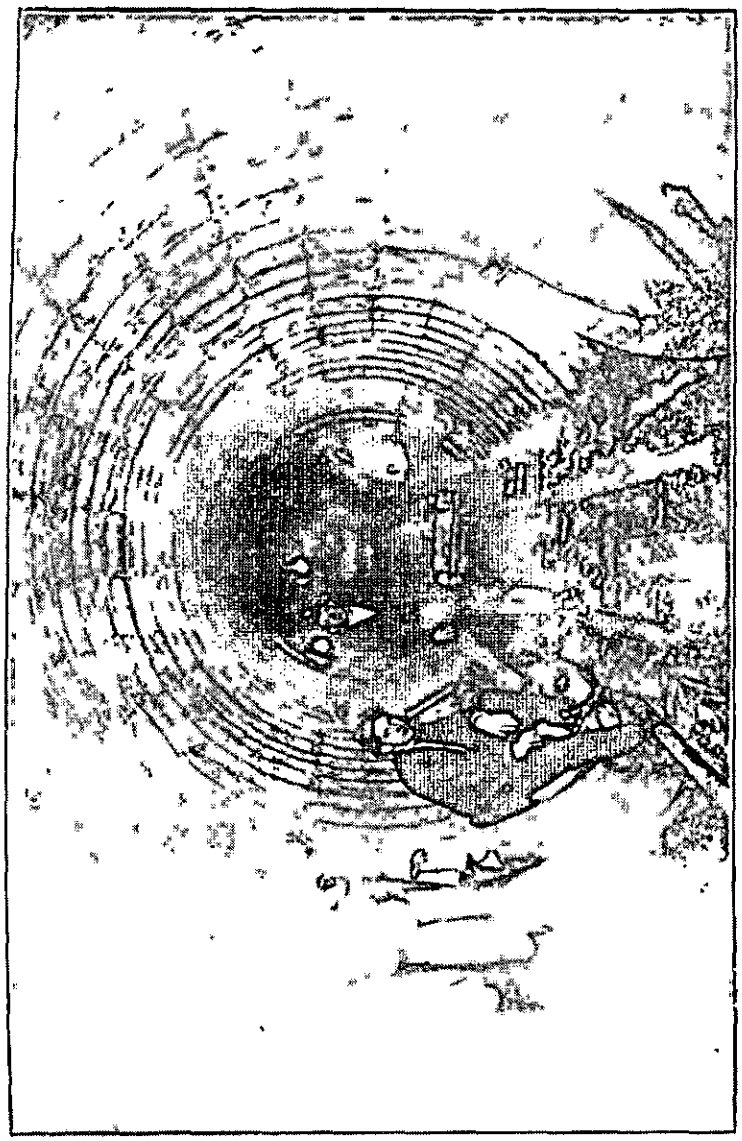

Austin Street Reinforced Concrete Sewer Over One Mile Long

This storm sewer, built in 1910 using the new tunneling method, was part of the city's ongoing effort to replace the old combined sewerage system with a system of separate storm sewers and sanitary sewers.

"To Lift the City Out of the Mud": Health, Sanitation and Sewerage in Houston, 1840-1920

Elisabeth O'Kane

By the turn of the century, Houston, like many other cities nationwide, had started to install a comprehensive public system of sewerage. Although the roots of this transition from an individual and private response to the problem of waste removal to one of municipal responsibility go well back into the nineteenth century, diverse factors such as improvements in urban technologies, advances in medical knowledge, demands for political and social reform, and in Houston, efforts to further the city's economic development, all provided a strong agenda for change between 1880 and 1900.

As early as the 1850s, officials in cities with dense populations such as Boston, Chicago, Brooklyn, and New York had begun to address the problems created by the enormous per capita increase of water consumption and the adoption of the water closet by affluent families.[1] The availability of piped water overwhelmed what one historian has termed the "private-lot waste removal" system featuring cesspools and privy vaults, which scavengers periodically cleaned out. Since city ordinances forbade water closets to connect with any existing sewers, wastes from them usually went into cesspools and privy vaults; but because of the increased volume of water,

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[1]By the mid-nineteenth century there were only 68 waterworks in the country. In 1880, this figure had jumped to 629 and increased to just over 2,000 by 1890. In less than a decade later, however, the number had grown to 3,196. See Howard D. Kramer, "The Germ Theory and the Early Public Health Care Program in the United States," *Bulletin of the History of Medicine* 22 (Jan.-June 1948): 238. For a good overview of the rise in water consumption see Joel A. Tarr, James McCurley, and Terry F. Yosie, "The Development and Impact of Urban Wastewater Technology: Changing Concepts of Water Quality Control, 1850-1930," in *Pollution and Reform in American Cities, 1870-1930*, ed. Martin V. Melosi (Austin: University of Texas Press, 1980), 59-82.

surrounding cellars and yards became flooded with fecal matter.[2] A system for removing household wastes through new more capacious brick sewers appeared, therefore, as a technological solution that would improve a city's health, promote its image, and replace the labor-intensive, and hence more costly, privy vault-scavenger system.[3] Overall, by the last decades of the nineteenth century, it was well accepted that sanitation technology had to be built on a large scale under public control.

The triumph of the "germ" theory over the "filth" or "miasmic" theory of disease by the turn of the century also helped to change attitudes toward public heath and sanitation. Historians have argued that the widely believed miasmic theory, which held that disease was caused by decaying organic matter, impeded the development of sewers. Fears of "sewer gas," or the odors from water closets and badly designed sewers, led many scientists and sanitary engineers to perceive sewers as a potential health threat.[4] By the 1880s, however, this "anticontagionism" was being supplanted by a new "contagionists" theory, which posited that disease arose from microscopic organisms. According to this theory, decaying matter and sewer gasses had little or no effect on public health.

A third reason for the implementation of comprehensive plans for sewage disposal was the impetus for reform which the Progressive movement provided to individuals, civic organizations, and municipal governments. Progressives emphasized city planning and improved public services as a way to cope with the adverse effects of industrialization. Although Houston experienced neither the level of industrialization nor the rapid urbanization of other places, it too had a Progressive movement. Reform in Houston, as in numerous cities and towns throughout the United States at this time, was also seen as a means of promoting economic growth. The development of the city's system of sewerage was one of a number of changes

[2]For the breakdown of the cesspool and privy vault system see Jon A. Peterson, "The Impact of Sanitary Reform Upon American Urban Planning, 1840-1890," *Journal of Social History* 13 (Fall 1979): 83-103; and Joel Tarr and Francis McMichael, "Decisions about Wastewater Technology, 1850-1932," *Journal of the Water Resources Planning and Management Division, A.S.C.E.* 103 (May 1977): 47-61.

[3]See Peterson, "The Impact of Sanitary Reform," 83-87.

[4]For an example of this argument see James H. Cassedy, "The Flamboyant Colonel Waring: An Anticontagionist Holds the American Stage in the Age of Pasteur and Koch," in *Sickness and Health in America: Readings in the History of Medicine and Public Health*, ed. Judith W. Leavitt and Ronald Numbers (Madison: University of Wisconsin Press, 1978), 451-458. See also Stuart Galishoff, *Newark: The Nation's Unhealthiest City, 1832-1895* (New Brunswick, N.J.: Rutgers University Press, 1988), 120-121.

intended to advertise Houston as a progressive and attractive home for both individuals and businesses.[5]

Although Houston's installation of a system of sewerage in the late 1890s fell within the context of these national developments, an examination of the efforts to improve the city's sanitation also reveals a number of other important issues. First, Houston's status as a southern city and a major urban area within the southern economy affected its policies of sanitation. Even though the city's approach to public health was, like much of the South's, ad hoc and incomplete, Houston displayed some methods of public health control quite early on in its history. Second, unlike the situation in older, larger cities, the need to install a comprehensive system of sewerage in Houston did not arise from the pressures of rapid industrialization. Rather, the desire for urban and economic growth, perceived by the city's civic-business groups and mayors as being linked to the development of a ship channel, was a primary motivating factor. Finally, an examination of the decision making behind the choice of sewerage systems also reveals something of the process of the transfer of technology from city to city. By constructing sewers in the last decades of the nineteenth century, smaller cities such as Houston were able to adopt or adapt sewerage systems already installed elsewhere. As the events in Houston indicate, city officials could draw upon the experience of a recognized group of experts in the field of sanitary engineering. A result of the growing professionalization of civil engineering, this network of consulting engineers went from city to city advising municipal governments on the most effective, and usually the most economical, method of waste disposal.

