THE MIASMIST: GEORGE E. WARING, JR. AND THE EVOLUTION OF MODERN PUBLIC HEALTH

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1. ABSTRACT
George E. Waring, Jr, developed an influential manual in 1867 entitled Draining for Profit, Draining for Health, reflecting two particular obsessions of the gilded age—wealth and miasma. Waring supported the long-held miasma, or anti-contagionist, theory, insisting that diseases were spread through the air, emerging as a poisonous vapor from damp soil. By the 1880s, the new contagionist theory of the germ was gaining European support, yet Waring remained a lifelong miasmist, supporting the anti-contagionist movement in the United States. He applied his technical knowledge of farm drainage to an urban theory of public sanitation, beginning with the drainage plan for Central Park in 1856, continuing with studies for Memphis and Havana, and culminating with the Department of Street Cleaning in New York City. Though Waring conducted his work on scientifically unsound precepts, his conclusions regarding drainage were correct. Waring is an important yet unsung hero of urban environmental history; his significant body of primary texts are worth revisiting to enhance current urban green infrastructure practices in the landscape architecture profession. Given the miasmists’ interest in urban disease transfer, particularly the spread of cholera and yellow fever, Waring’s emphasis on the sanitation of the physical environment is worth reassessing in light of current public health issues arising from the impact of climate change and the rise of vector-driven diseases such as Zika and dengue. Waring’s environmental emphasis on clean water, air, and soil reflects a contemporary vision of improving public health by reducing urban impacts on the atmosphere and waterways.

1.1 Keywords
George E. Waring, Jr., Central Park, public health, green infrastructure, drainage, miasma, contagionism
2  THE SCIENTIFIC MANAGEMENT OF FARMS

Colonel George E. Waring, Jr. was born in Pound Ridge, New York in 1833, the son of an industrialist father who ran a successful foundry in Samford, Connecticut, manufacturing stoves and agricultural tools. (See Figure 1.) Young Waring was educated as an agricultural scientist, avidly reading the current scholarship from Europe about new farming practices. He wrote his first technical manual, The Elements of Agriculture: A Book for Young Farmers, in 1853 and lectured widely at regional farmer clubs in New England. In 1855, he moved to Chappaqua, New York, to manage the farm of the editor of the New-York Tribune, Horace Greeley, a New York congressman and a one-time presidential candidate. Greeley, like many gentleman farmers of the period, dabbled in experimental agriculture on his Chappaqua farm, writing about these techniques in his popular weekly column in the Tribune, attracting a vast number of readers from rural America. Greeley also constructed an unusual concrete barn on the property, naming it the Rehoboth. This was one of the first concrete structures in the United States, and it drew visitors to Chappaqua from far away—indeed, Greeley wrote that he considered this barn his life’s finest accomplishment.1 Waring’s work with Greeley as farm manager gave him the opportunity to experiment with the novel techniques and tools of field drainage that he later developed into the influential manual of 1867 entitled Draining for Profit, Draining for Health, a lovely title reflecting two particular obsessions of this gilded age—wealth and miasma. The long-held miasma theory held that the origin of disease was in the air, emerging as a poisonous vapor from rotting organic matter or the soil. By the 1880s, strong support of the new contagionist theory of the germ was gaining support in Europe, yet Waring remained a lifelong miasmist and supporter of the anti-contagionist movement in the United States. And along the trajectory of his career from farm manager to drainage engineer to urban public health advocate, Waring’s mechanistic battle against miasma was waged at multiple scales, from the rural farm to the large urban park to the entire city.

The importance of Waring’s early work in agricultural drainage and its adaptation to the urban sphere as part of a comprehensive battle against disease transmission, particularly mosquito-borne yellow fever, is well worth revisiting as a significant contribution to a holistic view of environmental history and its beginnings in the late nineteenth century. Public health and adaptation to climate change are both critical issues of the twenty-first century and significant fields for engagement by landscape architects. New experimental urban green infrastructural practices addressing these issues would benefit from a contemporary examination of Waring’s innovative contributions, both the unexpectedly successful strategies—for example, the reduction of standing still water that supports mosquito larvae—as well as those best viewed with a cautionary lens, such as the complete drainage of intertidal wetlands for urban development.
THE MECHANIZATION OF CENTRAL PARK, NEW YORK

