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The modern New Orleans drainage system represents a unique technological solution to natural conditions that have played an important role in the settlement and expansion of the city. The system was designed in 1895, and construction of the system began in 1897. Improvements to Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 are proposed under the Southeast Louisiana Flood Control Project and the Lake Pontchartrain and Vicinity Louisiana Hurricane Protection Project. Drainage Pumping Stations Nos. 1, 3, 6, and 7, built in the period 1897-1903, are original constituents of the system that have been expended in capacity as the drainage requirements of the city have grown. The 12' Wood screw pumps in Station No. 1 have been designated National Engineering Landmarks, and stations 3, 6, and 7 have other examples of these pumps. Drainage Pumping Station No. 4 was constructed 1945-1946 as an addition to the system. This report recommends that Drainage Pumping Stations Nos. 1, 3, 6, and 7 be considered individually eligible for nomination to the National Register of Historic Places. In addition, these stations, along with their associated canals, should be considered contributing elements of a drainage system National Historic District. Proposed improvements under the Southeast Louisiana Flood Control Project and the Lake Pontchartrain and Vicinity Louisiana Hurricane Protection Project will have no adverse affect on the associative, architectural, and engineering significance of these stations or on the drainage system as a whole.

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TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION 1

CHAPTER 2
OVERVIEW OF THE DEVELOPMENT OF DRAINAGE IN EUROPEAN AND AMERICAN CITIES THROUGH THE NINETEENTH CENTURY 3

CHAPTER 3
HISTORY OF NEW ORLEANS DRAINAGE, 1718-1893 9

CHAPTER 4
HISTORY OF THE NEW ORLEANS DRAINAGE SYSTEM, 1893-1996 17
The Drainage Advisory Board and the Drainage Plan of 1895 17
Construction of the Drainage System, 1896-1910 20
Expansion of the Drainage System, 1911-1945 24
The Drainage System Since World War II 30
Histories of Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 30
Drainage Pumping Station No. 1 32
Drainage Pumping Station No. 3 39
Drainage Pumping Station No. 4 45
Drainage Pumping Station No. 6 51
Drainage Pumping Station No. 7 54
History of the Drainage Network 56

CHAPTER 5
BIOGRAPHIES OF IMPORTANT PERSONAGES ASSOCIATED WITH THE NEW ORLEANS DRAINAGE COMMISSION AND THE SEWERAGE AND WATER BOARD OF NEW ORLEANS 69
Rudolph Hering 69
Chief Engineer Benjamin Morgan Harrod 70
Superintendent George G. Earl 72
Superintendent Alfred Francis Theard 73
Superintendent Albert Baldwin Wood 73
Background 79

CHAPTER 6
NRHP EVALUATION OF DRAINAGE PUMPING STATIONS NOS. 1, 3, 4, 6, AND 7 AND OF THE NEW ORLEANS DRAINAGE SYSTEM 79
Engineering Description of the New Orleans Drainage System 79
Background 79
Design Constraints 79
System Description 80
Engineering Descriptions of Drainage Pumping Stations Nos. 1, 3, 4, 6, And 7 81
Drainage Pumping Station No. 1 81
Drainage Pumping Station No. 3 81
Drainage Pumping Station No. 4 82
Drainage Pumping Station No. 6 82
Drainage Pumping Station No. 7 82
Architectural Descriptions of Drainage Pumping Stations Nos. 1, 3, 4, 6, And 7 82
Drainage Pumping Stations Nos. 1, 3, 6, And 7 83
Drainage Pumping Station No. 1 87

Drainage Pumping Station No. 3 88
Drainage Pumping Station No. 6 88
Drainage Pumping Station No. 7 88
Drainage Pumping Station No. 4 88
Evaluation of the Integrity of Drainage Pumping Stations Nos. 1, 3, 4, 6, And 7 89
Evaluation of the Integrity of the Drainage System 89
Statement of Associative Significance (Criterion A) 91
Statement of Architectural Significance (Criterion C) 92
Statement of Engineering Significance (Criterion C) 93
Levels of Significance 96

CHAPTER 7
RECOMMENDATIONS 99
Effects of Proposed Improvements 99
Drainage Pumping Station No. 1 99
Drainage Pumping Station No. 3 100
Drainage Pumping Station No. 4 101
Drainage Pumping Station No. 6 102
Drainage Pumping Station No. 7 103
Effects of Proposed Improvements on Associative Significance (Criterion A) 104
Effects of Proposed Improvements on Architectural Significance (Criterion C) 104
Drainage Pumping Station No. 1 104
Drainage Pumping Station Nos. 3, 6, and 7 106
The Drainage System 108
Effects of Proposed Improvements on Engineering Significance (Criterion C) 108
Drainage Pumping Station No. 1 108
Drainage Pumping Station Nos. 3, 6, and 7 109
The Drainage System 112
Summary of Recommendations 112

APPENDIX I: INVENTORY OF DOCUMENTATION OF THE NEW ORLEANS DRAINAGE SYSTEM 123
Records of the Sewerage and Water Board of New Orleans 125
Sewerage and Water Board Network Department 229
Tulane University (Louisiana Collection) 259

APPENDIX II: SCOPE OF SERVICES 163

LIST OF FIGURES

Figure 1. The Dublin Drainage Machine in the early 1890's. On the right is the Corliss steam engine powering the machine (from Sewerage & Water Board 1971:23) 12

Figure 2. The Dublin Drainage Machine, no date (from Sewerage & Water Board 1966) 12

Figure 3. The "Old Melpomene Drainage Wheel," no date (from Martin Behrman Administration Biography 1916) 13

Figure 4. "A Flood at Canal and Claiborne" by A.R. Waud, 1871 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 13

Figure 5. The Drainage system of New Orleans Prior to 1897 (from Earl 1903:4) 18

Figure 6. The New Orleans Drainage System as proposed in the 1895 Drainage Plan (from Fitzpatrick et al. 1895) 19

Figure 7. The New Orleans Drainage system as constructed to the end of 1902 (from Sewerage & Water Board 1902) 22

Figure 8. Broad Street Canal before cleaning, 1904 (from Sewerage & Water Board 1904) .. 23

Figure 9. Broad Street Canal after cleaning, 1904 (from Sewerage & Water Board 1904) 24

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) 25

Figure 11. Cross-section of a 12' Wood screw pump (from Sewerage & Water Board 1914) .. 27

Figure 12. The New Orleans Drainage system as constructed to 1954 (from Sewerage & Water Board 1954) 31

Figure 13. Drainage Pumping Station No. 1 as originally built; photograph taken ca. 1911 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 32

Figure 14. Drainage Pumping Station No. 3 as originally constructed, 1909 (from Sewerage & Water Board 1909) 32

Figure 15. Drainage Pumping Station No. 6 as originally constructed, 1909 (from Sewerage & Water Board 1909) 32

Figure 16. Drainage Pumping Station No. 7 as originally constructed, 1909 (from Sewerage & Water Board 1909) 33

Figure 17. Interior of Drainage Pumping Station No. 1, ca. 1906 (from Earl 1906) 34

Figure 18. Vertical centrifugal pump motor housing of the type originally installed in Drainage Pumping Stations Nos. 1, 6, and 7, 1897-1903. This pump was manufactured by the E. P. Allis Co. and the motor was manufactured by the General Electric Co. This example remains at Drainage Pumping Station No. 7 34

Figure 19. Lower portion of vertical centrifugal pump motor and drive shaft, of the type originally installed in Drainage Pumping Stations Nos. 1, 6, and 7, 1897-1903. Photographed at Drainage Pumping Station No. 7 35

Figure 20. Vertical centrifugal pump pit, showing top of discharge pipe at right. These original pump pits, dating to 1897-1903, have been altered or eliminated at all stations except at Drainage Pumping Station No. 7, shown here.. 35

Figure 21. Drainage Pumping Station No. 1 during pump testing, 1904. The original caption states: "…shows one pump throwing 250 cubic feet of water per second over a weir erected for testing capacity of pumps. There are three similar pumps at this station" (from Sewerage & Water Board 1904) 36

Figure 22. Exterior of Drainage Pumping Station No. 1, after alteration for 12' Wood screw pumps, ca. 1914-1915. Original caption states: "showing the hydraulically operated flood gates and the discharge end of the twelve-foot screw pumps" (from Sewerage & Water Board 1914) 36

Figure 23. Exterior of Drainage Pumping Station No. 1, after alteration for 12' Wood screw pumps, photograph ca. 1915-1926 (from Sewerage & Water Board n.d.) 37

Figure 24. Interior view of Drainage Pumping Station No. 1, showing two 12' Wood screw pumps during installation, ca. 1914-1915 (from Sewerage & Water Board 1914) 37

Figure 25. Interior view of Drainage Pumping Station No. 1, showing switchboard and rotary apparatus during installation, ca. 1914-1915 (from Sewerage & Water Board 1914) 37

Figure 26. Interior view of Drainage Pumping Station No. 1 after installation of 12' Wood screw pumps and electrical equipment, ca. 1915. The Wood pumps are visible in the rear, the switch board to the right, and in the foreground, the motors for the vertical shaft screw pumps originally installed in the station ca. 1903-1904 (from Sewerage & Water Board 1915) 38

Figure 27. Testing of one 12' Wood screw pump at Drainage Pumping Station No. 1, ca. 1915. Original caption states: "…view of the discharge end of Pumping Station No. 1… pumping water from the area served by the Napoleon Avenue, Third Street, and Melpomene Street Canal into the Metairie Relief Canal on its way to Pumping Station No. 6. The picture shows discharge from one Wood screw pump through partly closed swinging control gates during the test. The discharge basin of this pumping station is so arranged…as to permit the discharging of the dry weather and small storm flow into the Broad Street Canal… This station is the first station designed to carry the dry weather flow across the city on its way to Lake Borgne, and thus relieve Lake Pontchartrain from the foul water which is pumped out of the city during dry weather or at the beginning of rains" (from Sewerage & Water Board 1915) 38

Figure 28. Testing of the 12' Wood screw pumps at Drainage Pumping Station No. 1 (background), ca. 1915. Pilot tubes have been placed in the Metairie Relief Canal to measure the velocity of flow. This data was used to calculate the efficiency of the pumps. Tulane engineering students are holding the tubes while engineers record data (from Sewerage & Water Board 1915) 39

Figure 29. Drainage Pumping Station No. 1. View of east facade, looking west from Martin Luther King Boulevard 39

Figure 30. Drainage Pumping Station No. 1. View looking southwest 40

Figure 31. Drainage Pumping Station No. 1. View looking northwest 40

Figure 32. Drainage Pumping Station No. 1. View looking south 41

Figure 33. Drainage Pumping Station No. 1. View looking southeast 41

Figure 34. Drainage Pumping Station No. 1. View of south facade, looking north 42

Figure 35. Drainage Pumping Station No. 1. View of northern end of interior, showing 12' Wood screw pumps and motors 42

Figure 36. Drainage Pumping Station No. 1. View of interior looking south from central portion of building. Foreground, prototype Wood screw pump on display; center, 250 cfs vertical screw pump motors 43

Figure 37. Testing of one 12' Wood screw pump at Drainage Pumping Station No. 1, ca. 1915. Original caption states: "...view of the discharge end of Pumping Station No. 1... pumping water from the area served by the Napoleon Avenue, Third Street, and Melpomene Street Canal into the Metairie Relief Canal on its way to Pumping Station No. 6. The picture shows discharge from one Wood screw pump through partly closed swinging control gates during the test. The discharge basin of this pumping station is so arranged...as to permit the discharging of the dry weather and small storm flow into the Broad Street Canal... This station is the first station designed to carry the dry weather flow across the city on its way to Lake Borgne, and thus relieve Lake Pontchartrain from the foul water which is pumped out of the city during dry weather or at the beginning of rains" (from Sewerage & Water Board 1915) 38

Figure 38. Drainage Pumping Station No. 1. View of interior, central portion of building, showing 30" Wood constant duty screw pump 44

Figure 39. Interior of Drainage Pumping Station No. 3 as originally constructed, showing horizontal centrifugal pumps, 1904 (from Sewerage & Water Board 1904) 44

Figure 40. Drainage Pumping Station No. 3, viewed from the northeast 45

Figure 41. Drainage Pumping Station No. 3, viewed from the northwest 46

Figure 42. Drainage Pumping Station No. 3, viewed from North Broad Avenue 46

Figure 43. Drainage Pumping Station No. 3, viewed from the northwest. Discharge basin and discharge pipes of 14' Wood screw pumps are visible 47

Figure 44. Drainage Pumping Station No. 3. View of discharge basin; 12' Wood pump at left, 14' Wood pumps at right (west) end of the station 47

Figure 45. Drainage Pumping Station No. 3, viewed from railroad bridge over the London Avenue Outfall Canal. View of the discharge basin 48

Figure 46. Drainage Pumping Station No. 3. View of interior looking east from the central portion of the building; in the foreground are two horizontal centrifugal constant duty pumps 48

Figure 47. Drainage Pumping Station No. 4, 1962, showing new 10' steel siphon over the London Avenue Outfall Canal (from Sewerage & Water Board 1962) 49

Figure 48. Drainage Pumping Station No. 4, viewed from the southeast. Pumping equipment is obscured by a tarpaulin; sand-blasting in progress 49

Figure 49. Drainage Pumping Station No. 4, viewed from the east 50

Figure 50. Drainage Pumping Station No. 4, viewed from the southwest, across the London Relief Outfall Canal 50

Figure 51. Figure 28. Interior of Drainage Pumping Station No. 6 as originally constructed, showing vertical centrifugal pumps (from Sewerage & Water Board 1904) 51

Figure 52. Interior view of Drainage Pumping Station No. 6, showing original vertical centrifugal pumps, 1909 (from Sewerage & Water Board 1909) 51

Figure 53. Drainage Pumping Station No. 6, after 1914 and 1929 extensions (from Sewerage & Water Board 1929) 52

Figure 54. Interior of Drainage Pumping Station No. 6 after installation of 14' Wood screw pumps (from Sewerage & Water Board) 53

Figure 55. Drainage Pumping Station No. 6, 1966 (from Sewerage & Water Board, 1966) .. 53

Figure 56. Drainage Pumping Station No. 6, viewed from the southwest 54

Figure 57. South facade of Drainage Pumping Station No. 6 54

Figure 58. Drainage Pumping Station No. 6, joint of 1897-1899 construction and 1986-1989 addition 54

Figure 59. Drainage Pumping Station No. 6, viewed from the north 55

Figure 60. Drainage Pumping Station No. 6. View of interior looking east; in the foreground are 250 cfs vertical centrifugal pump motors. The remainder of the pumps are Wood screw pumps; in the foreground are two 12' pumps, and in the background are four 14' pumps 55

Figure 61. Drainage Pumping Station No. 7. View from the southwest 57

Figure 62. Drainage Pumping Station No. 7. View from the southeast 57

Figure 63. Drainage Pumping Station No. 7. Viewed from the northeast, showing trash screen and hydraulic sluice gate mechanisms 58

Figure 64. Drainage Pumping Station No. 7. View of interior, showing motor covers of 250 cfs centrifugal "flathead" pumps 58

Figure 65. Drainage Pumping Station No. 7. View showing end of monitor 59

Figure 66. Drainage Pumping Station No. 7. Wooden vehicle door on west end of building 59

Figure 67. Old and new sections of small canals, from the 1902 Board of Inquiry report (from Hering et al. 1902) 64

Figure 68. Excavation of the Orleans Canal, n.d.; possibly ca. 1904 (from Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 64

Figure 69. Interior of the Hagan Avenue Canal, shown during construction, ca. 1906. This concrete-lined and covered canal was constructed 1904-1906 (from Sewerage & Water Board 1906a) 65

Figure 70. Melpomene Outfall Canal, 1906. The canal was timber-lined and the banks graded, 1905-1906. Drainage Pumping Station No. 1 is in the background (from Sewerage & Water Board 1906a) 65

Figure 71. Melpomene Outfall Canal after timber lining and grading, 1906 (from Sewerage & Water Board 1906b) 65

Figure 72. Sections of covered canals; old masonry and new concrete sections, 1910 (from Sewerage & Water Board 1910) 65

Figure 73. Napoleon Avenue Canal under construction, 1912 (from Sewerage & Water Board 1912) 66

Figure 74. Napoleon Avenue Canal under construction, interior view, 1912 (from Sewerage & Water Board 1912) 66

Figure 75. Interior view of the Broad Street culvert, July 27, 1913 (from Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 66

Figure 76. Interior view of the Broad Street culvert, July 27, 1913 (from Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 67

Figure 77. Upper end of the Metairie Relief Canal view from Drainage Pumping Station No. 1, 1914 (from Sewerage & Water Board 1914) 67

Figure 78. Lower end of the Metairie Relief Canal, approaching Pumping Station No. 6, 1914 (from Sewerage & Water Board 1914) 67

Figure 79. Construction of box culvert, Jefferson Davis Parkway, ca. 1961-1962 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University) 68

Figure 80. B.M. Harrod, Chief Engineer and architect for the New Orleans Drainage Commission, 1893-1902 (from Tompkins 1901:206) 70

Figure 81. George G. Earl, General Superintendent of the Sewerage and Water Board, 1900-1931 (from Martin Behrman Administration Biography, 1916) 72

Figure 82. Albert Baldwin Wood, General Superintendent of the Sewerage & Water Board, 1939-1956 (courtesy of the Sewerage & Water Board of New Orleans) 73

Figure 83. Typical column bay, Drainage Pumping Station No. 6. The bay proportions are uniform for Drainage Pumping Stations 1, 3, 6, and 7 (from Historic American Building Survey 1992) 83

Figure 84. Drainage Pumping Station No. 1. View of east facade, showing brick depth and projection 84

Figure 85. Drainage Pumping Station No. 1. View of upper portion of east facade of building, showing pilasters, wall, and entablature, quarter-round bricks at transition to cornice, and decorative cast-metal false keystone on window 84

Figure 86. Drainage Pumping Station No. 1. View of upper portion of southeast corner of building, showing projection of fascia brick courses and decorative metal castings 84

Figure 87. Drainage Pumping Station No. 1. View of upper portion of southeast corner of building, showing special round bricks, corner treatment of architrave, and quarter-round brick course below cornice 84

Figure 88. Drainage Pumping Station No. 1. View of roof on eastern side of building, showing decorative terra-cotta crest on monitor. The joint between the 1899-1904 masonry and 1915 construction is visible above the central pilaster 85

Figure 89. Drainage Pumping Station No. 1. View of west side of south facade, showing door and shuttered transom window 85

Figure 90. Drainage Pumping Station No. 1. View of east facade pilaster base, showing course of beveled bricks 86

Figure 91. Drainage Pumping Station No. 1. View of the monitor roof peak at the northern end of the building, with terra-cotta crest and finial 86

Figure 92. Drainage Pumping Station No. 1. View of lower portion of northwest corner of building, showing special round bricks and pilaster bases at corner 87

Figure 93. The Central Power Station (No. 1), built 1897-1899 (from Sewerage & Water Board 1909) 87

Figure 94. Drainage Pumping Station No. 1. Plan showing areas of potential effect. No scale available (NODCOE) 99

Figure 95. Drainage Pumping Station No. 1. Elevation showing areas of potential effect. No scale available (NODCOE) 100

Figure 96. Drainage Pumping Station No. 3. Plan of existing station (NODCOE) 101

Figure 97. Drainage Pumping Station No. 3. Plan showing proposed improvements (NODCOE) 101

Figure 98. Drainage Pumping Station No. 4. Plan of existing station (NODCOE) 102

Figure 99. Drainage Pumping Station No. 4. Plan showing proposed improvements (NODCOE) 102

Figure 100. Drainage Pumping Station No. 6. Plan of existing station (NODCOE) 103

Figure 101. Drainage Pumping Station No. 6. Plan showing proposed improvements (NODCOE) 103

Figure 102. Drainage Pumping Station No. 7. Plan of existing station (NODCOE) 104

Figure 103. Drainage Pumping Station No. 7. Plan showing proposed improvements (NODCOE) 104

Figure 104. Drainage Pumping Station No. 3. Currently existing station viewed from the north 106

Figure 105. Drainage Pumping Station No. 3. View of station after construction of proposed improvements 106

Figure 106. Drainage Pumping Station No. 6. Currently existing station viewed from the north 107

Figure 107. Drainage Pumping Station No. 6. View of station after construction of proposed improvements 107

Figure 108. Drainage Pumping Station No. 7. Currently existing station viewed from the north 107

Figure 109. Drainage Pumping Station No. 7. View of station after construction of proposed improvements 108

Figure 110. Plan of typical existing horizontal screw pump discharge tube and discharge tube foundation (NODCOE) 109

Figure 111. Plan of typical discharge tube extension, as proposed (NODCOE) 110

Figure 112. Elevation of typical discharge tube extension and sluice gate, as proposed (from Pepper & Associates 1995a) 110

Figure 113. Section and discharge head levels versus flow rate 111

Figure 114. Pump flow rates of existing pump and pump with planned fronting protection sluice gates 111

Figure 115. Effect of reverse flow 111

LIST OF TABLES

Table 1. Building Dates of Drainage Pumping Stations 1,3,4,6, and 7 31

Table 2. Drainage Network Construction, 1896-1941 60

Table 3. Pumps in Drainage Pumping Stations Nos. 1,3,4,6, and 7 94

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CHAPTER 1
INTRODUCTION

This volume presents the results of a study to evaluate the National Register eligibility of the New Orleans drainage system, with special focus on five stations and their components (buildings, pumps, canals, etc.) which will be impacted by planned projects by the New Orleans District, Corps of Engineers (NOD). The Southeast Louisiana Flood Control Project will involve additions to Pumping Station No. 1 which will have a visual and architectural effect on the structure, although the existing pumps and machinery will not be altered. In addition, the canals and underground drainage features will be affected as a result of this work. New Orleans Drainage Pumping Stations Nos. 3, 4, 6, and 7 will have fronting protection constructed on the outfall canal side of the stations to provide protection from hurricane storm surges as part of the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project. While the existing pumps and buildings will not be altered, the project will have a visual effect on the structures as well as an effect on the discharge tubes of the station pumps.

The primary purpose of the this study was to: (1) develop a comprehensive historic context for the evaluation of the New Orleans drainage system; (2) evaluate the above-mentioned structures in terms of National Register criteria within the framework of this context; (3) assess the nature and extent of the proposed project impacts, both in terms of architectural/engineering integrity and visual effects; and (4) provide recommendations for mitigation of adverse effects to significant architectural and engineering elements. A secondary objective was the evaluation of the New Orleans drainage system as a whole in terms of National Register criteria.

Chapter 2 presents an overview of the development of drainage in American and European cities, while Chapter 3 discusses the history of drainage in New Orleans to 1893. Chapter 4 provides the history of the New Orleans Drainage system since 1893. Included in this chapter are histories of Drainage Pumping Stations 1, 3, 4, 6, and 7. Biographies of important individuals associated with drainage and sewerage in New Orleans are presented in Chapter 5. Chapter 6 discusses the National Register eligibility of Stations 1, 3, 4, 6, and 7 and of the Drainage System as a whole. Evaluation of the effects of proposed improvements and recommendations is provided in Chapter 7.

CHAPTER 2
OVERVIEW OF THE DEVELOPMENT OF DRAINAGE IN EUROPEAN AND AMERICAN CITIES THROUGH THE NINETEENTH CENTURY

Sewerage practice was only approaching rational, scientific principles in the second half of the nineteenth century, despite the ancient history of sewerage engineering. During the early modern period, drainage for the removal of rainwater and groundwater in urban settings was uniformly viewed as part of the more general issue of sewerage. Until the concept of separate systems of drainage and sewerage was developed by professionally trained engineers, from 1880 on, urban drainage and sewerage were synonymous. In fact, engineering terminology continued to refer to urban drainage and sewerage beneath the rubric of sewerage well into the twentieth century (cf. Marston 1912, Metcalf and Eddy 1914), and removal of rainwater and house sewerage were frequently expected to utilize the same infrastructure. In addition, it was only in the last third of the nineteenth century that the public was willing to countenance significant taxation to build expensive infrastructure systems to deal with municipal drainage and sewerage. Construction of municipal drainage and sewerage systems was part of a more general trend in American and European cities to take action in the interest of public health. These endeavors were undertaken with a view toward the economic development and growth of municipalities. In the formative period of American drainage and sewerage practice, American planners were heavily influenced by experience in Europe (Metcalf and Eddy 1914:1).

The earliest sewerage works in Europe, during the classical era, were principally concerned with surface drainage and the abatement of public nuisances. Ancient Rome was one of the earliest cities to develop an extensive sewer system. However, most residences were not connected to Rome's great underground drains. Public sanitation centered around private or public latrines and privies, and large amounts of ordure found its way into street gutters, where it was irregularly washed into the public sewers by the action of rain or irrigation. The circumstances were even worse in European cities of the medieval and early modern world, where civil engineering lagged behind that of the Romans. Urban environments were remarkably filthy and unhealthy. In general, underground sewers were designed to carry storm water rather than human and household wastes. Street gutters were characteristically choked with human and animal excrement, and cities in poorly-drained landscapes festered in foul mud. Without any available scientific knowledge of hydraulics or topographical science, efforts to improve drainage or sewerage systems were universally piecemeal and ineffective. In fact, no marked progress was made in drainage and sewerage systems in Europe from the classical era to the early 1830s (Metcalf and Eddy 1914:1-2, 10-14; Tchobanoglous 1981:2-3; Cohn 1966:44)

The beginning of the modern era of drainage and sewerage systems began in Paris. As early as 1808, a comprehensive study was undertaken to determine the sewerage needs of the city. There were 14½ miles of drains in Paris in 1808, but only about 10½ miles were added by 1832. In that year, an epidemic of cholera in Paris led authorities to make a topographical survey of the city in preparation for a planned system of drainage. The system was to be based on topographical features rather than administrative boundaries, which avoided many delays encountered in subsequent efforts to modernize drainage in London, and even some American cities. The system construction begun in Paris in 1833 concerned drainage, and not house sewerage, and therefore has received less attention than some later efforts elsewhere. Many of the low-lying streets along the Seine were raised above the level of any expected flood; old drainage sewers were reconstructed or abandoned; and the cross-section of streets changed from concave to convex. For the ease of cleaning by workmen, the new sewers built in Paris after 1833 were made 6' or more high, so the workmen could stand up in them. These large sewers were intended to remove street refuse as well as rainwater. The solid sewage was mostly removed from the flow in collectors, and the greater part of the sludge and water was discharged into the river. While much of the water from rainfall was diverted into large "house drains," human and household wastes were not discharged into the sewers but into cesspools. The cesspools were not a satisfactory long-term solution to the sewerage problem, and a debate ensued over whether "dry carriage" or "water carriage" of human and household wastes was preferable. In the "dry carriage system", wastes are collected in dry containers, which are removed and exchanged at regular intervals. In the "water carriage" system, wastes are flushed into the sewers, and this became standard practice in the United States. In 1880, the Paris sewers began to be connected with sewage drains from houses (Metcalf and Eddy 1914:10-14; Tchobanoglous 1981:2-3; Cohn 1966:44).