The transition from private, ad hoc sanitation measures to comprehensive, public ones came slowly in Houston, as it did in other cities.[6] Houstonians depended on the cesspool-privy vault means of waste removal and dumped the bulk of the city's sewage into the nearest watercourse, Buffalo Bayou. The earliest health ordinances and reports of the Board of Health

[5]For an overview of this time period see Harold L. Platt, *City Building in the New South: The Growth of Public Services in Houston, Texas, 1830-1915* (Philadelphia: Temple University Press, 1983), chapters 7 and 8.

[6]Even in cities that had already installed sewer systems, the use of privy vaults and cesspools prevailed. As late as 1877, Chicago still had 30,000 private cesspools within the city limits, Philadelphia had 82,000, and Washington D. C. had 56,000. Howard D. Kramer, "Agitation for Public Heath Reform in the 1870s," *Journal of the History of Medicine and the Allied Sciences* 3 (1948): 473-488, and 4 (1949): 75-89.

were preoccupied with keeping privy vaults and the streets and sidewalks clean. An ordinance of 1866, for example, threatened Houstonians with a five- to ten-dollar fine if they failed to keep their "premises and the privy clean, and to remove all trash, dirt, dirty water, decaying animal or vegetable substance, filth of every description therefrom, and use lime, or other disinfectant as may be necessary to preserve the cleanliness thereof." Furthermore, at the request of the Board of Health, a five-dollar fine would be levied to "every person who shall empty upon the sidewalks or street, or into the ditches or sewers of the city, any feculent matter, filth or liquid emitting a noisome odor, or injurious to health."[7]

Such laws frequently went unenforced, and citizens tended to ignore Board of Health admonitions. A description of Houston from the late 1830s could well have applied to the city 30 or 40 years later. "The streets have remained unattended and consequently horribly filthy," an article declared in 1839. "Carrion has been suffered to lay unremoved in our vicinity, so near as to impregnate the atmosphere with its putridity. The washings of kitchens and backyards of the whole city have been permitted to be thrown into the streets and gutters, there to rot and emit a stench disgusting and poisonous in the extreme!" In terms of filth and dirt, however, Houston's streets were probably no worse than those elsewhere, including those cities that had a planned system of sewerage.[8]

The awareness of the filthy conditions of the city and the need for frequent cleaning of waste receptacles took on added meaning in Houston, as it did in other southern cities, since the prevention of epidemic disease was always a priority on the Board of Health's agenda. As John Duffy and others have pointed out, although endemic diseases such as smallpox, diphtheria, tuberculosis, and dysentery were constant killers in most densely populated areas, nothing moved public opinion and boards of health into action like the threat of an outbreak of cholera or yellow fever, and these diseases were rampant in southern cities.[9] Although Houston did not suffer as much as Galveston, New Orleans, and Memphis from the wave of epidemics that hit the South Atlantic and Gulf Coast regions between 1830 and 1880, the effects of yellow fever and cholera still took their toll on the

[7]W. A. Leonard, comp., *Houston City Directory for 1866* (Houston, 1866), 65-67.

[8]*Houston Telegraph and Texas Register*, October 30, 1839.

[9]John Duffy, "Social Impact of Disease in the Late 19th Century," in *Sickness and Health in America: Readings in the History of Medicine and Public Health*, 414-421. For his recent discussion on the effects of epidemic diseases see Duffy, *The Sanitarians: A History of American Public Health* (Urbana: University of Illinois Press, 1990), 79-109.

developing city. Between 1839 and 1900, yellow fever hit Houston 17 times and occurred almost every other year between 1853 and 1864. In 1848, for example, out of a total population of less than 3,500 there were 2,000 cases of which 300 proved fatal. Similarly, cholera appeared in Houston in 1848, and at regular intervals between 1854 and 1867.[10]

Historians have argued that public health measures in the South were tied to this cycle of epidemics and were therefore intermittent, with little or no long-term planning for a city's sanitation. An examination of Houston's Board of Health's response to the threat of epidemics suggests that, to a certain extent, concerns over the sanitary condition of the city also fell into this sporadic pattern. Along with other southern cities, Houston relied on quarantine measures, which businessmen often resented because of trade losses.[11] Health officials also advocated street cleaning and the liberal use of lime as a disinfectant, although they usually confined both efforts to the city's central business district. With the threat of a cholera outbreak in the summer of 1866, for example, the Board called for "the more effectual enforcement of the city ordinances preventing the accumulation of filth," and for the city to secure large quantities of lime.[12] The following year a newspaper editorial urged the city to purchase carbolic acid, "the unparalleled life saver," as another epidemic threatened the city.[13] Similarly, as news of the outbreaks of yellow fever in New Orleans and Memphis reached Houston by July 1878, the *Houston Daily Telegraph* printed notices for the Board of Health to supervise a thorough cleaning of the city and to levy a

[10]James B. Speer, "Contagion and the Constitution: Public Health in the Texas Coastal Region, 1836-1909" (Ph.D. diss., Rice University, 1974), 41-74. By contrast, the mortality rate was significantly higher for other areas in the South. Between 1832 and 1833 in New Orleans, 10,000 out of 50,000 cases died from yellow fever and cholera. In 1848, cholera claimed over 5,000 victims and a further 2,000 in 1886. Perhaps the worst yellow fever epidemic occurred in 1878 since it affected communities in 11 states and left a total of 20,000 dead out of 120,000 cases. In New Orleans alone, 4,000 died out of 27,000 cases of yellow fever. For background and statistics see Duffy, "Social Impact of Disease," 414-419; Dennis East, "Health and Wealth: Goals of the New Orleans Public Health Movement, 1879-84," *Louisiana History* 9 (Summer 1968): 246-247; and John H. Ellis, "Businessmen and Public Health in the Urban South During the Nineteenth Century: New Orleans, Memphis and Atlanta," *Bulletin of the History of Medicine* 44 (May-June 1970): 197-212 and (July-August 1970): 346-371, particularly 204-207.

[11]Dennis East noted, for example, that estimates of the cost of disruptions to the city's commerce caused by quarantine measures in New Orleans in 1878 ranged from $1,500,000 to $175,000,000.

[12]City Council Minutes, Book B, August 15, 1866, 155, 172.

[13]*Houston Daily Telegraph*, September 14, 1867.

$10 to $25 fine on citizens who failed to disinfect their premises.[14]

In some respects, however, Houston's response to the threat of epidemics and its attitude toward sewerage and drainage appears to have differed quite markedly from that of other cities in the South such as New Orleans, Memphis, and Atlanta. Although the city's Board of Health adopted something of a sporadic approach to the enforcement of sanitation measures, the board members (three representatives for each ward) demanded better drainage and sewerage quite early on in Houston's development.[15] In December 1866, for example, a Board of Health report to Mayor Horace D. Taylor declared "there is scarcely a citizen who is not aware that the sickness which prevails is caused by miasma and malaria and that these are indissolubly connected with stagnant waters and damp atmosphere. By perfecting adequate drainage," the report continued, "we facilitate cleanliness and strike a telling blow for the extinction of the numerous family of intermittent, and remittent fevers...to say nothing of those great scourges of the South, yellow fever and cholera."[16]

At the same time as this report, the Board also submitted a plan for sewerage and drainage drawn up by Colonel William H. Griffin, a civil engineer who became the city engineer between 1867 and 1869. Based on his earlier survey of the city in October 1865, Griffin estimated that at a cost of $675,000, three main sewers discharging into Buffalo Bayou would be sufficient to drain the southern part of the city. The city council unanimously endorsed Griffin's proposals on the understanding that a "more extensive area would be drained," and that the "habit of heaping the accumulated filth of the gutters onto the sides of the streets, there to putrefy," would be stopped.[17] This action indicates that the Board of Health, composed of physicians and prominent citizens, had succeeded in awakening Houston's municipal government to the need of assuming responsibility for the sanitary condition of the city. Whereas other cities in the South had often talked of sewerage as a means to combat yellow fever and cholera,

[14]*Houston Daily Telegraph*, July 26-27, 1878; *ibid.*, August 1, 1878; *ibid.*, September 25, 1878. Stories on the epidemic continued into November.

[15]This interpretation is based on a fairly extensive search through city council minutes and newspapers from the mid-nineteenth century onwards. It differs substantially from James Speer's findings in his dissertation, "Contagion and the Constitution."

