CHAPTER 4
HISTORY OF THE NEW ORLEANS DRAINAGE SYSTEM, 1893-1996

The Drainage Advisory Board And The Drainage Plan Of 1895

On February 6, 1893, the City Council of New Orleans passed ordinance number 7170 (Council series), a landmark in the history of the city. The ordinance noted in its preamble that "the drainage of the City of New Orleans, is in an extraordinary disastrous condition…" and the text of the ordinance provided "for the making of a topographical survey; and formulating a complete and comprehensive system of drainage for the City of New Orleans, and authorizing the making of the necessary investigations…" (Fitzpatrick et al. 1895:11). This was the initiation of modern drainage efforts in New Orleans. On March 3, 1893, Mayor John Fitzpatrick and the Council named an Advisory Board of Engineers, consisting of nationally renowned hydraulic and sanitary engineer Rudolph Hering, of New York, Henry B. Richardson, Chief State Engineer of Louisiana, and Major Benjamin M. Harrod, former Chief Engineer for the City of New Orleans. This Advisory Board of Engineers represented top-notch talent (see Chapter 5).

Hering, Harrod, and Richardson recognized that a topographical survey and hydrographical study of New Orleans were necessary for any engineering planning to proceed. The survey was begun on July 1, 1893, but was interrupted by an injunction of the Civil District Court on September 1 of that year; controversy has rarely been absent in consideration of drainage proposals and work contracts in New Orleans. The survey resumed in December 1893 and continued into the spring of 1895.

An enlarged Drainage Advisory Board was organized on November 24, 1893, and Hering, Harrod, and Richardson were named as the Engineering Committee on December 14 of the same year. The other members of the Drainage Advisory Board were Mayor John Fitzpatrick, R.M. Walmsley, J.C. Denis, and Edward Fenner. Fenner resigned before the Board issued its final report in 1895, and was replaced by A. Baldwin. In an important move, Fitzpatrick arranged for $700,000 from the sale of the franchise for city railroads to be dedicated to drainage construction (Fitzpatrick et al. 1895:11-12). This allowed New Orleans to approach drainage with almost twice the amount of funding available to Memphis for the construction of its sewerage system some 15 years before.

While the topographic and hydrographic survey was under way during the winter of 1893-1894, the Board held hearings on drainage plans formulated by private civil engineers and others. These included plans put forward by S.D. Peters, George F. Grandjean, Charles Louque, J.L Gubernator, A.F. Wrotnowski, and A.C. Bell. The Board concluded, upon the advice of the Engineering Committee, that none of the proposed plans could be recommended. The Board stated that "it therefore devolved upon the City Engineer, Mr. L.W. Brown, to make, with the funds available… all necessary computations and plans" (Fitzpatrick et al. 1895:13-14). Brown proceeded to design the system, with all available data from the topographical survey and hydrological study, and utilizing the ideas of other planners where they were efficacious.

Brown formulated plans for a system for the "removal of rainwater falling upon the inhabited and built-up portion of the city and removal of ground water saturating the soil" (Fitzpatrick et al. 1895:15). Sewerage, the removal of household and industrial wastes, was eliminated from the question by the establishment of a separate sewerage system. In fact, a separate system of drainage and sewerage in New Orleans met none of the criteria for the desirability of separate systems stated by Rudolph Hering in his seminal monograph of 1881. However, Hering was a pragmatic engineer, and the Engineering Committee and Brown recognized the unusual and overriding local conditions in New Orleans. New Orleans has frequently been likened to a shallow bowl or saucer surrounded by water. The levels of the Mississippi River and Lake Pontchartrain are frequently of higher elevation than most of the area of the city. New Orleans also has a high

natural groundwater table. Consequently, all rain and groundwater to be removed from the city must be lifted by pumps. In addition, relative to other American cities, New Orleans had rainstorms of extraordinary intensity and a high aggregate amount of rain. Economical pumps and their efficient arrangement were therefore placed at a premium in the design of the New Orleans system. The planners were also concerned about disposal of the water collected in the drainage system: "ordinary flow should not be delivered where even its slight pollution would be undesirable or detrimental to the value of adjoining lands" (Fitzpatrick et al. 1895:16). Heavy rain and storm flow were considered by the standards of their time to not be seriously polluted. Two other concerns of the planners was the silting of drainage canals, and that the existing navigation canals bisecting the city be maintained (Fitzpatrick 1895:16).

The plans for the city-wide drainage system by City Engineer Brown were carefully analyzed by the Engineering Committee, and approved by them and by the whole Drainage Advisory Board. The stated goal of the 1895 drainage plan was to encompass "all territory which is now, or will be, built upon in a reasonable time" (Fitzpatrick et al. 1895:12). This forward-looking stipulation allowed later engineers to adapt the system to changing conditions. In July 1896, the Louisiana Legislature enacted Act No. 114 of 1896, creating the Drainage Commission of New Orleans, which was organized in October of that year. R.M. Walmsley was made president and Major B.M. Harrod was appointed Chief Engineer (Sewerage and Water Board 1908:66; Behrman 1914:3).

In the drainage system of the city as it existed prior to 1897 (Figure 5), the outfall of the drainage canals had been entirely into Lake Pontchartrain. The Advisory Board wished to discontinue regular discharges into the Lake because of pollution concerns. Drainage outfalls into the Mississippi River were not seriously considered by the Advisory Board engineers. Since the city's

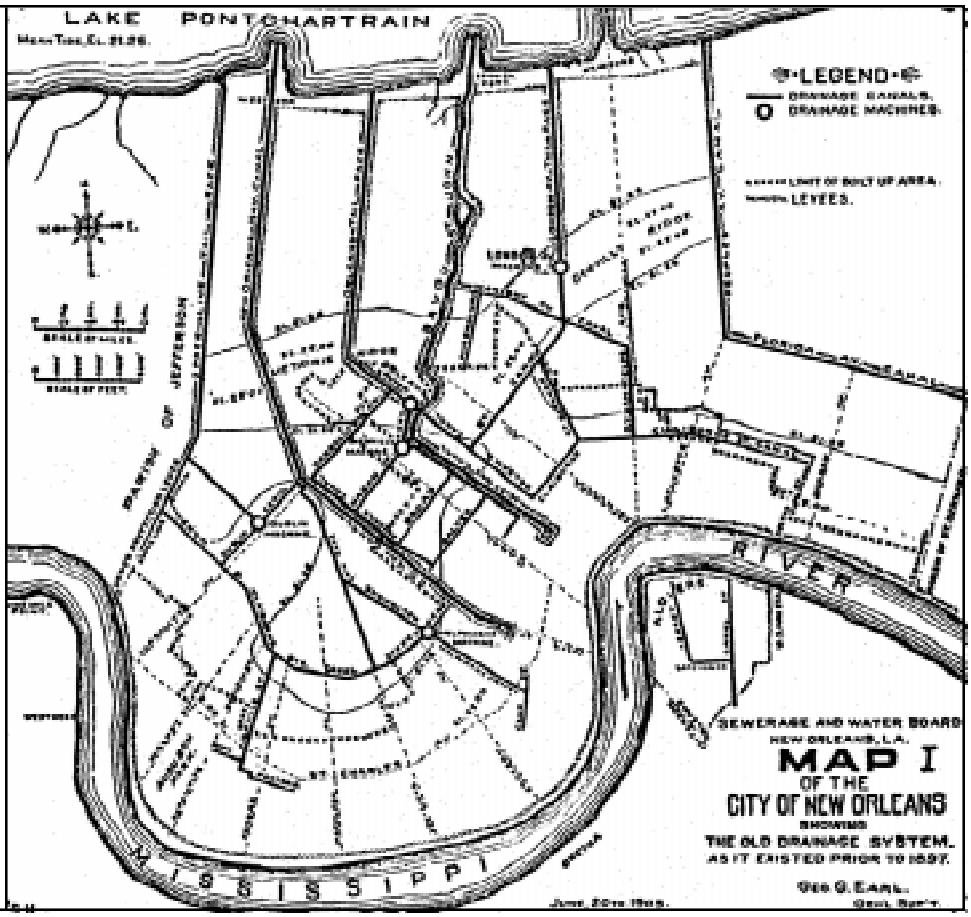

Figure 5. The drainage system of New Orleans prior to 1897 (from Earl 1903:4)

elevation decreases further away from the River, the pumpage lift would have to be enormous to get the water to run by gravity into the River, over the river levees. The 1895 Drainage Plan (Figure 6), revised during construction, consisted of:

> …a series of intercepting canals leading to Broad Street with a canal on Broad extending from Pumping Station No. 1 to Pumping Station No. 5. The canals extending back of Broad Street lead to Pumping Station No. 6 and Pumping Station No. 7, and a canal similar to the Broad Street canal will extend from Pumping Station No. 6 via Pumping Station No. 7 to Pumping Station No. 3. Into the canal on Broad Street the drainage of the area between the river front and Broad Street