Waring’s career was significantly transformed from that of an agricultural scientist to an urban public health advocate upon meeting Egbert L. Viele (1825-1902), a West Point graduate and civil engineer. Viele is well known for his highly detailed 1865 *Sanitary and Topographical Map of the City and Island of New York*, colloquially known as the “water map” of Manhattan, a topographic overlaid with the Commissioners' Grid of 1809 and identifying the historic streams, marshes, meadows, and “made land” that transformed the shoreline of Manhattan, along with the city’s main sewer lines. The map was prepared for the report of the Council of Hygiene and Public Health of the Citizens Association. But Viele had produced earlier surveys of Manhattan as well. In 1853, just after the City of New York legislated the Central Park Act, identifying as public land the parcel that was to become Central Park, Viele began a survey of this terrain, described in the Act as the land “bounded southerly by Fifty-ninth-street, northerly by One Hundred and Sixth-street, easterly by Fifth Avenue, and westerly by Eighth-avenue.”2 (See Figure 2.)

In 1856, Viele was appointed Chief Engineer of the future park by the First Central Park Board of Commissioners. Viele, himself an ardent miasmist, embraced the well-known “ground water theory” of disease developed by the German scientist Max Joseph von Pettenkofer (1818-1901) in the 1850s. Believing the cause of disease and fevers to be the result of noxious odors emitted from excess moisture in the ground, Viele prepared a preliminary drainage plan for the park from 1856 through 1857, an eleven-foot-wide drawing entitled *Plan of Drainage for the Grounds of the Central Park*. In August 1857, 24-year-old George E. Waring Jr. was hired by Viele as his Superintendent of Drainage—Waring assisted with the development of this drainage map and insisted, to the apparent annoyance of Viele, that his name be added to the title. [4] Shortly afterward, in September 1857, Frederick Law Olmsted was appointed by the Board of Commissioners as Superintendent of Central Park, reporting to Egbert Viele, Chief Engineer.
Waring’s new title and role, Superintendent of Drainage, may seem unusual for a project to construct a public park. But the very idea of Central Park was developed to provide much more than a place of recreation and open space within the city—those initial 778 acres were part of a carefully constructed argument to combat disease in an increasingly crowded city. Indeed, the park was seen not as a captured piece of unspoiled “nature,” as it is often characterized, but rather conceptualized as a massive air, water, and ground cleansing machine that would restore health to its urban citizenry.

At this same time, medical science, until the transformative European germ-theory discoveries of Robert Koch and Louis Pasteur in the 1870s and 1880s, still held that epidemic diseases such as cholera, typhoid, and yellow fever were caused by a noxious miasma, a word deriving from the ancient Greek Μιασμα, or ‘bad air,’ emerging from rotting organic matter in the ground. The miasma theory was further developed in the nineteenth century by the British sanitary engineer Edwin Chadwick, who posited that diseases were caused by a place, by an environment, by an odor—not by another infected person or agent. And that place, identified by its foul smell, was one with contaminated water, poor hygienic conditions, and decomposing organic matter. Pettenkofer and others believed it developed in deep wet ground as a poison, emerging as a diseased ground exhalation. Thus, in late nineteenth-century New York, the medical miasmists gave rise to this position of Waring as Superintendent of Drainage, transforming him from an agricultural engineer into an urban sanitary engineer. Waring drew on his agricultural knowledge of farm drainage and tiling and applied it to an urban park on a massive scale. He would mechanically...
transform the nature of this ground from its existing hydrology into a gravity-fed hydraulic system, quickly shedding and transporting surface and ground waters from the territory of the park.

In September 1857, the First Board of Commissioners of the Central Park requested that its new Central Park Superintendent, Frederick Law Olmsted, provide a comprehensive plan for draining the land of the park. This request came just one month prior to the launch of the competition for the design of the new Central Park, advertised in October 1857. Olmsted, ever strategic, knew the terrain well thanks to Viele’s comprehensive topographic survey. He responded to this request, the first since his appointment as Superintendent, by stating the following:

“Owing to the exceedingly diverse character of the ground, the great amount of rock, both above and below the surface, with which it is encumbered, and its numerous springs, hidden and superficial, a detailed plan of drainage for the Central Park could only be formed after such a careful study as a proper attention to the ordinary duties of my office forbids me at present to give to the subject. The depth and direction of the drains must be, in many cases, also, adjusted to the elevation of the brooks, cascades, and standing water, which will be established solely on artistic grounds, as well as to the roads which may be lain out. Until therefore, a complete plan of the Park shall have been definitively determined on, I think it would be unwise to carry a consideration of the drainage-plan beyond the adoption of certain fundamental rules, to which even the landscape design should be subordinate.”