[16]City Council Minutes, Book B, December 20, 1866, 199-201.

[17]*Ibid.* Sewers would be built on Caroline Street, Texas Avenue, and Bagby Street. With a population of nearly 9,000 and a total area of three square miles, however, Griffin's plan would only have covered a small portion of the city and mostly the immediate business district.

Griffin's plan for a waste removal system was a pioneering attempt in Houston toward ameliorating the ravages of epidemic diseases.

In March 1867, city engineer Griffin started to survey the streets for grading.[18] Within a few months construction began, but it continued slowly because of financial difficulties and the simultaneous building of private sewers which impeded the development of a comprehensive system. Although declared a "masterly specimen of workmanship," the Caroline Street brick sewer, for example, was not completed until 1872 and the city council was still considering contract bids for a sewer in Congress Street as late as 1874.[19] The city council minutes show that in spite of the initial enthusiasm for Griffin's drainage plan, most demands for city improvements centered around the need for street and bridge construction and street paving. These items dominated council meetings and newspaper editorials.[20] It was not until the mid-1880s that the effects of unplanned sewer building and the neglect of sewerage in general began to reemerge as an issue for Houstonians.

With traditions of weak boards of health and inefficient local government, southern cities often depended on the leadership of private groups and businessmen, who came down heavily in favor of public health reforms. As John H. Ellis concluded from his examination of New Orleans, Memphis, and Atlanta, businessmen "perceived the crisis in public health as a business problem to be solved by business methods: business situations governed their thinking on every health issue from quarantine to drainage." Business groups frequently joined ranks with civic organizations, public health officials, reformers, and sanitarians on public health issues. Moreover, local businessmen often led in the demands for improved

[18]City Council Minutes, Book B, March 28, 1867, 254.

[19]City Council Minutes, Book C, July 6, 1872, 49; July 20, 1872, 52-53; January 10, 1874, 252; May 9, 1874, 339.

[20]So did petitions for private sewer construction. For examples, see the business recorded in City Council Minutes, Books C and D which cover this period. Chapter two of Platt, *City Building in the New South*, looks in detail at the Reconstruction years, and especially the efforts of Mayor Scanlan (1870-73) to improve city services. He argues, however, that financial constraints and problems with the tax base meant that public improvements such as street paving and bridge building were usually of cheap and shoddy construction. In addition to the emphasis on road improvement, Platt also shows that the city council gave most attention to developing private services such as gas lighting and streetcars, developing the ship channel, building railroads, and constructing the downtown Market House. See Table 2.2: Houston Bond Issues, 1866-1874, in *City Building in the New South*, 40.

sanitation under city government supervision and also raised public consciousness as to the need for better health practices.[21]

In southern cities that had been ravaged by outbreaks of yellow fever, business groups led the way in demanding better sanitation and more stringent quarantine measures.[22] In March 1879, a group of merchants and businessmen, previously known as the "Committee of Seventy," reorganized to form the New Orleans Auxiliary Sanitary Association. Using the motto "public health is public wealth," this organization undertook projects to improve the city's sewerage, drainage, and water supply and also advocated the benefits of efficient quarantine to the city.[23] Similarly, in Memphis, business groups founded their own Auxiliary Sanitary Association and their efforts to improve the city's sanitary conditions complemented the earlier work of the Howard Associations, which had centered upon improving the health of the poor.[24]

Although Houston had a somewhat stronger Board of Health, local conditions and the needs of the community, or at least the needs of the business and civic groups which represented the economic goals of the city, nonetheless influenced its attempts to construct a sewerage system. Boosters bent on promoting Houston's advantages and maintaining its position within the regional economy were keenly aware of the importance of public health to the wealth of their community. While no groups had emerged in Houston comparable to the Auxiliary Sanitary Associations, a Citizen's Committee had coalesced by the 1880s to "discuss the construction of street

[21]Ellis, "Businessmen and Public Health," 350. There is a wealth of literature on the role of businessmen in promoting sanitary reform in southern cities. See for example, East, "Health and Wealth," 245-275; David R. Goldfield, "The Business of Health Planning: Disease Prevention in the Old South," *Journal of Southern History* 42 (Nov. 1976): 557-570; and Margaret H. Warner, "Local Control Versus Natural Interest: The Debate Over Southern Public Health, 1878-1884," *Journal of Southern History* 50 (1984): 407-428. The role of business groups was not just a southern phenomena. Stuart Galishoff's study of sanitation reforms in Newark, New Jersey, similarly concludes that the city's sewerage system came about because of the lobbying by the board of trade, which believed that municipal services such as sewerage and water supply were essential to attract individuals and businesses into the city. See Galishoff, *Newark: The Nation's Unhealthiest City*, 193-194.

[22]In addition, as a result of the severity of the 1878 outbreak of yellow fever, the federal government funded a National Board of Health (1878-1882) to supervise an efficient system of quarantine in coastal communities. For a detailed look at the National Board of Health see Warner, "Local Control Versus Natural Interest," 407-428.

[23]East, "Health and Wealth," 250-251. In 1881, the Auxiliary Sanitary Association obtained a charter to form the New Orleans Drainage and Sewerage Company to install the Waring system (discussed on page 13). The municipal government took over responsibility in 1903.

[24]For a study of the sanitary changes in Memphis, Atlanta, and New Orleans, see Ellis, "Businessmen and Public Health," 350-369.

paving, drainage and sewerage in the city."[25] Made up of Houston's leading businessmen such as T. W. House, W. P. Cleveland, E. W. Cave, and Judge E. P. Hill, the committee's members had a strong interest in the economic growth of their city, including the proposal to build a ship channel, which they saw as the key to Houston's economic growth.

The dream of a deepwater channel into the city was almost as old as Houston itself. Many of the businessmen in the Citizen's Committee were also members of the Houston Navigation Company, which had been organized in the early 1850s to improve navigation on Buffalo Bayou. Their goal was to construct a channel which would enable deepwater navigation from the Gulf of Mexico to the city, thereby allowing Houston to compete with the Port of Galveston for trade. A boost to their efforts came in 1853 when the Texas State Legislature appropriated $4,000 toward clearing this waterway. In 1867, a new company called the Buffalo Bayou Ship Channel Company began cleaning up the bayou and, together with the municipal government, succeeded in getting the federal government to declare Houston an official port of entry. This proved to be the beginning of many attempts to involve the national government and, more importantly, federal money in the development of Houston's ship channel.[26] Many businessmen believed, however, that basic improvements such as street paving, lighting, and sewerage had first to occur in the city to attract both federal interest and outside investment in the deepwater project.

By the mid-1880s, the inadequacies of Griffin's unfinished system had become obvious in a city that continued to expand outward and whose population had nearly doubled within a decade (see Table 1). With only five main sewers and some badly constructed private lines, all within the city center, most Houstonians were still dumping their wastes into cesspools. Less than five percent of houses had water closets or connections to the sewers.[27] As a result, there was a perceptible increase in the number of city council meetings and newspaper articles devoted to improving Houston's sewerage and drainage. In a plea to his fellow council members in April

[25]*Houston Daily Post*, January 8, 1889.

[26]For more on local business leaders and the ship channel project see Marilyn McAdams Sibley, *The Port of Houston: A History* (Austin: University of Texas Press, 1968), 67-72, 79-101.

[27]*Tenth Census of the United States, 1880, Report of the Social Statistics of Cities*, comp. by George E. Waring, Jr., 2 vols. (Washington D.C., 1887), 2: 301-332. Houston was still better off than other major cities in Texas since Austin, Galveston, and San Antonio had no sewers at all, and Dallas could claim only a few.