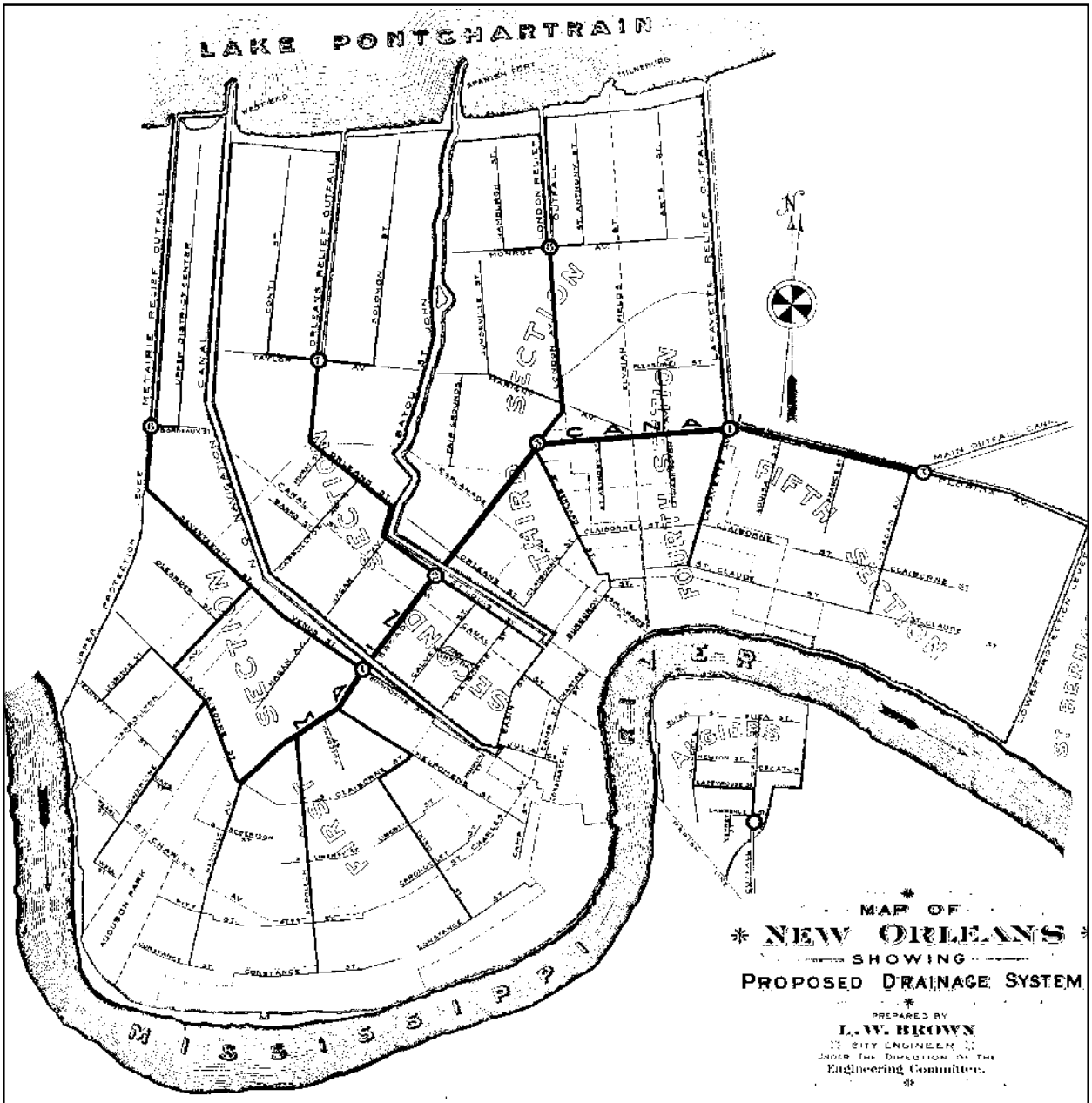

Figure 6. The New Orleans Drainage System as proposed in the 1895 Drainage Plan (from Fitzpatrick et al. 1895).

> will flow by gravity through the several sub-canals, which canals in turn, are supplied with water from the gutters, and in newly paved streets, by subsurface drain pipes. The plan proposes that the canal on Broad Street and the canal extending from Pumping Station No. 6 to Pumping Station No. 3 shall receive all water from the daily flow and from the storms of moderate intensity only. The original plan provided that the daily flow and water from small storms on the area between Broad Street and Lake Pontchartrain should drain from the shore of the lake backward and into Broad Street canals. Later study has shown, and the advisory board has since recommended, that all the drainage of those sections back of Broad Street should be towards Stations Nos. 6 and 7. The canal connecting Stations Nos. 6 and 7 with Station No. 3 will collect all the foul water of the daily flow and the first street washing of small storms between Broad Street and the lake and discharge them into the main canal at Pumping Station No. 3, to be delivered from Pumping Station No. 3 to Pumping Station No. 5, from which station the water will be discharged through the main outfall into Bayou Bienvenu, below the city, and thence into Lake Borgne. This will prevent the pollution of Lake Pontchartrain, and will obviate the necessity of the large canal on Broad Street, as originally suggested by the Advisory Board.
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> While these canals will have a capacity to receive the daily flow and the water from small storms, and to deliver all the water into Lake Borgne instead of into Lake Pontchartrain, it was never intended, and it will not be possible, on account of the enormous cost, to keep the water of all storms out of Lake Pontchartrain. It has always been purposed, when the canals leading into Lake Borgne are filled during rain storms to send the surplus water into Lake Pontchartrain. This will not be objectionable since the cause of the pollution of the waters of the Lake is mainly do to the pumping of dry weather flow, which is very foul. During rains, after the first street and gutter washings have been sent to Lake Borgne, no objection can be found to the discharge of the comparatively clean water into Lake Pontchartrain for a few hours at a time on a few occasions during the year. It would cost millions of dollars to discharge this surplus water into Lake Borgne, and the advantage gained would, in no manner, justify the cost [Sewerage and Water Board 1910:156-157].

In the 1895 plan, the total system was to have 95 miles of canals, 30 of which would be lined and covered, and eight drainage stations with a total capacity of 18,991 cubic feet per second or 8,327,000 gallons per minute (Sewerage and Water Board n.d.).

Construction of the Drainage System, 1896-1910

In late 1896, specifications for the capacities of the drainage station pumps were issued by the Drainage Commission. Although the specifications of 1896 seem small by standards developed in the twentieth century, they were to be a vast improvement over the capacities of the old drainage machines. The city of New Orleans began to accept bids on the planned drainage system in the same year. The initial contracts were broken up into several sections, consisting of the Central Electric Power Station and Pumping Stations Nos. 2, 6, and 7; the lined and covered canals; and the open and unlined canals, the reasoning for the division being that each element of the system required different expertise and construction methods. The National Contracting Company of New York was the low bidder for all three (Mr. Wes Busby, personal communication 1995) and received these contracts on August 9, 1897. Actual construction began in 1897, with the Central Power Station followed by pumping stations Nos. 2, 6, and 7.

The architectural designs for the Central Power Station and Drainage Pumping Stations Nos. 1, 2, 3, 6, 7, and 8 were evidently prepared by B.M. Harrod, Chief Engineer of the Drainage Commission. The histories of the individual Drainage Pumping Stations are presented below.

Station 4 was not built until 1945-1946, to a different plan. Station No. 5, at the intersection of Florida and Jourdan avenues, was constructed by the Orleans Levee Board ca. 1896-1899, and consequently bore no resemblance to the stations built by the Drainage Commission. The original Station No. 5 was replaced in 1915-1916 (Sewerage and Water Board 1910:160; 1916:79).

Nature provided further impetus for drainage efforts when New Orleans suffered recurrences of yellow fever in 1897, 1898, and 1899. Although minor, the outbreaks raised public concern over New Orleans' insalubrious reputation. Fear arose that investment, tourism, and immigration would all be negatively affected by the lack of public utility development (Behrman 1914:4). Progress in sewerage and water supply efforts had been limited until Act No. 6 of the Extra Session of the Louisiana State Legislature in 1899 consolidated the authorities in charge of sewerage and water, creating the New Orleans Sewerage and Water Board. The Drainage Commission remained separate at this time (Sewerage and Water Board 1988:6). The Legislature also authorized a bond issue for New Orleans utility modernization, and on June 6, 1899, the property taxpayers of New Orleans approved a special tax of two mills on the dollar for forty-three years. The revenue from this tax was to be used for acquisition of a waterworks, construction of a sewerage system, and completion of the public drainage system already under construction. Female property owners were allowed to vote in this municipal referendum, possibly the first instance of female suffrage in Louisiana. Mayor Martin Behrman lauded the women voters of the city for supporting the millage for public improvements (Enzweiler et al. 1992:16; Behrman 1914:4).