(Olmsted 1857, in Beveridge and Schuyler, eds. 1983: 94)

Olmsted goes on to insist upon these fundamental rules of drainage: the drainage of the park should be “thorough,” meaning a completely comprehensive system of underground drainage tiles, a “mechanical improvement” removing all excess water; the drains themselves should be ceramic tubes of one-inch diameter and greater, in sections laid end to end; and the drains should be set at a depth of three feet in the open glades and at a depth four feet in the wooded areas, and in both cases spaced fifteen feet apart.

A month after writing this letter to the Commissioners, Frederick Law Olmsted and Calvert Vaux entered the competition to improve and expand New York’s Central Park. In April 1858, their Greensward Plan was selected as the winning entry. Viele would become Olmsted’s frustrated rival, while Waring would continue to work closely with Olmsted, developing a close relationship with him and even renting his family farm on Staten Island. Olmsted and Vaux’s Greensward Plan won on the grounds of artistic achievement. Viele also submitted a proposal to the competition, but lost. Indeed, Viele’s submission to the competition was dismissed by Clarence Cook as being “just such a matter-of-fact, tasteless affair as is always produced by engineers, when they attempt anything in the way of ornamental design.” (Cook 1869: 25) Shortly after selecting the submission of Olmsted and Vaux, the Commissioners dismissed Viele and promoted young Waring, who had assisted Viele on his earlier drainage plan for Central Park, as the new Drainage Engineer for the execution of the Greensward Plan.

Immediately upon the award of the commission for the Greensward Plan, Olmsted began implementing “thorough” drainage based on the new plan drawn by Waring. The Second Annual Report of the Board of Commissioners of the Central Park, published in January 1859, includes a beautiful drawing entitled Map of the Drainage System on Lower Part of the Central Park as far as completed up to December 31st, 1859. (See Figure 3.) In this drawing, which includes the southern section of the park from 59th Street to the 66th Street transversal road, major rock outcrops are identified with topographic shading, lawns are lightly shaded, and paths are left unshaded. The red lines represent the tile drains, red circles are the silt basins, and the heavy black lines indicate the sewers. In Olmsted’s words, the park is “mechanically improved.” Olmsted later described Waring as the man who “planned and superintended the work of agricultural drainage, superficial and thorough, upon the Central Park from the outset. I believe it to be the best work of the kind in the world. The difficulties he met were great and various and the experience acquired in overcoming them must be very valuable for any similar undertaking.” (Olmsted 1860, in Beveridge and Schuyler, eds. 1983: 105)
4 THE MEMPHIS SYSTEM AND THE MOSQUITO

In 1861, after completing his work on the Central Park drainage network, Waring enlisted in Union Army at the onset of the Civil War, accepting a commission as a Major in the 4th Missouri Calvary. He was promoted to the rank of Colonel in 1862. After the end of the war in 1865, Waring returned to Rhode Island and his career of farm management and treatise writing, but continued to expand and focus his work on sanitary engineering. (Melosi, 1977) Waring began by advocating sewerage within the individual house, then expanded this theory to advocate for the necessity of cleansing entire communities in order to prevent disease. Pure air, pure water, pure soil: this was the “sanitary idea” as presented by Edwin Chadwick in 1828, borrowed from the ancient Hippocratean ideal, and was to be considered at the scale of the city. Waring landed the opportunity to test sanitation at an urban scale in 1878, after the devastating yellow fever epidemic in Memphis, Tennessee that infected around 17,000 people and killed over 5000. Appointed by President Rutherford B. Hayes as a Commissioner working with the National Board of Health, Waring was charged with creating a plan for the sanitary improvement of Memphis. He proposed a complete sewerage system—his work for the “thorough” drainage of Central Park was now expanded to a city scale. Interestingly, Waring championed and installed a separate sewage system—the alternative to the combined sewage system and its overflows that are still the environmental plague of large urban cities such as New York and Chicago. Waring claimed that his separate sewer system, the “Memphis” system, had banished yellow fever from Memphis. Though better drainage did keep waste water away from drinking water wells, yellow fever was not in fact spread by inadequate sanitation, but by the *Aedes* or *Haemagogus* species mosquito, which breeds in stagnant water. But this connection had not yet been established, and for now, Waring won a battle in Memphis in the ongoing debate between the contagionists and the miasmists. And indeed, much of today’s focus on developing new urban green infrastructures, such as bioswales and constructed wetlands, is intent on reducing the negative impacts of the combined sewer systems that discharge wastewater directly into rivers and oceans when
overwhelmed by storm water from heavy rains. Infiltration is the key element of these green infrastructures—but here the difference between Waring’s tiling and sewer ing and the current green infrastructural practices advocating absorption and evapotranspiration is revealed.