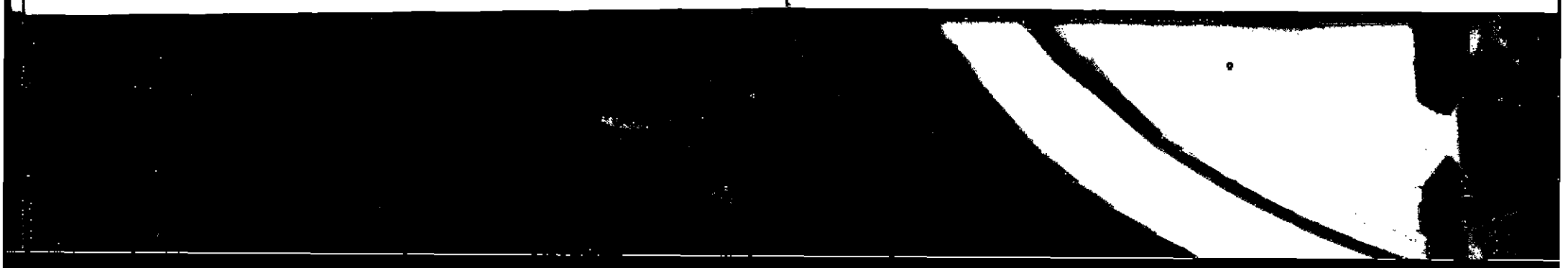


Table 1: Population in Houston, 1850-1920

Year:	1850	1860	1870	1880	1890	1900	1910	1920
Pop:	2,396	4,845	9,382	16,513	27,557	44,633	78,800	138,276

1885, for example, Alderman Thomas urged that the "construction of sewers be placed under the supervision of the city engineer and that no new sewers be constructed without permission from the Mayor and the Street and Bridge Committee."[28]

It was over two years before Mayor Daniel C. Smith and the city council seriously began to concentrate their attention upon these measures for sanitary reform. In June 1887, W. M. Harkness, the city engineer, put forward proposals for the drainage and sewerage of the city. In appealing to the council's cost consciousness, Harkness declared the need "for improvements on a well defined plan. It would greatly facilitate the carrying on of all public improvements," he argued, "to have a well devised plan of sewerage and drainage determined. I have all the necessary data by which the matter can be intelligently arranged and would suggest that steps be taken to find out what we need in that way by examining plans in operation elsewhere, and allowing the city engineer the advising assistance of some expert in city sewerage and drainage."[29]

Harkness's proposal for sewer construction came at a time when municipal reform and expansion of public services were politically popular topics. A consensus had been reached on the need for public improvements. The debatable issues under Mayor Smith's government were largely those of funding: whether new taxes, special assessments, or municipal bonds should finance public works projects.[30] In light of financial constraints, therefore, Harkness's report was important because he assuaged the fears of the municipal government regarding its responsibility for the city's sewerage. The promise of data collection through the examination of sewerage systems in other cities and the use of an outside expert who would be capable of the long-range planning which these systems required helped convince Mayor Smith and the council members to embrace his proposal.

The plan for Houston's sewerage also came as a result of civic and business groups' demands for better sanitation in the city. By early 1889, the Citizen's Committee had met with Mayor Smith and the city engineer and outlined a plan for the sewerage of the city. A "competent engineer" would make a topographical survey of Houston, survey the bayou, grade the streets, and determine the "proper location for [the] main, secondary and lateral sewers." The city council decided that the sale of sewer bonds, two series of $100,000 each for 20 years at six percent interest, and an assessment on abutting property owners or those who connected to the sewers, would be sufficient to cover the costs of construction.[31]

[28]City Council Minutes, Book F, April 6, 1885, 324.
[29]*Ibid.*, June 27, 1887, 565.
[30]See Platt, *City Building in the New South*, 125-131.

Once it had decided to build a sewer system, Houston faced the technologically complex decision of what type of system to install. To strengthen its case to both the city government and the taxpayers, Houston's Citizen's Committee included a glowing report by the mayor of Norfolk, Virginia, on the separate system of sewerage (sanitary sewers and storm water sewers) constructed there by 1881. The mayor declared that by "carrying off the disease germinating refuse and household waste from our residences in the most expeditious manner," the separate system advocated by Col. George E. Waring had accomplished "the principle end for which sanitary science aims."[32]

Although the separate system of sewerage had been discussed and in some cases installed in European cities since the 1840s, Waring became the chief proponent of this system in the United States. In both popular and scientific publications, he expressed his belief that in order to prevent miasmas and disease, fecal matter had to be removed before it started to decompose. The quickest and most efficient way, he argued, was through small pipes of vitrified clay, which would totally exclude storm water and thereby only carry human wastes. Since the beginning of sewer construction in the United States, however, sanitary engineers in cities like Chicago and Brooklyn had built combined systems whereby household wastes, rainwater, and street runoff collected into large brick sewers, which invariably emptied into the nearest watercourse.[33] While the controversy over the

[31]*Houston Daily Post*, January 8, 1889.
[32]*Ibid.*, January 22, 1889. The total estimated cost of Norfolk's system was $139,000.
[33]For a detailed examination of Waring's system which also looks at the separate and combined sewer controversy see Joel A. Tarr, "The Separate Versus Combined Sewer Problem: A Case Study in Urban Technology Design Choice," *Journal of Urban History* 5 (May 1979): 308-339. Waring discussed the two systems and the advantages of the separate system in numerous studies and articles. See for example, *Sewerage and Land Drainage* (New York, 1891), 28-53.

merits of the separate versus combined systems raged for many years, most experts agreed that separate sewers were suitable for smaller cities and combined systems were most cost-effective and practical for large, densely populated metropolises. Furthermore, after exhaustive investigations and collection of data, neither system appeared to offer any superior benefits to public health. Sanitary engineer Rudolph Hering concluded from his extensive survey of European sewerage that the crucial difference between the two was "mainly a question of expediency and cost."[34]

Although the debate appeared settled, Waring remained a controversial figure within the growing profession of sanitary engineering. He installed separate sewers in Memphis, Tennessee, after the 1878 yellow fever epidemic, the first major application of his separate system in the country. A few years later in 1881, Major J. H. Humphries, who had worked on the Memphis sewer system, constructed separate sewers in Norfolk, Virginia, using Waring's design.[35] In both cases, Waring claimed to have perfected a technology which excluded rainwater, had no manholes, and relied on regular flushing through the use of automatic flush tanks. Convinced of the value and originality of his design, he tried to patent them as the "Waring's System of Sewerage."[36]

In Houston, the Citizen's Committee's presentation of the Norfolk mayor's favorable report on the Waring system did not go unheeded. Many Houstonians were convinced that their city would benefit from the same type of sewerage system that had proved successful in Norfolk and in Memphis, both of which had larger populations than Houston.[37] Waring's system and

[34]Rudolph Hering, "Sewerage Systems," *Transactions of the American Society of Civil Engineers* 10 (1881): 361-385.

[35]On Norfolk's sewerage see *Engineering News* 9 (May 5, 1883): 212-215. For a contemporary discussion of the system in Memphis see Frank S. Odell, "The Sewerage of Memphis," *Transactions of the American Society of Civil Engineers* 10 (1881): 23-52. For an overview of sewerage in Memphis see John H. Ellis, "Memphis' Sanitary Revolution, 1880-1890," *Tennessee Historical Quarterly* 23 (March 1964): 59-72.

[36]Arguing that his system of sewerage did not admit rainwater into the sewers and claiming to have adapted the design of Field's flush tank, Waring applied for a patent in January 1881, and then again in June 1883. He gave these patents to the Drainage Construction Company, an engineering firm that he had helped found. On the issue of patents see *Engineering News* 8 (Oct. 22, 1881): 425-427. By the 1890s, in spite of the criticisms levied against him by the engineering profession, the "Waring System of Sewerage" had been accepted as a variation on the separate system. For Waring's own point of view and justification of the system see Chapter 10 and Appendix C of *Sewerage and Land Drainage*, 89-108, 373-391. For a list of the cities and towns that had installed his system see *ibid.*, 388.

[37]Compared to Houston's population of 16,513 in 1880, Norfolk had 21,966 and Memphis had 33,592 inhabitants.

the efficient removal of wastes appeared, therefore, to be a way to eliminate epidemics and improve sanitary conditions. By 1889, for example, Memphis could boast that its death rate per 1,000 had been cut in half from an average of 46 to 21. This figure closely paralleled the national mortality rate, which had dropped from 40 deaths per 1,000 to 26 between 1860 and 1880 as a result of improved sewerage systems and sanitation practices.[38]

In November 1889, in an attempt to fully legitimize the proposals for Houston's sewerage, the Citizen's Committee and council members requested that a consulting engineer be brought in to work with the city engineer, now C. W. Jarvis. Accordingly, after some deliberation, the recently constituted Board of Public Works (a supervisory body over public improvements) recommended Wynkeep Kiersted, a sanitary engineer from Kansas City. Kiersted was probably chosen because he had been involved in the plans to install the Waring system in Kansas City in 1883.[39] Together with Jarvis, Kiersted devised a separate plan of sewerage and drainage, starting with the city's third and fourth wards: the central business district and the area southwest of it.[40] One month later, they had divided the rest of the city into several main sewerage districts. Construction in the San Felipe sewerage district, for example, covering Travis, Milam, Louisiana, Walker, and Lamar streets began in early December 1889 and had ended by April 1891.[41] It appears, however, that construction was not completed in all

[38]Ellis, "Businessmen and Public Health," 207; Kramer, "The Germ Theory," 235. The mortality rate decreased because of the drop in the number of cases of typhoid. Although there was some correlation, the installation of a sewerage system did not automatically mean a drop in a city's death rate. Sewers did not normally extend into the poorer parts of town, and diseases that were not caused by waterborne bacillus still raged. Furthermore, for towns and cities that drew their water from sources polluted with sewage from their upstream neighbors, the mortality rate actually increased. The mortality rate in Trenton, New Jersey, for example, went from 17 per 1,000 in 1880 to 32.7 per 1,000 in 1900. For more information see Tarr et al., "The Development and Impact of Urban Wastewater Technology," 69-72.