The New Orleans drainage system has never been a static entity. Changes were made in plans and construction of the system from the earliest days of the Drainage Commission, and there was never a point where the system planned in 1895 was in place, as designed. Among other changes to the 1895 plan, Drainage Pumping Stations Nos. 1, 3, and 6 were not built in their originally proposed locations; Stations No. 4 and No. 8 was omitted from initial construction; alterations were made in the alignment of the Broad Street and Melpomene Canals; and changes were made in the locations of various smaller canals (Hering et al. 1902:135). As the system infrastructure was being constructed, public controversy arose over alteration of the planned system and the use of various materials in construction, particularly the grade of cement used by the National Contracting Co. A Board of Inquiry on the Conduct and Character of the Drainage works was set up under Rudolph Hering, and delivered their report in March 1902. The Board of Inquiry approved the changes that had been made in the overall plans of 1896 (Hering et al. 1902:6-8). The questions that had been raised concerning acceptable building materials were somewhat more complicated, and legal action against the National Contracting Co. (the "Cement Case") continued until January 1906 (Sewerage and Water Board 1906b).

In March 1902, The Drainage Commission was merged with the Sewerage and Water Board (Sewerage and Water Board 1908:66-68; Sewerage and Water Board 1988:6), probably for efficiency of administration. Figure 7 shows the drainage system as built up to the time of the merger of the Drainage Commission and the Sewerage and Water Board. Within a year of the merger, recommendations had been approved to improve the timber lining of existing canals, alter the discharge basin at Draining Pumping Stations Nos. 1 and 2, and modify the suction basin intake pipes at Draining Pumping Stations Nos. 6 and 7 (Sewerage and Water Board 1903b).

Alfred Raymond, M.E., was in charge of the operation and maintenance of the drainage pumping stations from 1899. Albert Baldwin Wood, M.E., was Raymond's assistant after 1902. Wood was a crucial figure in the history of the New Orleans drainage, sewerage, and water systems (see Chapter 5). Wood was hired as Assistant Manager of Drainage by the Drainage Commission in 1899. After the merger of the Drainage Commission and the Sewerage and Water Board, Wood was assistant manager of drainage under Raymond until 1906, when he was promoted to the position of Mechanical Engineer. In 1908, he was placed in charge of the water works pumping stations and the sewerage pumping stations. A.B. Wood was responsible for the development of

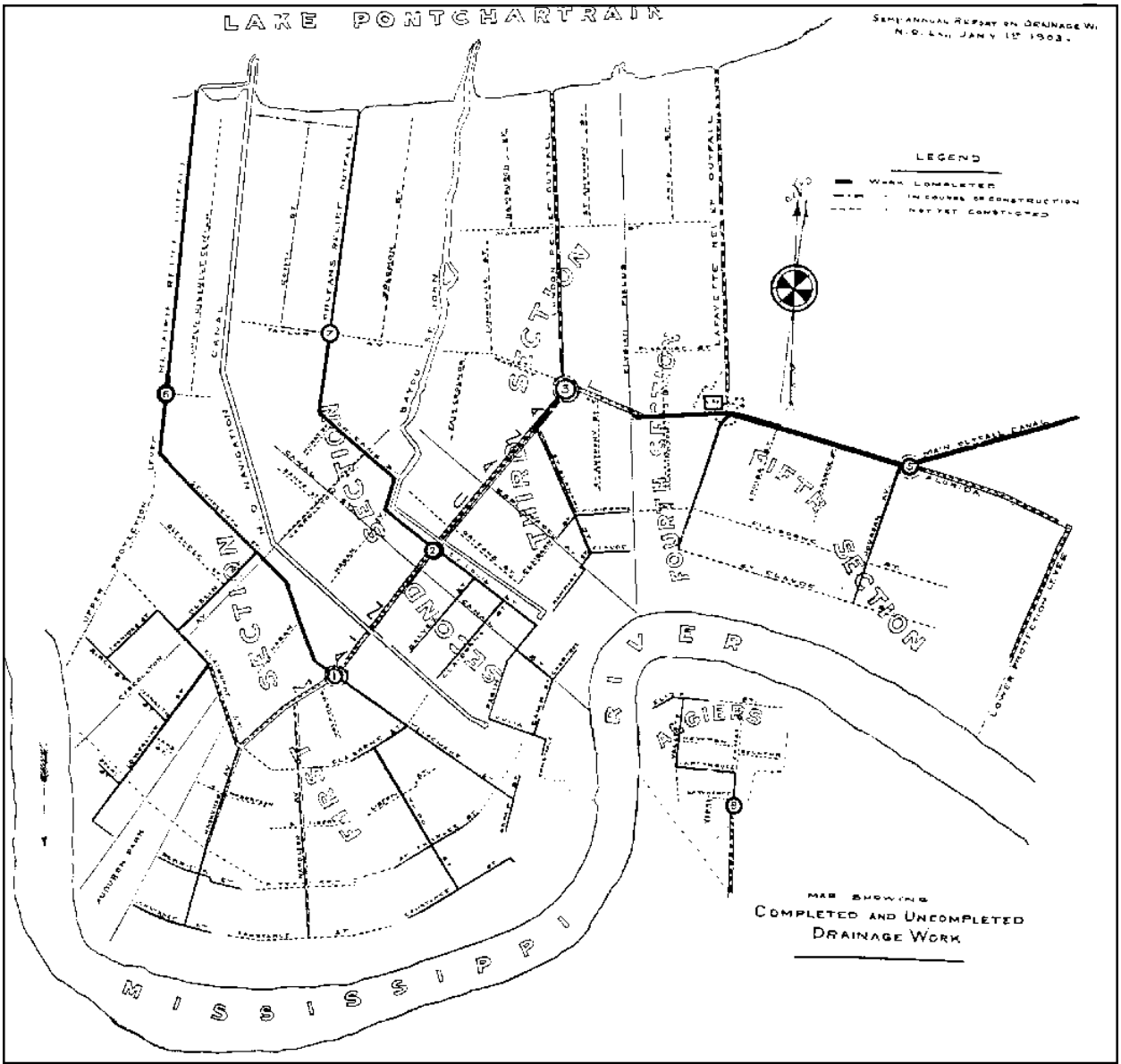

Figure 7. The New Orleans Drainage System as constructed to the end of 1902 (from Sewerage & Water Board 1902).

dramatically superior drainage pumps that vastly increased the capacity of the New Orleans drainage system. In 1906, Wood responded to increased demands for pumping capacity, and developed a six-foot centrifugal drainage pump, the largest in the world at that time. A short time later, Wood invented "flapgates," which prevented water from backing up in the system when the pumps were stopped. These flapgates became standard in drainage engineering (Enzweiler 1992:76). Wood also invented improved sewerage pumps and developed other drainage and sewerage advances. Wood's name has become almost synonymous with the distinctive technological features of the New Orleans drainage and sewerage systems. However, the 1895 drainage plan, and the initial phase of its construction (prior to 1910), were not predicated on any pumping technology designed by Wood.

In 1899, the New Orleans drainage system encompassed about 16,000 acres, with a drainage pumping capacity of 1,200 cubic feet per second (Sewerage and Water Board 1926). By 1905,

the city drainage system served 22,000 acres, with 20 miles of lined and covered canals, three miles of wood lined canals, and 17 miles of open and unlined canals, plus many miles of pipelines and drains; and six eastbank pumping stations were operating, with a drainage pumping capacity of 5,000 cubic feet per second. The system at this date represented about 44% of what was planned in 1895 (Sewerage and Water Board 1905:9; Sewerage and Water Board 1926). The benefits of the improved drainage system were substantial even before the system was completed. Storm water from moderate storms was removed rapidly, and saturated soil and stagnant street gutters were drained by pumping standing water in the canal system to ten or fifteen feet below street level. Mosquitoes decreased noticeably. Land within the city limits that had formerly been too wet for building or agricultural use became available for development, and mortality rates for city residents dropped significantly (Behrman 1914:5).

Municipal utility development required certain changes in the mentality and behavior of individual New Orleans residents and of businesses located in the city. Seemingly, wherever separate systems of drainage and sewerage were undertaken, some small percentage of persons sought to take advantage of the new infrastructure by discharging household and industrial wastes into the drainage system through irregular hookups and dumping. Public apathy and ignorance concerning the efficient functioning of the drainage system were also prevalent. As early as 1902 the Board of Inquiry, headed by Rudolph Hering, had complained about:

> …the abuses of carelessness and wantonness to which the work is subjected, and which requires vigorous municipal action [to prevent]… Already piles of ashes and other heavy refuse are found in the conduits. The grating of catch basins and drains are intentionally broken or stolen. As many as twenty-three are already stolen on Third Street, the last finished work. Drains are choked with a most remarkable collection of garbage and trash. Added to this is the careless and unsightly deposit of paper and sweepings in the gutters, which, if not peculiar to, is excessive in New Orleans… [Hering et al. 1902:178]

Thus, many urban blights are shown to be nothing new. Thorough regulations concerning discharge into drainage features and canals by manufacturing plants and by the public at large were adopted by the Sewerage and Water Board in December 1904 (Sewerage and Water Board 1904b:13-16). Enforcement of the regulations eventually lessened the deliberate misuse of drains and canals, although the problem has remained significant to the present. Particularly, there remains the problem of debris, such as old automobile tires and scrap automobile gasoline tanks, which cannot be put in municipal landfills but which, after being discarded into drainage canals, are carried through the system by storm runoff.