In 1842 a conflagration destroyed the older part of the city of Hamburg, and it was decided to rebuild it with, among other features, a new sewerage system. W. Lindley, a leading English engineer, designed the system, considered the first truly modern system for removal of rainwater and household wastes. The sewers of Hamburg remained among the most advanced in the world for a generation. However, the building of the sewers of Hamburg was an exceptional situation in which it was possible to plan streets and sewers together to best answer the needs of the community and local topographical conditions (Metcalf and Eddy 1914:2-3; Cohn 1966:44-45). More typical of the mid-nineteenth century experience in Europe was London, England, whose sewerage history was also studied closely by American engineers. Until 1815, human wastes could not be disposed of directly into London sewers. By the 1840s, London's population numbered over two million, living in several hundred thousand households. Awareness of the need for sewerage reform and development led to the first comprehensive study of the metropolis for the purpose of planning sewerage improvements. In 1847, the first official engineer's report on sewerage and drainage in London contained the following description, which could have been said about almost any large city in Europe or America:

> There are hundreds, I may say thousands, of houses in this metropolis which have no drainage whatever, and the greater part of them have stinking, overflowing cesspools, and there are also hundreds of streets, courts and alleys that have no sewers; and how the drainage and filth are cleaned away and how the miserable inhabitants live in such places it is hard to tell… I have visited very many places where filth was lying scattered about the rooms, vaults, cellars, areas, and yards, so thick and so deep that it was hardly possible to move for it. I have also seen in such places human beings living and sleeping in sunk rooms with filth from overflowing cesspools exuding through and running down the walls and over the floors… the effects of the effluvia, stench and poisonous gases constantly evolving from these foul accumulations were apparent in the haggard, wan and swarthy countenances and enfeebled limbs of the poor creatures whom I found residing over and amongst these dens of pollution and wretchedness… [quoted in Metcalf and Eddy 1914:4]

Also in 1847, a cholera epidemic raged in India and fear arose that a similar epidemic might break out in London. This stimulated the formation of a unified sewerage board to improve sanitation practices. In the same year, London issued an edict that required that all privies drain into the sewers which were already present. Cholera epidemics in 1849 and 1852-1854 further motivated sanitation improvement efforts (Metcalf and Eddy 1914:4-5; Tchobanoglous 1981:2-3; Cohn 1966:44).

The engineering of London's sewerage and drainage provided a laboratory of experience that influenced American practice later in the century. In particular, the engineers of the London system underestimated the requirements of the metropolis for sewerage and drainage capacity, and consequently constructed a system with features that were too small. In addition, Parliament began national regulation of sanitation in 1848 and regulation of nuisance pollution in 1855 (Metcalf and Eddy 1914:5-8).

The sewerage situation was similar in European and American cities in the early-nineteenth century. In the United States, drainage efforts were often constructed by individuals or inhabitants of small districts, at their own expense and with little or no public supervision. In the early part of the nineteenth century, water boards were not infrequently in charge of drainage works. The sewers which were constructed were usually for storm water and not for human wastes (Metcalf and Eddy 1914:14-15). Human wastes were, for example, excluded from Boston's sewers until 1833 and from Philadelphia's until 1850. Prior to 1850, sewerage facilities in most American cities were the same as those in rural areas. Privies or water closets were utilized, and these often emptied into vaults or cesspools. Waste material either soaked into the ground or was hauled away in wagons. Kitchen waste in many cities ran into ditches along the streets. Often, these ditches also carried urine and fecal matter because only inadequate numbers of privies were present in congested districts. For instance, in Cincinnati in 1865, there was only one privy associated with a two-story tenement house inhabited by 102 individuals (Glaab and Brown 1983:77). The irregular flow of badly-engineered street gutters found its way into drainage sewers, many of which were constructed along natural watercourses, such as small brooks. Frequently these sewers were large and of insufficient grade, with the result that the waste matter released in them accumulated and decomposed, producing a serious public nuisance (Metcalf and Eddy 1914:17).

American urbanites began to confront sanitation problems forcefully in the mid-nineteenth century. The quality of life and the health of most city dwellers was obviously threatened by a lack of sanitation. There was no garbage collection. Excrement and other filth lay in the streets and gutters. Many cities had no pure water supply, and smoke from factories polluted the air. Epidemics decimated urban populations. However, many Americans blamed the unhealthy conditions of city life on human infirmity. The native poor and new immigrants also became the scapegoats for these problems (Schultz and McShane 1978:397-398; Baudier 1955b:11).

In 1849, New York City created a municipal department of sewers. At that date, the city had only 70 miles of sewers. Eight years later, there were 158 miles, but these served only about one-quarter of the city. Brooklyn constructed sewers designed for the transport of sewage between 1857 and 1859 (Cohn 1966:47). This early Brooklyn system was designed by Julius W. Adams. In 1866, a cholera epidemic stimulated New York to organize a Metropolitan Board of Health. One aspect of its sanitation program was to require the disinfection of privies, indicating that the sewerage system was far from complete by that date (Glaab and Brown 1983:77-78). In 1857, a report was issued concerning poor sanitation conditions in Philadelphia. The report urged that "There should be a culvert on every street, and every house should be obligated to deliver into it by underground channels all ordure or refuse that is susceptible to being diluted." Construction of Philadelphia's sewer system began shortly thereafter (Cohn 1966:47). In 1858, Chicago began rudimentary sewer construction from designs by E.S. Chesbrough (Metcalf and Eddy 1930:10).

Not all sewerage improvements in the 1850s and 1860s were undertaken by northern cities. Charleston, South Carolina constructed a unique sewerage system, without any slope to the sewers; tidal action flushed the sewers of solid matter. In the Mid-West, St. Louis began construction of a large sewer, draining storm flows from 6400 acres of the city, in 1864 (Metcalf and Eddy 1914:18, 22).

Through the 1870s, private vaults and cesspools were still in use to deal with house wastes in most American cities. In 1877, there were approximately 82,000 such facilities in use in Philadelphia, 56,000 in Washington, and 30,000 in Chicago (Glaab and Brown 1983:172). Although privies were still in use in Chicago in 1877, that city had begun to construct a sewerage system in 1871. As part of the effort, the direction of flow of the Chicago River was changed so that it ran to the Illinois River rather than into Lake Michigan. Despite Chicago's efforts, conditions in 1880 were apparently similar to those in New Orleans in the same year (see Chapter 3). The *Chicago Times* reported in that year that:

> The [Chicago] river stinks. The air stinks. People's clothing, permeated by the foul atmosphere stinks... No other word expresses it so well as stink.

> A stench means something finite. Stink reaches the infinite and becomes sublime in the magnitude of odiousness [quoted in Glaab and Brown 1983:172].

Other northern cities that began sewerage efforts in the post-Civil War period were Providence, Rhode Island, which began a system designed by J. Herbert Shedd in 1874, and Boston, which began a system designed by E.S. Chesbrough, Moses Lane, and Dr. C.F. Folsom in 1876 (Metcalf and Eddy 1930:10).

Despite the example of Charleston, many Southern cities instituted comprehensive efforts to solve the problems of sewage disposal only after 1878. A yellow fever epidemic in the Mississippi Valley in that year stimulated an intense concern among business leaders about public health in a number of urban centers. The epidemic resulted in 20,000 deaths and the loss of hundreds of millions of dollars in business revenues. Earlier in the nineteenth century, outbreaks of yellow fever, as well as cholera and smallpox, were recognized as having an adverse economic effect in addition to representing major causes of mortality. However, the diseases were often viewed simply as part of doing business in cities which were located in inherently unhealthy areas (Ellis 1969a:197-198, 203-207).

The 1878 outbreak of yellow fever, which stimulated much concern with public sanitation in the American South, began in New Orleans. By August 1878, approximately one-fifth of New Orleans' population had fled, and in doing so they spread the disease to other Southern cities. Many cities invoked a quarantine, but New Orleanians still managed to find refuge there. When the first case was reported in Memphis, a "human stampede" resulted. Less than half of Memphis' population of 48,000 remained in that city three days later (Ellis 1969b:346-347). Despite a growing awareness of the importance of public health and the development of infrastructure, systematic improvements in New Orleans' drainage and sewerage would not occur in the 1870s, or even the 1880s, but in the second half of the 1890s (see Chapters 3 and 4).

Of great importance to the history of drainage in New Orleans is the development of concepts of separate systems of sewerage and drainage, in which house sewage and rain water are kept nearly or completely distinct. The designer of the first separate system is not definitely known, but the principle was strongly advocated as early as 1842 by Edwin Chadwick, who has been called "the father of sanitation in England." Chadwick did much to encourage sanitary efforts in British cities and countryside, but his own designs were severely flawed. Chadwick was:

> …a man of convincing address, great self-reliance and enthusiasm, and strong imagination which was unfortunately not restrained by technical knowledge. As a result he advocated, even in meetings of engineers, so-called hydraulic principles and some features of design that were wholly incorrect and at last resulted in his being publicly branded as a charlatan at a meeting of the Institution of Civil Engineers at which he was in attendance [quoted in Metcalf and Eddy 1914:23].

Chadwick was similar in some respects to a prominent proponent of separate systems in the United States, Colonel George E. Waring, Jr., who is discussed in greater detail below. Despite Chadwick's shortcomings, the principle of separation of house sewage from rain water was recognized as advantageous in certain settings, and was developed along rational lines by a number of leading English engineers, notably Sir Robert Rawlinson. American engineers devoted much study to separate systems, and early on recognized the less frequent but more intense character of American rainfalls, relative to those of Great Britain. The heavier rains in North America allowed sewer systems to be designed without the elaborate flushing provisions utilized in many European cities. Separate systems were manifestly advantageous wherever the surface drainage could be cared for satisfactorily at a low cost, without the use of large combined sewers receiving both house-sewage and rain water. Separate systems were designed almost simultaneously by Benezette Williams for Pullman, Illinois, and George Waring for Memphis (Metcalf and Eddy 1914:24).

Memphis, like New Orleans, had serious public health problems resulting from inadequate drainage and sewerage. Yellow fever claimed more than 2,000 lives in Memphis in 1873, and another 5,635 in 1878-1879. In 1878, an Auxiliary Sanitary Association was formed in Memphis, which undertook public works that included employing laborers to clean streets and alleys and to empty privies. A public latrine project was also begun. The Legislature authorized unusual taxation and administrative methods in the stricken city, whose affliction aroused the sympathy of the whole nation and was largely responsible for the formation of the National Board of Health. A committee of the Board sent Col. George Waring to Memphis, which was inspected and surveyed under his supervision. The maximum sum that could be raised by taxation for sewers was $368,702; so critical was the need for sewerage that it was necessary to make this money go as far as possible. Waring designed a separate system in which rainwater was to be excluded from the sewers, the mains of which were to be of pipe 10" to 20" in diameter. Waring received patents on his separate sewerage system in 1881 and 1883. A similar sewerage system in Croydon, England, had proved a failure almost thirty years before, and problems with Waring's designs became apparent well before the system proposed in 1880 was completed. By 1882, some of the main lines were already taxed to their full capacity, and hundreds of obstructions had been cleared at great effort and expense. By 1885, a relief sewer had to be constructed, and the Memphis system was conclusively a comparative failure. Municipal authorities prevented this fact from being widely publicized for some time, but sanitary engineers were aware of the Memphis failure. The separate system designed by Sir Robert Rawlinson, with larger pipes laid without vertical or horizontal bends between successive manholes, was shown to be a superior model for separate systems (Metcalf and Eddy 1914:24-25).

Beside its design shortcomings, the Waring system in Memphis did little to improve conditions in areas inhabited by those of lower socioeconomic status. However, the Memphis effort was an important beginning for publicly funded sanitation efforts in the urban South. In fact, the building of the Memphis sewerage system appears to have stimulated a national boom in sewer construction (Ellis 1969b:352-353; Glaab and Brown 1983:172-173; Larsen 1985:124).

George Waring was a man of great charisma, and the prestige of the Memphis project was such that he impressed his views on small-pipe sewers on a number of other cities, contracting with them for the use of his patent system. However, not only was the Memphis system severely flawed, but the use of his patents by Waring was regarded by many engineers as unprofessional. The National Board of Health had doubts about the Waring system from the earliest date, and in 1880 sent Rudolph Hering to Europe on a tour of investigation of sewerage and drainage systems (see Chapter 5). Based upon the findings of his tour, Hering issued an elaborate report on sewerage and drainage practice in 1881. Hering's monograph retained its value for over 25 years, an unusual longevity for an engineering work, and did much to set American sanitary engineering on a sound and scientific basis. Hering's consideration of separate systems specifically emphasized local requirements for removal of rainwater and house sewage (Metcalf and Eddy 1914:25-26), which was of great importance to the eventual design of the New Orleans drainage system.

Atlanta's efforts to deal with the problems of drainage and sewage had actually begun slightly earlier than those of Memphis. The main trunks of Atlanta's system were constructed by the postwar Reconstruction government. However, by 1880, there were only seven miles of sewers, which followed no systemic plan. They were intended primarily as conduits for storm water. When yellow fever broke out in Jacksonville in 1888, Atlanta was stimulated to expand the system. By 1894, there were 54 miles of trunk, branch, and lateral mains, and many public buildings and residences were connected to the system (Ellis 1969a:210, 1969b:358-359). Other southern cities lagged behind Atlanta and Memphis. By 1880, Lexington, Kentucky, had only a few stone sewers that emptied into a creek. Augusta, Georgia, had drainage sewers that also were used for sewage disposal. Macon, Georgia, had only a few sewers, and these discharged into a swamp just outside the city limits. Montgomery, Alabama, had only inefficient brick and wooden mains. In 1880, Baltimore, Maryland, had only 12 miles of storm sewers to serve the entire city and lacked any plan for sewage disposal (Larsen 1985:122). In that year, Baltimore's mayor stated that:

> The city of Baltimore requires a system of sewerage. The continuance of the plan of digging the cesspools now honeycombing the surface of the ground upon which the city is built - these being on an average about one to each of its eighty thousand houses - must be discontinued if the health of the community is to be considered… [Mayor F.C. Latrobe, quoted in Larsen 1985:122].

Baltimore, like New Orleans (as detailed in Chapter 4), adopted a separate plan of drainage and sewerage, and both cities represented rare opportunities for engineers to design a complete sewerage system for a large city without any necessity for utilizing existing sewerage structures. Drainage arrangements at Baltimore involved discharge of storm water into the nearest watercourses adapted to receiving it, which was considered at the time of design to be an unobjectionable practice (Metcalf and Eddy 1930:17).

In the 1880s, the ultimate disposal of sewage received less attention in the United States than it did in Europe. The disposal of sewage in most cities prior to about 1910 was carried out in the easiest way practicable, "without much regard to unpleasant conditions produced at the place of disposal" (Metcalf and Eddy 1914:27). The major methods of disposal of sewage in Europe included discharge into rivers, irrigation or sewage farming, filtration, septic tanks, and contact beds. Because of the small size of British rivers, discharge of sewage directly into them had been regulated by Parliament after 1855, although industrial sewage treatment was not made compulsory until after 1876. In the United States, disposal of sewage was not at this time considered a pressing problem, unlike the situation in more densely populated Europe. Water discharge and disposal by dilution were not viewed as acute nuisances in the United States. Also, a greater area of land was available in America for other disposal practices. These methods included broad irrigation or intermittent filtration on beds graded *in situ*, and relatively cheap materials suitable for the construction of artificial disposal beds were available. The first extensive sewage treatment plant utilizing chemical precipitation was built at Worcester, Massachusetts, in 1889-1890, and it furnished a large amount of data for experimental work (Metcalf and Eddy 1914:29).

Disposal of sewage by dilution in bodies of water remained in favor in the United States longer than in Britain because of the larger bodies of water available for receiving the sewage. The first comprehensive American study of the subject was begun in 1887 by Rudolph Hering for the City of Chicago and resulted in his recommendation of a drainage canal to dilute the sewage with water from Lake Michigan and deliver it to the Desplaines River, flowing into the Illinois River, a tributary of the Mississippi. Many subsequent studies demonstrated satisfactorily to the engineers of the 1890s and 1900s that disposal by dilution was the most economical option for disposing of sewage. However, by World War I, dilution came under greater criticism, largely on the basis of the potential contamination of rivers or lakes furnishing water for potable purposes. Legal factors influenced the course of regulation on this issue (Metcalf and Eddy 1914:30). In the early years of the twentieth century, concern over the polluting potential of drainage flow largely resulted from the presence of organic wastes, such as animal excrement, washed from streets by rain. Of course, the potential for pollution complications caused by petroleum wastes, detergents, and other chemicals became much more acute in the twentieth century. In the case of New Orleans, the decision was made to construct separate systems of drainage and sewerage, and to discharge daily drainage flow into Lake Borgne. Only stormwater flow was to be discharged into Lake Pontchartrain. This decision was based on concern about pollution of Lake Pontchartrain and the volume of precipitation and high level of ground water with which the drainage system was required to handle. The history of how these issues affected the eventual drainage system design in New Orleans is discussed in greater detail in Chapter 4.

CHAPTER 3
HISTORY OF NEW ORLEANS DRAINAGE, 1718-1893

New Orleans was not in the national forefront of efforts by cities to improve either their drainage or sewage disposal. Prior to the mid-1890s, drainage and the sanitary disposal of sewage in New Orleans were viewed as a single issue (Enzweiler et al. 1992:14) when any serious thought was given to improvement at all. Natural conditions in New Orleans made both flooding and sanitary conditions into severe problems for the city's inhabitants, with disastrous consequences for public health. However, solving the drainage problems of New Orleans was not a simple matter. In the early-twentieth century, Sewerage and Water Board Superintendent George W. Earl summarized the major technical difficulties confronting engineers considering New Orleans' drainage problems:

> First of all, New Orleans had to face the problem of overflows from the Mississippi River and from tidal waters in Lake Pontchartrain, and the construction of levees, first along the river bank, because high water in the river was above the level of even the highest land in the city, and later, in the rear, to prevent high lake tides from backing into the lower part of the inhabited area, followed. Then came surface ditches and canals to drain the storm water into the tidal bayous, which often rose to a level which precluded much relief by such method, since only a small area of land along the river bank in New Orleans is higher than the high tides of the lake, and the ditches and canals were more or less filled by tidal water and gave very inadequate drainage even for the highest portion of the city. Rainfalls of great intensity were of frequent occurrence, and these falling on a ground which was always saturated made the need for better drainage imperative…[quoted in Behrman 1914:2].

The plan for the original town of New Orleans was created by the engineer, Pierre Le Blond de la Tour, and his assistant engineer, Adrien de Pauger. The plan called for fourteen squares extending along the river with a depth of six squares back from the river. Each square was encircled by a ditch, and the whole city was surrounded by a canal. The flow from the ditches around the squares fed into two large ditches, which emptied into the canal. The canal, in turn, emptied into the swamp lying behind the city and stretching to the natural levee of Lake Pontchartrain. A map dated 1728 shows another drainage ditch at the approximate location of present-day St. Claude Street. This ditch was supposed to empty into Bayou St. John, but it extended only as far as the current Dumaine Street bridge. This drainage system was totally inadequate, even for a town with as little runoff as early New Orleans. During heavy rain storms, the streets were completely flooded, and each square became an island (Baudier 1954a:14-15).

Little was done during the French colonial period (1718 to 1769) to improve sanitary conditions. Some individuals built cesspools, but generally raw sewage ended up in the open drainage gutters. Drainage and flood protection received somewhat more attention from the government, but remained totally inadequate. During the term of Governor Etienne de Perrier (1725-1732), a levee extending eighteen miles upriver and downriver from the city was erected for flood protection (Baudier 1954a:15, 1954b:10). The Spanish were just as ineffective in improving New Orleans' sanitary conditions during their rule (1769-1800). Governor Estevan Miro, whose administration lasted from 1785 to 1791, recognized the unhealthy situation and called for an "improvement of sanitary conditions… for proper drainage of the streets, for preventing hogs from running about the streets, against keeping too many dogs and for the removal of dead animals" (quoted in Baudier 1954b:10) However, little was done to solve these persistent problems.

Francisco Luis Hector, Baron de Carondelet, served as the Governor of Louisiana from 1792 to 1797. He constructed the Carondelet or "Old Basin" Canal, which ran from Bayou St. John to the city. The canal, which was built in 1795, was intended to improve drainage and sanitary conditions as well as to provide a better route for shipping goods from the lakeshore to New Orleans. By the early-1800s, however, the canal was choked with weeds and debris and was impassable except by pirogue at some points. The Carondelet Canal thus did little to alleviate the city's unhealthy conditions (Baudier 1954b:10; Garvey and Widmer 1989:88,229).

Sporadic efforts were made in the early American period to improve drainage and sanitary conditions, but these also met with little success. A nineteenth-century visitor to New Orleans remarked that:

> [The soil is] in the driest time of the seasons… filled with humidity, and under favor of rain showers soon overflows… Shunning the river, the choking gutters send their burdens swamp-ward, littering the angles of the pavements with clumps of cotton and wood, heads of barrels, broken paper boxes, bits of pasteboard, twine and bagging rope, all of which the ever-thirsty swamp licked, in due course of time, into its capacious maw… [Sewerage and Water Board n.d.]

In 1819, architect Benjamin Latrobe described New Orleans in three words: "mud, mud, mud" (quoted in Junger 1992:44). Inadequate drainage and the necessity of collecting rainwater in cisterns for drinking had consequences that were more than merely inconvenient. The city was plagued by mosquitoes, as reported by Latrobe in 1808:

> As soon as the sun sets, the muskitoes appear in clouds and fill every room in the house, as well as the open air. Their noise is so loud as to startle a stranger to its daily occurrence. It fills the air, and there is a character of occasional depression and elevation in it, like that of a concert of frogs in a marsh [Sewerage and Water Board n.d.].

Mosquitoes were the vector for yellow fever and malaria, diseases endemic (and periodically epidemic) in New Orleans throughout the nineteenth century. Mortality rates for New Orleans residents were relatively very high. Gibson reports in his *Guide and Directory of Louisiana* of 1838 that the annual mortality rate for New Orleans during this period was approximately 3,800 in "ordinary years" (quoted in Baudier 1955b:11-12).

During the administration of Mayor Louis Philippe de Roffignac (1820-1828), a canal was dug in the rear of the American Quarter for drainage purposes. This canal was later developed into the Melpomene Canal. The Poydras Canal was dug through the middle of Faubourg Saint Marie, at the location of present-day Poydras Street. This canal became clogged with weeds and filth and fell into disuse. The Marigny Canal, in unsatisfactory fashion, handled drainage below the city (Baudier 1955a:24).

During the 1830s and 1840s, yellow fever and other diseases ravaged New Orleans. Nevertheless, city officials did little to improve sanitary conditions. Sewage disposal methods had remained unchanged since the French colonial period. Fecal matter was put in shallow, open pits or cesspools with porous bottoms. These cesspools overflowed during heavy rains and floods, leaving fecal matter in the yards and streets. Occasionally, these pits were partially emptied out by sanitary excavating companies that dumped the contents into the river below the city limits. The pits smelled especially bad after these cleanings. All other liquid household wastes ended up in the gutters, which became clogged with excrement and other filth. The stagnant waters of the gutters became covered with green slime in the hot summer months. Ineffectual efforts to flush the gutters were sometimes undertaken by means of sluices in the levees during river rises. However, the gutters were never entirely drained.

In 1835, a twenty-year charter was granted to the New Orleans Drainage Company to improve drainage conditions. The charter made the company responsible for draining and reclaiming the land bordered by the upriver limits of the Suburb Livaudais, the line of the New Canal to Lake Pontchartrain, along the shoreline of the lake to Bayou Cochon, and then a straight line to Fisherman's Canal, and on down to the Mississippi River. This monumental task was to be accomplished through a series of canals and ditches. Ditching was begun in the rear of the Vieux Carre. In addition, the Canal Girod or Orleans Canal became the primary draining artery, with a pumping station located at its junction with Bayou St. John (Baudier 1955b:17; Fitzpatrick et. al. 1895).

The New Orleans Drainage Company received some important recommendations concerning its endeavors from George T. Dunbar, the Engineer of the State of Louisiana. In 1840, the President of the Bureau of Public Works asked Dunbar to survey and make a topographical examination of the back section of the city. Dunbar reported his findings to Felix Garcia, the president of the drainage company, on February 17, 1840. This was the first drainage plan for the city that was based on New Orleans' topography and environmental conditions. It was also the first time that underground drainage was recommended for New Orleans. Dunbar stated in his report that:

> No city in the Union needs underground drains more than New Orleans, and none where it could be done more easily and more cheaply, and still, it is the only city of any importance in which underground drains have not been used [Baudier 1955b:17].

Dunbar also reported that the sizes of the current drains and gutters were too small to carry off the necessary amounts of water. He recommended that their dimensions be increased. He encouraged the drainage company to use steam-powered drainage machines in order to lift the water that was drained off the streets. He pointed out that other places such as Holland utilized these machines very effectively (Baudier 1955b:17).

The specific recommendations outlined in Dunbar's report were intelligent and succinct. He proposed that two underground drains, five feet deep by four feet wide, leading to the swamp canal, be placed under Canal Street. These would drain Canal Street and its side streets as far as Customhouse Street. Two underground drains of the same dimensions under Bienville Street would drain from Customhouse to Conti Streets, terminating at the Claiborne Canal. Two more underground drains under St. Louis Street would also join the Claiborne Canal and drain from Conti to Toulouse Streets. Orleans Street would also have two underground drains which would service the streets adjacent on either side of it. This pattern of drains would be continued for the other streets, taking into account their slopes. These underground drains would empty into the Claiborne Canal which would feed into the Orleans or Girod Canal. Dunbar further recommended that canals be located on streets running parallel to Claiborne Avenue in the area beyond that avenue up to Grand Avenue or Broad Street (Baudier 1955b:17-18).

Unfortunately, New Orleans' city officials were not impressed by George Dunbar's report and did not act upon it. Following the panic of 1837, the city had little money for such a project. The public opposed the plan because mortgages in favor of the New Orleans Drainage Company would be placed on property to finance the undertaking. The drainage company finally dissolved because of the hard economic times (Baudier 1955b:18).