5 THE WHITE WINGS OF NEW YORK CITY

In 1894, Waring was appointed Commissioner of the Department of Street Cleaning of the City of New York, the predecessor of today’s Department of Sanitation. Waring radically and aggressively reformed the department, outfitting the men in white canvas uniforms, updating the street-cleaning and garbage collecting equipment, and establishing military-like discipline. (See Figure 4.) Under his leadership, and in the name of health and cleanliness, the streets of New York were cleared of waste in daylight hours by this new corps of streetcleaners, the “White Wings.” Waring established new practices, including the separation of trash at each household (organic garbage, ashes, and rubbish), a rubbish-sorting plant, a reduction plant at Barren Island, and land reclamation at Rikers Island. Waring wrote of his department:

“An inefficient and ill-equipped working-force, long held under the heel of the spoilsman, has been emancipated, organized, and brought to its best. It now constitutes a brigade three thousand strong, made up of well-trained and disciplined men, the representative soldiers of cleanliness and health, soldiers of the public, self-respecting and life-saving. These men are fighting daily battles with dirt, and are defending the health of the whole people. The trophies of their victories are all about us—in clean pavements, clean feet, uncontaminated air, a look of health on the faces of the people, and streets full of healthy children at play.”

(Waring 1896: 190)
His efforts were successful. The streets of New York, once shin-deep with waste, were swept clean on a regular schedule. In 1896, Waring orchestrated a grand parade of his sanitation men in their white uniforms and helmets down Fifth Avenue—he led the parade, astride a white stallion. Though his position as Commissioner ended in 1898, his innovative reforms led to permanent improvements in the street cleaning and garbage collection services in New York, and served as an example for many other cities. It was the miasma theory at its finest—anti-filth, clean, and pure white.

6 HAVANA

In 1898, at the end of the Spanish American War, the United States Army commanders were concerned with the risk of yellow fever to the troops that would be occupying post-war Havana. Indeed, it was this fever which had caused most of the American casualties during the war. Waring was appointed by President William McKinley as the chairman of the Commission charged with making suggestions for the proper sanitation of Havana and the army camp sites in Cuba, and he arrived in Havana in October 1898. He surveyed Havana for three weeks, noting the extensive marshes, its lack of sewers, the abundant filth and garbage in the streets, and the lack of any street cleaning or garbage disposal plan. Drawing on this work for both Memphis and New York, Waring drafted a proposed set of recommendations during his return trip to the United States, including the construction of a complete sewerage system, extensive street paving, thorough marsh drainage, and the organization of a Department of Public Cleansing.

The day after his return to New York, Waring contracted a fever. He died of yellow fever four days later, at the age of 65, on October 23, 1898. Public health officials in the city, now adhering to the contagion theory of disease transmission, required that his body be placed in a hermetically-sealed metallic casket and transported by a quarantine boat to Swinburne Island in New York Harbor, where his remains were cremated.

7 LESSONS LEARNED FROM THE MIASTIST

Did Waring’s death ironically demonstrate the futility of the miasma theory? Though it appears the contagionists may have won the final battle, Waring’s death by yellow fever was not in fact caused by a contagious disease transmitted person-to-person. There was no need for such extraordinarily careful handling of his remains. Two years after his death, in August 1900, the United States Army physician Walter Reed proved that yellow fever was spread by a bite from an infected *Aedes aegypti* mosquito—now known as the yellow fever mosquito, this is the same mosquito that is the main carrier of the Zika virus, along with its cousin the Asian tiger mosquito, *Aedes albopictus*. (See Figure 5.) In addition to the Zika virus, other threats from these species of mosquitoes include the West Nile virus, dengue fever, chikungunya, and several types of encephalitis.

Waring and other miasmists’ focus on the visible environmental factors of disease control were somewhat on the right track—although they did not realize that the importance of draining for health was to eliminate the breeding grounds of the vector of a disease-causing virus—the mosquito—not to purge the noxious exhalations of the earth. Today, international health officials struggling to contain the spread of the Zika virus advise citizens to remove or cover containers or rain gutters that might collect standing water—spraying larvicide over nonresidential areas, which has environmental complications, is not a particularly effective tactic against *Aedes aegypti*, as this species breeds primarily in gardens and homes.