Trash obstructing drains, catch basins and other drainage features has proven a perennial headache to the Sewerage and Water Board. In the earlier decades of the drainage system, many major canals were all or partially unlined, creating an ideal environment for the growth of hyacinths and lilies. Within five or six years of excavation, open, unlined canals were often choked with vegetation (Figures 8 and 9). In addition, gutters and catch basins on unpaved streets soon filled up sub-drainage pipes with mud and sediment, entailing

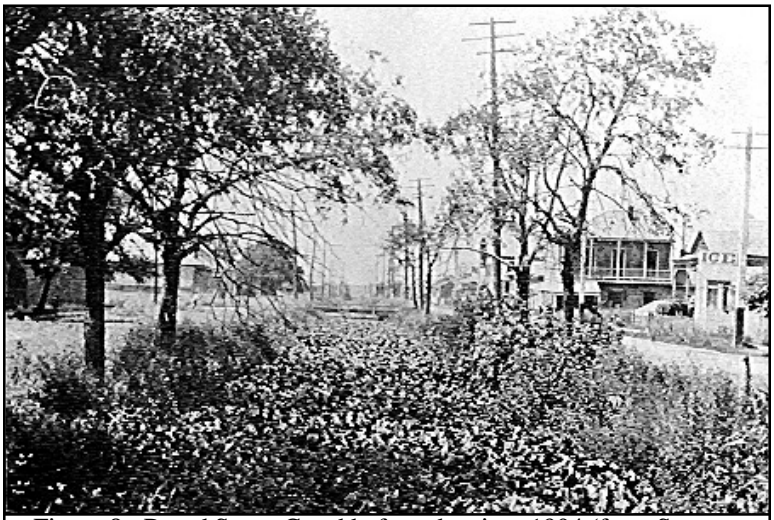

Figure 8. Broad Street Canal before cleaning, 1904 (from Sewerage & Water Board 1904).

a constant routine of cleaning (Sewerage and Water Board 1904b).

Figure 9. Broad Street Canal after cleaning, 1904 (from Sewerage & Water Board 1904).

Revisions in the drainage plans of 1895 as the system was constructed, and the city's rapid development, made it apparent by 1910 that a new overall drainage plan was necessary. Increasing numbers of buildings and area of paved land, particularly on the lake side of Broad Street, were reducing the ability of the soil to retain precipitation, thereby overwhelming the drainage system. Original members of the 1895 Drainage Advisory Board, Major B.M. Harrod and Rudolph Hering, convened in April 1910. They issued an exhaustive report that same month recommending a detailed outline of drainage construction. The report called for widespread improvements in the major canals of the system. Another major recommendation of Harrod and Hering was an increase in pumping capacity at several drainage pumping stations. Specifically, their recommendations included the installation of new constant duty pumps and pumps of 500 cfs capacity (Sewerage and Water Board 1910:23; Sewerage and Water Board 1911:135-137).

Expansion Of The Drainage System, 1911-1945

Figure 10 shows the system of drainage as of 1911, with the unfinished features proposed in the 1895 plans. By this date, it had become clear that the older pumps in place in the drainage stations were not sufficient for the requirements of draining the city. Implementation of the recommendations made by Harrod and Hering would require the capacity of individual large pumps to be double that of the original centrifugal pumps installed in the stations. A Sewerage and Water Board engineer summarized the problems at hand:

> …The pumping lift at the various drainage stations varies from almost nothing, in times of great emergency, to nine feet at the intermediate lift stations and 15 feet at the final discharge stations. The pumps are operated by synchronous motors, driven by 25 cycle 3 phase alternating current. The motors cannot be started under a load, and if the pumps are submerged, each discharge pipe has to be protected against back flow by an elaborate check gate, with cushioning arrangements, to avoid sudden closure, when pumps are stopped either intentionally or due to trouble with current. These motors have to be run at a constant speed. The time from the beginning of a storm until the various stations receive the full force of maximum rate of run off varies from only a small fraction of an hour to about two hours. The rapidity with which water accumulates and rises from an empty canal to a full canal is such that if pumps are not started just as rapidly as the increasing amount of water approaching the stations will permit, the best results cannot be obtained… [Sewerage and Water Board 1915:42-43].

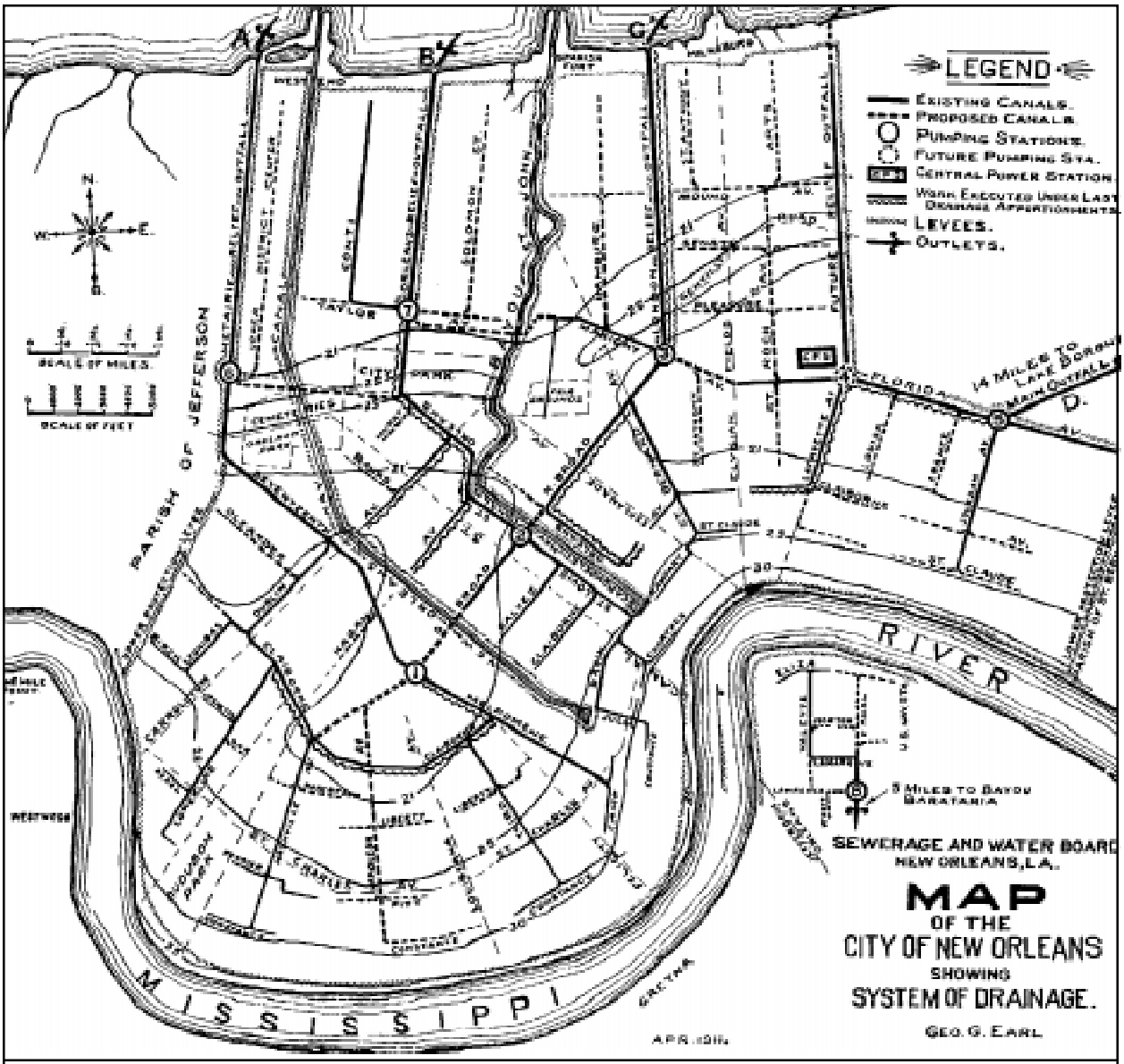

Figure 10. The drainage system of New Orleans in 1911, showing the system proposed in 1895 and construction to 1911 (from Sewerage & Water Board 1911).