For the next fifty years, all efforts to drain New Orleans met with failure. The challenge of draining the city was not met because of lack of money, the apathy of city officials, and public opposition. Louis H. Pilié, the City Surveyor, submitted a drainage plan to the Common Council in 1857. Pilié's plan concentrated on draining the land behind Claiborne Avenue. Drainage would flow into Lake Pontchartrain. In the period between 1858 the Civil War, four drainage machines were installed on drainage canals in the city. These drainage machines were large wooden paddle wheels (Figure 1), driven by Corliss steam engines. One was located at Dublin Street in the rear of Carrollton (Figure 2); one at Melpomene Street and South Claiborne Avenue (Figure 3); one at Bienville and Hagen streets; and one at London Avenue and Gentilly Road. The paddle wheels varied from 28½ feet to 34 feet in diameter, with paddles 4 feet square to 7 feet square. Providing a lift of 3 to 5 feet, the total pumping capacity of these four drainage machines was completely insufficient for the drainage requirements of the city. These machines apparently remained in use after the Civil War, although the drainage canals deteriorated (Williams 1876:26; Peyronnin 1977:2; Sewerage and Water Board n.d.).

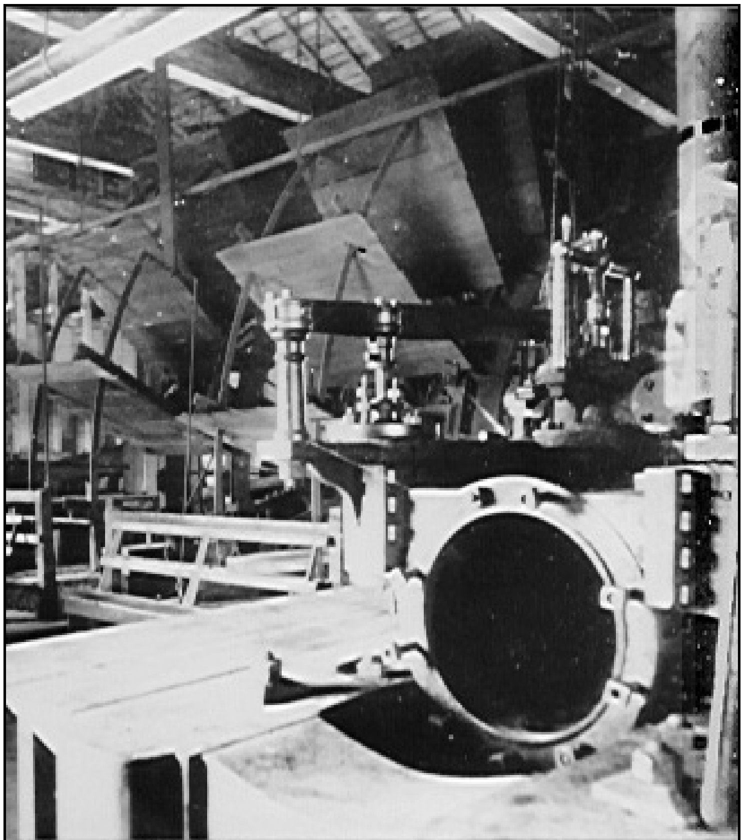


Figure 1. The Dublin Drainage Machine in the early-1890s. On the right is the Corliss steam engine powering the machine (from Sewerage & Water Board 1971:23)

The Civil War blocked any further efforts to follow through with Pilié's proposed system. Drainage remained woefully inadequate in the post-Civil War period (Figure 4). In 1871, more comprehensive attempts to address the drainage problems of New Orleans were initiated. The New Orleans Board of Health con-

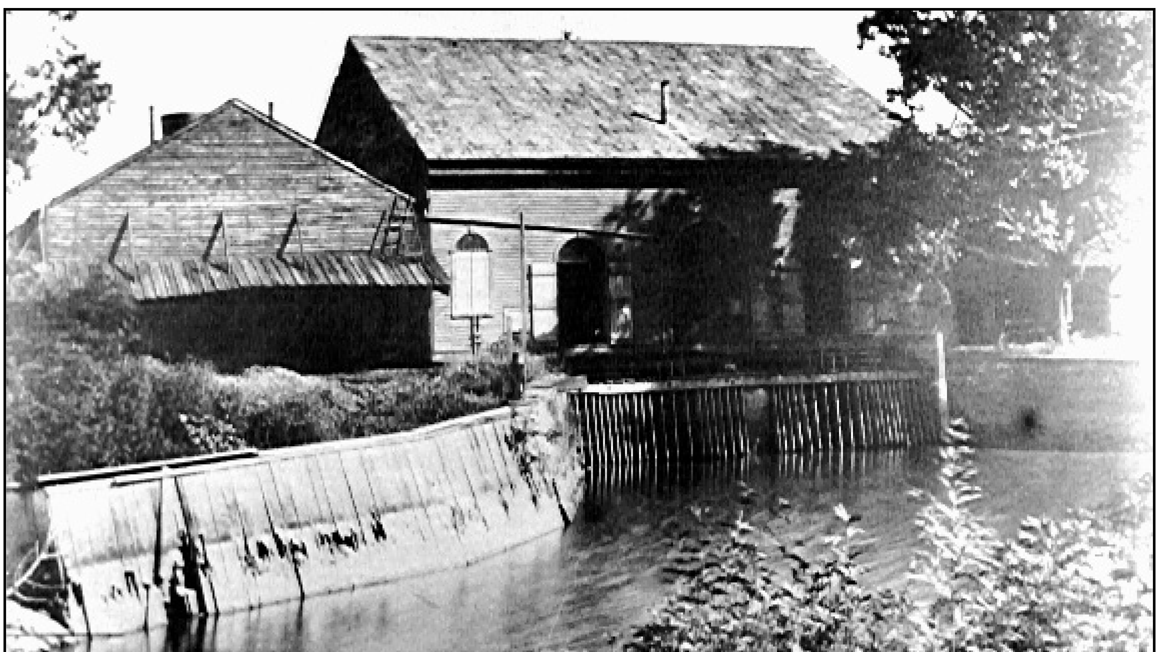


Figure 2. The Dublin Drainage Machine, no date (from Sewerage & Water Board 1996)

cluded a study of drainage that year, and G.W.R. Bayley commented in the Board's report:

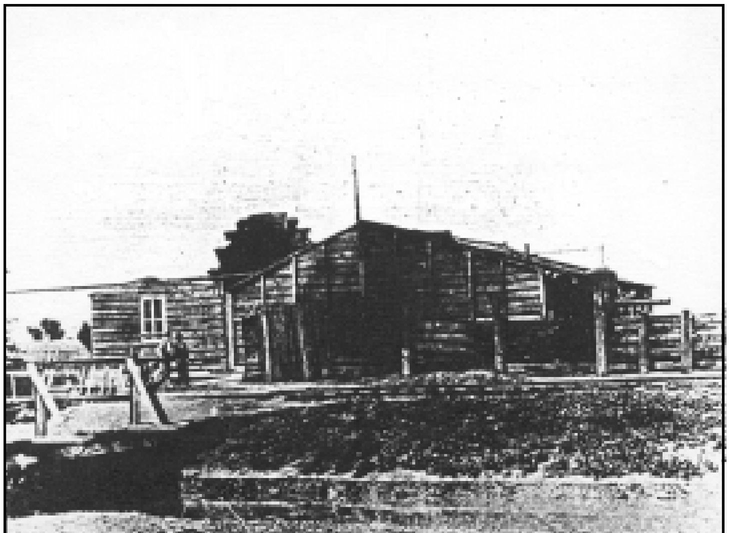


Figure 3. The "Old Melpomene Drainage Wheel," no date (from *Martin Behrman Administration Biography* 1916).

> It is well known that canals which drain the thickly settled portions of our City, rapidly become obstructed and partially filled with the heavier and most offensive feculant and fecal portions of the city sewage, together with the garbage and dead animals thrown into them, and that during dry weather when there is not sufficient water passing through the canals to sweep away the accumulation, our canals or sewers are in their worst state. Heretofore, when the canals become thus too much obstructed to serve the purposes of drainage, the custom has been to excavate and cast out upon the margins of the canals to putrefy or dry up in the hot sun, the deposits from sewage in them [Board of Health 1871:6].

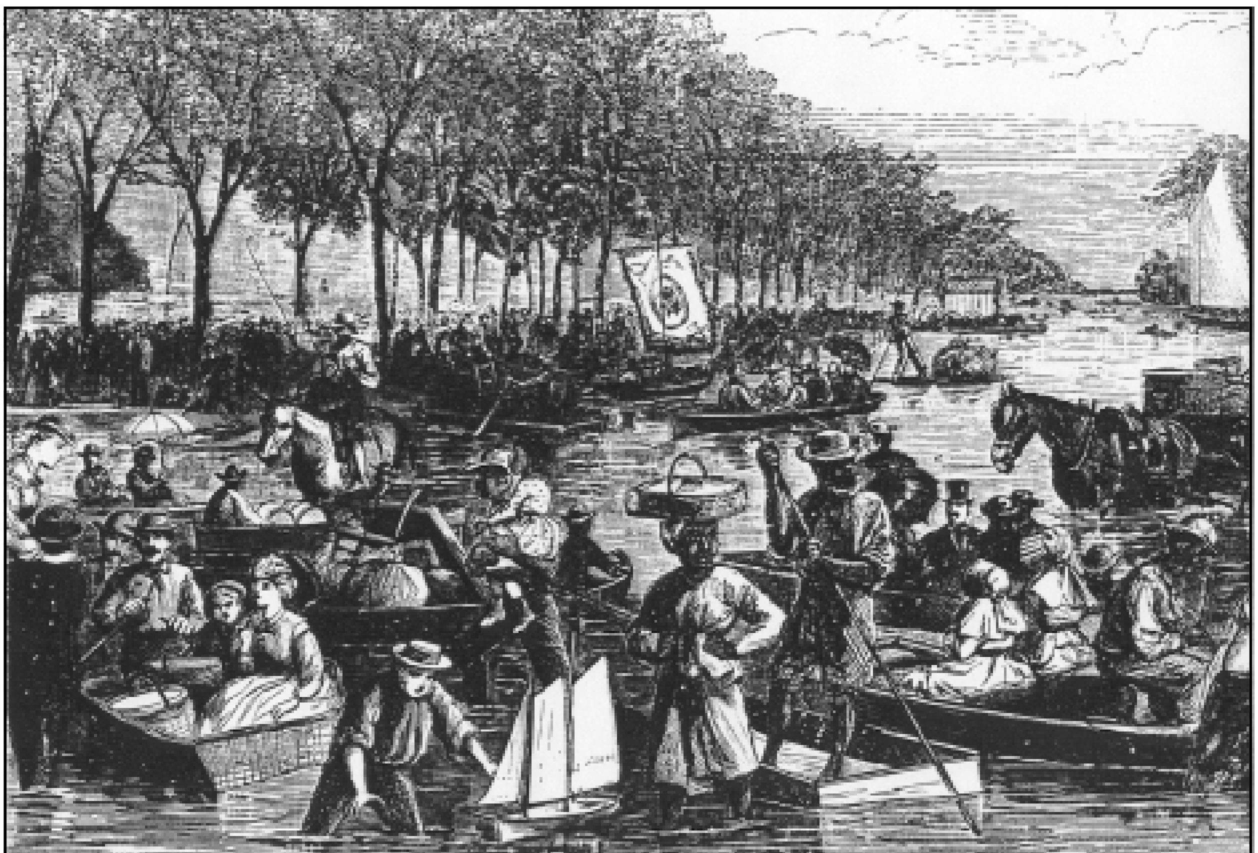


Figure 4. "A Flood at Canal and Claiborne" by A.R. Waud, 1871 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

Also in 1871, the state legislature authorized the Mississippi and Mexican Gulf Ship Canal Company, a private firm, to develop a drainage system for New Orleans. This company's initial project had been to dig a canal from St. Bernard Parish to the Gulf of Mexico. The firm managed to dig 36 miles of canals in New Orleans, and this was largely the extant drainage canal system when more substantial improvements began to be made in the 1890s (Behrman 1914:2). These measures were still woefully inadequate, and the city's drainage problems were not alleviated before the Mississippi and Mexican Gulf Ship Canal Company went into receivership. In 1872, the city of New Orleans purchased the system of drainage works for $300,000 (Villarubia 1984). Additional plans and proposals came to naught. W. H. Bell, the City Surveyor in 1876, proposed a drainage plan that would utilize the canals already in service and place pumping stations along the lake front. In 1878, G. W. R. Bayley submitted a drainage proposal that incorporated the use of Bayou Bienvenue (Fitzpatrick et al. 1895; Baudier 1956a:18, 1956b:16).

The great yellow fever epidemic that struck many southern cities in 1878 began in New Orleans. The disease was introduced to the city by passengers on ships from South America and Caribbean ports, and the vast mosquito population of New Orleans spread the disease around the city. The first cases were unofficially reported as early as May, but no official reports were filed until July. At that time a cluster of cases appeared in one of the more affluent and cleaner neighborhoods of New Orleans. Only the French language newspapers reported these incidents. Nevertheless, rumors of the presence of the disease spread, and residents of the city panicked. By August 1878, approximately 20% of the city's population had left the city. These refugees managed to spread the disease to other southern cities. In response to the 1878 epidemic, business leaders in New Orleans formed the New Orleans Auxiliary Sanitary Association in 1879. The motto of the organization was "Public Health is Public Wealth," but the impact of their efforts was limited (Ellis 1969b 346-347, 352-353). Without proper drainage of the city and establishment of a modern sewerage system, New Orleans could not hope to conquer yellow fever, cholera, and other diseases.

In 1881, the city had an opportunity to contract with the newly established New Orleans Drainage and Sewage Company to construct a drainage system and an underground sewerage system connected to residences. Public opinion rang out against the proposal. A petition citing some very strange arguments was sent to Mayor Joseph Shakespeare, asking him to veto the measure. The petitioners believed that the sewerage system would be bad for public health. They argued that the soil was too soft for the installation of pipes. The pipes would sink, become clogged with filth, and then crack, thereby emitting harmful gases into the air. At this time, such gases were frequently blamed for the outbreak and spread of epidemic disease. The petitioners totally ignored the fact that these very gases were already being released into the air from uncovered cesspools and open gutters. Despite opposition, Mayor Shakespeare approved the measure. However, the sewerage plans were never carried out (Baudier 1956b:16).

At some point prior to 1885, the number of drainage machines may have been altered, since multiple wheels are documented at three of the four draining machine locations at that time. In that year, two machines were at the Dublin Station, located at 14th Street and Dublin. One had a wheel of 34' diameter with a 5' face, and the other wheel was 34'4" in diameter and had a 5'9" face. These wheels had a capacity of 490 cubic feet per second (cfs) against a 5' lift. The Claiborne and Melpomene wheel had a 35' diameter and 4'6" face. It had a capacity of 150 cfs and a 5' lift. The Bienville Station at Hagen and Toulouse had two wheels, one 28'6" in diameter with a 4'4" face, and one 34' in diameter with a 7' face. These wheels pumped 240 cfs against a 5' lift. The London Avenue Station had two wheels of 35' diameter with 4'10" faces, with a capacity of 300 cfs against a 5' lift. At maximum effort, all of these machines could only clear the city of about 1½ inches of rain in a day (*The Consultant* 1977:2).

The lack of a public sewerage system caused some private and public enterprises to install their own underground sewer lines which emptied into the Mississippi River. This trend would continue up to the turn of the century. Eventually, the Cotton Exchange, A. Baldwin, the Boston Club, the Morris Building, and the Louisiana National Bank were connected to a sewerage line built by the St. Charles Hotel. The Board of Trade also had a private sewerage system which was utilized by Vonderbank's Hotel, the I.L. Lyons Company, and the Masonic Building. Other establishments which had their own sewer lines included the U. S. Marine Hospital, the Louisiana Brewery, Hernsheim's Cigar Factory, the Planters' Refinery, the Louisiana Refinery, Jackson Brewery, the U.S. Mint, G. W. Dunbar's Sons, St. Mary's Boy Asylum, and the Commercial Soap Works (Baudier 1956c:11, 1956d:11). However, private, limited efforts to improve drainage could not provide significant relief from flooding and high groundwater levels, and were doomed to failure. A comprehensive, systematic approach was required.

The 1890s was a crucial decade in terms of public utilities for New Orleans. In 1893, prominent citizens of New Orleans came to realize that an adequate drainage and sewerage system and an adequate supply of drinking water were necessary for further economic growth (Enzweiler 1992: 14). A drainage report issued that year referred to "the recent establishment of a sewerage system" and described its function as the removal of solid waste from buildings to an appropriate outfall. This was a very significant distinction, because the sewerage was to be developed as a clearly separate system from drainage. The question of drainage for the city now involved only the removal of rain water and ground water saturating the soil (Fitzpatrick et al. 1895: 15). New Orleans was not the first American city to establish separate systems for sewerage and the removal of stormwater by underground drains and pipes; Pullman, Illinois had built such a system by 1885. However, New Orleans was a relatively early case of a major city choosing to build a sewerage system with separate (and more expensive) underground stormwater removal (Tarr 1979:3I6-325 *passim*). Ultimately, the New Orleans drainage system became a unique and world-class model of modern drainage. This was due to the excellence of the design of the original plan, and technological advances, unforeseen in 1895, developed in the context of New Orleans conditions by native engineering genius. The following chapter discusses the New Orleans Drainage Plan of 1895, which instituted modern drainage in the city, and the development of the system to the present time.

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.

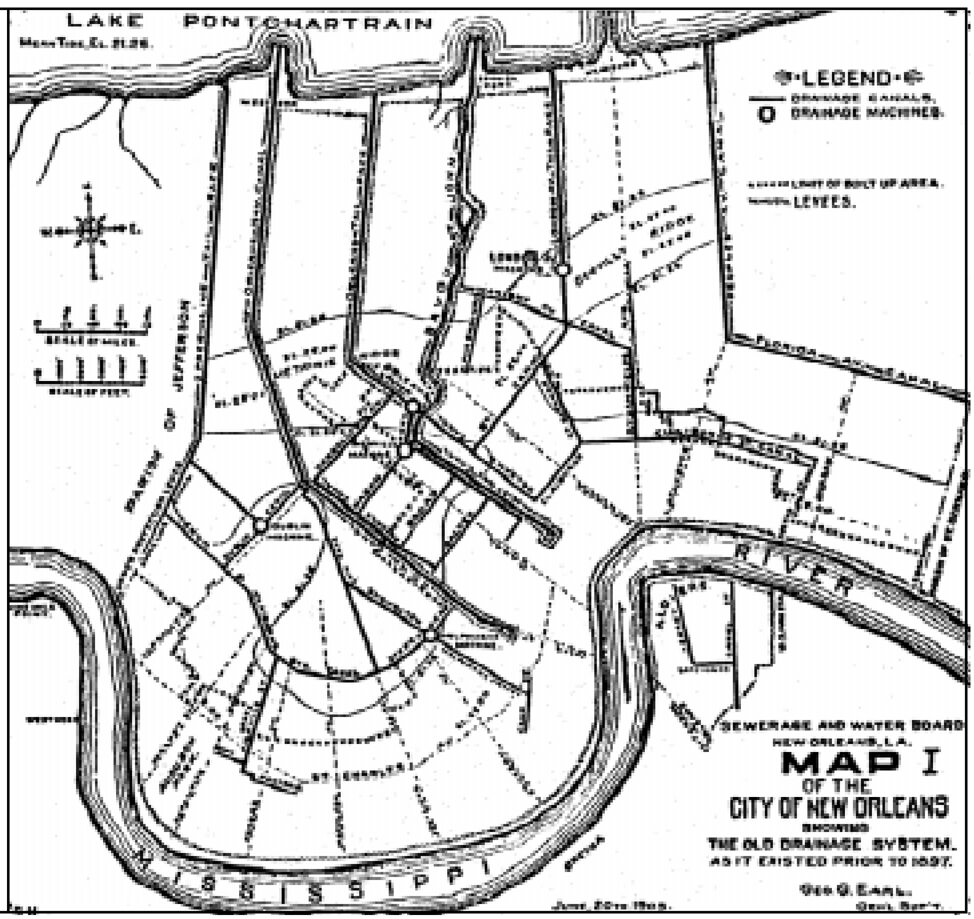
While the topographic and hydrographic survey was under way during the winter of 1893-1894, the Board held hearings on drainage plans formulated by private civil engineers and others. These included plans put forward by S.D. Peters, George F. Grandjean, Charles Louque, J.L Gubernator, A.F. Wrotnowski, 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

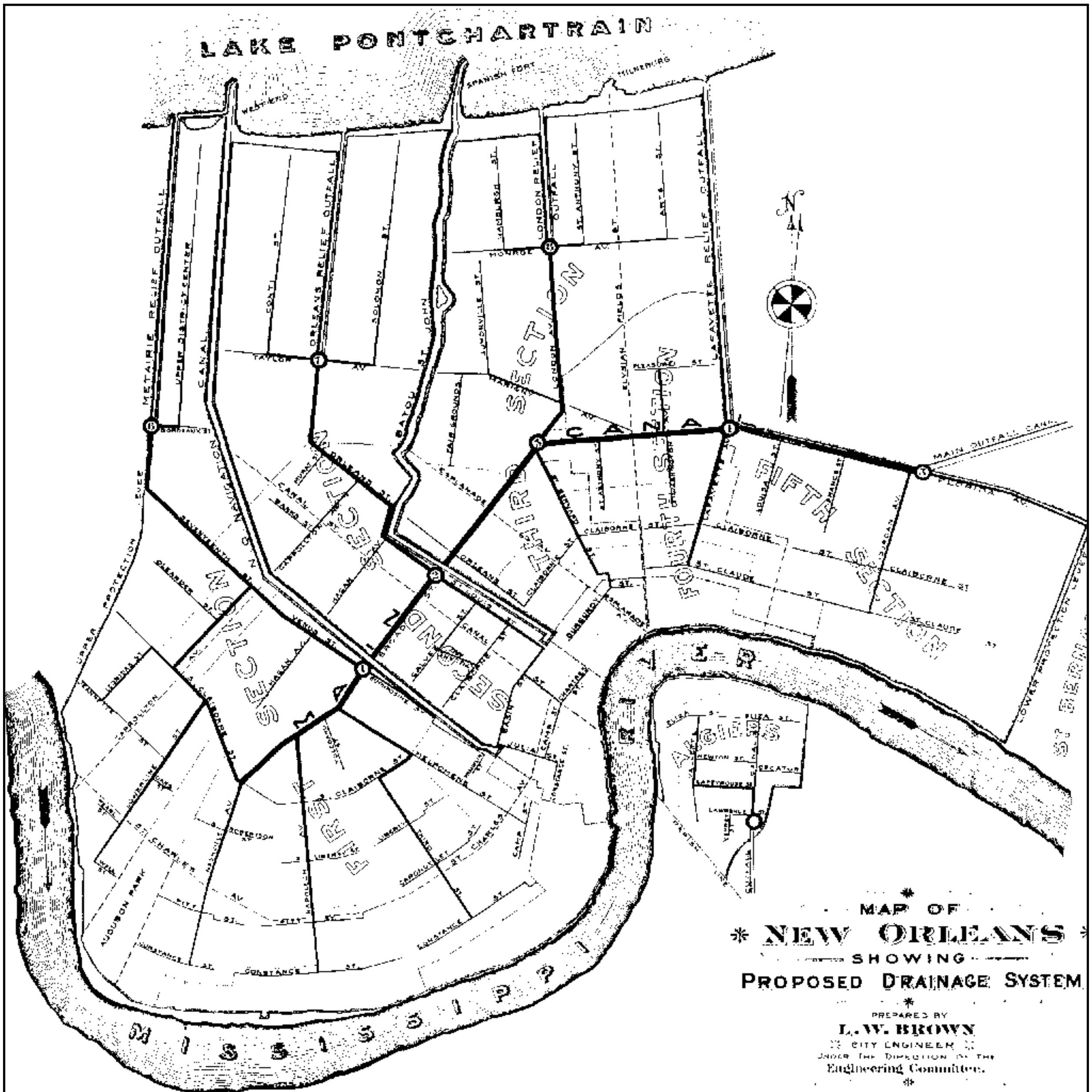


Figure 6. The New Orleans Drainage System as proposed in the 1895 Drainage Plan (from Fitzpatrick et al. 1895).

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.

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

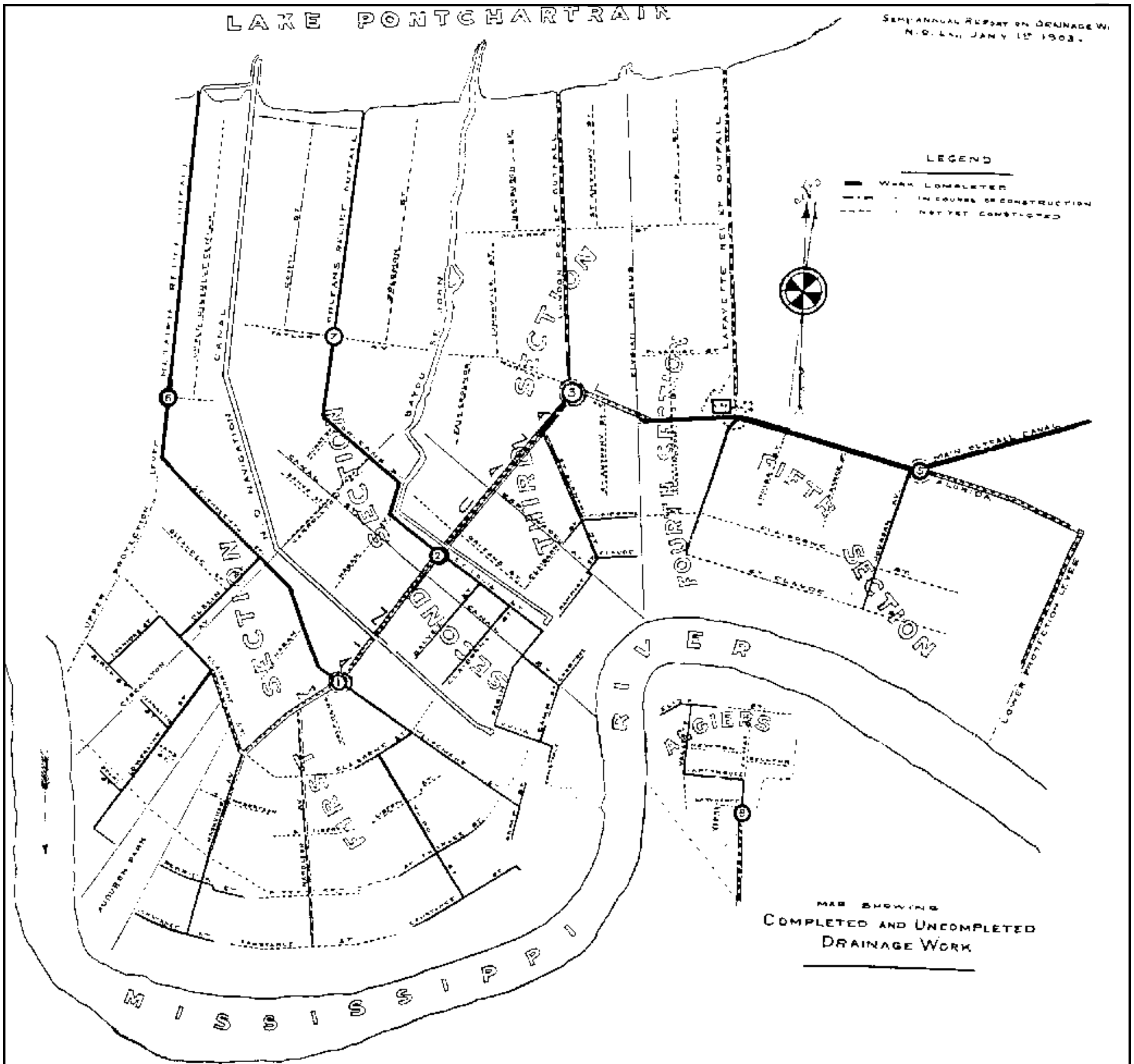


Figure 7. The New Orleans Drainage System as constructed to the end of 1902 (from Sewerage & Water Board 1902).