[39]From lack of biographical information it is difficult to determine if Kiersted was the city engineer in Kansas City, but he was involved at some level in the installation of the Waring system under the direction of Octave Chanute, the project's consulting engineer. *Engineering News* 9 (December 15, 1883): 604. The system was in place by 1890, but as Kiersted pointed out, it was not entirely on the Waring system since rainwater was admitted into some of the lateral sewers. *Engineering News* 23 (April 12, 1890): 358.

[40]City Council Minutes, Book G, November 25, 1889, 301.

[41]*Ibid.*, December 2, 1889, 310; April 13, 1891, 423. These records reveal little about the districts or when construction was completed. For a full listing of the sewerage districts and for the areas they covered see *The Charter of the City of Houston, 1893 and Revised Code of Ordinances of the City of Houston* (Houston, 1893), 187-195.

districts. A booster publication produced for the World's Columbian Exposition claimed that the system was in place in 1893, and that Houston had 24 miles of sewers, although several were still under contract. Later pamphlets were also prone to exaggeration with their claims that Houston had over 50 miles of sewers by 1897.[42]

If this second attempt at sewering and draining Houston was not as successful as anticipated, it had nonetheless come about from the long-standing awareness by citizens and city government alike that sanitary reform was just as important as any other public improvement. Kiersted's plans for the construction of Waring's separate system had reinforced the political changes occurring within the city government, particularly the charter revisions, which had reorganized and created new supervisory boards and departments to handle the increased areas of responsibility. The fact that the city now had a number of sewers meant that, in addition to the Board of Health, the city needed a Board of Public Works and a sewer inspector to supervise sanitation matters. A great number of new regulations concerning plumbing, drain-laying, catch-basins, and the connection of water closets, cesspools, and privy vaults to sewers quickly fell within their purview. Furthermore, the city government also had to rewrite its sanitary ordinances and enforce stricter laws over dumping, for example, since blockages were expensive and threatened the efficiency of the sewerage system.[43] This new organizational structure was well in place by the late 1890s.

Other changes in Houston's municipal government, particularly Mayor Samuel Brashear's promises to expand public services, also meant that by the late 1890s the city council was in a strong position to extend and improve the city's methods of sewage disposal. Soon after taking office in 1898, Brashear expressed the goals of the new municipal administration and paid particular attention to the city's sanitation which was, he declared, "in need of a thorough over hauling. The first step by the city government," he continued, "should be to compel sewer connections under ordinances, remove the surface closets and clean and drain the city from border line to border line."[44]

[42]Charles F. Morse, *The City of Houston and Harris County, Texas: World's Columbian Exposition Souvenir* (Houston: Cumming & Sons, Printers, 1893), no page numbers. Although this pamphlet claimed the city had 24 miles of sewers, the city directory for 1892-1893 said there were 16.

[43]Details can be found in *The Charter of the City of Houston for 1893*, 195-206.

[44]*Houston Daily Post*, April 12, 1898. For background on the mayoral campaign of 1898 between Brashear and H. Baldwin Rice, see Platt, *City Building in the New South*, 157-164.

Numerous factors influenced this decision to try once again to devise a comprehensive system of sewerage and drainage. The increased amount of sewer construction all over the country did not escape the attention of the mayor or council members.[45] But local conditions and considerations undoubtedly had the most sway. Problems with the quality of the water, which the city's waterworks supplied, meant that Buffalo Bayou, as part of the source, had to be cleaned up. Concern over the unhealthy conditions in the bayou and the effect of fecal matter and animal carcasses in the water supply, however, was only part of the incentive to make improvements. The biggest push for change came from commercial and business groups, especially the Houston Business League, who convinced Brashear that Houston's sewage would have to be removed from the bayou before the federal government would appropriate any funds to help build a ship channel.[46] Not wanting to jeopardize Houston's economic development, the city council placed the issue of sewerage at the top of its agenda. In late January 1899, the recently appointed Sewer Committee requested that another sanitary engineering expert be brought in to make a preliminary survey of the city's sanitary conditions.[47]

One month later, Alexander Potter, a sanitary engineer from New York City, arrived in Houston and shortly presented a detailed report to Mayor Brashear. Potter argued that the increase in population, now over 40,000, and residential expansion had rendered Kiersted's system inadequate: sewer lines covered less than 50 percent of the city's area and only about 15 percent of residents had sewer connections. He reminded council members that conditions in Buffalo Bayou deterred federal interest in assisting plans for a ship channel. "In all my experience," he declared, "I have met with no parallel or equal to the conditions which must prevail in the bayou during the summer months. The sewage of the city, the refuse from the gas works, oil works and slaughter houses, it is difficult to imagine its being much worse. The velocity is so sluggish and the banks of the stream so winding that nearly all of the solid portion of the sewage is precipitated

[45]By the 1890s, out of 96 cities with populations over 10,000, only 26 had no sewers. Edward Meeker, "The Improving Health of the United States, 1850-1915," *Explorations in Economic History* 9 (Summer 1972): 372.

[46]Platt, *City Building in the New South*, 159-161; and David G. McComb, *Houston: The Bayou City* (Austin: University of Texas Press, 1969), 129-131. Furthermore, the Rivers and Harbors Act of 1899 prohibited dumping wastes into navigable waters. For additional background information on federal involvement in Houston's deepwater project see Sibley, *The Port of Houston*, 102-145.

[47]City Council Minutes, Book J, January 23, 1899, 602.

directly in front of the city." To remedy these conditions and reduce pollution in the bayou, especially "in view of the [federal] appropriation for deepening the bayou," Potter recommended the construction of separate sewers for wastes and storm water. Appealing to the cost-conscious city government, he argued that the smaller pipes used in the separate system reduced construction costs, that separate sewers were easier to maintain, and that the system had proved successful in cities with similar-sized populations.[48] Although not an avowed follower of Waring, Potter believed that in the case of Houston this separate system would be the most efficient at meeting the city's needs. "All existing sewers, and all sewers to be constructed," he argued, "must be incorporated into a strictly separate system from which all storm water and street drainage must be absolutely excluded."[49]

Houston's officials chose Potter for the position of consulting engineer for several reasons. From a cost-benefit perspective—and given the fact that Kiersted had already laid the foundations of this system—Potter's analysis appealed to city officials. Moreover, Potter had had years of experience in constructing both combined and separate systems, and had in fact worked with the city engineer in Kansas City during 1886 to 1888 as that city's separate sewerage system was under construction. He was a well-respected figure within sanitary engineering, an associate member of the American Society of Civil Engineers, and as his role of consulting engineer reflected, also a recognized expert in the field of water supply and sanitation.[50] Crucial, however, was Potter's rationale behind his recommendation for a separate system of sewerage in Houston. It was one matter to design a system for the effective removal of waste from residences, but Houston's sewage had to be taken out of the bayou. In their choice of consulting engineer, the city's business groups and government officials selected an expert who had written extensively and believed firmly that sewage had to be treated.[51]

Unlike the majority of sanitary experts, Potter did not believe that streams

[48] *Houston Daily Post*, February 21, 1899. See also City Council Minutes, Book J, February 20, 1899, 625. Potter's report also included plans for an electric plant and a municipal garbage incinerator.

[49] *Houston Daily Post*, February 21, 1899.

[50] One of the few sources of biographical information on Potter is his obituary in the *Transactions of the American Society of Civil Engineers* 106 (1941): 1652-1654.