The writer continued, discussing several of the specific engineering challenges confronted in considering the design of larger-capacity pumps, thereby revealing something of the genius with which A.B. Wood approached these challenges:

> …To meet these conditions for storm drainage, where the various stations would be called upon to handle from 1,200 to 2,500 cubic feet of water per second, it was found that the largest pumping units were necessary with the most certain and simple methods of starting the pumps. To obviate the necessity for great check gates on the discharge lines, to obtain easy access to pumps for maintenance and repair, and to obtain pumps that could be started and brought up to speed without a load, it was found best to set the pump above the level of the water on its discharge side, i.e. practically at the summit of a siphon; and finally, to get large enough units and to obtain pumps that would meet the required conditions and work with satis-

> factory efficiency, through the very wide range of lifts required at these stations, it was decided to undertake some development work to determine whether a screw pump could not be constructed which would meet the requirements of the Board's service better than either the existing vertical shaft submerged screw pumps or the existing centrifugals, some of which are submerged, with vertical shafts, and some of which are set up above discharge water level, with horizontal shafts…
>
> …This development work was put into the hands of Mr. A.B. Wood, Mechanical Engineer in charge of Sewerage and Water Power and Pumping Stations, who had already demonstrated his great ability in centrifugal pump design work, and who had already formulated a theoretical basis of screw pump design for his work, which looked as though it was sound in theory and certain to give the results desired. The first step was the construction of a 12" experimental pump, which was very carefully tested and which fully confirmed the theory which Mr. Wood had worked upon. With this confirmation, two additional designs were made, the one for a 30" constant duty pump and the other for the ultimate 12-foot pump. The 30" pump was rushed to completion and put into regular service. It was then given the same careful tests that were made on the 12" pump, and after these tests had fully confirmed the earlier tests, bids were invited upon the plans for the 12-foot pumps [Sewerage and Water Board 1915:43-44].

The Wood screw pump was almost completely successful in meeting the design requirements of the Sewerage and Water Board. The Wood screw pump is fully referred to as a low-head high volume (or capacity) screw (or axial flow) pump, and consists of:

> …a syphon, in the summit of which a screw type, steel bladed impeller rotates. The casing is split horizontally to facilitate access to the interior of the pump. The pumps were placed at the summit of a pipe syphon and pipe connections are made to the suction and discharge canals without the intervention of valves or gates. Priming is accomplished by means of rotary vacuum pumps. By admitting air to the casing before stopping the pump the vacuum is broken and the water prevented from syphoning back into the suction basin [Thompson n.d.:11, *sic* throughout].

The original prototype 12" Wood screw pump is preserved and on display in Drainage Pumping Station No. 1. The 30" Wood constant duty screw pump was installed in Drainage Pumping Station No. 1 in 1912, and remains in use today (Mr. Rudy St. Germain, personal communication, 1996). Wood's design for the full-size 12' pump, shown in Figure 11, was the largest and most powerful pump yet developed. The Sewerage and Water Board was so confident of Wood's design that the plans put out for bid:

> …were in full detail as to design, material and workmanship in all respects, and the specifications did not require the contractor to make any guarantee of efficiency, or for that matter, even that the "thing which he would build would pump water," but merely required the construction and erection on foundations of the specified equipment within the time stipulated [Sewerage and Water Board 1915:44].

Some elements of opinion objected to the awarding of such a major contract in this fashion, but the Sewerage and Water Board were decisive and the City Council agreed with their recommendation (Sewerage and Water Board 1915:44; Enzweiler 1992:76). There were 11 bids received for the pumps and related equipment, ranging from $446,450.00 by the Bethlehem Steel Company to $159,042.00 by the Nordberg Manufacturing Company. On January 26, 1914, the Sewerage and Water Board issued Contract 58-D, contracting with the Nordberg Manufacturing Company, of Milwaukee, for the manufacture of eleven Wood screw pumps, one 36" high-lift centrifugal pump, and gates, suction and discharge pipes, shafts, bearings, and couplings for the pumps. The Allis-

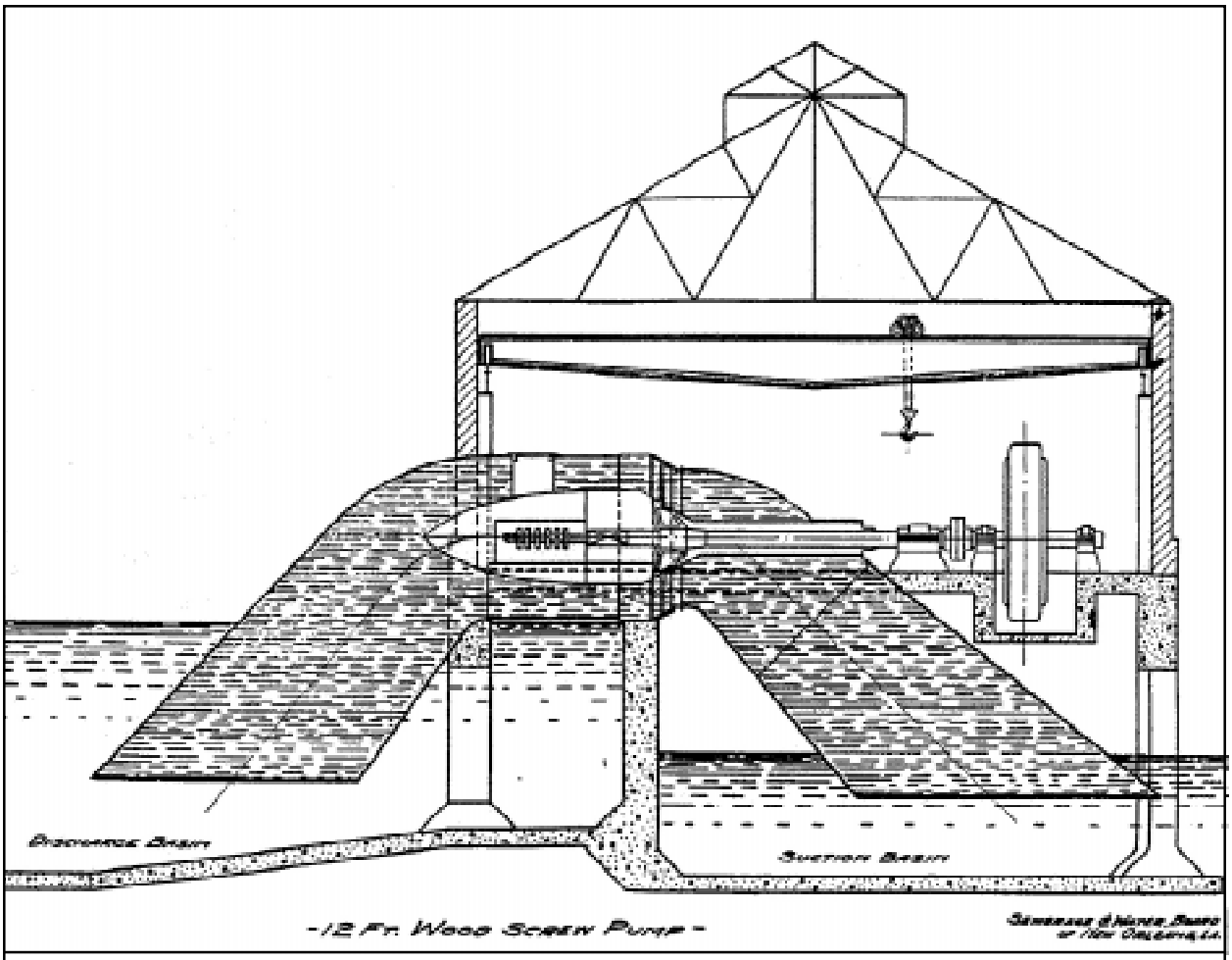

Figure 11. Cross-section of a 12' Wood screw pump (from Sewerage & Water Board 1914).

Chalmers Company, also of Milwaukee, received contract 59-D on March 5, 1914, to make the motors and electrical equipment to operate the pumping installations. These included four 600-horsepower synchronous motors for the drainage pumping stations. Allis-Chalmers also manufactured equipment installed to upgrade the central electric power-generating facilities of the drainage system (Sewerage and Water Board 1914:134-135; Sewerage and Water Board 1915:44, 179-181; Behrman 1914:15).

The pumps were built to be built to two standards, one for intermediate lift stations, and one for final discharge stations. They were designed to give a discharge of at least 550 cubic feet per second each, at lifts of, respectively, five and ten feet from basin to basin at the pumping station. The screw pumps operated at 75 to 83½ rpm, respectively, with 6,000-volt 3-phase synchronous motors of, respectively, 600 and 1,200 horsepower. The pumps were designed to function without overloads at any lift from zero up to, respectively, 8 to 13 feet. These new pumps, together with additional, constant-duty units, would increase the total pumping capacity of the system under storm conditions by approximately 6,600 cubic feet per second. This would give the total system a capacity for drainage of 11,200 cubic feet per second or 7,149,600,000 gallons per twenty-four hours. This twenty-four hour capacity was greater than the annual pumpage of the New Orleans Water works as of 1914 (Behrman 1914:15; Sewerage and Water Board 1915:44).