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.

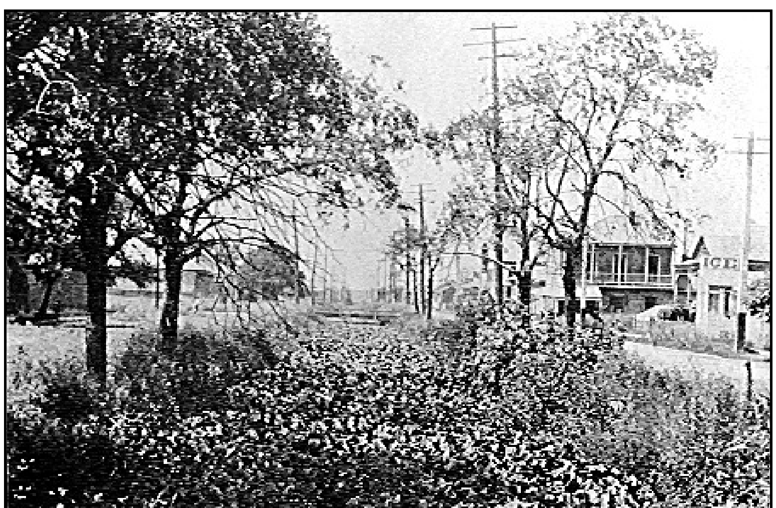


Figure 8. Broad Street Canal before cleaning, 1904 (from Sewerage & Water Board 1904).

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 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].

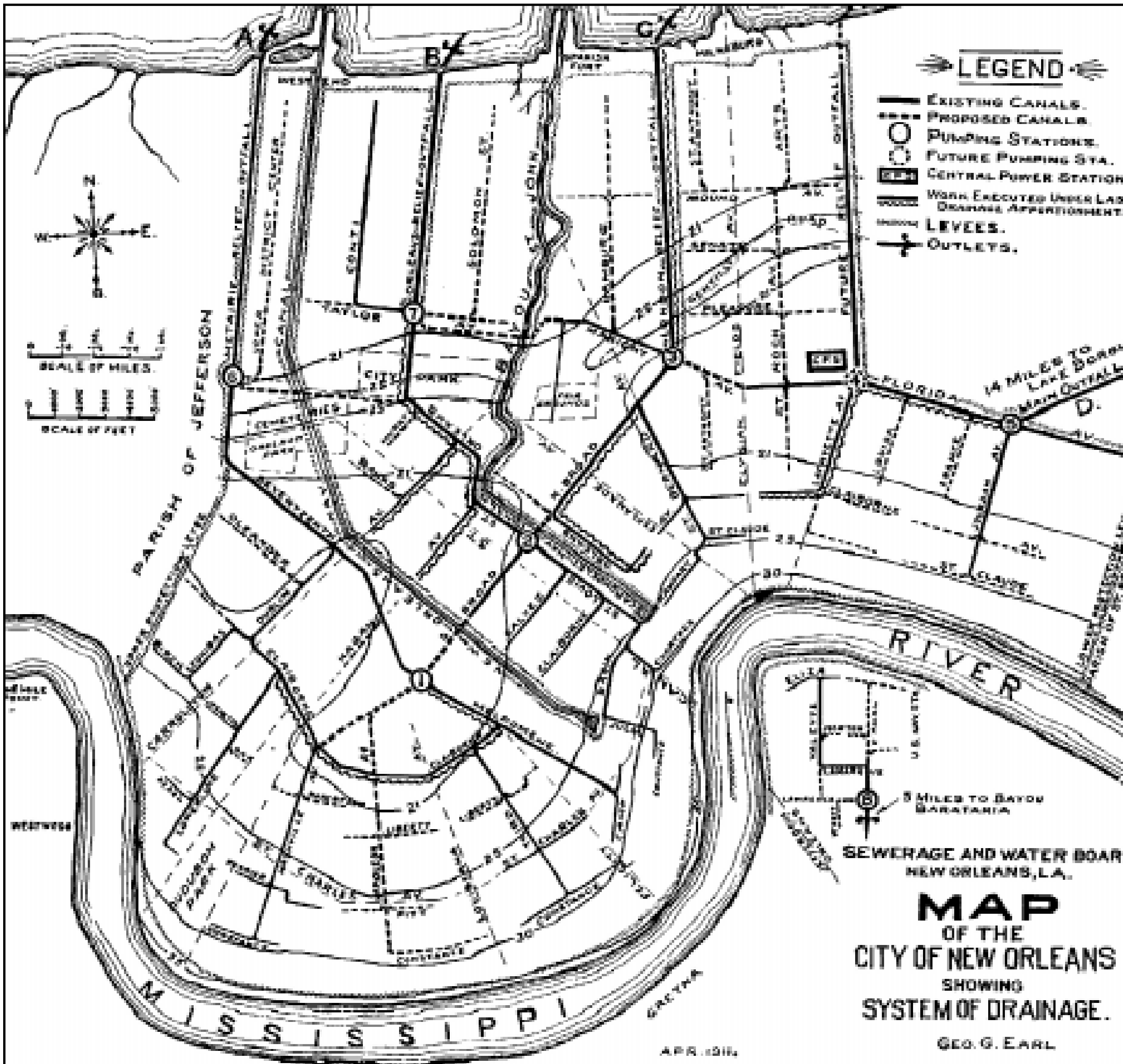


Figure 10. The drainage system of New Orleans in 1911, showing the system proposed in 1895 and construction to 1911 (from Sewerage & Water Board 1911).

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-

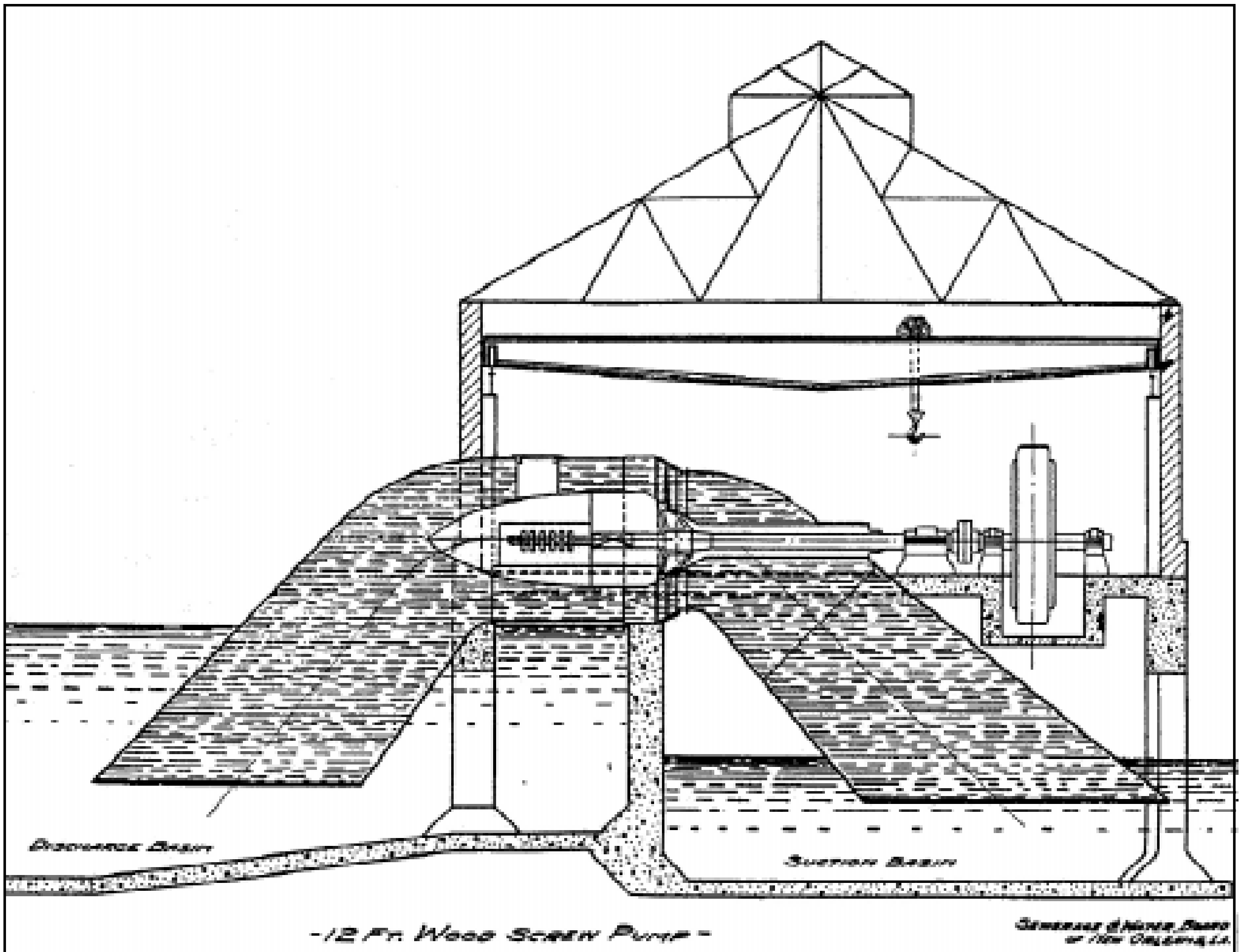


Figure 11. Cross-section of a 12' Wood screw pump (from Sewerage & Water Board 1914).

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

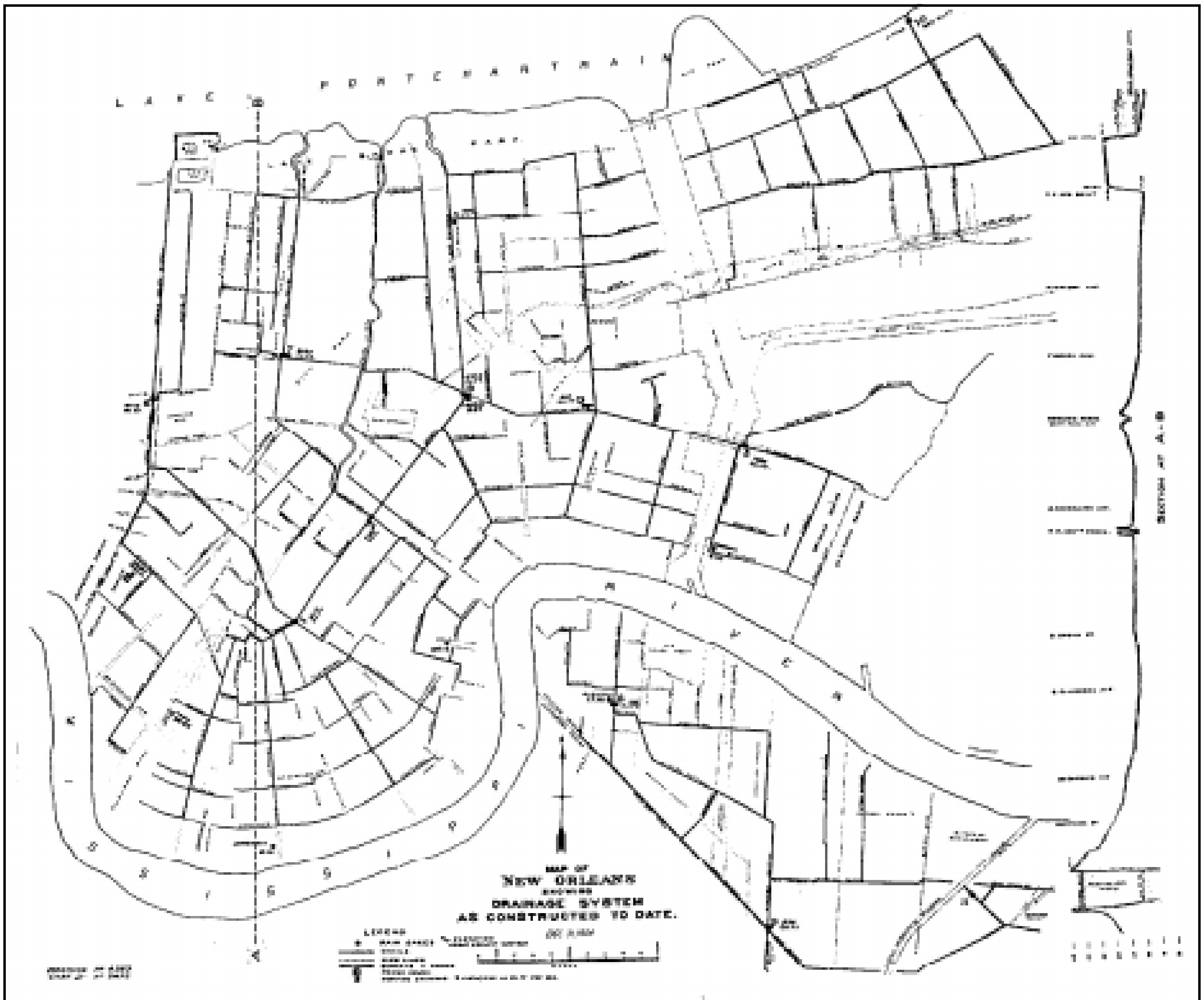


Figure 12. The New Orleans Drainage System as constructed to 1954 (from Sewerage & Water Board 1954).

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

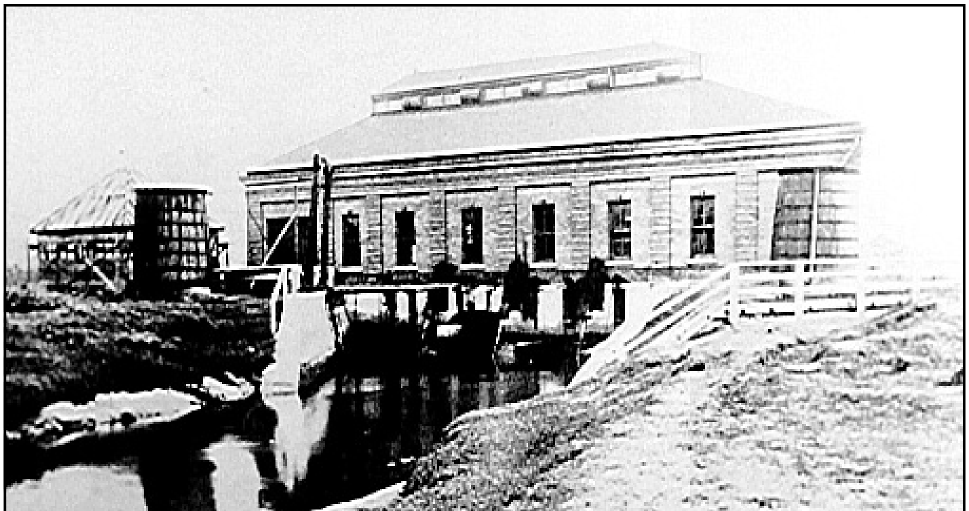


Figure 13. Drainage Pumping Station No. 1 as originally constructed, 1911 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

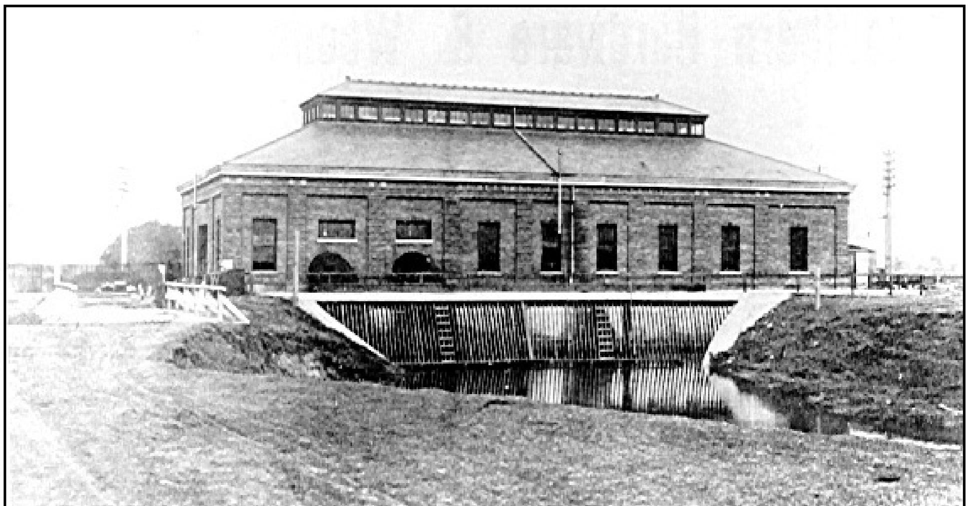


Figure 14. Drainage Pumping Station No. 3 as originally constructed, 1909 (from Sewerage & Water Board 1909).

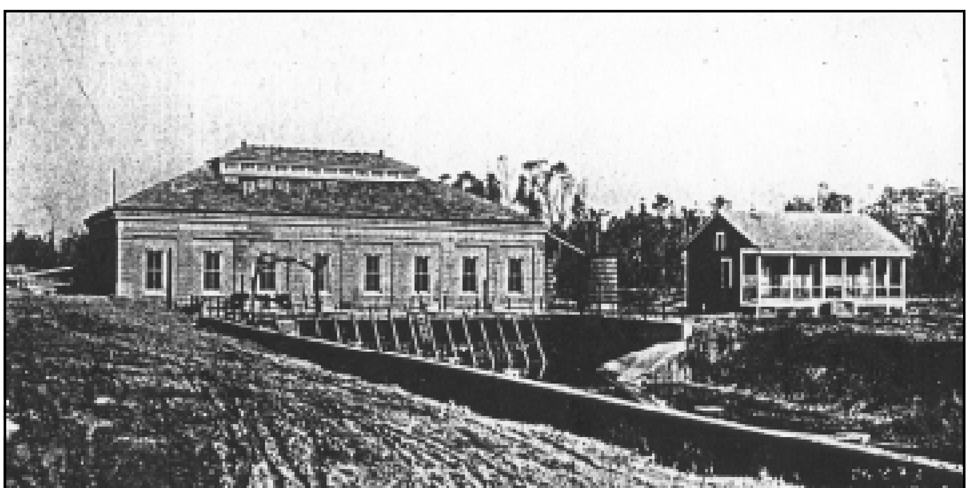


Figure 15. Drainage Pumping Station No. 6 as originally constructed, 1909 (from Sewerage & Water Board 1909).

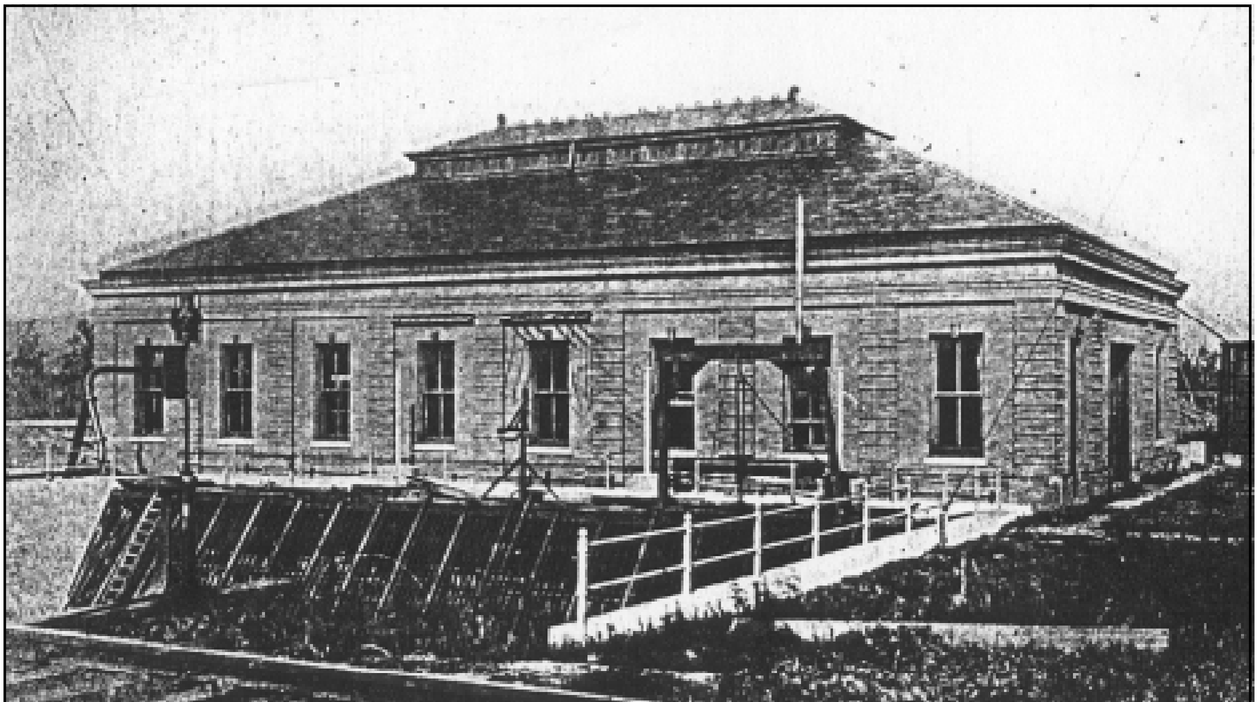


Figure 16. Drainage Pumping Station No. 7 as originally constructed, 1909 (from Sewerage & Water Board, 1909).

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).

Construction of Drainage Pumping Station No. 1 was contracted for in Contract "E", July 1899, for the bid of $224,500.00 (Sewerage and Water Board 1908:66-67). Construction of the station was by the National Contracting Co. of New York (Sewerage and Water Board 1911:125).

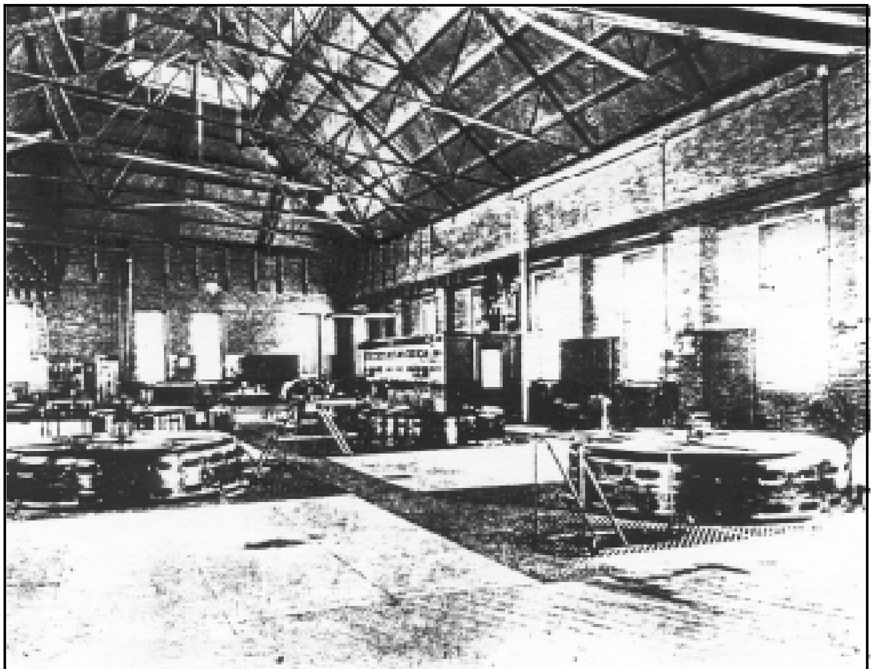


Figure 17. Interior of Drainage Pumping Station No. 1, ca. 1906 (from Earl 1906).

As originally constructed, Drainage Pumping Station No. 1 (Figure 17) had three vertical pumps, manufactured by the E.P. Allis Co. of Milwaukee. Each pump had a capacity of 250 cubic feet per second, with a lift of five feet from the level of the suction basin to the level of the discharge basin. The screw impellers of the pumps had eight blades, with a total diameter of 108". The pumps, of the type shown in Figures 18 through 20, were set in pits below the floor of the station. The pumps were driven by means of 200 kilowatt synchronous motors, each pump being connected to its motor directly by a vertical shaft and the motors turning at 88 revolutions per minute. The pump motors were manufactured by the General Electric Co. of New York. The suction and discharge pipes of the pumps were eight feet in diameter. A small centrifugal pump was installed in the station for use in pumping the dry weather flow. This pump was of single suction vertical shaft type, with an enclosed impeller of 49½" diameter; its capacity was 40 cfs with a lift of 10 feet. It was also driven by a synchronous motor (Sewerage and Water Board 1904b:2; Sewerage and Water Board 1910:159; Sewerage and Water Board 1911:124-125).

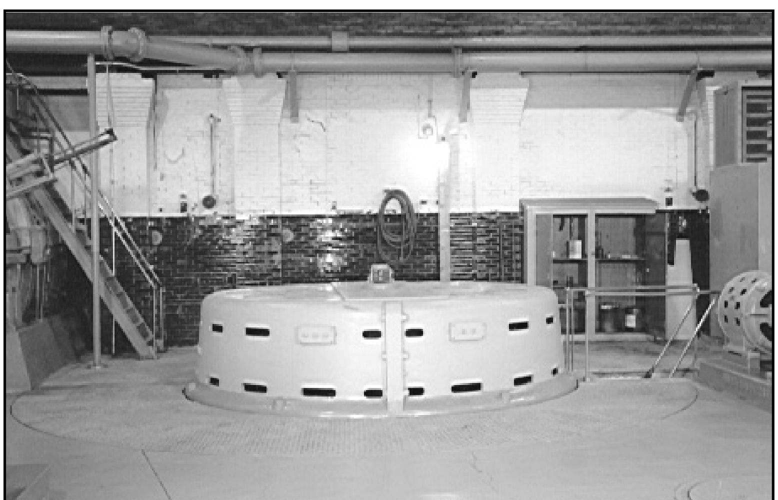


Figure 18. Vertical centrifugal pump motor housing of the type originally installed in Drainage Pumping Stations Nos. 1, 6, and 7, 1897-1903. This pump was manufactured by the E. P. Allis Co. and this motor was manufactured by the General Electric Co. This example remains at Drainage Pumping Station No. 7.

