanded public participation and a widening array of different interest groups; and the resurgence of private provision, in conjunction with new patterns of capital investment, is generating a different kind of urban landscape to the more ostensibly homogeneous technological landscapes of the past.

Conclusions

The complex interactions between disease, water and urban infrastructure reveal that while the “bacteriological city” may represent an abstract ideal for the organizational structure of the modern city it has never fully corresponded with urban realities because of the political and economic tensions that underlie the processes of capitalist urbanization. These anomalies that pervade the technological structure of the modern city become most strikingly represented in the marginal spaces of the city and in those cities that are themselves marginal within the global economy. In the rapidly growing cities of the global South, for example, the dilapidated or never completed infrastructure systems of the bacteriological era have been superseded by a proliferation of alternative networks. By exploring the history of water infrastructure beyond the metropolitan core of Europe and North America we can uncover fresh insights into the limitations of the bacteriological city as a universal model and also disentangle some of the political tensions underlying the introduction of technological networks in the capitalist city.

The modernization of urban infrastructure required an institutional context that could facilitate the flow of capital into the built environment, yet this historic dynamic has been neglected by neo-Foucauldian interpretations of “liberal governmentality.” The political dimensions to urban technological networks encompass not just the interface between technology and the body but also the evolving institutional context for the shaping of cities themselves. The bacteriological city emerged out of a synthesis between the scientific and political dimensions to modernity so that technological characteristics of the networked modern city became characteristic features of a more rationalized urban form. Yet the degree to which these achievements have tended to be associated with individual engineers rather than any more enduring political philosophy underlies the extent to which the sanitarian emphasis of the bacteriological city foreclosed wider political considerations transforming issues such as citizenship rights to basic services into more narrowly technical questions. We can argue that the public realm under the age of the “heroic engineer” remained only tangentially linked to the city as a whole as evidenced by the extensive fracturing of technocratic planning ideals in the last quarter of the twentieth century. Rather than a teleological conception of urban change, it is important to recognize that the bacteriological city was one of a number of possible manifestations of urban form in spite of its aura

of permanence and universality. The triumph of the nineteenth-century technocratic vision did not completely preclude its alternatives: the “discontents” associated with the bacteriological city extend to those voices, both now and in the past, who distrust an extended role for the state in urban governance as well as to those critics of the inherent inequities engendered by capitalist urbanization. In reality, the bacteriological city has proved to be a transitional phase: even at its acme, in the middle decades of the twentieth century, the techno-managerialist urban paradigm displayed a series of fiscal and ideological weaknesses that would not be fully revealed until the political and economic turbulence of the late 1960s and 1970s. Though most contemporary cities remain dependent on the technological networks built up under the political aegis of the bacteriological era, these increasingly dilapidated urban infrastructures serve as a poignant symbol of the fragility and historical specificity of metropolitan urban form.

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Notes

1. *Stadtbad Oderberger Straße: Porträt eines historischen Bades* (Berlin: Gesellschaft der behutsamen Stadterneuerung, 2001).
2. See, for example, Stephen Graham and Simon Marvin, *Splintering Urbanism: Networked Infrastructures, Technological Mobilities and the Urban Condition* (London and New York: Routledge, 2001); Elisabeth Heidenreich, *Fließräume: die Vernetzung von Natur, Raum und Gesellschaft seit dem 19. Jahrhundert* (Frankfurt: Campus, 2004); Maria Kaïka and Erik Swyngedouw, “Fetishising the Modern City: The Phantasmagoria of Urban Technological Networks,” *International Journal of Urban and Regional Research* 24 (2000): 120–38.
3. In an urban context the advent of neo-liberalism is associated in particular with a diminution in the role of the state in the coordination and provision of collective services yet this process exhibits wide variations in its scope and timing ranging from new strategies for urban regeneration to vast programmes of divestment in public utilities. See, for example, Neil Brenner and Nik Theodore, “Cities and the Geographies of ‘Actually Existing Neoliberalism,’” *Antipode* 34 (2002): 349–79.
4. Compare, for example, Graham and Marvin, *Splintering Urbanism*; Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City* (London and New York: Verso, 2003); and Martin Melosi, *The Sanitary City: Urban Infrastructure in America From Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000).
5. Alain Corbin, *The Foul and the Fragrant: Odor and the French Social Imagination* (Cambridge, MA: Harvard University Press, 1986 [1982]); Michel Foucault, “The Politics of Health in the Eighteenth Century,” in Paul Rabinow, ed., *The Foucault Reader*, trans. Christian Hubert (Harmondsworth: Penguin, 1984): 277. Originally published in *Power / Knowledge*, ed. Colin Gordon (New York: Pantheon, 1980). See also Susanne Frank, *Stadtplanung im Geschlechterkampf: Stadt und Geschlecht in der Großstadtentwicklung des 19. und 20. Jahrhunderts* (Opladen: Leske und Budrich, 2003) and E. Lupton and Janice A. Miller, *The Bathroom, the Kitchen, and the Aesthetics of Waste: A Process of Elimination* (New York: Princeton Architectural Press, 1992).
6. See, for example, Matthew Gandy, *Concrete and Clay: Reworking Nature in New York City* (Cambridge, MA: The MIT Press, 2002).