Erection of the pumps was put in the hands of A.C. Hoffman, erecting engineer for the Nordberg Manufacturing Co. Hoffman was born in 1895, making him barely 20 years old when

installation of the pumps began. Getting the pump castings from the nearest railroad siding to the pumping stations, and then erected, was an engineering feat in itself. The weight of one pump, without accompanying steel work and 1200 hp synchronous motor, was approximately 100 tons. The impeller shafts were 32' long and each had a casting weight of 24,410 pounds. As the heavy castings arrived, they had to be stored on solid ground adjacent to the station, since the castings needed first sometimes arrived after those needed last and the castings also arrived faster than the crews could assemble them inside the stations. At one station, the street next to the station was the only available space to store the castings. Runways of 12" square timbers were set up from the railroad sidings to the stations to allow the pieces to be moved. Hoffman was also in charge of installation of the "butterfly" flood gates in the discharge basins. The gates were constructed of planks 2" by 10" or 12", of the highest quality timber. These timbers had to be trimmed to fit the gates, and A.B. Wood and Hoffman got two shipwrights from the United States Naval Training Station in Algiers to do the carpentry work. The shipwrights fitted the timbers with adzes, and the sight of them swinging with all their might at timbers between their feet filled Hoffman with dread. However, Hoffman was able to note that installation of the pumps and gates was completed without a single mishap or injury to the workmen (Sewerage & Water Board Engineering Dept. files).

The first two of the 12' pumps were installed at Drainage Pumping Station No. 1 between December 1914 and April 1915, and were operating by the end of the first half of 1915. They immediately demonstrated their superiority over the previous equipment. However, a rigorous series of tests were performed at Drainage Pumping Station No. 1 to accurately identify the performance parameters of the pumping system (Sewerage and Water Board 1914:134; Sewerage and Water Board 1915:44, 179-181). These tests were supervised by Professor W.H.P. Creighton, Dean of the Department of Technology, Tulane University. Following their tests, the Wood screw pumps were praised in an article by S.L. Menge in the *Journal of the American Society of Mechanical Engineers* in July 1916:

> The decreasing amount of power required to operate the new pumps as their lift decreases will more than compensate for the excess amount required by the old ones when their lift decreases and the necessity to pump is at its greatest… the best of these [old] pumps… adds only 50 per cent to its capacity per applied brake horsepower as its lift drops from its point of maximum efficiency, which is 11 ft, down to zero, while the new screw pump increases its capacity per applied brake horsepower 300 percent from its lift for maximum efficiency at 7½ ft. down to zero… In a system like that in New Orleans, operated electrically with power and pump capacity designed to give the required output under those low-lift conditions which require the greatest quantity of discharge, the power requirement to operate all units will be much less with screw than with centrifugal pumps… It should be noted that these pumps are not designed to fit a certain condition of lift, which may be more or less arbitrary and theoretical, but are designed to work with the maximum economy, on widely varying lifts, such as actually obtain in service on practically every drainage problem. The New Orleans units… can be advantageously installed in a space only slightly wider than the suction bells themselves (22 feet) and depth of building of 50 ft. inside. They are particularly free from any vibration and, therefore, require little foundation mass. They operate at relatively high speeds, being particularly suited for direct connection to electric motors at constant speed. They are entirely self-oiling, no bearing coming in contact with the water or subject to grit and wear… [Menge 1916:556]

By September 1, 1914, the drainage system served about 35 square miles, and had cost $9.3 million; another $2.5 million was projected to be spent on drainage in the next three years. Construction of the drainage system had stimulated efforts to establish the other two major public utilities, the sewerage and water systems. By 1914, the sewerage and water systems covered about 18 square miles of the city. Among the effects of these improvements was a rapid increase in the

assessed values of taxable properties in the city, which grew almost 80% between 1900 and 1914 (Behrman 1914:5).

Among the major contributions of the drainage, sewerage, and water systems was their effect on public health. In 1899, the death rate from malaria stood at 70 persons per 100,000 residents, and from typhoid, 40 persons per 100,000 population. By 1905, malaria deaths had been reduced to 13 persons per 100,000 residents, and deaths from typhoid declined to 30 per 100,000 residents (Sewerage and Water Board 1926:n.p.). By 1913, the incidence of typhoid in New Orleans had been halved, and deaths from malaria virtually eliminated. The overall death rate per one thousand residents decreased by 7.4 persons per year between 1900 and 1913, a 25% reduction from 1900. The lives of thousands of New Orleanians were saved in the first decade of the twentieth century alone by the net effects of drainage, sewerage, and water system modernization (Behrman 1914:11, 13). Martin Behrman in 1914 lauded the drainage system in unreserved terms: "no project ever brought to a successful issue in the history of New Orleans had so deep and wide an influence for good in all directions as that which ensued from this achievement (Behrman 1914:5)".

During the later 1910s and into the 1920s, progress continued in the drainage system, particularly the extension, widening, and covering of drainage canals and pipelines (see below). By the end of 1925, the drainage system of New Orleans served 30,000 acres with 560 miles of low-level canals and drains and a pumping capacity of 13,000 cfs. Expenditure on the drainage system had totaled $15,300,000. The improvement in public health wrought by the combined effects of the drainage, sewerage, and water systems continued to be dramatic. Deaths in New Orleans from malaria and typhoid combined numbered fewer than one dozen per 100,000 persons in 1925, and the total death rate had declined to fewer than 18 persons per year for every 100,000 people, a reduction of over 75% from 1899 (Sewerage and Water Board 1926).

The 12' Wood screw pumps operated with remarkable reliability and efficiency. In the *Fiftieth Semiannual Report of the Sewerage and Water Board* (1924), Wood stated, with a note of pride,

> …the 12' Wood screw pumps, some of which have been in service since April, 1915, or ten years, have continued to give full service at all times. The cost of maintaining all of the eleven 12' screw pumps, proper, has not exceeded $10.00 since installation, which is truly a remarkable record.
>
> They have performed most of the storm pumping of New Orleans in this period, and a careful inspection does not disclose any signs of wear or deterioration. The original oil placed in the bearings ten years ago is still in them, being added to for evaporation only [Sewerage and Water Board 1924:93].

In 1926, Wood pointed out, by way of warning, that no increases had been made in the pumping capacity of the New Orleans drainage system since the installation of the Wood 12' pumps a decade before (Sewerage and Water Board 1926:102), despite substantial growth and development in the city. The massive Good Friday flood of April 15, 1927, demonstrated beyond a doubt that further upgrading of drainage capacity was necessary (Villarrubia 1984). The Sewerage and Water Board decided that it was necessary to double its drainage capacity. Wood designed a 14' version of his screw pump, with a capacity of one million gallons every five minutes. Bids were taken on the accepted design, and contract 100-D was issued on October 10, 1928, to the Dibert, Bancroft, and Ross Company of New Orleans for 14 of the 14' Wood screw pumps, at a gross cost of $285,700.00. At the time of manufacture, these pumps were the largest pumps in the world and the largest castings ever made in New Orleans. Each of the 14' Wood pumps has a capacity of 1000 cfs against a 9-foot lift, and is driven by a 1200 horsepower motor turning at 83.3 rpm (Sewerage and Water Board 1927:108, 115; Sewerage and Water Board 1929:113; Sewerage and Water Board 1930:283).

In the *54th Semi-annual Report* (1926), Wood complained that the electrical power supply to the pumping stations was inadequate and vulnerable to accidents (Sewerage and Water Board 1926:102). This situation had, in fact, always been the case. The electrical supply systems of the drainage pumping stations, formerly incompatible with that of New Orleans Public Service, Inc., were modernized in the late 1920s by the installation of large-capacity rotary converters with cross-connections with NOPSI. In late 1927-early 1928, a 6000 kilowatt underground cable was laid between Drainage Powerhouse No. 2 and Pumping Station No. 1. The electrical switching equipment of Drainage Stations Nos. 1 and 6 was modernized, provided with three independent busses with full relay protection, so that electrical problems could be isolated and cleared as quickly as possible; this allowed interruption to only a portion of the pumping equipment in each case of failure (Sewerage and Water Board 1928:108; Sewerage and Water Board 1929:113; *The Consultant* 1977:3).

The Sewerage and Water Board began an intensive three-year, $8 million construction program in 1929 for extensions of the Sewerage, Waterworks, and Drainage system. These improvements included the manufacture and installation of the 14' Wood screw pumps at the older drainage pumping stations, and the construction of a new Drainage Pumping Station, No. 9, in Algiers. By 1930, New Orleans was in the grip of the Great Depression, and Sewerage and Water Board revenues declined dramatically. With the decline in revenues, new drainage construction slowed greatly. Circumstances improved in 1934, and by 1937, the federal Works Progress Administration was actively assisting in drainage improvements, particularly street drainage. The majority of new work undertaken by the Sewerage and Water Board in the 1930s and World War II years consisted of maintenance improvements to the drainage network. An exception was the design of Drainage Pumping Station No. 4 in the late 1930s, and its construction 1945-1946.