The exact date of completion of the Drainage Pumping Station No. 1 building, or the date of installation of its first set of pumps, is not clear. *The Sixth Semiannual Report of the Sewerage and Water Board of New Orleans* states that the station was "not quite complete" at the end of 1902 (Sewerage and Water Board 1902:36), implying the station would be done in 1903. However, the *Tenth Semiannual Report* states that the contractor turned the station over to the Sewerage and Water Board in May 1904, ready "to be operated

Figure 19. Lower portion of vertical centrifugal pump motor and drive shaft, of the type originally installed in Drainage Pumping Stations Nos. 1, 6, and 7, 1897-1903. Photographed at Drainage Pumping Station No. 7.

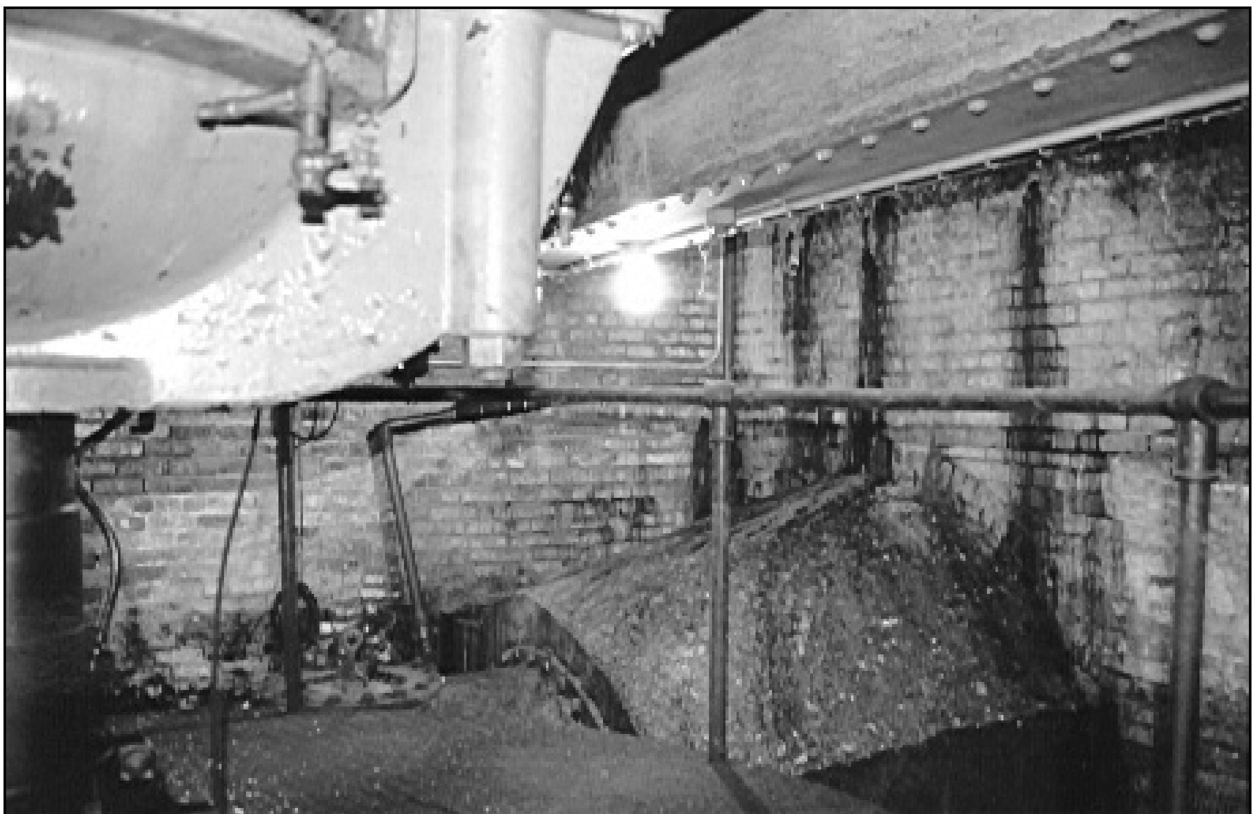


Figure 20. Vertical centrifugal pump pit, showing top of discharge pipe at right. These original pump pits, dating to 1897-1903, have been altered or eliminated at all stations except at Drainage Pumping Station No. 7, shown here.

for drainage purposes pending final tests and acceptance… the final test awaits the completion of the improvements to the Melpomene Canal from Claiborne to Broad" (Sewerage and Water Board 1904a:70). Figure 13 is a photograph of the exterior of Pumping Station No. 1 in its original configuration. Figure 17 shows the interior of the Station in 1904; the electric pump motors are pictured. Figure 21 shows one of the initial tests of Drainage Station No. 1, with one of the screw pumps then in place, pumping 250 cubic feet of water per second over a weir in the Melpomene Canal.

Figure 21. Drainage Pumping Station No. 1 during pump testing, 1904. The original caption states: "…shows one pump throwing 250 cubic feet of water per second over a weir erected for testing capacity of pumps. There are three similar pumps at this station' (from Sewerage & Water Board 1904).

On September 12, 1913, in anticipation of increased capacity at Drainage Pumping Station No. 1, the Sewerage and Water Board signed contract 55-D with Hampton Reynolds, a contractor of New Orleans, to enlarge the station and to build new suction and discharge basins and a portion of the Broad Street wood-lined Canal (Figures 22 and 23). The contract price was $86,400.00. A 60' by 50' addition was made on the eastern end of the station to house the 12' pumps, seen clearly in Figures 22 and 23. The work was 94% completed by December 1914; the floor of the station and a portion of the wood-lined canal could not be completed until all the pumping and electrical machinery had been installed. The contract was finally completed and accepted in April 1915, at a total cost of $91,742.43. Wooden sluice gates to control the direction of flow of the drainage water were contracted (Contract 56-D) to the Roe, Stephens

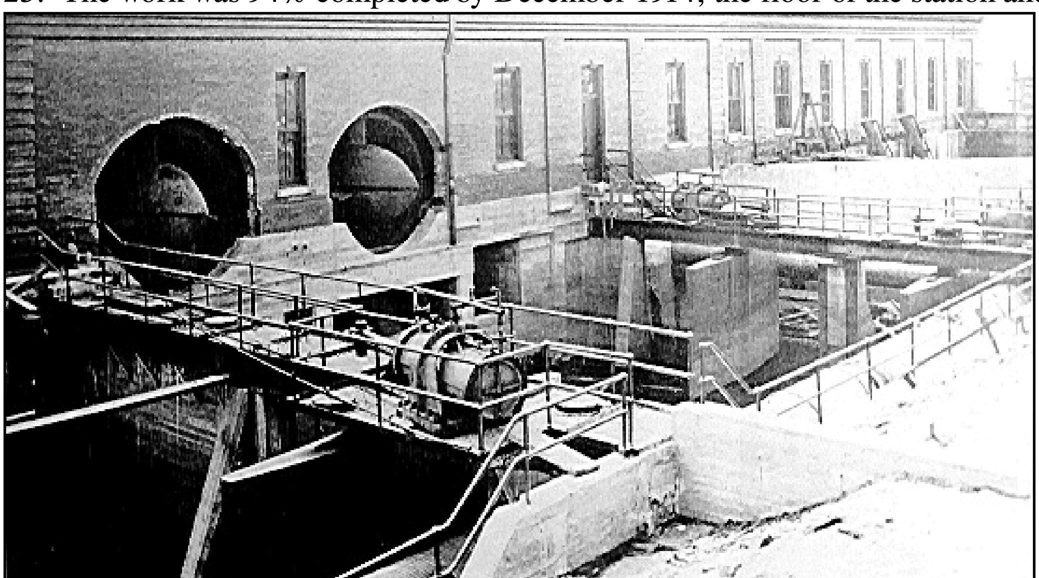


Figure 22. Exterior of Drainage Pumping Station No. 1, after alteration for 12' Wood screw pumps, ca. 1914-1915. Original caption states: "…showing the hydraulically operated flood gates and the discharge end of the twelve-foot screw pumps" (from Sewerage & Water Board 1914).

Manufacturing Company of Detroit, and completed on August 6, 1914. These sluice gates allowed water from the 12' pumps to be directed to either Pumping Station No. 6 on the Metairie Outfall Canal, or to Pumping Station No. 2, at Broad and St. Louis Streets. In order to install the pumps and other heavy equipment in Drainage Pumping Station No. 1, the Sewerage and Water Board issued contract 57-D, for a 15-ton hand operated crane to be erected in the drainage station. The

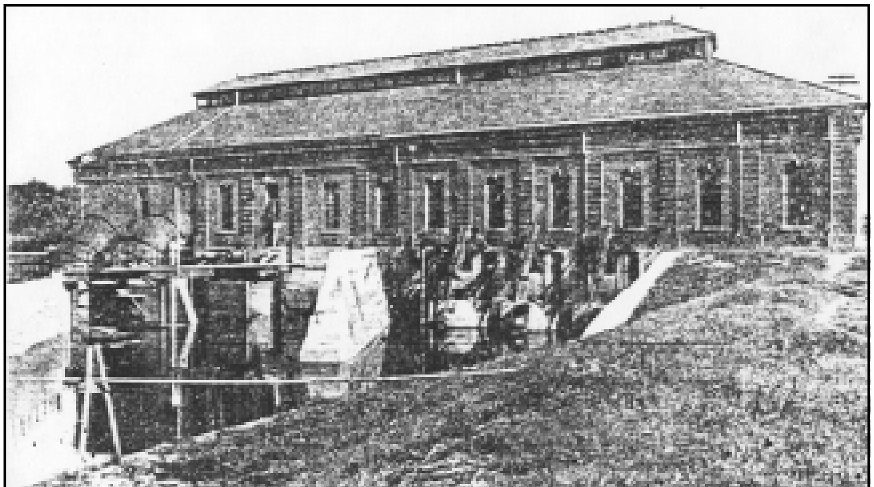


Figure 23. Exterior of Drainage Pumping Station No. 1, after alteration for 12' Wood screw pumps, photographed ca. 1915-1926 (from Sewerage & Water Board n.d.).

The first two of the 12' pumps were installed at Drainage Pumping Station No. 1 (Figures 24, 25, and 26) between December 1914 and April 1915, and were operating by the end of the first half of 1915. Testing of the Wood 12' pumps (Figures 27 and 28) was supervised by Professor W.H. Creighton, Dean of the Department of Technology, Tulane University. He was assisted by other engineers and Tulane students. Concerning the tests, Creighton stated:

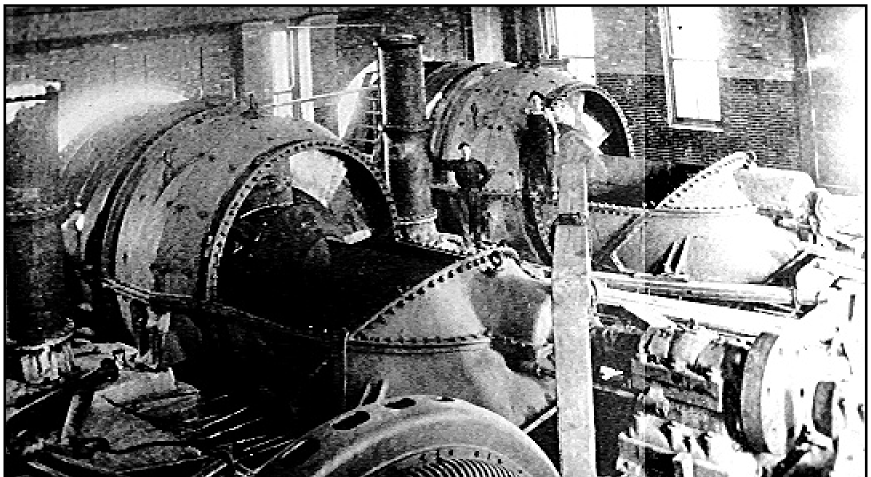


Figure 24. Interior view of Drainage Pumping Station No. 1, showing two 12' Wood screw pumps during installation, ca. 1914-1915 (from Sewerage &Water Board 1914).

> …the pump is… 12 feet in diameter of horizontal type, designed to give 225,000 gallons per minute against a 7 foot lift at 75 RPM and to work at this constant speed driven by a 600 hp synchronous motor for any lift from 0 to 10 feet… while the Wood screw pump surpasses in efficiency, under normal conditions, those of previous installations, the superiority is much greater just when the

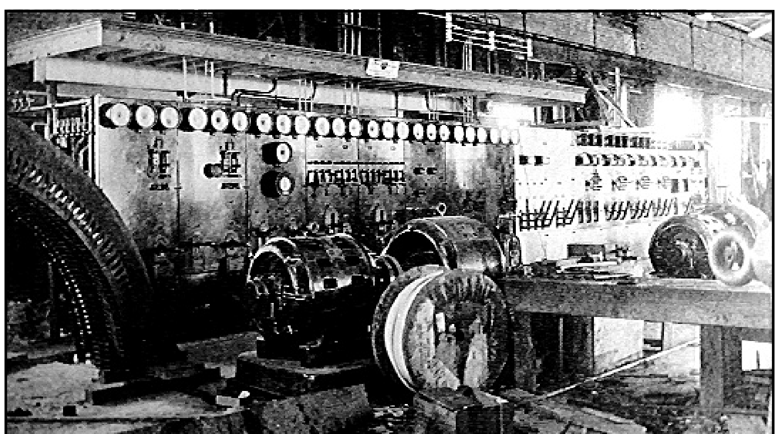


Figure 25. Interior view of Drainage Pumping Station No. 1, showing switchboard and rotary apparatus during installation, ca. 1914-1915 (from Sewerage & Water Board 1914).

greatest service is required. Emergency service is probably the weak point of the old pumps. It is the forte of the new… results show that the pump easily answered all requirements and that they are the largest and most efficient low lift pumps in the world [quoted in Thompson n.d.:14].

Creighton's observations were widely reported in professional journals; *The Engineering News* (1/13/1916), *The Engineering Record* (1/8/1916), and also in *The Municipal Journal* (1/6/1916) (Sewerage and Water Board 1915:51).

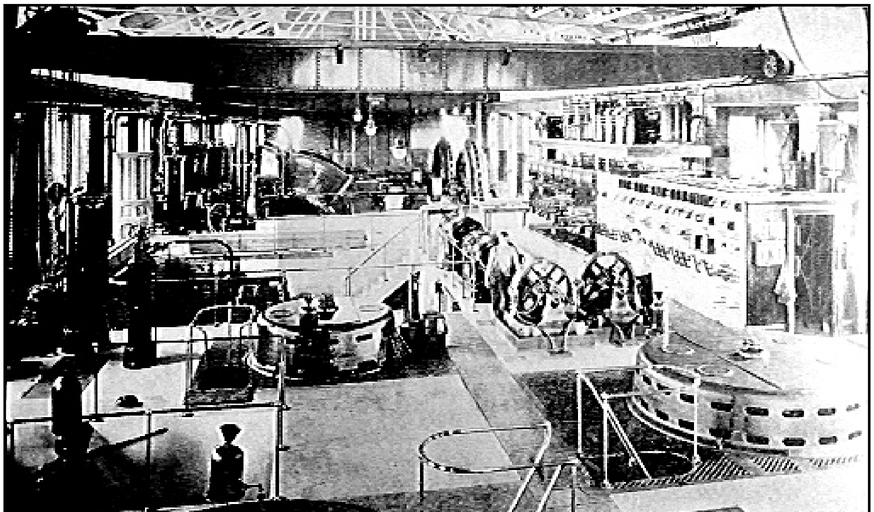


Figure 26. Interior view of Drainage Pumping Station No. 1 after installation of 12' Wood screw pumps and electrical equipment, ca. 1915. The Wood pumps are visible in the rear, the switchboard to the right, and in the foreground, the motors for the vertical screw pumps originally installed in the station ca. 1903-1904 (from Sewerage & Water Board 1915).

Following the installation of the 12' Wood screw pumps in Drainage Pumping Station No. 1 in 1915, additional alterations were made in the station's equipment. In 1916, friction clutches were installed in the old screw pumps at the station. These clutches allowed the synchronous motors driving the pumps to be started without load. This made it no longer necessary to slow down the engines of the Central Power Station in order to start the older pumps. Drainage Pumping Station No. 1 was also the site of tests of an experimental device to determine the best form of trash cleaner for adoption at all pumping station suction basins (Sewerage and Water Board 1916:78). As of 1925, all of the original pumps were still in use in Drainage Pumping Station No. 1, even though changes had been made to the electrical apparatus (Sewerage and Water Board 1925a:94).

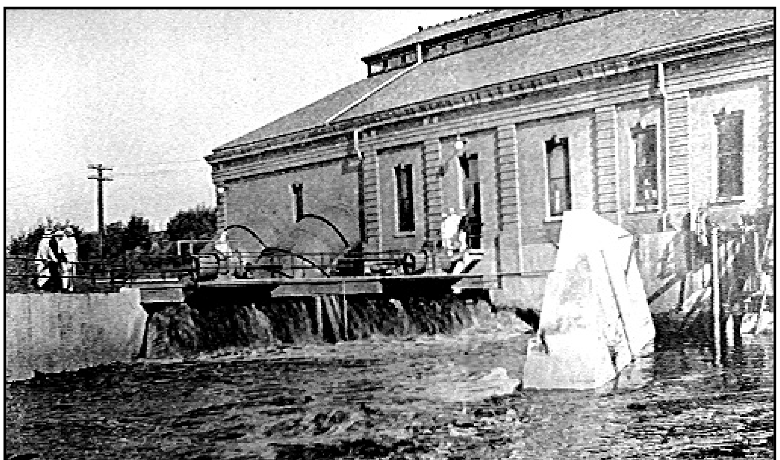


Figure 27. Testing of one 12' Wood screw pump at Drainage Pumping Station No. 1, ca. 1915. Original caption states: "…view of the discharge end of Pumping Station No. 1… pumping water from area served by Napoleon Avenue, Third Street, and Melpomene Street Canal into the Metairie Relief Canal on its way to Pumping Station No. 6. The picture shows discharge from one Wood screw pump through partly closed swinging control gates during the test. The discharge basin of this pumping station is so arranged… as to permit the discharging of the dry weather and small storm flow into the Broad Street Canal… This station is the first station designed to carry the dry weather flow across the city on its way to Lake Borgne, and thus relieve Lake Pontchartrain form the foul water which is pumped out of the city during dry weather or at the beginning of rains (from Sewerage & Water Board 1915).

On May 29, 1929, a contract was awarded to John Reiss for extension of Drainage Pumping Station No. 1 to house three of the 14' Wood pumps, at a price of $153,425.00. The structural addition and alteration was performed rapidly, because the 14' Wood pumps were reported as installed and ready for operation by April 8, 1930. As of 1930, Drainage Pumping Station No. 1 had three 14' Wood screw pumps, two 12' Wood screw pumps, three vertical shaft screw pumps, one 42" vertical shaft centrifugal pump, and one 30" Wood screw pump. These 10 pumps had a combined capacity of 5,310 cfs (Sewerage and Water Board 1927:108, 115; Sewerage and Water Board 1929:113; Sewerage and Water Board 1930:283). With the addition of the 14' Wood pumps, Drainage Pumping Station No. 1 had a capacity seven times greater than it had when put into operation in 1904, and greater than the combined total of the seven drainage pumping stations extant in 1905.

Figure 28. Testing of the 12' Wood screw pumps at Drainage Pumping Station No 1 (background), ca. 1915. Pitot tubes have been placed in the Metairie Relief Canal to measure the velocity of flow. This data was used to calculate the efficiency of the pumps. Tulane engineering students are holding the tubes while engineers record data (from Sewerage and Water Board 1915).

When the 14' Wood pumps were installed in Drainage Station No. 1, the gates and basins at the station were arranged so that the output of these pumps was directed only towards Pumping Station No. 6. The 12' Wood pumps could still be directed towards either Pumping Station No. 6 or No. 2, and vertical screw pump units could be opened towards Pumping Station No. 2 independently of the other pumps.

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 Station No. 1 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).

In 1965, the original vertical pumps in Drainage Pumping Station No. 1 were removed, and more modern pumps of the same capacity were installed. This was the last pump replacement undertaken at the Station to date (1996). After the 1965 equipment changes, Drainage Pumping Station No. 1 had three 14' Wood screw pumps, two 12' Wood screw pumps, one 30" Wood constant duty screw pump, two vertical constant duty pumps, and two vertical pumps with 250 cfs capacity. One of the vertical constant duty pumps was recently removed (Mr. Rudy St. Germain, personal communication 1996). The sluice gates and other suction and discharge basin features have been modified several times since 1961.

Figure 29. Drainage Pumping Station No. 1. View of east facade, looking west from Martin Luther King Boulevard.

Figures 29 through 38 are views of Drainage Pumping Station No. 1 as it appears today (1996).

Drainage Pumping Station No. 3. Drainage Pumping Station No. 3, sometimes called the St. Bernard Pumping Station, is located at the intersection of Broad, London, and Marigny Avenues. It was designed to drain the area between the Carondelet ("Old Basin") Navigation Canal, Elysian Fields Avenue,

Figure 30. Drainage Pumping Station No. 1. View looking southwest.

Figure 31. Drainage Pumping Station No. 1. View looking northwest.

Figure 32. Drainage Pumping Station No. 1. View looking south.

Figure 33. Drainage Pumping Station No. 1. View looking southeast.

Figure 34. Drainage Pumping Station No. 1. View of south facade, looking north.

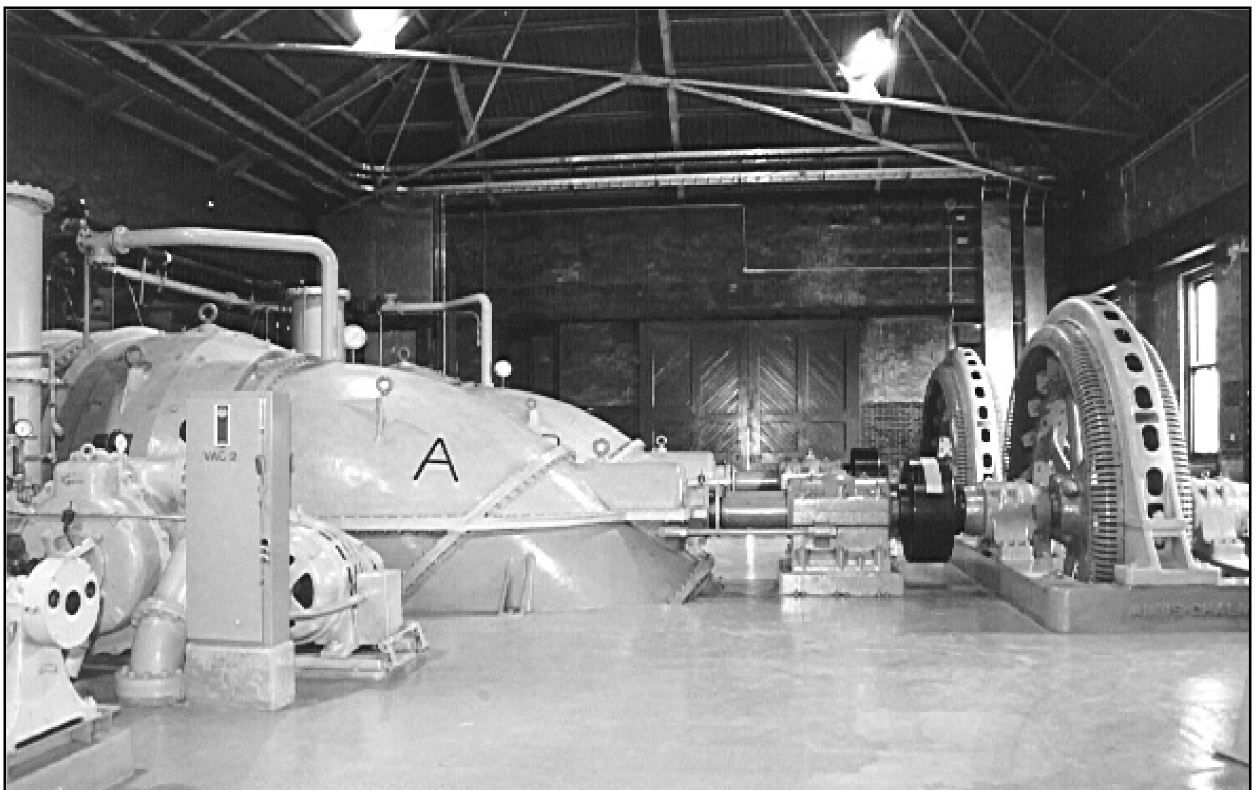


Figure 35. Drainage Pumping Station No. 1. View of northern end of interior, showing 12' Wood screw pumps and motors.

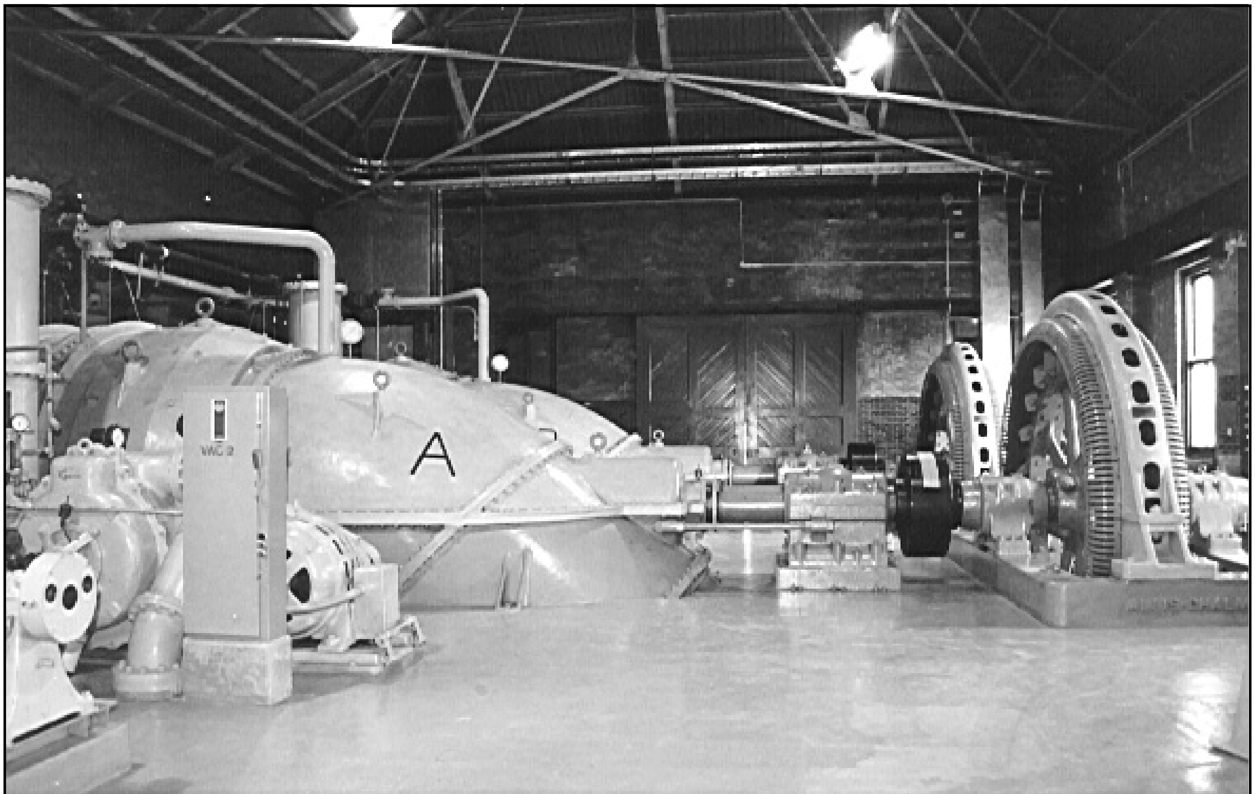


Figure 36. Drainage Pumping Station No. 1. View from southern end of interior, showing 14' Wood screw pumps.