[51] Potter believed that sewage purification was "the most pressing of all sanitary problems." See for example his article, "The Relation of Mayors and Councilmen to Sanitary Problems," *City Government* (October 1897), 125-128.

naturally cleansed themselves from the effects of raw sewage deposits. This widely held theory of natural purification had retarded the development of sewage treatment in the United States. Leading sanitary engineers argued well into the twentieth century that it was more beneficial and cost-effective to treat a city's water supply than its wastes. As a result, water treatment technology developed at a much faster rate than that of sewage treatment. In Pittsburgh, for example, two renowned engineers, George C. Whipple and Allen Hazen, assuaged the fears of civic leaders and health officials by affirming in 1910 that the sewage dumped into the Monongahela, Allegheny, and Ohio rivers was naturally purified. Accordingly, the city did not need to redesign its sewerage system or build treatment facilities, but should concentrate on improving the filtration of its water.[52]

By the 1890s, there were only a handful of sewage treatment plants in the country. The engineering profession's emphasis on water filtration was only part of the reason, however. Until this time, by far the majority of cities and towns had constructed sewers on the combined system. The combination of street runoff, storm water, and sewage simply produced too great a volume for wastes to be treated effectively, so that treatment of sewage remained far too costly for municipal governments to even consider. As a result, over 90 percent of cities and towns simply discharged their raw sewage into the nearest water course, believing that the flow of water created a process of natural filtration through dilution of the sewage.[53] The advantage of the separate over the combined system in terms of sewage treatment is reflected in the data. In 1892, for example, out of 27 cities and towns that treated their sewage, 26 had separate sewers. By 1902, all but two of 95 cities which had sewage treatment facilities also had separate systems of sewerage.[54]

Given the pressing need in Houston to clean up Buffalo Bayou, Potter presented to Mayor Brashear and the city council an exhaustive summary of the latest sewage filtration methods in Europe and the United States with their relative merits in terms of effectiveness and cost. Out of the

[52] See George P. Gregory, "A Study in Local Decision Making: Pittsburgh and Sewage Treatment," *Western Pennsylvania Historical Magazine* 57 (Jan. 1974): 25-42.

[53] For a good summary of the developments of sewerage systems in American cities up to the 1920s see Harrison P. Eddy, "Sewerage and Drainage of Towns," *Transactions of the American Society of Civil Engineers* 92 (1928): 1225-1239.

[54] Tarr, "The Separate Versus Combined Sewer Problem," 328; and Tarr and McMichael, "Decisions About Wastewater Technology," 54. On the benefits of the separate over the combined system in terms of sewage treatment see Tarr, "The Separate Versus Combined Sewer Problem," 321-333.

choice of chemical disposal, the septic tank system, forced aeration, land irrigation, and intermittent filtration, the latter appeared as the most viable option. Once sewage had flowed over filter beds of sand or gravel, the water, Potter declared, "is fit to drink," but he would only decide if this was the best method for Houston after he had surveyed Buffalo Bayou and the sand deposits in the area.[55] He concluded his report by playing upon civic pride. If the city adopted his proposal, he argued, "Houston in the future may be known as the most sanitary city in the South, whose public improvements are established and conducted upon the most approved scientific and economic principles."[56]

The city government wasted little time in making a decision, and with the consent of Brashear and the Finance and Sewer committees, gave Potter $5,000 to survey the city.[57] Three months later in May 1899, Potter had concluded his work and reported to the Sewer Committee that the process of intermittent filtration appeared, after all, to be the "most effective and scientific method of sewage purification" for Houston.[58] According to his design, sewers would carry wastes through small vitrified pipes to a central station, which would then pump the sewage through 24-inch cast-iron pipes to the filtering beds, located five miles outside of the city center. Here the sewage would be strained through coke filters at a rate of 1,000,000 gallons per 24 hours and then filtered through beds of sand or fine gravel. Potter argued that the coke straining alone would remove 48 percent of organic matter and that after the natural oxidation and nitrification processes had occurred, the effluent discharging into the bayou would be practically as

[55] *Houston Daily Post*, February 21, 1899. Intermittent filtration was a process developed in the early 1890s from research at the Lawrence Experiment Station in Massachusetts. Potter argued that chemical disposal was expensive and not always effective, the septic tank system where the solids in sewage broke down was not practical for large sewerage systems, forcing chemically treated sewage through sand had had mixed results, the sluggishness of the rate of flow in the bayou ruled out dilution, and land irrigation required a great deal of land.

[56] *Ibid.*

[57] *Ibid.* The City Council stressed that a sewer system was essential to "the health of the citizens of Houston," but also mentioned the need for sanitation reform in light of the recent federal regulations. *Ibid.*, February 27, 1899.

[58] City Council Minutes, Book J, May 15, 1899, 685-686. In a survey of 91 cities and towns which had constructed some type of sewage treatment works between 1894 and 1904 (this survey included Houston), George W. Fuller found that intermittent filtration was the most popular method of purification (45 percent). Septic tank treatment was used by 19 percent of these cities, land irrigation 15 percent, and chemical treatment 14 percent. For a detailed discussion see George W. Fuller, "Sewage Disposal in America," *Transactions of the American Society of Civil Engineers* 54E (1904): 147-195.

Table 2: Miles of Sewers in Houston by December 1902

Wards	Type of Sewers			
	Sanitary	Combined	Storm	Total
First	1.85	none	none	1.85
Second	2.9	0.76	0.96	4.62
Third	14.7	0.33	2.37	17.4
Fourth	6.65	none	0.64	7.29
Fifth	none	1.8	3.07	4.87
Sixth	0.38	0.95	none	1.33
Total				37.35

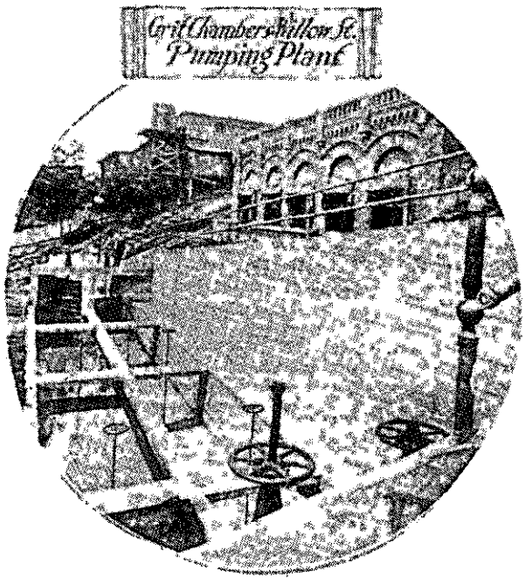
Source: *Annual Message of O. T. Holt Mayor of the City of Houston and Annual Reports of City Officials for the Year Ending December 31, 1902* (Houston, 1903), 52, 59, for figures given in lineal feet.

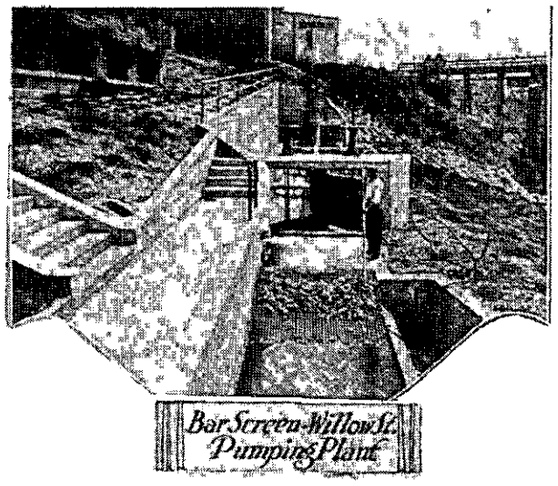
pure as water. Impressing upon the Sewer Committee once more that the bayou had to be cleaned up for both Houston's health and for the ship channel project, Potter argued that the large financial outlay for building the infrastructure (a pumping station and filter beds as well as sewers), would pay off in the long term. As a result, the city government voted unanimously for Potter's sewerage plans and decided to call for a $300,000 bond issue with five percent interest to finance the work.[59]

By July 1900, the bond issue had gone through and construction began on the treatment plant. The city purchased property on Willow Street in the Fifth Ward along White Oak Bayou for the pumping station and also 200 acres of land four miles outside of the city for the filtering beds. Potter divided Houston into 12 sewerage districts covering all of the city's wards, but initial sewer construction concentrated on the more affluent inner Third Ward, which included most of the central business district.[60] By 1902, main and lateral sewers in five sewerage districts, La Branch, San Felipe, Caroline, Washington, and Buffalo, had been constructed, so that the city now had 37 miles of sanitary and storm sewers. Two-thirds of the sewers were in the Third and Fourth wards, which together contained the entire downtown

[59] City Council Minutes, Book J, May 15, 1899, 685-686. See also *Houston Daily Post*, July 25, 1900.