The Drainage System Since World War II

Major drainage projects were initiated during the post-World War II period. Figure 12 shows the drainage system as of 1954. Major drainage system improvements were planned by the Sewerage and Water Board in 1956, 1958 and again in 1967, and typically these improvement programs included enlarging the drainage network, increasing the pumping capacity of the older pumping stations, and new pumping station construction in developing parts of the city.

By 1970, the New Orleans Drainage system consisted of 167 miles of open and covered canals, 45 miles of pipelines, and 14 pumping stations with a capacity of 28,000 cubic feet per second. Pumping capacity reached 34,880 cfs by 1977 (*The Consultant* 1977:6). The limitations of the system were revealed by the 100-year floods that occurred on May 3, 1978, and April 12, 1983 (Villarrubia 1984). The Sewerage and Water Board developed a plan to double the city's drainage capacity to 5 inches of rainfall in five hours by the year 2041, at a projected cost of $1.8 billion (Ruth 1991). By the mid-1980s, the New Orleans drainage system had a primary storm water collection system consisting of 83 miles of covered canals, 57 miles of large pipelines, 83 miles of open canals, and 1258 miles of subsurface drain pipes, served by 18 large pumping stations and three smaller stations with a combined capacity of 22,500,000 gallons of water per minute (Sewerage and Water Board n.d.). Of the over one hundred pumps in New Orleans' drainage system in 1991, 48 of them are Wood designs (Ruth 1991). In 1992, the total pumping capacity of the 22 New Orleans Drainage system pumping stations had reached 47,000 cubic feet per second, and alterations and modifications to the drainage system have continued in the 1990s.

Histories Of Drainage Pumping Stations Nos. 1, 3, 4, 6, And 7

As indicated in Table 1, Drainage Pumping Stations Nos. 1, 3, 4, 6, 7 were not built simultaneously. Stations 1, 2, 3, 6, 7, and 8 were all designed during the system development phase directed by B.M. Harrod, Chief Engineer of the Drainage Commission. As suggested in the discussion in Chapter 6, Harrod evidently designed these six pumping station buildings and the

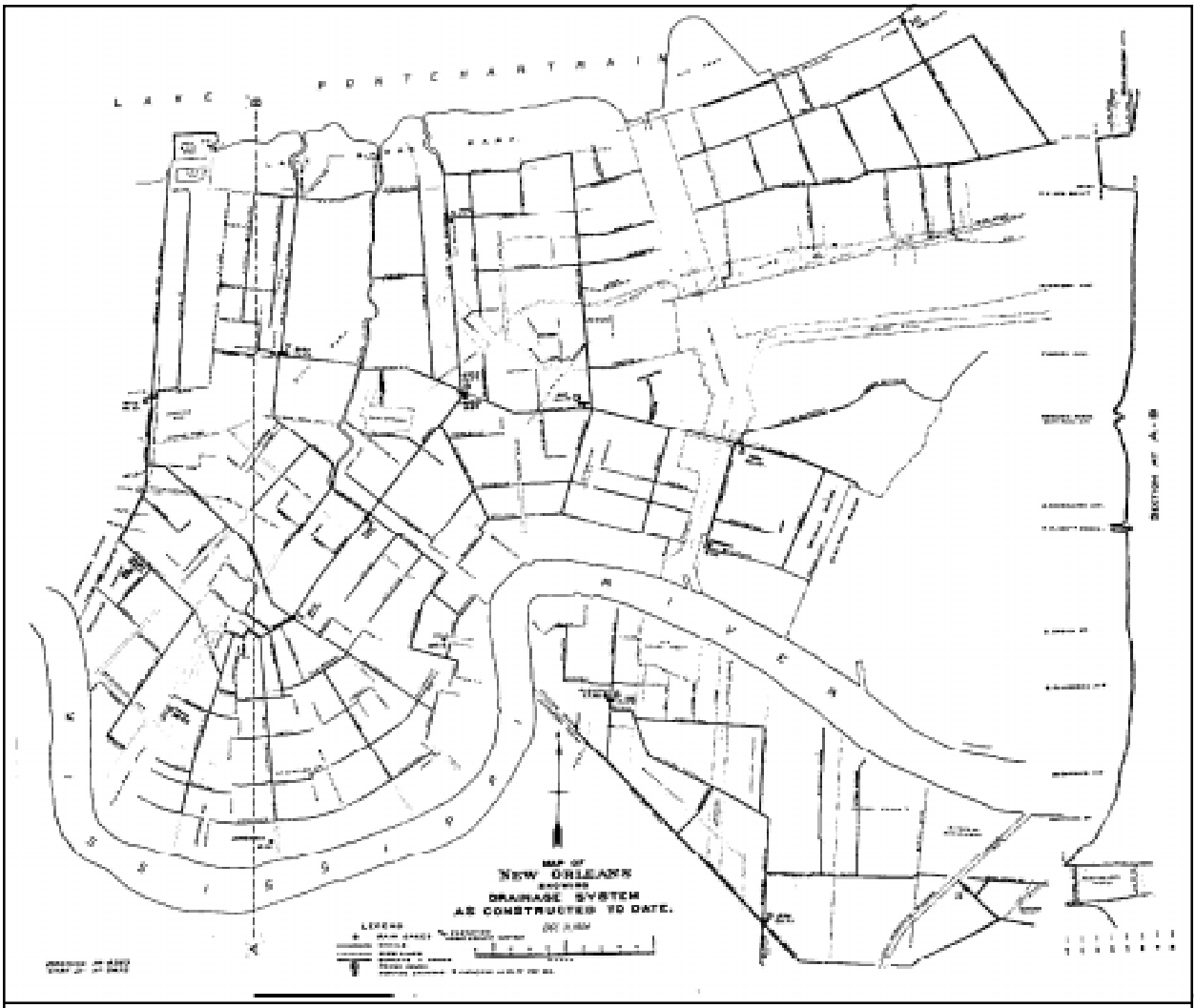

Figure 12. The New Orleans Drainage System as constructed to 1954 (from Sewerage & Water Board 1954).

Central Power Station [No. 1] (now Sewage Pumping Station D), which all have an obvious architectural uniformity. Of the stations originally designed by B.M. Harrod and constructed in the period 1897-1903, Stations 1 (Figure 13), 2, 3 (Figure 14), 6 (Figure 15), and 7 (Figure 16) have

Table 1. Building Dates of Drainage Pumping Stationa 1, 3, 4, 6, and 7.

Station	Location	Contract	Date of Contract	Date of Completion/ Acceptance	Cost of Contract	Original Pumps
1	Intersection Broad and Melpomene Sts.	E	July 1899	1900/1902	$224,500	4-250 cfs vert. centrif.
3	Intersection London and Marigny Aves.	I	July/Aug.1900	1902/1903	$187,000	3-250 cfs horiz. centrif.
4	Prentiss and London Aves.	136-D	1945	1946		2-320 cfs horiz. centrif.
6	Upper Protection Canal, back of Metairie Cemetery	A	Aug. 9,1897	1898/1900	$229,000*	4-250 cfs vert. centrif.
7	Intersection Taylor Ave and Orleans St.	A	Aug. 9, 1897	1898/1900	$192,000*	3-250 cfs vert. centrif.

all been modified, but remain in use. Drainage Pumping Station No. 2 was constructed 1897-1898. Drainage Pumping Station No. 8 was constructed 1899-1900, put into operation in 1901, and demolished in 1986. Drainage Pumping Stations Nos. 4 and 5 are anomalies both architecturally and chronologically. Drainage Pumping Station No. 4 was never built in the location planned in 1895. The station currently designated Drainage Pumping Station No. 4 was built in 1945-1946. Drainage Pumping Station No. 5 was originally built by the Orleans Levee Board in 1896, prior to its acquisition by the Drainage Commission. The Sewerage and Water Board replaced Drainage Pumping Station No. 5 with a new structure in 1915-1916.