Figure 37. Drainage Pumping Station No. 1. View of interior looking south from central portion of building. Foreground, prototype Wood screw pump on display; center, 250 cfs vertical screw pump motors.

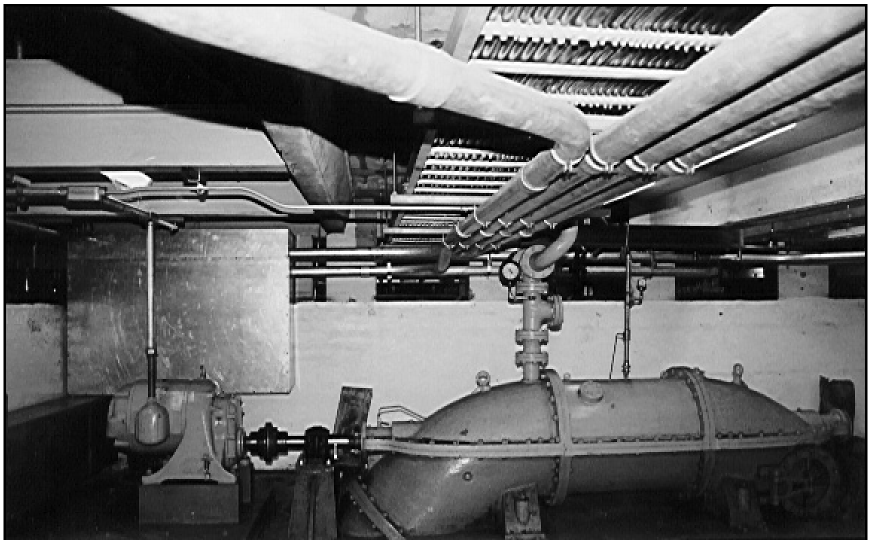


Figure 38. Drainage Pumping Station No. 1. View of interior, central portion of building, showing 30" Wood constant duty screw pump.

and Lake Pontchartrain into the Marigny Avenue Canal, and thence to the proposed the intermediate lift at Drainage Pumping Station No. 4. Station No. 4 was to pump into the Florida Walk/Florida Avenue Canal, which carried the flow to Station No. 5 at the Main Outfall Canal. Construction did not begin on the Florida Walk and Marigny Avenue canals until 1914, and the Marigny Avenue Canal was not completed until 1917. Furthermore, Drainage Pumping Station No. 4 was never built at its proposed location, the intersection of Lafayette Avenue and Florida Avenue. Instead, Station No. 3 pumped only into the London Relief Outfall Canal and Lake Pontchartrain until completion of the Marigny Avenue and Florida Walk canals (Sewerage and Water Board 1909:7; 1910:159).

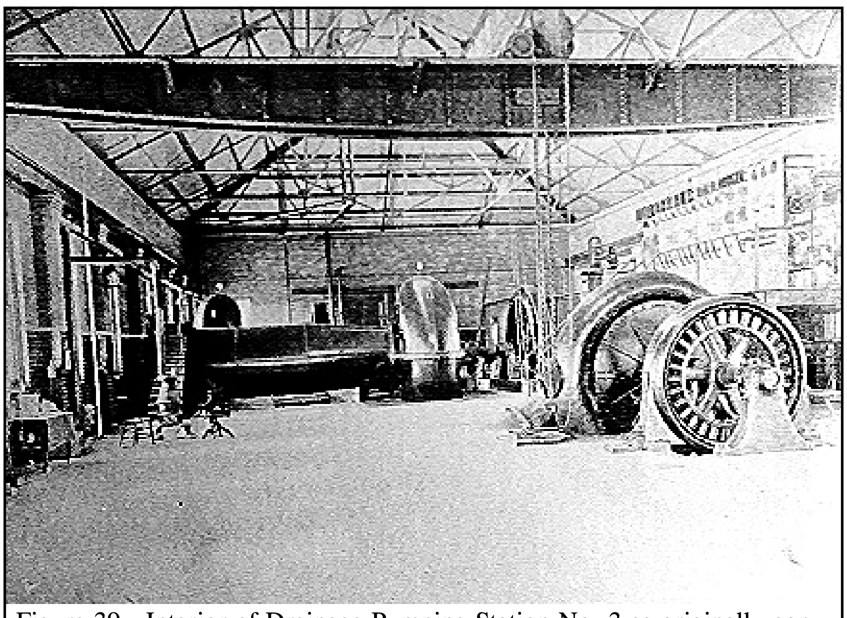


Figure 39. Interior of Drainage Pumping Station No. 3 as originally constructed, showing horizontal centrifugal pumps, 1904 (from Sewerage and Water Board 1904).

Construction of Drainage Pumping Station No. 3 was contracted for in Contract "I" of the Drainage Commission in July or August 1901. The contracted price for the station was $187,000 (Sewerage & Water Board 1908). The station was planned to initially have two centrifugal pumps of 250 cfs capacity, one pump of 50 cfs, and reserve space for four additional pumps. In contrast to Drainage Pumping Stations Nos. 1, 6, and 7, the centrifugal pumps at Station No. 3 were horizontal centrifugals (Figure 39), with both pumps and motors erected on the floor of the station instead of in sub-floor pits. The pumps were not submerged and were primed by means of a motor-driven vacuum pump. No gates were required in the suction and discharge basins of these pumps, and being at floor level, they were easily accessible for maintenance and repairs. The horizontal centrifugals were also more easily started than the vertical centrifugals because they were not under load until they were run at full speed, and were primed by the vacuum pump. The two larger pumps were designed for a lift of eight feet, and the smaller a lift of 12 feet across the station. Each 250 cfs pump was driven by a three phase, 25 cycle, 3,300 volt synchronous motor (Sewerage and Water Board 1904b:2; 1909:7; 1910:159; 1915:168). The 50 cfs pump was the constant-duty pump. Construction of Drainage Pumping Station No. 3 was virtually complete by the end of 1902, and the completion of the contract was accepted by the Sewerage and Water Board in 1903. Figure 14 shows Drainage Pumping Station No. 3 as originally built. Figure 39 is an interior view of Station No. 3, showing one of the horizontal centrifugal pumps.

In 1912, planning began for an increase in pumping capacity at Stations 1, 3, 6, and 7 (Sewerage and Water Board 1912a:17). Stations 3 and 7 were enlarged after Stations 1 and 6. Contract 76-D, for construction of foundations and concrete suction pipes for two 12-foot Wood screw pumps, discharge basins, bypass, and switchboard gallery at Drainage Pumping Station No. 3, was issued to John Reiss of New Orleans on May 25, 1917. The contract amount was $60,365.00. Installation of the Wood pumps and other work was completed in 1918 (Sewerage and Water Board 1917:81; 1918:82)

Drainage Pumping Station No. 3 was modified for the installation of 14' Wood screw pumps in 1930-1931. The building's western end was extended and three 1,000 cfs Wood pumps installed in 1931 (Contracts 114-D, 116-D, 183-D, 5036).

In 1950, new flood gates were constructed at Station No. 3, and in 1970-1972, further alterations were made. These modifications in the early 1970s included the addition of a mechanical trash screen cleaner. In 1976, attempts were made to floodproof part of the machinery at the station, but these modifications were not apparently fully successful. Figures 40 through 46 show Drainage Pumping Station No. 3 as it appears today (1996).

Figure 40. Drainage Pumping Station No. 3, viewed from the northeast.

Drainage Pumping Station No. 4. Drainage Pumping Station No. 4 was not built in the location originally proposed in the 1895 Drainage Plan. Instead, Station No. 4 was not constructed until almost one-half century later, at a completely different location. Plans for a new drainage pumping station, designated Station No. 4 but located at Prentiss Avenue and the London Outfall Relief Canal, were drawn up in 1938; however, construction was not to begin until late in

Figure 41. Drainage Pumping Station No. 3, viewed from the northwest.

Figure 42. Drainage Pumping Station No. 3, viewed from North Broad Avenue.

Figure 43. Drainage Pumping Station No. 3, viewed from the northwest. Discharge basin and discharge pipes of 14’ Wood screw pumps are visible.

Figure 44. Drainage Pumping Station No. 3. View of discharge basin; 12’ Wood pump at left, 14’ Wood pumps at right (west) end of the station.

Figure 45. Drainage Pumping Station No. 3, viewed from railroad bridge over the London Avenue Outfall Canal. View of the discharge basin.

Figure 46. Drainage Pumping Station No. 3. View of interior looking east from the central portion of the building; in the foreground are two horizontal centrifugal constant duty pumps.

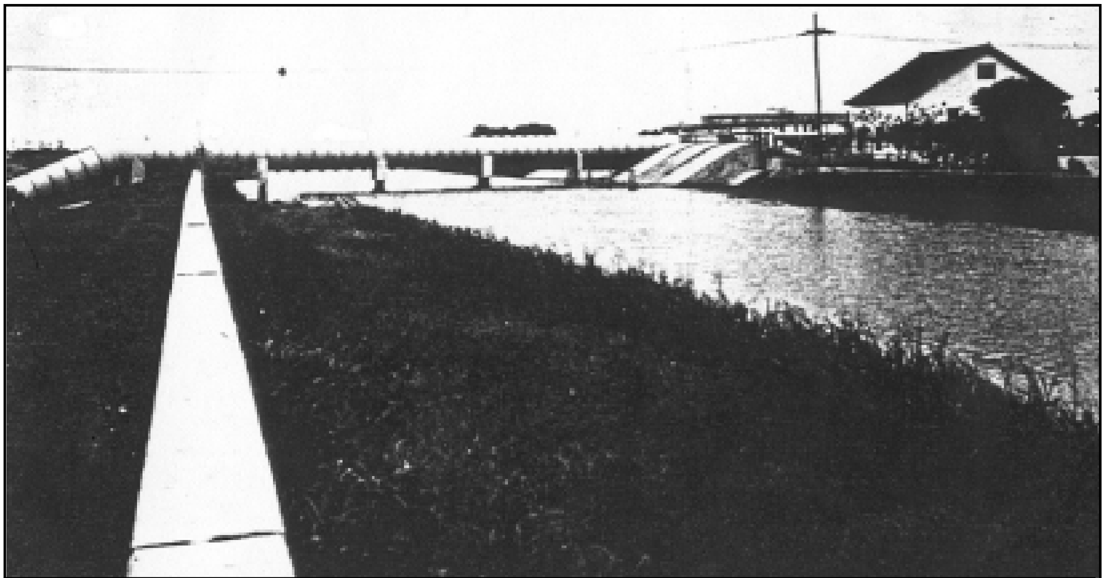


Figure 47. Drainage Pumping Station No. 4, 1962, showing new 10' steel siphon over the London Avenue Outfall Canal (from Sewerage and Water Board 1962).

World War II. On August 9, 1945, Contract 136-D was issued for construction of Drainage Pumping Station No. 4. Originally, the station was equipped with two 320 cfs horizontal centrifugal pumps. Construction of the station was completed in 1946.

Major additions were made to Station No. 4 in the late 1950s, and a 1000 cfs screw pump was installed ca. 1960. A new 36" constant duty trash pump was installed in 1963/1964. A mechanical trash screen cleaner and another 1000 cfs screw pump were added to Station No. 4 in the late 1960s. Figure 47 shows Station No. 4 in 1962. A flood protection wall was constructed on the London Outfall Canal side of the station ca. 1972. A third 1000 cfs screw pump was installed at this station an unclear date. Figures 48 through 50 show Drainage Pumping Station No. 4 as it appears today (1996).

Figure 48. Drainage Pumping Station No. 4, viewed from the southeast. Pumping equipment is obscured by a tarpaulin; sandblasting in progress.

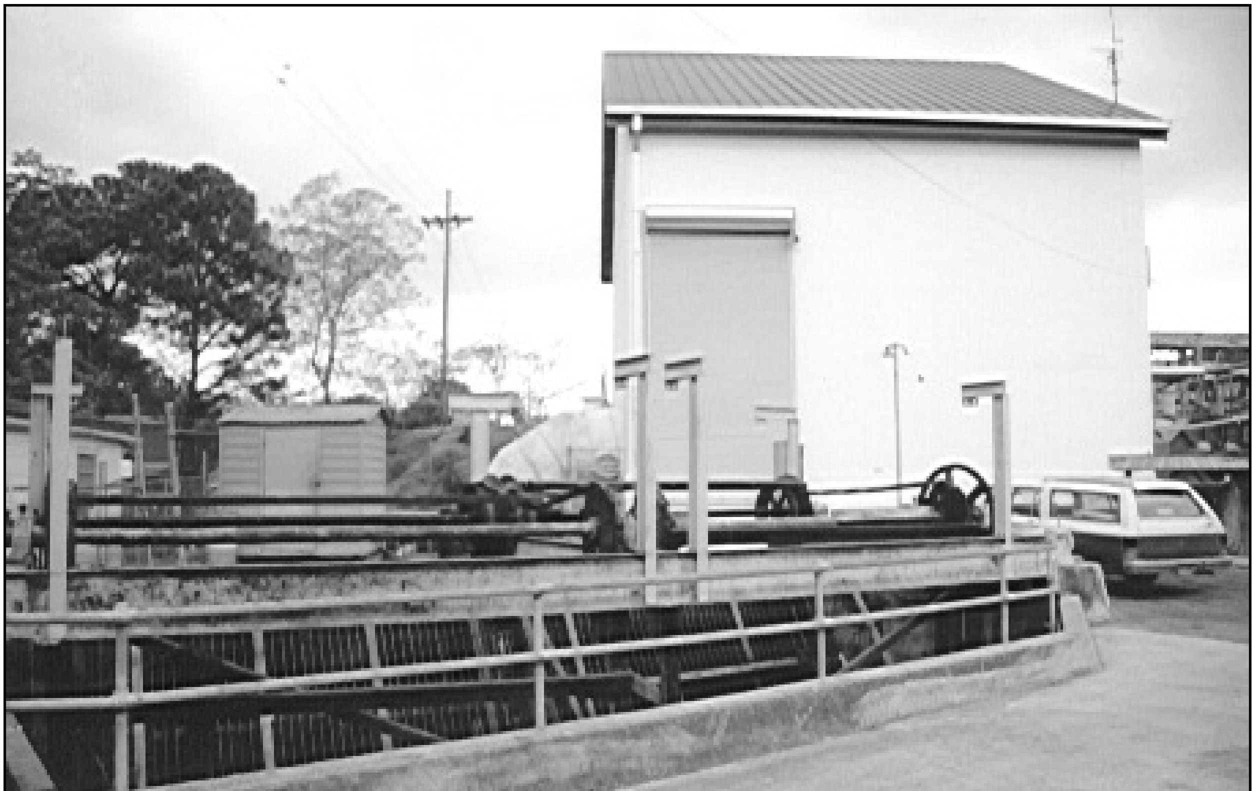


Figure 49. Drainage Pumping Station No. 4, viewed from the east.

Figure 50. Drainage Pumping Station No. 4, viewed from the southwest, across the London Relief Outfall Canal.

Drainage Pumping Station No. 6. Drainage Pumping Station No. 6 is located on the Upper Protection Levee and the Metairie Relief Outfall Canal. The Station was designed to pump the water sent to it from Drainage Pumping Station No. 1 and the runoff of the area on the upper side of the Carondelet (New Basin) Canal up to the Protection Levee and out to the River, and when the system was complete, to pump the water from the area between Broad St. and the Lake, lying between the Metairie Relief and the New Orleans Navigation Canal (Sewerage and Water Board 1909:8). Contract "A", issued by the Drainage Commission on August 9, 1897 to the National Contracting Co., included construction of Drainage Pumping Station 6. Construction of the station was substantially completed in 1898 and the contract finally accepted in 1900. The individual cost of the station's building and foundations was $71,600 (Sewerage and Water Board 1911:129). Figure 15 shows the exterior of Drainage Pumping Station No. 6 as originally constructed.

Figure 51. Interior of Drainage Pumping Station No. 6 as originally constructed, showing vertical centrifugal pumps (from Sewerage & Water Board 1904).

Original pumps at the Station were four 250 cfs single-suction vertical-shaft centrifugal pumps, three of them manufactured by the E.P. Allis Co. of Milwaukee, and one manufactured by the I.P. Morris Co. of Philadelphia. These pumps had a lift of 10 feet across the station. The pumps were placed in pits beneath the floor of the station so that their runners were submerged. The impeller diameter of these pumps was 9½', and the suction and discharge pipes of these pumps were 8' in diameter. Each pump was connected to a 400 kilowatt 466-horsepower synchronous revolving field motor, which ran at 62 ½ rpm on three phase energy at 25 cycles and 3000 volts. Figures 51 and 52 are interior views of the Station showing its original vertical centrifugal pumps. Figures 18 through 20 show the interior of the original pumps in Drainage Pumping Station No. 7, identical to those originally installed in Station No. 6. Drainage Pumping Station No. 6 has had the largest pumping capacity of any of the drainage stations in the New Orleans system since its construction (Sewerage and Water Board 1904b:3; 1910:160; 1911:128-129).

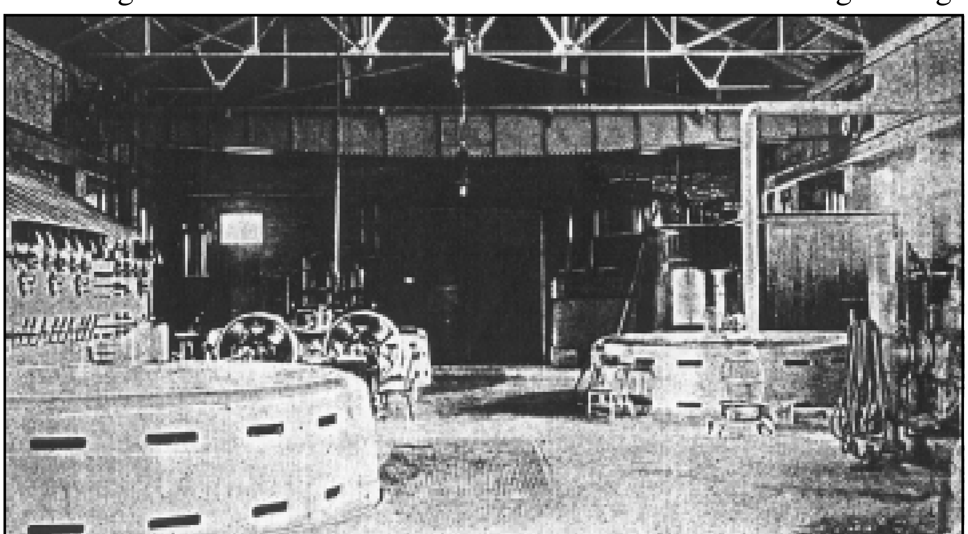


Figure 52. Interior view of Drainage Pumping Station No. 6, showing original vertical centrifugal pumps, 1909 (from Sewerage & Water Board 1909).

In 1902, Contract "Q" was issued to the Camden Iron Works of Camden, N.J., for a 30 cfs constant-duty pump to be installed in Station No. 6. A single-suction vertical shaft centrifugal pump was installed in 1903. This pump was driven by a ten-pole induction motor, "squirrel cage" type, of 100 hp, designed for three phase energy at 25 cycles and 3000 volts, without transformers. The speed of the motor at full load was 285 rpm. The motor was manufactured by the Westinghouse Electric and Manufacturing Co., East Pittsburgh, PA. The cost of this pump brought the total cost of the building and machinery at the station to $223,000.00 (Sewerage and Water Board 1911:129).

On November 4, 1914, John Reiss of New Orleans received contract 67-D for enlarging Drainage Pumping Station No. 6 in anticipation of installation of the new Wood screw pumps. The addition to the station consisted of an extension measuring 67 feet by 50 feet, enlargement of the suction basin, and construction of a reinforced concrete discharge flume. The successful bid for this contract was $57,356.92. On December 19, 1914, John H. Murphy of New Orleans received contract 71-D for construction of the suction and discharge pipes for the constant-duty pump at Station No. 6. Also issued in connection with installation of the 12-foot Wood screw pumps in Station No. 6 was contract 74-D, issued to the Northern Engineering Works, of Detroit, for a 15-ton hand operated crane. The contract was issued on June 1, 1915 and the crane delivered and erected in December 1915; by the end of the year the crane was hoisting the castings of the 12-foot Wood pumps into position in the Station (Sewerage and Water Board 1914:137; 1915:112-113, 184).

In Drainage Pumping Stations No. 6 and 7, the pump pits for the original vertical-shaft centrifugal pumps were altered in 1915. These alterations were made to facilitate starting the pumps under load. On October 22, 1914, the Roe, Stephens Manufacturing Co. of Detroit received contract 70-D for the construction and delivery of hydraulic cylinders, gate valves, and sluice gates for Drainage Pumping Stations Nos. 6 and 7. The hydraulic cylinders were attached to the suction gates so that they could be operated quickly and safely. A 30-inch tunnel was drilled through the basin masonry to connect all of the large pump suctions and that of the constant-duty pump. If the suction gates were throttled, the constant duty pump, driven by an induction motor, or any of the large pumps, could lower the water behind the gates so as to clear the runners of the other pumps, which could therefore be started with compensators, and the gates then raised (Sewerage and Water Board 1915:114). Installation of the 12-foot Wood pumps and other improvements at Drainage Pumping Station No. 6 were completed in 1916.

Drainage Pumping Stations No. 1 and 6 were the first to receive 14-foot Wood screw pumps. Contract 103-D, for an extension of Drainage Pumping Station No. 6, was issued to H. Pratt Farnsworth in 1928, for a bid of $183,879.80. Figure 53 shows the western end of Drainage Pumping Station in 1929, after extension to receive the 14-foot Wood screw pumps. The four 14-

Figure 53. Drainage Pumping Station No. 6, after 1914 and 1929 extensions (from Sewerage & Water Board 1929).

foot Wood screw pumps added to the station were installed and in operation by February 5, 1930 (Sewerage and Water Board 1930:122, 124). Figure 54 shows the interior of Station No. 6 after installation of the 14-foot Wood screw pumps. Because the required lift was higher at Station No. 6 than at Station No. 1, fourteen feet versus eight feet, the 14-foot pumps at Station No. 6 were equipped with 2,000 h.p. motors, rather than 1200 h.p. motors as at Station No. 1.

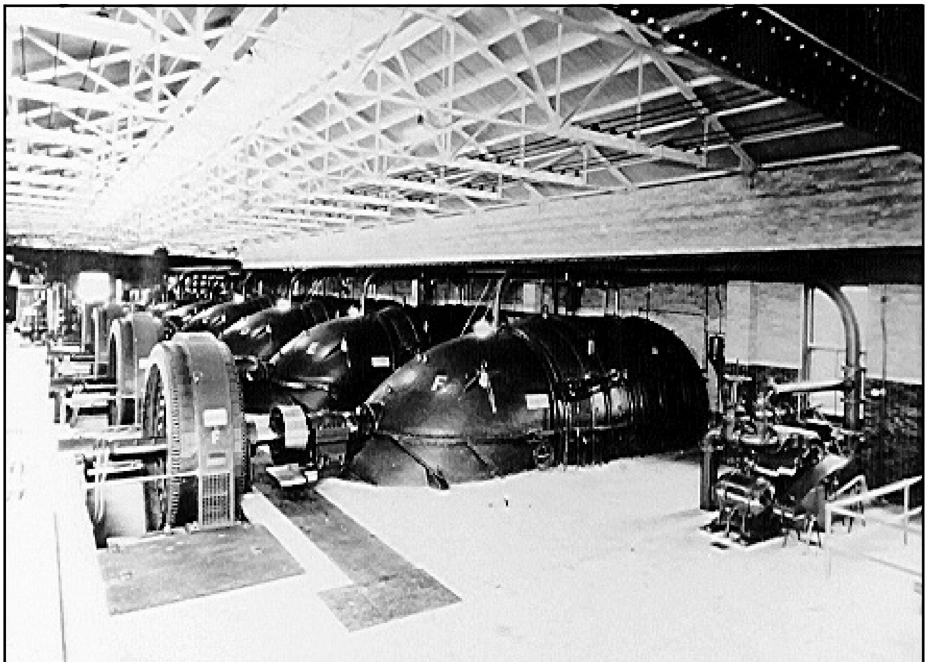


Figure 54. Interior of Drainage Pumping Station No. 6 after installation of 14’ Wood screw pumps (from Sewerage & Water Board).

In 1929, H. Pratt Farnsworth received Contract 210-S to alter Drainage Pumping Station No. 6 to receive four 6’ vertical centrifugal Wood trash pumps of 250 cfs capacity, for a bid of $13,700. The vertical trash pumps were manufactured by the Hardie-Tynes Mfg. Co. (Contract 208-S), with valves by the Michigan Valve and Foundry Co. (Contract 209-S). These pumps were put into operation in early 1930 (Sewerage and Water Board 1929:112; 1931:16).

As of 1930, Drainage Pumping Station No. 6 had four 14-foot Wood screw pumps (1000 cfs), two 12-foot Wood screw pumps (550 cfs), four vertical shaft 72” Wood centrifugal trash pumps (250 cfs), and one 36” constant-duty vertical shaft centrifugal pump (25 cfs). By this date, the electrical equipment at the station had been divided into three separate operating busses to localize interruptions in the power supply during severe storms (Sewerage and Water Board 1929:112).