[60] *Houston Daily Post*, July 25, 1900. The 12 sewerage districts were Washington Avenue; Montgomery Avenue; Hardy Street; San Felipe; White Oak; La Branch; Commerce; and East, North, South, Southeast, and Southwest Pumping districts.





and the most affluent residential areas of the city. Streets in the First, Second, Fifth, and Sixth wards, where the city's industrial development and its populations of blacks, Hispanics, and working-class white immigrants were concentrated, had the smallest number of sewers. This pattern of sewering the affluent sections of a city was by no means unique to Houston.

Despite initial enthusiasm for Potter's work, problems plagued the entire new system from the outset. The data in Table 2 show that Potter, like Kiersted before him, did not strictly adhere to Waring's system. In Houston, as in many other cities that endorsed a dual sewer plan, financial constraints limited the degree of storm water sewer construction. The main provision for handling rainwater was through surface drainage. As a result, "storm water, street refuse and sand" entered through the catch-basins, causing stoppages within the sanitary sewers. The fact that only two men maintained the sewers compounded the expense of removing such obstacles and many of the lines remained blocked or worked inefficiently.[61] Underlying these problems was the issue of city budgeting. Although the appropriation for the city's sewers had been steadily rising (by 1902 the city council had also created a separate Sewer Department), it had not increased enough to accommodate the requirements of Houston's complex sewerage infrastructure.[62]

As the city records indicate, the Willow Street Pumping Station, in operation by May 1902, was the most troublesome and took up most of the available financial resources. Repairs and operation of the pumping station and filter beds cost almost $11,000 in 1902 and $7,000 in 1903, while sewer inspections received $1,500 and sewer repairs only $800 from the 1903 budget.[63] City engineer F. L. Dormant stated in his 1902 report to Mayor Oran T. Holt that because of the bad condition of the pipes and a leaky roof at the plant, the filtration of sewage was far from satisfactory:

[61]See *Annual Message of O. T. Holt Mayor of the City of Houston and Annual Reports of City Officials for the Year Ending December 31, 1902.* (Houston, 1902), 38-43. (This publication was published each year. Starting in 1914, the mayor's message and departmental reports were issued under other titles, including *Illustrated City Book of Houston, Municipal Book of the City of Houston,* and *City Book of Houston,* each subtitled *Annual Message...* Hereafter all will be cited as *Annual Mayor's Message.*)

[62]For example, between 1902 and 1905, the Sewer Department's budget increased from $15,000 to $17,500 and then again to $20,000 the following year. From 1907 until 1910, it received $25,000, although appropriations for other departments such as fire and streets increased significantly. See *Annual Mayor's Messages* for the years 1894-1910.

[63]Expenditures on the sewage plant doubled in one year from $4,874 in 1901 to $10,846 in 1902. See *Annual Mayor's Message for 1902.*

"Anyone visiting the plant can judge for himself that the effluent, as finally discharged...is not as pure as modern practice demands." Along with decrying the conditions at the sewage plant, Dormant also recognized that separate sewers needed to be constructed in each of the city's wards. He stated that "some of the best portions of the city are without any sanitary sewerage at all." In spite of his plea, however, the number of sewer miles in Houston remained static as most funds continued to go to maintain the city's sewage treatment facilities.[64]

The pressure to clean up the bayou through effective sewage treatment increased after the federal government appropriated $1,000,000 in 1902 for the ship channel project.[65] In the following years, however, the Sewer Department found it a struggle even to maintain the existing system, let alone extend it. Problems with financing led the city council to reorganize some of the Sewer Department's functions, especially its responsibility over conditions at the Willow Street Pumping Station.[66] Many council members had, however, almost given up on the sewage treatment facilities and believed that Potter should be brought back to "save the system from total ruin." Dormant, the city engineer, was among a few who proposed some practical solutions. He argued that the pumping station should run for 24 hours a day to "insure a continuous flow of the sewage to the filter beds, and prevent its running into the bayou." In order to promote public health, the existing sewers also had to receive better maintenance. Furthermore, plumbing ordinances, especially those concerning sewer connections, needed to be revised.[67] As the 1905 health ordinances show, a few of his suggestions made their way into law. The new ordinances required all privy vaults, cesspools, and water closets to have flushing devices before connecting with a sewer, for example, and all property owners within 200 feet of a main or lateral sewer had to apply for a connection or face a fine of up to $100. In addition, uniformed sanitary policemen would now patrol neighborhoods and enforce the new regulations.[68]

[64]*Annual Mayor's Message for 1902*, 38-49. There were 37 miles of sewers in Houston between 1902 and 1904. The number increased to 41 in 1905 and then to 47.5 by 1907. By 1914, there were at least 92 miles of sewers in the city. See *Annual Mayor's Message* for the years 1902-1914.

[65]Sibley, *The Port of Houston*, 126-128.

[66]In 1904, the Sewer Department spent $20,473, although the city government had originally allocated $12,000. As a way to cut costs, the city government also took three plant employees off the payroll as part of this reorganization. See *Annual Mayor's Message for 1904*, 76-90.

[67]*Ibid.* See also City Council Minutes, Book O, December 12, 1904, 216.

[68]*Extracts from the Health Ordinances of the City of Houston, 1905* (Houston, 1905).

In spite of legislative and bureaucratic reforms, the condition of Houston's sewerage system, and especially the treatment plant, changed little. In July 1905, Mayor H. Baldwin Rice visited the sewage filtration facilities and found them in a neglected state with birds, snakes, and alligators living alongside the sand beds.[69] A few months later, after further repairs and a doubling of the work force, Rice was optimistic enough to assert that with more money and attention Houston would soon have "all sewage matter taken out of Buffalo Bayou and properly filtered." Although problems with sewage filtration continued, on the positive side about one-fifth of the population, or 15,000 residences, were using the sewers. In addition, the city's mortality rate had begun to drop, even if marginally, from 15.4 to 14.6 deaths per 1,000 between 1902 and 1906.[70]

By 1907, as Houston's population surged toward 70,000, both the city engineer and the Sewer Department realized that if sewerage problems were to be overcome, additional infrastructure would have to be built before the system could be extended into unsewered areas. In the Fourth Ward, for example, Potter initiated plans in February 1907 to build a sub-treatment station so that the sewerage of that part of the city would not be dependent on the over-burdened Willow Street plant. Construction of the Westmoreland station began after the city government passed a bond issue for $450,000, and after its completion in 1910, the station treated wastes from both the Fourth and Second Wards. Similarly, in 1912, as extensions to Houston's sewerage system continued, the city purchased 197 acres north of Sims Bayou and built a new treatment plant which received wastes from the First and Sixth Wards.[71]

[69]McComb, *Houston: The Bayou City*, 131-132.