Yet certainly the consequences of removing all standing water, when expanded to the agricultural or urban scales addressed by Waring, must be carefully considered by today’s health officials, landscape architects, and environmental advocates. The “thorough” drainage of swamps, as advocated by Waring in the 19th century and as practiced in the early 20th century as a mosquito control measure, resulted in serious environmental degradation due to the destruction of valuable wetland ecosystems. These same wetlands, though indeed providing potential mosquito breeding areas and habitat, also support the predator species that contain mosquito populations. Robust salt marsh wetland systems do not maintain ponded standing water, but support intertidal flow. The extensive “mosquito trenching” of urban wetland areas through the creation of open ditches, a practice common in the early 20th century, has had serious detrimental impacts on the integrity of the salt marsh complex. First employed in the intertidal salt marsh complexes of New York City’s Jamaica Bay and Staten Island, as a mosquito eradication technique, the implementation of these V-shaped anti-mosquito ditches to drain the marshes of standing water resulted in massive marsh fragmentation and degradation.
Though the theory of miasma was disproven by the success of germ theory in the early twentieth century, the miasmists, particularly George E. Waring, Jr., failed brilliantly in the urban realm, leaving an extraordinary legacy for urban design and planning, landscape architecture, and the continuing development of new forms of urban green infrastructure. The miasmists' focus on an improvement of the visible environment developed into contemporary urban public health strategies supporting a cleaner, healthier planet as well as healthier inhabitants. Much can be learned from the miasmists and applied to today's novel conditions, addressing issues that will continue to emerge with climate change. Waring developed a fascinating mechanical park, an atmospheric scrubber and carbon sink. His reforms at the Department of Street Cleaning in New York City led to modern practices of recycling and waste reduction. His separated sewer system at Memphis remains a conceptually radical alternative to the antiquated combined systems that discharge raw sewage into adjacent waterways with each moderate to heavy rainfall. A contemporary interpretation of the miasmists' emphasis on clean water, clean air, and clean soil reflects a shared landscape ethic—not simply a singular concern addressing disease transmission, but a series of strategies for reducing the environmental impact of urban actions on the atmosphere, waterways, and planet.
8 ENDNOTES

1 For more on Greeley’s experimental agricultural practices, with an extensive discussion of the concrete barn and strategies of drainage, see Horace Greeley (1871), *What I Know of Farming: A Series of Brief and Plain Expositions of Practical Agriculture as an Art Based upon Science* (New York: The Tribune Association).

2 Waring argues for thorough land drainage wherever possible, stating, ‘Land which requires drainage hangs out a sign of its condition, more or less clear, according to its circumstances, but always unmistakable to the practiced eye. Sometimes it is the broad banner of standing water, or dark, wet streaks in plowed land, when all should be dry and of even color; sometimes only a fluttering rag of distress in curling corn, or wide-cracking clay, or feeble, spindling, shivering grain, which has survived a precarious winter, on the ice-stilts that have stretched its crown above a wet soil; sometimes the quarantine flag of rank growth and dank miasmatic fogs.’ See more in George E. Waring, Jr. (1867), *Draining for Profit, and Draining for Health* (New York: Lovejoy and Son).

3 The Central Park Act of 1853 and the delineation of this parcel of land is cited by Morrison H. Heckscher (2008), *Creating Central Park* (New York: The Metropolitan Museum of Art and New Haven: Yale University Press), 15. The precision of these boundaries and dimensions were predicated on siting the existing rectangular Receiving Reservoir, another hydraulic mechanism, at the exact center of the park.


5 Waring was an early American proponent of the British-designed ‘earth closet,’ an alternative to the increasingly popular ‘water closet,’ which he claimed, in true miasmist style, could pose dangers to human health because of the noxious sewer gas which the defective units produced. For more on the earth closet, see George E. Waring, Jr. (1868), *Earth Closets: How to Make them and How to Use Them* (New York: Tribune Association). Later Waring wrote the influential 1884 *The Sanitary Drainage of Houses and Towns* (Boston: Houghton, Mifflin and Company), a book much admired by Olmsted.


8 *Indiana State Journal*, Indianapolis, Indiana, Wednesday, November 2, 1898, 74/44: 2.

9 In 1919, the state of New Jersey reported trenching approximately 120,000 acres of salt marsh, which involved the cutting of 18,244,217 linear feet of open ditches, 10 inches wide and 24 to 30 inches deep, in order to destroy mosquito-breeding habitat. See Thomas J. Headlee, “The Mosquitoes of New Jersey and their Control,” *New Jersey Agricultural Experiment Stations Bulletin 348* (New Brunswick, New Jersey, 1921).
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