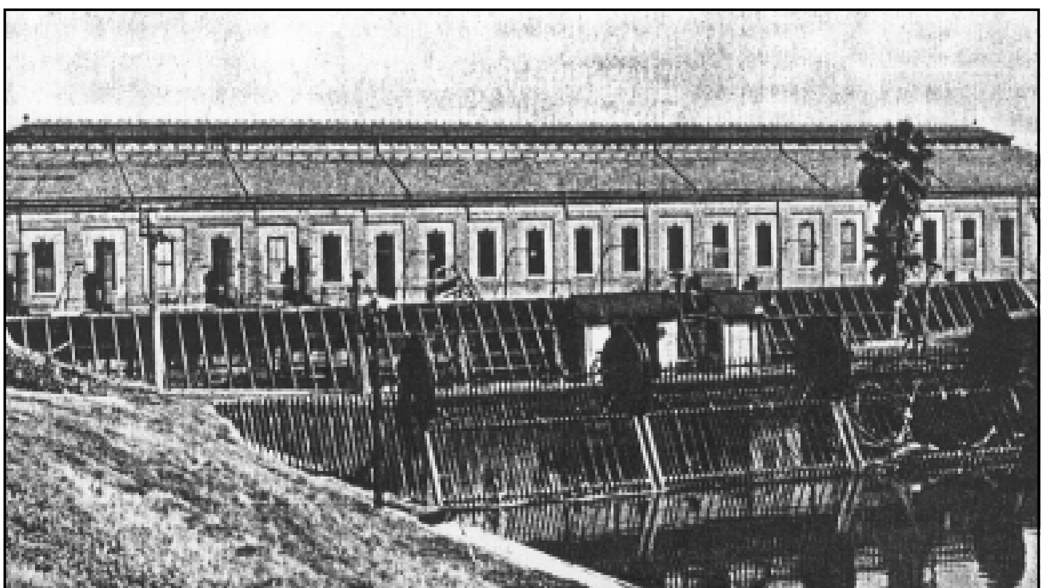


Figure 55. Drainage Pumping Station No. 6, 1966 (from Sewerage & Water Board, 1966).

Figure 55 shows Drainage Pumping Station No. 6 in 1966, before construction of the contemporary trash screen cleaners which obscure the view of the station from the south (Figures

Figure 56. Drainage Pumping Station No. 6, viewed from the southwest.

Figure 57. South facade of Drainage Pumping Station No. 6.

Figure 58. Drainage Pumping Station No. 6, joint of 1897-1899 construction and 1986-1989 addition.

56 and 57), and before enlargement of the suction basin. In 1967, plans were made for an expansion of the Station on its western end, known as the Jefferson Parish Addition because this portion of the Station lies in Jefferson Parish. One 1,000 cfs pump was installed in the western extension. A floodwall was constructed on the Outfall Canal side of the Station in 1983. Construction of another addition on the western end of the Station began in 1986. Ca. 1985-1988, the older 250 cfs vertical pumps were replaced with more modern units. In 1986-1989, the Station was expanded considerably into Jefferson Parish. One 1,000 cfs pump and two 1,050 cfs pumps were installed in the addition. The 1986-1989 addition to Station No. 6 is in a different architectural style than the 1897-1900 and 1929-1930 construction, but utilizes some architectural details from the style of the older portions of the building (Figure 58). Figures 59 and 60 show Drainage Pumping Station No. 6 as it appears today (1996).

Drainage Pumping Station No. 7. Drainage Pumping Station No. 7 is located at the intersection of Taylor Avenue and the Orleans Relief Canal, in City Park. As originally proposed, Station No. 7 was to be strictly a final lift station, but early on the role of the station in the system was modified. As mentioned above, the original conception of the Main (Broad Street and Florida Avenue Canal) was that the daily flow of the area both on the river side and the lake side of the Main Canal would drain into it. Instead, the city drainage engineers determined that it was advantageous to reroute the drainage from the portion of the city on the lake side of Broad Street. In the first decade of the drainage system, Drainage Pumping Station No. 7 pumped the water conveyed from Drainage Pumping Station No. 2 by way of the Orleans Canal, draining the area from Broad Street to Taylor Avenue, the Old and New Basins, and also the area between the Orleans Navigation Canal Orleans Relief Outfall, and from the Lake to Taylor Avenue. It was antici-

Figure 59. Drainage Pumping Station No. 6, viewed from the north.

Figure 60. Drainage Pumping Station No. 6. View of interior looking east; in the foreground are 250 cfs vertical centrifugal pump motors. The remainder of the pumps are Wood screw pumps; in the foreground are two 12’ pumps, and in the background are four 14’ pumps.

pated (1909) that Drainage Pumping Station No. 7 would pump the water from the area between the Orleans Outfall and Bayou St. John and the Lake and Taylor Avenue.

Drainage Pumping Station No. 7 was one of the first three stations to be built. Construction was contracted with the National Contracting Co. in Contract "A" on August 9, 1897. Figure 16 shows Drainage Pumping Station No. 7 as originally constructed. The contracted price was $192,000.00. Its original complement of pumps was three vertical centrifugal pumps of 250 cfs capacity. The pumps had a 10' lift across the station and suction and discharge pipes of 8' in diameter. The pumps were driven by 400 kilowatt synchronous motors, which ran at 62 ½ rpm. The suction and discharge pipes were provided with eight-foot sluice gates operated by small electric motors, and the discharge pipes had flap gates which automatically closed when the pump was shut down (Sewerage and Water Board 1910:160). These three original vertical centrifugal pumps, manufactured by the E.P. Allis Co. of Milwaukee with motors by the General Electric Co. of New York, are still in place at Drainage Pumping Station No. 7 (Figures 18 through 20). Ca. 1911, one single-suction vertical centrifugal pump was installed in Station No. 7 as a constant duty pump. This 30 cfs pump, manufactured by the Camden Iron Works of Camden, N.J., was driven by a 100 h.p. synchronous motor manufactured by the Westinghouse Electric and Manufacturing Co. of East Pittsburgh (Sewerage and Water Board 1911:130-131).

The pump pits for the original vertical-shaft centrifugal pumps in Drainage Pumping Station No. 7 were altered in 1915. These alterations were made to facilitate starting the pumps under load. On October 22, 1914, the Roe, Stephens Manufacturing Co. of Detroit received contract 70-D for the construction and delivery of hydraulic cylinders, gate valves, and sluice gates for Drainage Pumping Station No. 7. The hydraulic cylinders were attached to the suction gates so that they could be operated quickly and safely. A 30-inch tunnel was drilled through the basin masonry to connect all of the large pump suctions and that of the constant-duty pump. If the suction gates were throttled, the constant duty pump, driven by an induction motor, or any of the large pumps, could lower the water behind the gates so as to clear the runners of the other pumps, which could therefore be started with compensators, and the gates then raised (Sewerage and Water Board 1915:114).

Station No. 7 was modified on its western end, but was not enlarged, to receive one of the 12' Wood screw pumps ca. 1914-1916; the eastern end was also modified and evidently enlarged to receive two new constant duty pumps (Contracts 58-D, 70-D, 77-D, 78-D, 100-D). The 12' Wood screw pump, manufactured by the Nordberg Manufacturing Co. (Contract 58-D), was installed at Drainage Pumping Station No. 7 in late 1917 or early 1918. In 1931, the Station was expanded in order to receive two 14' Wood screw pumps (Contracts 116-D, 121-D, 175-D, 187-D). Also ca. 1931, two vertical constant duty trash pumps were installed in Station No. 7 (Contract 208-S), evidently replacing the pumps installed as constant duty pumps ca. 1916. These pumps and motors were modernized ca. 1966. In 1976-1977, efforts were made to floodproof Station No. 7. A new control room was constructed ca. 1985.

Drainage Pumping Station No. 7 has several unique features remaining from the its original configuration and early modifications. Among these features are the three original 250 cfs vertical centrifugal pumps and motors, and the station's constant duty pump No. 1, installed ca. 1911. Figures 61 through 66 show Drainage Pumping Station No. 7 as it appears today (1996).

History Of The Drainage Network

The 1895 Drainage Plan (Figure 6) called for the construction of a network of 95 miles of drainage canals, 30 of which were to be masonry lined and covered. This proposed network represented several years of construction. Table 2 contains information on the construction of individual canals in the network, and the dates of canal modification, for the period 1896-1941. The first canals contracted for construction included the Seventeenth Street, London Outfall, and

Figure 61. Drainage Pumping Station No. 7. View from the southwest.

Figure 62. Drainage Pumping Station No. 7. View from the southeast.

Figure 63. Drainage Pumping Station No. 7. Viewed from the northeast, showing trash screen and hydraulic sluice gate mechanisms.

Figure 64. Drainage Pumping Station No. 7. View of interior, showing motor covers of 250 cfs centrifugal "flathead" pumps.

Figure 65. Drainage Pumping Station No. 7. View showing end of monitor.

Figure 66. Drainage Pumping Station No. 7. Wooden vehicle door on west end of building.

Dublin open and unlined canals; the St. Louis, Basin, Canal St., Camp, Chartres, Julia, Constance, Galvez, and Claiborne lined and covered canals; and the Oleander, Claiborne, Orleans St., Orleans Relief, Metairie Relief, and Jourdan Ave. unlined and open canals, all constructed in 1896-1897. Work began on the Main Canal and Main Outfall Canal in 1897-1898, and other major lined and covered canals in 1901. As indicated by Table 2, there is no single date at which the "New Orleans Drainage System" as built, represented the static version of the system proposed in 1895.

The methods utilized in constructing the New Orleans drainage network also did not remain constant over time. As early as initial construction of the network in the period 1897-1902, the construction of small drainage canals was changed from that detailed in the 1896 speci-

Table 2. Drainage Network Construction, 1896-1941.

Contract	Canal Name	Construction	Award Date	Completion Date	Contractor
unk.	Seventeenth St.	unlined and open	1896	unk.	
unk.	London Relief Outfall	unk.	[1897]	unk.	
unk.	Dublin	unk.	unk	unk	
C	St. Louis, Basin, Canal, Camp, Chartres, Julia, Constance, Galvez,	lined and covered	1897	unk.	
D	[Oleander, Claiborne, Orleans St.,] Orleans Relief, Metairie Outfall, and Metairie Relief	unlined and open	1897	unk.	
unk.	Jourdan Ave.	unlined and open	1897	unk.	
unk.	Lafayette, Florida Ave.	unlined and open	1898	unk.	
unk.	Galvez	unk.	unk.	unk.	
unk.	Main	unk.	unk.	unk.	
unk.	Main Outfall	unlined and open	1898	unk.	
F	St. Charles, Third St.	lined and covered	1899	unk.	
G	Melpomene, Claiborne, Orleans Relief	unlined and open	1899	unk.	
unk.	Julia	unk.	unk.	unk.	
unk.	Camp	unk.	unk.	unk.	
J	Third, Constance	lined and covered	1901	unk.	
K	St. Bernard Ave., St. Claude, Esplanade, and Rampart Sts.	lined and covered	1901	unk.	
L	Nashville, Perrier, Constance	lined and covered	1901	unk.	
M	Lowerline, Jeannette, Pearl, Wall, Leonidas, Birch	lined and covered	1901	unk.	
N	Vallette, Eliza	lined and covered	1901	unk.	
O	Lapeyrouse, Whitney	unlined and open	1901	unk.	
R	Leonidas, Lowerline	timber lined and open	1902	unk.	
S	Nashville Ave.	timber lined and open	1902	1906	J.J. Keegan
T	St. Bernard Ave.	unlined and open	1902	1906	Jno. McCoy
unk.	Laurel	unk.	unk.	unk.	
unk.	Canal St.	unk.	unk.	unk.	
unk.	Algiers Outfall	unk.	unk.	unk.	
unk.	Perrier	unk.	unk.	unk.	
27	Broad St.	timber lined and open	1904	1906	WB
31-D	St. Mary	timber lined	1904	1908	Dunn, Philbrick &
U	Orleans and Claiborne	concrete lined and covered	1904	1905	Dowdle and Windett
V		unk.	1904	1906	
Y	Orleans Relief, Melpomene, and Claiborne	unk.	1904		
Z	Hagan Ave.	unk.	1904	1905	
32-D	Melpomene and Claiborne, w/ bypass at DPS 1	timber lined	1905	1906	
33-D	London Ave. Outfall	unlined and open	1905	1905	
unk.	Seventeenth St.	open and unlined	1906	unk.	
unk.	Claiborne	enlarging and grading	1907	unk.	
unk.	Melpomene	cementing I-beams	1907	unk.	
unk.	Algiers Outfall	unlined and open	1907	unk.	S. & W. B..
36-D	Napoleon Ave., suction basin DPS 1	unk.	1911	1915/1916	A.L. Patterson & Co.
42-D	Claiborne, Lafayette	unk.	1912	1913	W.J. Comerford
44-D	Metairie Relief, Broad St.	wood lining of sub-channel	1912	1915	Hampton Reynolds
45-D	New Basin Navigation Canal	siphon	1912	1913	Laing & Freret

Table 2, Continued.

Contract	Canal Name	Construction	Award Date	Completion Date	Contractor
48-D	Upper Protection Levee, Claiborne St., Florida Walk, Marigny Ave., Broad St.	open and unlined; wood lining in bottom of Broad St. from Marigny Ave. to St. Bernard Ave.	1912	1914	Etta Contracting Co.
50-D	Broad St. from St. Bernard Ave, to Carondelet Walk, Lapeyrouse St., Maurepas St., Esplanade Ave., Carondelet Navigation Canal	canal, branch canal, pipeline, siphon	1912	1916	Mitchell-Borne Construction Co.
60-D	Upper Protection, Claiborne	wood lined and open	1914	1915/1916	General Contract Co.
65-D	Lowerline, Leonidas	lined and covered	1914	1915	M.M. Wren
66-D	Nashville Ave.	reinforced concrete	1914	1916	W.J. Kane
68-D	Broad St.	reinforced concrete	1914	1916	Victor Lambou
69-D	St. Bernard Ave.	reinforced concrete	1914	1915	Victor Lambou
n/a	Ursuline Ave.	unlined and open	1914	1915	
n/a	Florida Walk, Tupelo St.	unlined and open	1914	1915	
n/a	Marigny Ave.	unlined and open	1914	1916	
n/a	Jourdan Ave., Claiborne Ave.	unlined and open	1914	1915	
n/a	Jourdan Ave. Outfall	unlined and open	1916	1918	
n/a	Canal Boulevard	unlined and open	1916	1917	
n/a	Upper District Center, Avenue C	unlined and open	1917	1919	
n/a	Paris Ave., Marigny Ave.	unlined and open	1917	1917	
n/a	Taylor Ave.	unlined and open	1917	1917	
n/a	Carrollton Ave. Canal	reshaping, deepening	1919	unk.	
n/a	Peters Ave.	reshaping, deepening	1919	unk.	
n/a	St. Anthony	reshaping, deepening	1919	1921	
n/a	Jourdan Ave., St. Claude St.	lined and covered	1919	unk.	
n/a	Algiers Outfall	deepening and widening	1919	1919	
n/a	Alvar St.	lined and covered	1919	1922	
n/a	Marigny Ave.	reshaping, deepening	1920	unk.	
n/a	Peoples Ave.	reshaping, deepening	1920	1921	
n/a	London Ave.	reshaping, deepening	1920	unk.	
n/a	Carrollton Ave.	lined and covered	1920	unk.	
n/a	Calhoun	reshaping, deepening	1920	unk.	
n/a	Lafayette Ave.	lined and covered	1921	1923	
n/a	Dublin St.	pipeline	1921	unk.	
n/a	Florida Ave. Open Canal	cleaning, reshaping	1921	1921	
n/a	Broad St. Wood-lined Canal	cleaning, reshaping	1921	1921	
n/a	Upper Protection Wood-lined Canal	cleaning, reshaping	1921	1922	
n/a	Florida Ave., Industrial Canal	siphon	1921	1921	
n/a	Dublin St.	pipeline	1921	unk.	
n/a	Toledano St.	pipeline	1922	unk.	
n/a	Main [Florida Ave.]	concrete channel lining	unk.	1929	
n/a	S. Claiborne	sub-channel wood lining	unk.	1929	
n/a	Paris Ave.	reshaping, deepening	unk.	1929	
n/a	Prentiss Ave. (formerly Calhoun St.)	reshaping, deepening	1929	1930	
n/a	S. Liberty St.	pipeline	1929	1929	
n/a	Algiers Outfall	reshaping, deepening	1929	1929	
n/a	St. Roch Ave.	pipeline	unk.	1930	
200-D	N. Rocheblave St.	reinf. conc. canal	1929	1929	A.P. Boh & Co.

Table 2, Continued.

Contract	Canal Name	Construction	Award Date	Completion Date	Contractor
201-D	Mirabeau Ave. Canal	reinf. conc. canal and pipeline	1929	1929	John B. Mooney
202-D	Nashville Ave. Extension, McKenna Street, S. Lopez, Fontainebleau Dr.	reinf. concrete, lined and covered	1929	1930	Thos. H. Brockman
203-D	N. Prieur St	reinf. concrete, lined and covered, pipelines	1929	1930	O'Brien Construction Co.
204-D	St. Claude Ave.	reinf. concrete, lined and covered	1929	1930	A.P. Boh & Co.
205-D	Metairie Relief [Melpomene, Washington Ave., Palmetto St., North Line St., Upper Protection Canal]	reinf. concrete, lined and open	1929	unk.	Fuller Construction Co.
n/a	S. Derbigny, S. Prieur, S. Galvez, and S. Tonti Sts.	pipelines	1930	1930	
n/a	Marigny Ave. Open	lining	1930	1930	
n/a	Mirabeau Open, St. Anthony	connection	1930	1930	
n/a	Peoples Ave. Open	deepening	1930	1930	
n/a	Tupelo Open	deepening	1930	1930	
n/a	Jourdan Ave. Open	reshaping	1930	1930	
n/a	Canal Blvd. Open	clearing	1930	1930	
206-D	Magellan	unk.	1930	1930	J.L. McWilliams
207-D	Algiers Outfall	unk.	1930	1931	McWilliams Dredging
208-D	Metairie Outfall	unk.	1930	1930	M.T. Ducros
209-D	Orleans Relief	lining	1930	1931	Co., Inc.
210-D	Florida Ave. (Main Canal)	lined and open	1930	1932	Co.
n/a	Lavender St.	concrete pipeline	1930	1931	M.T. Ducros
n/a	S. Murat St.	concrete pipeline	1930	1931	M.T. Ducros
n/a	S. Claiborne Ave.	wood lining	1931	1931	
n/a	Upper Protection	reinforc. conc. apron	1932	1932	
212-D	Orleans Relief	suction basin approach	1932	1932	A.P. Boh & Co.
214-D	S. Claiborne Ave. at Mistletoe St.	lined and covered	1932	1933	
n/a	Paris Ave.	enlarging and reshaping	1933	1934	
n/a	Peoples Ave.	enlarging	1933	1934	
n/a	Florida Ave.	enlarging	1933	1934	
n/a	Avenue C	enlarging	1933	1934	
n/a	Viavent St.	enlarging	1933	1934	
n/a	Norman	enlarging and reshaping	1933	1934	
215-D	Orleans Relief Canal and Bayou St. John	pipeline and gate	1933	1934	
216-D	Orleans Outfall Canal	re-dredging	1934	unk.	
217-D	Almonaster Ave.	lined and covered	1934	unk.	
218-D	St. Charles Ave.	conc. pipeline	1934	unk.	
219-D	S. Claiborne Ave.	lined and covered, pipeline	1934	1938	
220-D	N. & S. Olympia, Baudin St., S. Murat, and St. Claude Ave.	conc. pipelines	1934	unk.	
221-D	Lamarque St., Whitney Ave., Numa St., Genl. Meyer Ave.	lined and covered	1934	1938	
222-D	Genl. Taylor St.	lined and covered	1934	unk.	
223-D	Jefferson Ave.	pipeline	1934	unk.	

Table 2, Continued.

Contract	Canal Name	Construction	Award Date	Completion Date	Contractor
224-D	London Ave., Broad St.	widening & partly lining, lining and covering	1934	unk.	
n/a	Ursuline Ave.	subsurface drainage	1937	1938	
n/a	Orleans Ave.	subsurface drainage	1937	1937	
n/a	Florida Ave.	subsurface drainage	1937	1937	
n/a	Canal Blvd.	subsurface drainage	1937	1939	
n/a	N. Claiborne Ave.	subsurface drainage	1937	1938	
n/a	St. Roch Ave.	subsurface drainage	1937	1937	
n/a	St. Peter St.	subsurface drainage	1937	1937	
n/a	Esplanade Ave.	subsurface drainage	1937	1937	
n/a	Poydras St.	subsurface drainage	1937	1937	
n/a	Louisiana Ave.	subsurface drainage	1937	1937	
n/a	Pontchartrain Blvd.	subsurface drainage	1937	1937	
n/a	Gentilly Blvd.	subsurface drainage	1937	1937	
n/a	N. & S. Claiborne	subsurface drainage	1937	1937	
n/a	Gravier St.	subsurface drainage	1937	1937	
n/a	Perdido St.	subsurface drainage	1937	1937	
n/a	Gen. Pershing St.	subsurface drainage	1937	1937	
n/a	Nashville Ave.	subsurface drainage	1937	1937	
n/a	S. Johnson St.	subsurface drainage	1937	1937	
n/a	N. Carrollton Ave.	subsurface drainage	1937	1937	
n/a	Hamilton, Hollygrove, Mistletoe, Nelson Sts.	subsurface drainage	1937	1937	
n/a	La Salle St.	subsurface drainage	1937	1937	
n/a	Verna, Leda Sts.	pipeline	1938	unk.	
n/a	Broad St.	monolithic conc. canal	1938	1940	
n/a	Elysian Fields	subsurface drainage	1938	unk.	
n/a	Tchoupitoulas	subsurface drainage	1938	unk.	
n/a	Florida Ave.	enlarging	1939	unk.	
n/a	Milne Canal	enlarging	1939	unk.	
n/a	N. Claiborne	enlarging	1939	unk.	
n/a	Broad St.	extending, enlarging	1940	1940	
n/a	Peoples Ave.	extending, enlarging	1940	unk.	
n/a	Protection	extending, enlarging	1940	1940	
n/a	Florida Ave., Tupelo	extending, enlarging	1940	1940	
n/a	Milne, Harrison	extending, enlarging	1940	1940	
n/a	Paris Ave., Mirabeau, Pratt Dr.	extending, enlarging	1940	1940	
n/a	N. Claiborne, Jourdan	extending, enlarging	1940	1940	
n/a	Thomy Lafon	unk.	1940	1940	
n/a	Viavant No. 2	unk.	1940	1940	
n/a	Argonne	unk.	1940	1940	
n/a	Harrison Ave	unk.	1940	1940	
n/a	S. Claiborne Ave.	lined and covered	1941	1941	
n/a	Louisiana Ave., St. Charles	lined and covered	1941	1941	
n/a	Melpomene Canal	unk.	1941	1941	

fications issued to contractors (Figure 67). As originally specified, the covered small canals were to have vertical masonry walls, regular concave bottoms, and concrete caps. This was changed in construction to a plan with steeply sloped walls, more angular bottom sections, and a masonry cap supported by iron or steel I-beams. These changes in the 1896 specifications were approved by the Board of Inquiry, headed by Rudolph Hering, in 1902 (Hering et al 1902:139). In addition, even major canals were built incrementally, with some sections built years before the full length of the canal was completed. Figure 68 shows the excavation of the Orleans Canal ca. 1904. Figure 69 shows the construction of a typical covered canal, the Hagan Avenue Canal, built 1904-1906.

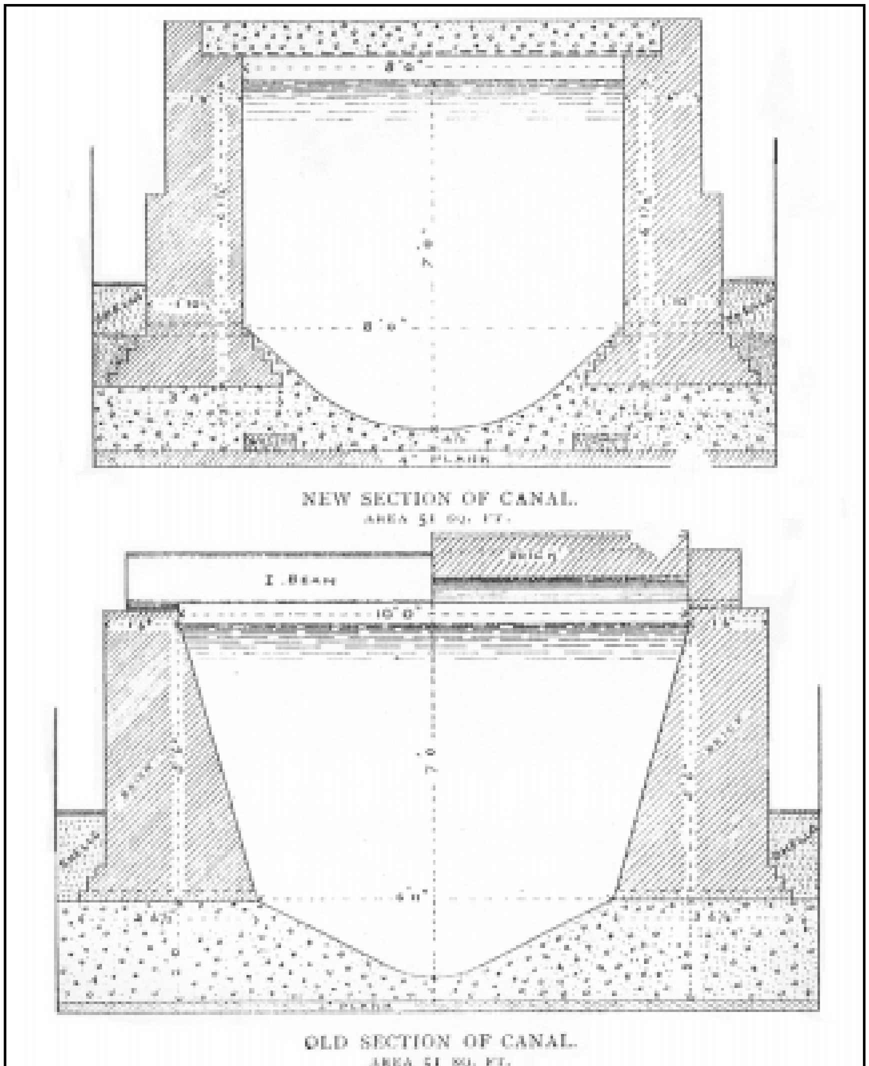


Figure 67. Old and new sections of small canals, from the 1902 Board of Inquiry Report (from Hering et. al 1902).

Even before the canals proposed in 1895 were nearly all completed, the process of modifying the construction of the older canals had already begun. Unlined canals were never fully satisfactory, since they more easily became obstructed by sediment and vegetation (Figures 8 and 9), and open canals were a constant hazard to vehicles, children, and livestock. For example, the Orleans and Claiborne canals were constructed as unlined and open canals beginning in 1897, and in 1904, work began to line and cover them. Another example is the Melpomene Canal, begun in 1899 as an unlined and open canal. It was timber-lined in 1905-1906 (Figures 70 and 71), and a portion of the Melpomene Canal began to be covered in 1907.