Drainage Pumping Station No. 1. As proposed in the original 1895 plan, Drainage Pumping Station No. 1 was to be an intermediate lift station located at the intersection of Broad Street, Venus Street, and Euphrosine Street. This location was adjacent to the

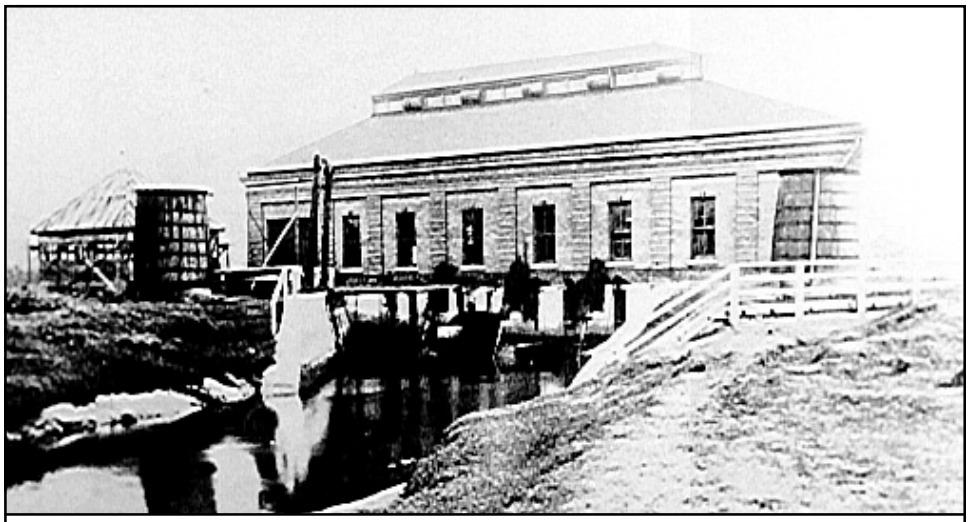

Figure 13. Drainage Pumping Station No. 1 as originally constructed, 1911 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

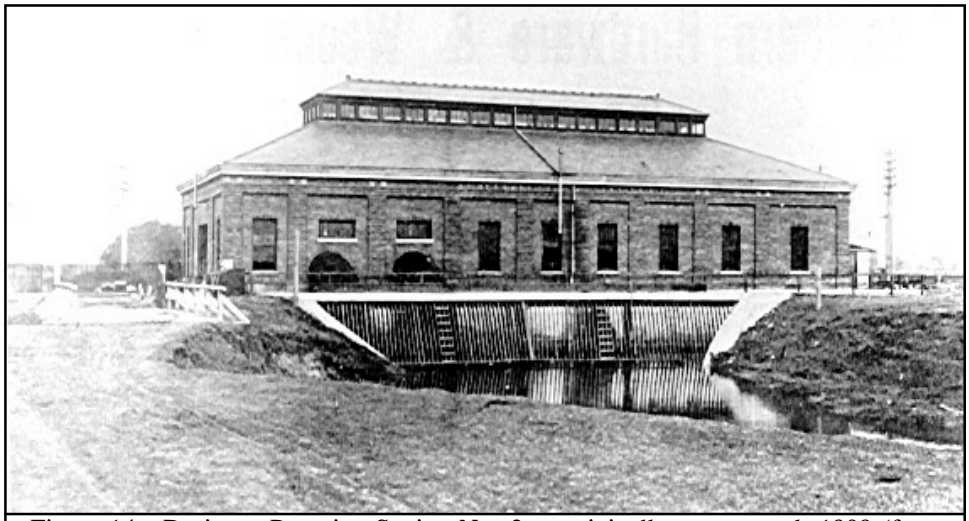

Figure 14. Drainage Pumping Station No. 3 as originally constructed, 1909 (from Sewerage & Water Board 1909).

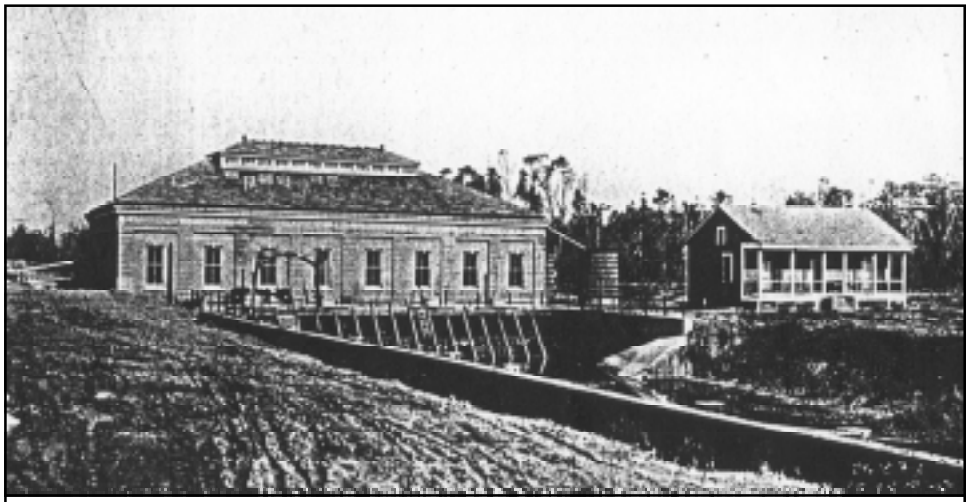

Figure 15. Drainage Pumping Station No. 6 as originally constructed, 1909 (from Sewerage & Water Board 1909).

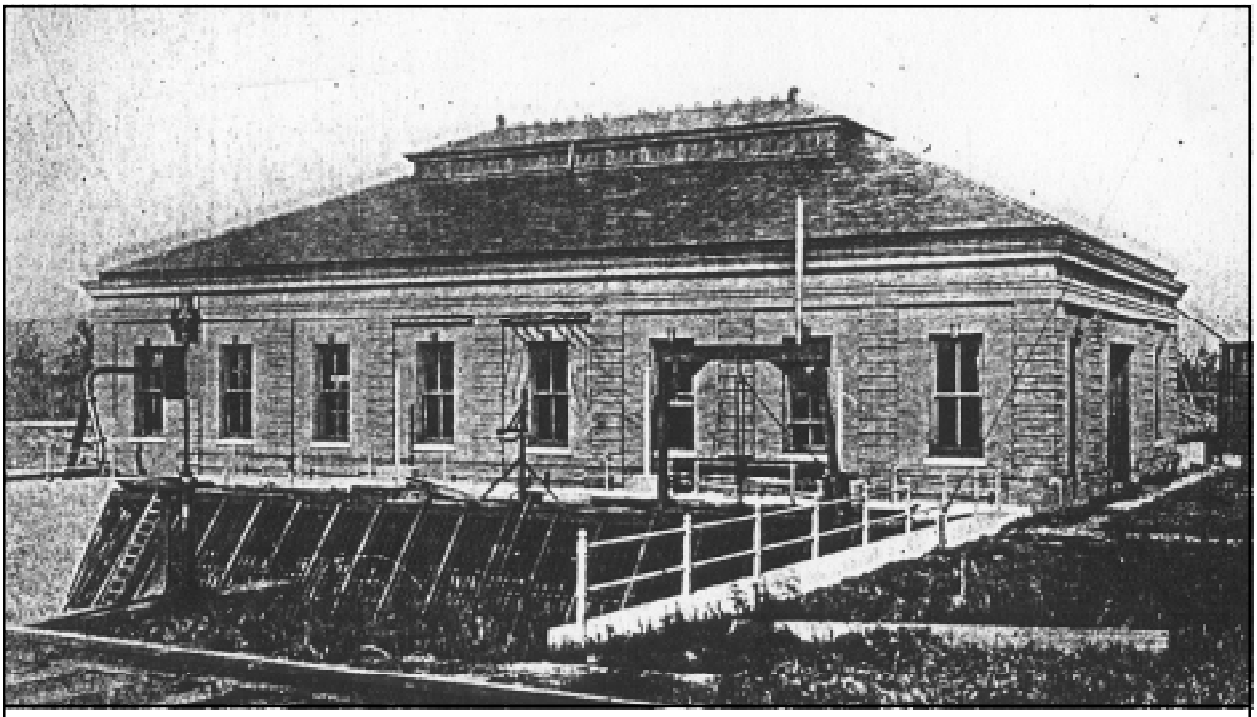

Figure 16. Drainage Pumping Station No. 7 as originally constructed, 1909 (from Sewerage & Water Board, 1909).

New Orleans Navigation Canal, which ran from Basin and Julia Street to West End, and the Main Canal which was to be excavated along Broad Street (Fitzpatrick et al. 1895:14, 23). The station was not actually built at this location (see below). The Specifications issued in 1896 for the Broad Pumping Station (Drainage Pumping Station No. 1) stated:

> …This station shall be provided with "High Duty" pumping machinery of a capacity to lift the daily flow from Section No. 1, a minimum volume of fifteen cubic feet per second, from 4 C.D. [Cairo Datum] to 7.94 C.D., or 3.94 feet, and deliver it through a conduit under the New Orleans Navigation Canal into the main canal in Section 2.
>
> …It shall also be provided with "Compound" pumping machinery of a capacity to deliver 500 cubic feet per second of run-off from Section No. 1, through conduits under the New Orleans Navigation Canal into the main canal in Section No. 2. These pumps shall be arranged to lift this volume three feet, with the surface of the water on the suction side ranging between 9 and 16 C.D.
>
> …It shall also be provided with "Compound" pumping machinery of a capacity to deliver 500 cubic feet per second of run-off from Section No. 1 into the Venus relief canal leading to the Metairie Pumping Station (No. 6). These pumps shall be arranged to lift this volume four feet, with the surface of the water on the suction side ranging between 9 and 16 C.D. [City of New Orleans 1896:35].

The location of Pumping Station No. 1 was changed "for economical reasons" by the Drainage Commission prior to contracting for construction. The station was to be built at the intersection of Broad and Melpomene streets, adjacent to the Melpomene Canal (or original Metairie Outfall Canal) instead of at the intersection of Broad and Venus streets, with consequent alterations to the location of the Main Canal (Hering et al. 1902:6-8).