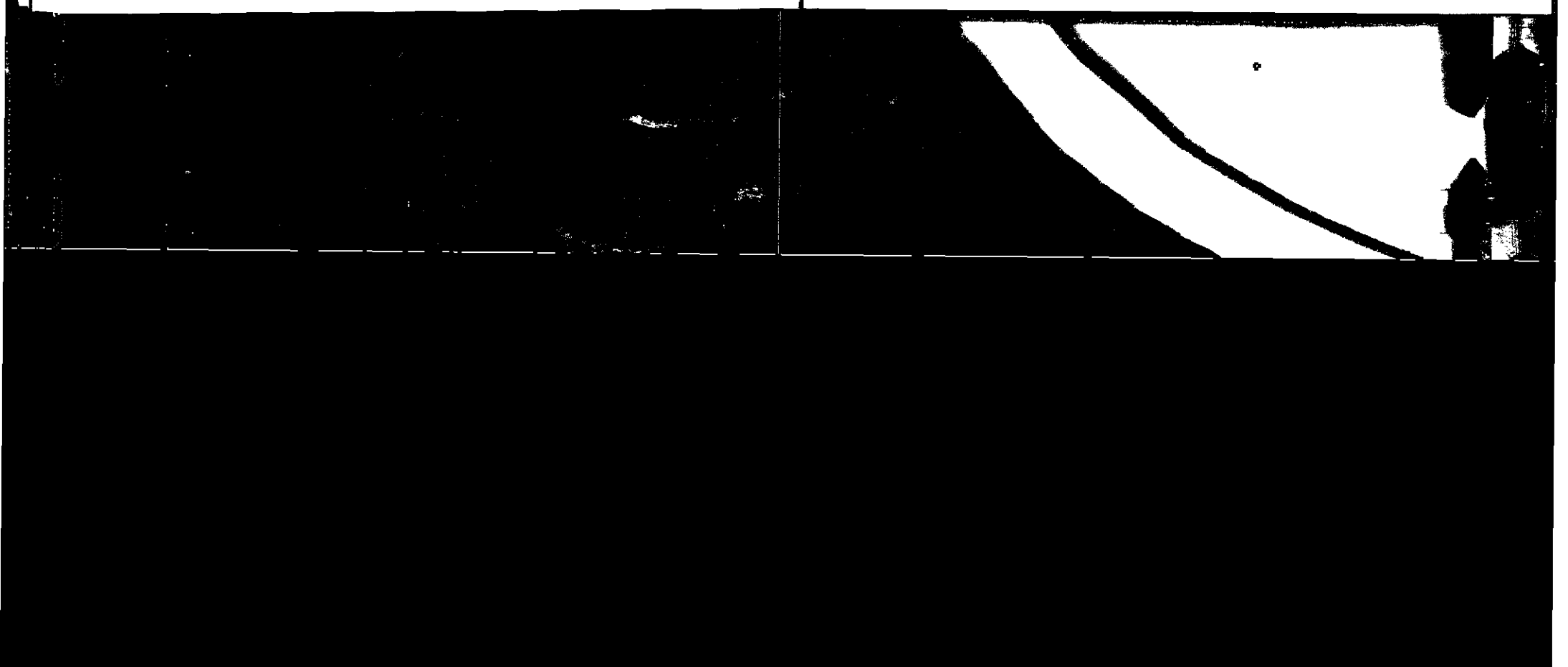
[70]*Mayor's Annual Message for 1905*, 10, 24. Houston's mortality rate fluctuated throughout the early years of the twentieth century, but had lowered by 1915 to 13 deaths per 1,000, largely because of the drop in the number of typhoid cases. Blacks, however, had a much higher rate, although health officials insisted that because of Houston's sewerage system, their mortality rate, as well as the city's average rate, was much lower compared to other cities in the South.

Deaths per Thousand

Year:	1902	1906	1910	1911	1912	1913	1915
Deaths:	15.4	14.6	13.5	13.5	14.1	14.7	13.0
Whites:				10.7	11.3	11.9	10.3
Blacks:				22.1	22.7	23.2	20.9

Source: *Annual Mayor's Messages.*

[71]For detailed information on sewerage construction see *Annual Mayor's Messages* for the years 1907-1920. See also the articles in *Progressive Houston: A Journal for the Advancement of the City*, October 1909, February 1910, May 1910, January 1911, and May 1912.



After years of repairs, new construction, and the application of new technologies such as electrical power in the pumping stations, it was still obvious that the city's sewerage system was far from perfect. In 1916, although it had been illegal to dump sewage into Buffalo Bayou for many years, between 70 to 80 percent of Houston's wastes still discharged directly into this watercourse.[72] Mayor Ben Campbell blamed the problem partly on the bad condition of the sanitary sewers and flush tanks, and partly on the too-small work force, which allowed the sewers to remain clogged with sediment. He also realized, however, that the great increase in Houston's population, from 78,000 in 1910 to over 138,000 in 1920, meant that the city's system of sewerage was overloaded and had "long outgrown its usefulness." Consulting with city engineer E. E. Sands, Campbell stated in 1914 and again in 1916 that the Willow and Westmoreland sewage treatment facilities were no longer adequate. At least two new sewage disposal plants needed to be built, one on the north side and one on the south side of the ship channel. It was time, he declared, "to establish in Houston the latest and most approved sewage disposal system."[73]

To meet the needs of a growing population and to conform to state legislation prohibiting the pollution of watercourses, the city did indeed adopt a relatively new sewage treatment technology. After touring plants which were experimenting with the so-called activated sludge process, E. E. Sands designed plans for the construction of two plants in Houston.[74] As with every other form of sewage treatment, the activated sludge process depended on the breakdown of organic matter through oxidation and nitrification. The difference lay, however, with the separation of sewage into solids and the application of aeration and drying techniques to these treated solids so that they could be converted into fertilizer. By 1917 Houston was among a few pioneering cities, including Indianapolis, Chicago, and Milwaukee, to have adopted this form of sewage treatment.[75]

[72]Percentage quoted in McComb, *Houston: The Bayou City*, 132. Both inefficient treatment of the city's sewage and the surreptitious dumping of wastes accounted for this high figure.

[73]*Annual Mayor's Message for 1914; Annual Mayor's Message for 1916.*

[74]A law of 1915 prohibited dumping of untreated sewage in watercourses after January 1917. For background information on the city engineer's plans see *Engineering News* 74 (July 22, 1915): 170-171.

[75]Eddy, "Sewerage and Drainage of Towns," 1234-1235. For an examination of this process see "The Treatment of Sewage by the Activated Sludge Process," *The American City* 18 (January-June 1918), January: 1-4; February: 114-119; March: 199-203. For a detailed look at Houston see C. L. Williford, "Activated Sludge Plants at Houston, Texas," *Engineering News* 77 (February 8, 1917): 236-238.

As an examination of one city's attempts to improve its sanitation and sewerage, the case of Houston presents several perspectives often absent in studies of more industrial cities. Recognizing early on a connection between economic growth and good sanitation, Houston's municipal government implemented measures to sewer and drain the city in the 1860s, and then to treat the city's sewage in the 1890s. By attempting to do more with its sewage than just dumping it into Buffalo Bayou, these efforts at sewage filtration placed Houston near the forefront of cities in sewage system technology, even ahead of places with larger populations.[76]

Progressive reform, particularly concerning public health measures, was clearly not the only factor behind the city government's concern with sewer construction and sewage treatment. From the time of Potter's first surveys at the turn of the century to the opening of the activated sludge plant by 1920, the development of the ship channel was an important motivating force behind plans for comprehensive sewerage. In fact, the building of the sewerage system occurred simultaneously with the construction of the ship channel, and both schemes had the backing of Houston's civic-business groups.[77] This suggests that the underlying forces of change did not depend on the political leaders of the time or their ideological stances. Plans formulated under reform-minded Mayor Brashear continued under the more conservative H. Baldwin Rice, despite the political differences that historians have attributed to each of them regarding the role of municipal government in providing public services.[78] The apparent lack of ideological conflict indicates that broad-based business-civic groups transcended city hall politics and pushed for a system of sewerage as a means of securing Houston's economic growth.

While these factors explain why Houston built its system, other considerations affected how it did so and its choice of technology. In this case, consulting engineers, as sanitary experts, played a crucial role in the decision-making process. Sanitary engineers such as Kiersted and Potter drew

[76]Although by 1930, 87 percent of Americans lived in areas with sewers, only 26 percent of them had their sewage treated. Tarr et al., "The Development and Impact of Urban Wastewater Technology," 77-78.

[77]The fiscal conservatism characteristic of cities in the South is evident in the municipal government's approach to expanding and maintaining Houston's sewerage system. As the problems of budgeting suggest, the attitude of both city officials and civic-business groups was to proceed only as far with the city's sewerage as was necessary to keep the ship channel project going.

[78]For an example of this argument see Platt, *City Building in the New South*, 181-208.

upon years of professional experience to adapt the principles of a sewerage system from one city to best serve the local needs of another. Furthermore, their adroitness at convincing municipal governments, civic-business groups, and health officials alike that one form of technology was most economical and most efficient clearly determined the type of system that would be installed. In the same way that the separate systems in Memphis and Norfolk influenced the choice of technology in Houston, the process of technology transfer continued as Houston became the model for other cities in Texas.[79]

[79]By 1917, Austin, Dallas, El Paso, Fort Worth, and San Antonio had built separate sewerage systems. With the exception of Austin, which was considering plans for sewage treatment, they also treated their sewage. See *Engineering News* 70 (August 28, 1913): 435; and 78 (October 18, 1917): 742-746.