7. See Hilmar Bärthel, *Wasser für Berlin* (Berlin: Verlag für Bauwesen, 1997) and Heinrich Tepaspe, *Stadttechnik im Städtebau Berlins 19. Jahrhundert* (Berlin: Gebr. Mann, 2001).
8. David Cutler and Grant Miller, *Water, Water Everywhere: Municipal Finance and Water Supply in American Cities*. Working paper 11096 (Cambridge, MA: National Bureau of Economic Research, 2005); John Teaford, *The Unheralded Triumph: City Government in America, 1870-1900* (Baltimore: Johns Hopkins University Press, 1984).
9. Cutler and Miller, *Water, Water Everywhere*; William L. Kahrl, *Water and Power: The Controversy over Los Angeles's Water Supply in the Owens Valley* (Berkeley: University of California Press, 1982); Werner Troesken, "Typhoid Rates and the Public Acquisition of Private Waterworks, 1880-1920" *The Journal of Economic History* 59 (1999): 927-48; Werner Troesken and Rick Geddes, "Municipalizing American Waterworks, 1897-1915" *Journal of Law, Economics, and Organization* 19 (2003): 373-400; John Walton, *Western Times and Water Wars: State, Culture, and Rebellion in California* (Berkeley: University of California Press, 1992).
10. See, for example, Martin Daunton, "Public Place and Private Space: The Victorian City and Working-Class Housing" in D. Fraser and A. Sutcliffe, (eds.) *The Pursuit of Urban History* (London: Edward Arnold, 1983); Richard J. Evans, *Death in Hamburg: Society and Politics in the Cholera Years 1830-1910* (Oxford: Oxford University Press, 1987); P. Penzo, "L'urbanistica e l'amministrazione socialista a Bologna, 1914-1920," *Storia Urbana* 18 (66) (1994): 109-43; John V. Pickstone, "Dearth, Dirt and Fever Epidemics: Rewriting the History of British 'Public Health,' 1780-1850," in Terence Osborne and Paul Slack (eds.) *Epidemics and Ideas: Essays on the Historical Perception of Epidemics* (Cambridge: Cambridge University Press, 1992).
11. Improved flood control was a key part of the New Deal agenda for water management in the wake of extensive loss of life and damage to property in low-lying parts of the Gulf Coast during the 1920s and earlier. On the history of U.S. water resources policy see, for example, David Lewis Feldman, *Water Resources Management: In Search of an Environmental Ethic* (Baltimore: Johns Hopkins University Press, 1991).
12. See, for example, A. Aderibigbe, *Expansion of the Lagos Protectorate, 1863-1900* (Unpublished PhD dissertation, University of London, 1959).
13. "Increased comfort and cleanliness lead to health and lengthened human life," wrote Rawlinson, "and such improvements ought in their results to be at least an equivalent for the annual money value of the works and costs of management." To Sir Charles Wood, Principal Secretary of State for India from Robert Rawlinson. Report on the proposed scheme of main sewerage and drainage submitted to the Municipal Commissioners of Bombay, dated April 1863. Maharashtra State Archives, Mumbai. See also Mariam Dossal, *Imperial Designs and Indian Realities: The Planning of Bombay City 1845-1875* (Bombay: Oxford University Press, 1991) and J.A. Jones, *A Manual of Hygiene, Sanitation and Sanitary Engineering with Special References to Indian Conditions* (Madras: Government Press, 1896).
14. See David Arnold, *Colonizing the Body: State Medicine and Epidemic Disease in Nineteenth-century India* (Berkeley: University of California Press, 1993); Ira Klein, "Urban Development and Death: Bombay City, 1870-1914," *Modern Asian Studies*, 20 (1986): 725-54.
15. See Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City* (London and New York: Verso, 2003).
16. See Christopher Hamlin, *Public Health and Social Justice in the Age of Chadwick* (Cambridge: Cambridge University Press, 1998).
17. On the history of water supply see, for example, Jean-Paul Goubert, *The Conquest of Water: The Advent of Health in the Industrial Age*. Trans. A. Wilson (Oxford: Polity Press, (1989) [1986]); André Guillerme, "Sottosuolo e costruzione della città / Underground and Construction of the City," *Casabella: International Architectural Review* (1988) 542/543: 118; and Charles D. Jacobson and Joel A. Tarr, "The Development of Water Works in the United States," *Rassegna: Themes in Architecture* 57 (1994): 37-41.
18. See Dominique Laporte, *History of Shit*. Trans. Nadia Benabid and Rodolphe el-Khoury (Cambridge, MA: The MIT Press, 2000 [1978]); John von Simson, *Kanalisation und Städtehygiene im 19. Jahrhundert* (Düsseldorf: Verein Deutsche Ingenieure, 1983).
19. See Matthew Gandy, "Rethinking Urban Metabolism: Water, Space and the Modern City" *City* 8 (2004): 371-87.
20. See Jürgen Büschenfeld, *Flüsse und Kloaken: Umweltfragen im Zeitalter der Industrialisierung (1870-1918)* (Stuttgart: Klett-Cotta, 1997).
21. Richard J. Evans, *Death in Hamburg: Society and Politics in the Cholera Years 1830-1910* (Oxford: Oxford University Press, 1987). Political attempts to refute Koch's research into the epidemiology of cholera also acquired an international dimension. See Mariko Ogawa, "Uneasy Bedfellows:

- Science and Politics in the Refutation of Koch's Bacterial Theory of Cholera," *Bulletin of the History of Medicine* 74 (2000): 671-707.
22. Baron Haussmann, for example, refused to allow human wastes to enter the newly constructed sewers of Second Empire Paris. See Matthew Gandy, "The Paris Sewers and the Rationalization of Urban Space" *Transactions of the Institute of British Geographers* 24: 1 (1999): 23-44; Gérard Jacquemet, "Urbanisme Parisien: la bataille du tout-a-l'égout a la fin du XIXe siècle," *Revue d'histoire moderne et contemporaine* 26 (1979): 505-48.
 23. See, for example, D. Glassberg, "The Public Bath Movement in America," *American Studies* 20 (1979): 5-21; J.-P. Goubert, "Wasser und Intimhygiene am Beispiels Frankreichs," in Bernd Busch and Larissa Förster, eds., *Wasser* (Köln: Wienand Trans. Stefan Barmann, 2000): 168-76. In private rented sectors of the housing market in some European cities we find that many households lacked bathrooms as recently as the 1970s or even later in the case of Altbau [old build] apartments in the former German Democratic Republic.
 24. Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City* (London and New York: Verso, 2003): 245.
 25. Thomas Osborne, "Security and Vitality: Drains, Liberalism and Power in the Nineteenth Century," in Andrew Barry, Thomas Osborne and Nikolas Rose (eds.), *Foucault and Political Reason: Liberalism, Neo-liberalism and the Rationalities of Government* (London: UCL Press, 1996): 115. See also Christopher Otter, "Making Liberalism Durable: Vision and Civility in the late Victorian City" *Social History* 27 (2002): 1-15. For recent debates over "governmentality" and the application of Foucault's ideas to urban theory see, for example, M. Dean, *Governmentality: Power and Rule in Modern Society* (London: Sage, 1999); Colin Gordon, "Governmental Rationality: An Introduction" in G. Burchell, C. Gordon and P. Miller (eds) *The Foucault Effect: Studies in Governmentality* (Hemel Hempstead, Harvester Wheatsheaf, 1991): 1-52; Nikolas Rose, *Powers of Freedom: Reframing Political Thought* (Cambridge: Cambridge University Press, 1999).
 26. See also Mahmood Mamdani, *Citizen and Subject: Contemporary Africa and the Legacy of Late Colonialism* (Princeton, NJ: Princeton University Press, 1996).
 27. Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City* (London and New York: Verso, 2003): 250.