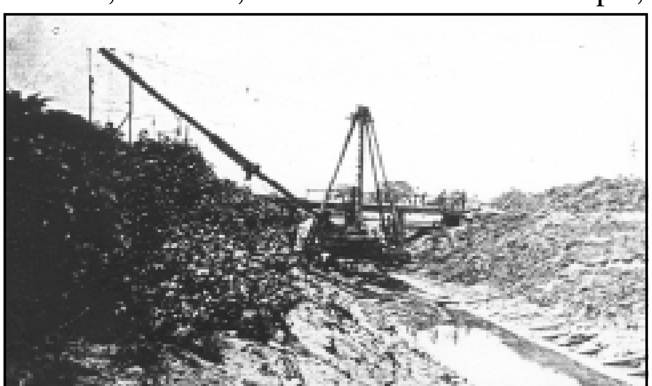


Figure 68. Excavation of the Orleans Canal, n.d.; possibly ca. 1904 (from Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

About 1910, the method of constructing the large lined and covered canals utilized in the New Orleans network also changed. Originally, the linings of the large canals had walls constructed of masonry with the bottom of the canal channel made of concrete. The

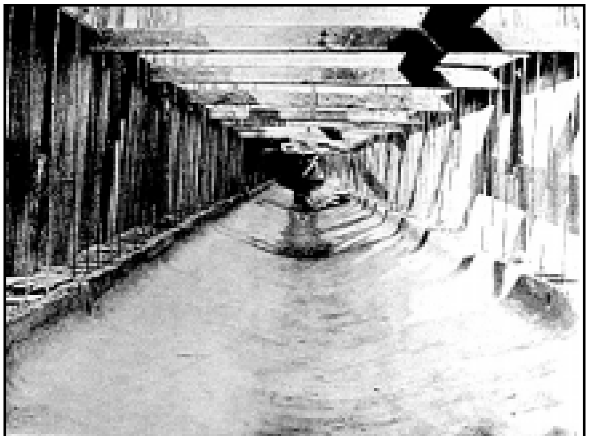


Figure 69. Interior of the Hagan Avenue Canal, shown during construction, ca. 1906. This concrete-lined and covered canal was constructed 1904-1906 (from Sewerage & Water Board 1906a).

Figure 70. Melpomene Outfall Canal, 1906. The canal was timber lined and the banks graded, 1905-1906. Drainage Pumping Station No. 1 is in the background (From Sewerage & Water Board 1906a).

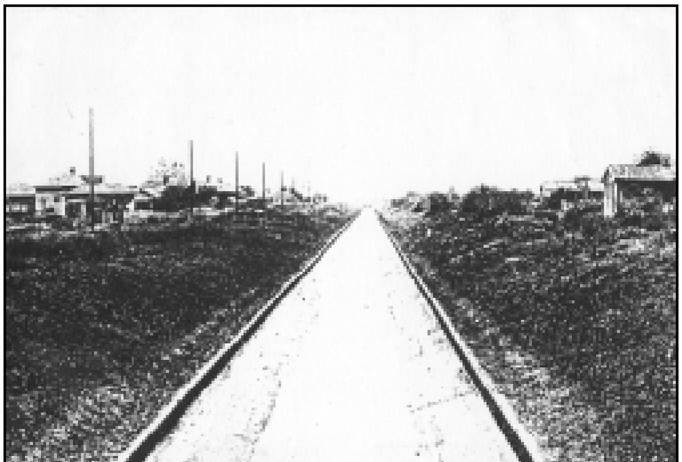


Figure 71. Melpomene Outfall Canal after timber lining and grading, 1906 (from Sewerage & Water Board 1906b.

coverings of the canals were constructed on steel I-beams spanning the canal. After 1910, the entirety of the linings and coverings of canals were constructed of reinforced concrete (Figure 72). The sections of the all-concrete canals was also modified from the older masonry canals, to improve the dry-weather flow. The move to reinforced concrete was part of the trend in drainage and sewerage engineering begun by D.E. McComb in the late nineteenth century. McComb demonstrated the structural integrity and economic efficiency of concrete for sewer construction in Washington, D.C. (Metcalf and Eddy 1914:16), and after 1910 New Orleans joined other major cities in changing from masonry to concrete canal construction.

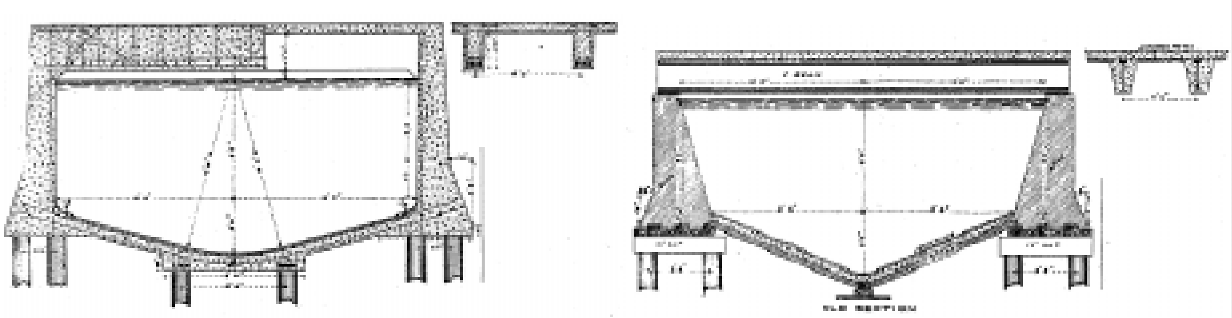


Figure 72. Sections of covered canals; old masonry and new concrete sections, 1910 (from Sewerage & Water Board 1910).

Figure 73. Napoleon Avenue Canal under construction, 1912 (from Sewerage & Water Board, 1912).

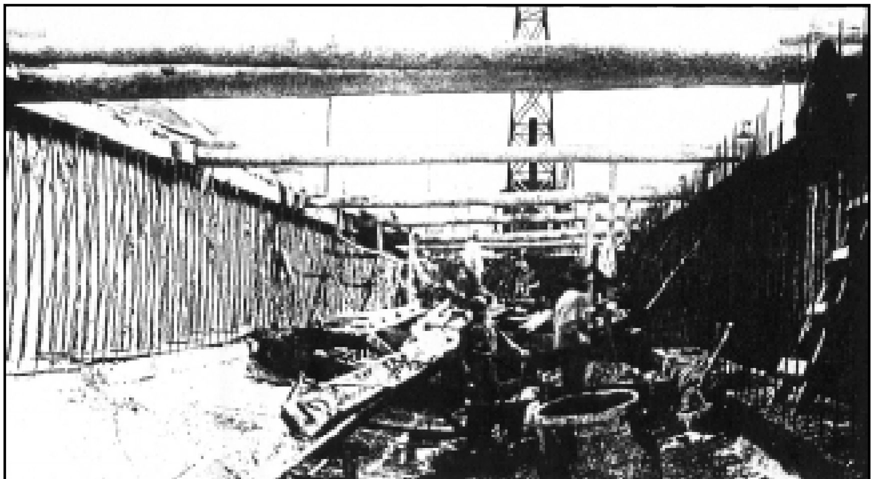


Figure 74. Napoleon Avenue Canal, under construction, interior view, 1912 (from Sewerage & Water Board 1912).

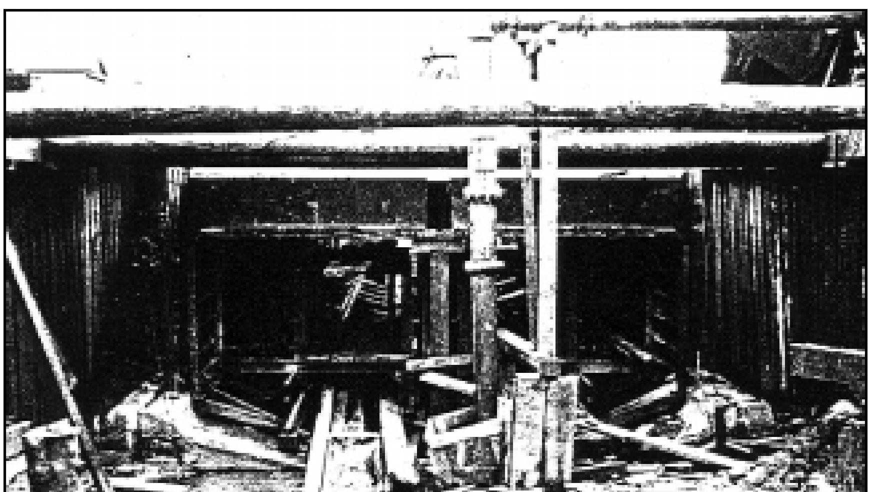


Figure 75. Interior view of the Broad Street culvert, July 27, 1913 (from Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

Several major canals proposed in 1895 remained to be constructed in 1910, among them the Napoleon Avenue Canal (Figures 73 and 74), begun in 1911 and completed in 1915/1916. Other major canals, such as the Broad Street Canal (Figures 75 and 76) were in the process of completion during the period between 1910 and American involvement in World War I. In 1914-1916, a portion of the Broad Street Canal, formerly unlined, began to be lined in reinforced concrete. Figures 77 and 78 show the Metairie Relief Canal in 1914, with a timber-lined channel. Almost all older canals were cleaned and reshaped beginning after World War I, and many were lined with concrete and covered in the later 1920s and 1930s. One example is the Carrollton Avenue Canal, built in 1907, reshaped and deepened in 1919, and lined and covered beginning in 1920. The large relief canals, in particular, have been altered since their original construction. As drainage demands have increased, all of the outfall canals have been fully lined with reinforced concrete and provided with walls at street level to prevent pedestrians and vehicles from falling into the canals.

The Sewerage and Water Board began an intensive three-year construction program in 1929 for extensions of the Sewerage, Waterworks, and Drainage system. Almost $8 million was spent on construction in 1929-1931, including the manufacture and installation of the 14' Wood screw pumps at the older drainage pumping stations and the construction of Drainage Pumping Station No. 9 on the West Bank. However, The *64th Semi-Annual Report* (1931) noted that because of business depression and unemployment, Sewerage and Water Board revenues were much below projected levels. Sewerage and Water Board expenditures for drainage construction would not again approach pre-Depression levels until after the conclusion of World War II. Only three contracts for new drainage construction were issued in 1932 and two in 1933. Circumstances improved in 1934, and by 1937, the federal Works Progress Administration was actively assisting in drainage construction, particularly subsurface drainage. However, in the late 1930s most drainage construction consisted of minor improvements to the existing system (Sewerage and Water Board 1931-1941).

Following the Second World War, the New Orleans drainage system continued to expand, including in areas of the West Bank and east of the Industrial Canal that were not included in the coverage of the 1895 Drainage Plan (see Figure 12). Drainage Pumping Stations 4, 10, and 11 came into service between 1946 and 1954. Expansion of the drainage system has continued in recent decades. Figure 79 shows

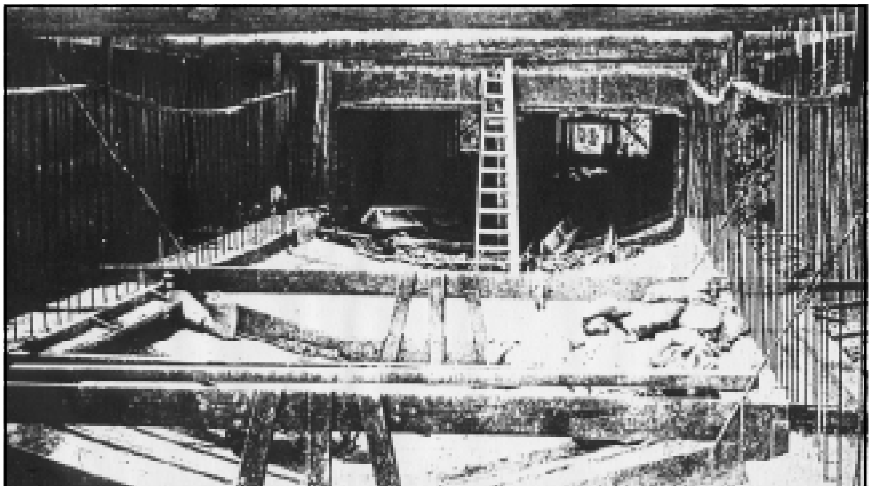


Figure 76. Section of the Broad St. Canal showing reinforced concrete canal construction, 1914 (from Sewerage & Water Board 1914).

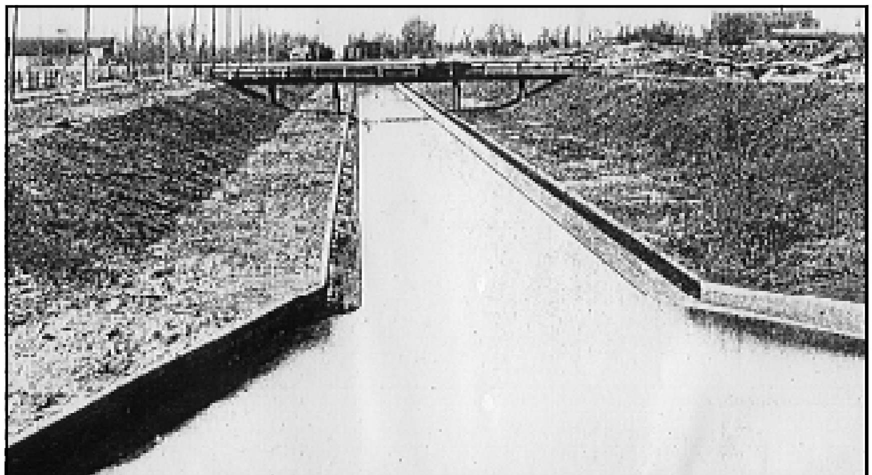


Figure 77. Upper end of the Metairie Relief Canal, view from Drainage Pumping Station No. 1, 1914 (from Sewerage & Water Board 1914).

Figure 78. Lower end of the Metairie Relief Canal, approaching Pumping Station No. 6, 1914 (from Sewerage & Water Board 1914).

Figure 79. Construction of box culvert, Jefferson Davis Parkway, ca. 1961-1962 (from the Louisiana Collection, Howard-Tilton Memorial Library, Tulane University).

the installation of a box culvert on Jeff Davis Avenue, typical of the major drainage improvements undertaken in the 1960s.

CHAPTER 5
BIOGRAPHIES OF IMPORTANT PERSONAGES ASSOCIATED WITH THE NEW ORLEANS DRAINAGE COMMISSION AND THE SEWERAGE AND WATER BOARD OF NEW ORLEANS

Rudolph Hering

Rudolph Hering was a widely influential hydraulic and sanitary engineer who played a pivotal role in the late-nineteenth century movement among American cities to modernize their drainage and sewerage systems. It would not be an exaggeration to name him as the father of modern American municipal sewerage systems. Hering was born in Philadelphia in 1847, and graduated from the Dresden Polytechnic, a leading German school, in 1867. In 1868 he was an assistant engineer at Prospect Park, Brooklyn, and was also an assistant engineer at Fairmount Park, Philadelphia, from 1869 to 1871. Hering was an astronomer at the fledgling Yellowstone National Park in 1872. From 1873 to 1880 he was assistant city engineer in Philadelphia. While engaged in various projects in Philadelphia, Hering became interested in the failed sewerage system extant in the city. He presented a paper before the 1878 annual meeting of the American Society of Civil Engineers on sewer section design, the first, and for many years the only, American discussion of its subject (Metcalf and Eddy 1914:16; A.N. Marquis Co. 1943:554).

In 1880 Hering entered private practice. Hering's professional papers brought him to the attention of the National Board of Health, who selected him in 1880 to conduct a survey of European sewerage and drainage systems. Bearing letters of introduction from this prominent semiofficial body, Hering was able to become acquainted with leading European sewerage designers and the details of their work, including controversial features. Hering issued an exhaustive report on sewerage and drainage after his return. This report was the first clear American analysis of all the main problems of sewerage and drainage, and the methods of solving them. The report firmly secured Hering's reputation as a specialist. Included in Hering's analysis was a recognition of the importance of underground removal of stormwater in large cities, a point of great relevance for the design of the New Orleans drainage system (Metcalf and Eddy 1914:16; A.N. Marquis Co. 1943:554; Tarr 1979:318-319).

Hering became a prominent critic of controversial sewerage designer George Waring, and made a great contribution to the professionalization of the sewerage and drainage aspects of civil engineering. Following his trip to Europe for the National Board of Health, Hering conducted an investigation for a new municipal water supply for Philadelphia from 1883-1886. In 1889 he was a consulting engineer for the Department of Public Works of New York City. He was also a consulting engineer for water supply, sewerage, and drainage works in Philadelphia, Baltimore, Washington, Buffalo, Cleveland, Atlanta, Montgomery, Los Angeles, Tacoma, Victoria, San Francisco, Honolulu, and Columbus (OH) (Metcalf and Eddy 1914:16; A.N. Marquis Co. 1943:554). In 1893, Hering was named to the Engineering Committee of the New Orleans Drainage Advisory Board, with B.M. Harrod and Henry B. Richardson. With the rest of the full Board, the Engineering Committee carefully examined and approved the planning and design work of the City Engineer, L.W. Brown. The final report of the Drainage Advisory Board was issued in 1895 and became the basis for construction of the modern New Orleans Drainage system. In 1902, Hering was appointed to head the Board of Inquiry on the Conduct and Character of the Drainage Works for the City of New Orleans, and largely approved modifications that had been made to the 1895 plan. In 1910, the City Council of New Orleans named Rudolph Hering and B.M. Harrod to a new advisory board, to examine the alterations to the 1895 plan that had been made during the first fifteen years of system construction. Hering and Harod approved the alterations and made further recommendations, as detailed in Chapter 4.

Hering concluded his career as engineer for the Department of Water Supply, Gas, and Electricity, New York. Hering died in 1923, his reputation established as a uniquely important figure in the history of American sewerage and drainage engineering (A.N. Marquis Co. 1943:554; Metcalf and Harrison 1914:16).

Chief Engineer Benjamin Morgan Harrod

Benjamin Morgan Harrod (Figure 80) was born in New Orleans in 1837, the son of Charles Harrod and Mary Morgan Harrod. He was prepared by tutors to enter Harvard College, where he joined the class of 1856 for their sophomore year. He earned an A.B. degree from Harvard in 1856. Conventional in his antebellum southern political views, Harrod drew attention at Harvard by making pro-slavery arguments during a debate at which everyone else present was an abolitionist. After Harvard Harrod studied, first, architecture, possibly opening an office in New Orleans, and then civil engineering. In 1858 he worked for the Engineers Department of the U.S. Army, conducting works at forts and lighthouses along the Gulf Coast. Harrod was awarded an A.M degree by Harvard in 1859 (Hart 1925:668; A.N. Marquis Co. 1943:528; McCullough 1977:449).

Harrod returned to New Orleans shortly before the outbreak of the Civil War, and in 1861 enlisted as a private in the Crescent Rifles. Soon afterwards, he was appointed Second Lieutenant in the Second Louisiana Regular Artillery. One month after receiving his commission, he was promoted to First Lieutenant and detailed as an engineer on the staff of General M.L. Smith. In this capacity Harrod served at Vicksburg and was captured with the rest of the garrison in 1863. Released on parole, Harrod then served in the Second Regiment in Virginia as a brigade and division engineer. He was sent to Petersburg, arriving a few days after the Battle of the Crater and remaining there until after the city was evacuated. Harrod was at Appomatox Court House for the surrender of the Army of Northern Virginia. After the surrender, Harrod was put in charge of about two hundred men from the Gulf Coast. They marched to Burkeville Virginia, where they entrained for City Point. From City Point, Harrod and the soldiers went by ship to New Orleans. After the War, Harrod was given the courtesy title of "Major" although, evidently, the highest rank he had attained was First Lieutenant. Upon his return to New Orleans, Harrod set to work in architecture and engineering (Hart 1925:668, 670; McCullough 1977:449; A.N. Marquis Co. 1943:528).

Figure 80. B.M Harrod, Chief Engineer and architect for the New Orleans Drainage Commission, 1893-1902 (from Tompkins 1901:206).

The following introduction to Harrod's architectural production comes from the indices of the seven volumes of *New Orleans Architecture* (Christovich et al. 1974, 1977, 1978; Wilson et al. 1979, 1984; Toledano et al. 1980; Schlesinger et al. 1989); from the Southeastern Architectural Archives (Tulane University) index to contracts in the Notarial Archives, City of New Orleans; and from a list of drawings recently given by the Andry family to the Southeastern Architectural Archives. There are several documented contracts for houses and warehouses, dated 1866 through 1876, in which Harrod is stated as the architect. One Harrod-designed warehouse stood until recently near the International Trade Mart, in the 600 block of South Front Street. This building showed a brave and clever attempt to upgrade a simple brick building with a low gable roof unto a Renaissance-like design. Harrod achieved classical architectural references with a variety of stepped and rounded brick coursing. If Harrod had been able to make the building symmetrical, it would have been worthy of the fifteenth century Italian master, Leon Battista Alberti, who Harrod had probably studied.

In 1874, Harrod designed the Confederate Monument in Greenwood Cemetery to mark a mass grave of 600 soldiers. During part of this period, Harrod worked with a Mr. Reid, and that partnership produced designs for a Hebrew Education Society School House on Calliope Street. In 1888, Harrod became City Engineer of New Orleans. Several drawings by Harrod for railroad tracks and bridges survive in the Southeastern Architectural Archives. As City Engineer, he also designed buildings. An example is his design for an Italianate fire station, which was built at least four times in different locations throughout the city. The station buildings which survive—on Julia, Tchoupitoulas, and Magazine streets—have deeply channeled masonry bases which give some of the same effect as the rusticated pilasters of the drainage stations. During the 1880s Harrod also laid out Metairie Cemetery, using the existing race course, and designed its now-demolished entry lodge and gates. He also supervised the reconstruction of Christ Church to designs by a New York architect.

The firm Harrod and Andry was formed in the early 1890s. In 1892, Harrod and Paul Andry were engaged in designing school buildings for the Orleans School Board (Goodspeed Publishing Co. 1892:252). In 1894, Andry, Harrod's twenty-one-year-old employee, won a national competition for the Tulane Arts and Sciences Building (now Gibson Hall). The competition-winning design is a limestone Richardsonian Romanesque structure which is classical in its overall massing. The *Daily Picayune* described it upon completion in 1894 as being both "Renaissance" and "modernized Gothic," combining richness and dignity. Harrod and Andry also designed the two orange brick buildings placed on diagonals behind the Arts and Sciences Building (originally the Physics and Chemistry buildings, now F. Edward Hebert Hall and the Richardson Building). The three Tulane buildings were quickly joined by the Civil Engineering Building, a power plant, and a variety of shops for Tulane's manual training school. Harrod and Andry's excellent understanding of classicism as the sensitive relationship between the dimensioning of molding profiles and overall proportions, evidence of which dignified the drainage buildings, is clearest on the two orange brick structures. The firm of Harrod and Andry did other work as well, including a public market on North Rocheblave Street and a building for the Ursuline Convent. By 1898, Harrod and Andry had taken on Albert Bendernagle as a junior partner, and by 1900 Harrod dropped out of the partnership. Harrod seems to have ended his architectural practice at about this time, although not his engineering practice.

Harrod's engineering endeavors, though not directly germane to an architectural evaluation, are what he emphasized in his own accounts of his achievements. Harrod was Chief State Engineer of Louisiana from 1877-1880, a member of the U.S. Mississippi River Commission from 1879 to 1904, an active member of the American Society of Civil Engineers (serving as President for two years in the 1890s) and a member of the Louisiana Engineering Society. Published writings by Harrod as a member of the Mississippi River Commission remain at Tulane University. Harrod became City Engineer of New Orleans in 1888. While serving as City Engineer, Harrod drafted the levels of the water and sewerage systems that were utilized when those systems were put under construction. At an unknown date prior to 1893, Harrod was succeeded as City Engineer by L.W. Brown. In 1893, Harrod was named to the Drainage Advisory Board that oversaw the drafting of the original plans for the modern New Orleans drainage system. Harrod was made Chief Engineer for the Drainage Commission in 1895, serving in that capacity until 1902 (Hart 1925:669; Archives, Harvard University; A.N. Marquis Co. 1943:528).

By 1902, the reputation of B.M. Harrod had become international, and he was among the first men appointed by President Roosevelt to serve on the Panama Canal Commission. Harrod also served on the second Panama Commission, the only member of the first commission asked to sit on the second. However, Harrod evidently did not act in an executive capacity on the Panama Canal Commissions. Tulane University awarded Harrod an honorary LL.D. in 1906. Also in 1906, Harvard invited him to return to deliver the Memorial Day address, the first time it had offered that honor to a veteran of the Confederacy. In 1910, Harrod was recalled by the city of New Orleans to serve on another Drainage Advisory Board, which reviewed the changes in the 1895 plan and made recommendations for completion and improvement of the drainage system. Among Harrod's other notable activities, he was a consulting engineer for the construction of the Roosevelt Dam in Arizona, and consulting engineer for the construction of the Delgado Art Museum in City Park. Harrod was particularly interested in the Delgado Art Museum, which exhibited his art collection soon after opening. A lifelong member of Christ Church, Harrod supervised its reconstruction, and he was an active member of the Louisiana Historical Society, and the Army of Tennessee, Confederate Veterans. An ardent supporter of the Audubon Society, Harrod hoped to make Ship Island and some islands that he owned into bird sanctuaries. Benjamin Morgan Harrod died in 1912, after a long and distinguished career, as engineer, architect, and public servant.

Superintendent George G. Earl

George G. Earl (Figure 81) was born into a Quaker family near Allentown, New Jersey, during the Civil War. He was the only child of Holmes Earl and Annie Taylor Earl. In 1880, Earl graduated from the Freehold Institute. Four years later, he received his degree as a Civil Engineer from Lafayette College in Eaton, Pennsylvania. Because of his subsequent achievements in engineering, Lafayette College conferred the degree Doctor of Science upon George Earl in 1918 (Chambers 1925:365; Kendall 1922:1089).

Earl worked for the United States Geological Survey in New Jersey in 1884 and 1885. For the following two years, he worked in the engineering department of the Atchison, Topeka and Santa Fe Railroad. He did location and construction work on the line between Chicago and Kansas City. Earl came south in 1888 to undertake sewer construction work in Montgomery, Alabama. He eventually went into business with Captain W. G. Williamson, the former city engineer for Montgomery. Their firm specialized in sewerage and water works construction. Earl then served as city engineer of Americus, Georgia from 1890 to 1891 (Chambers 1925:365, Kendall 1922:1089-1090).

Figure 81. George G. Earl, General Superintendent of the Sewerage and Water Board, 1900-1931 (from Martin Behrman Administration Biography, 1916).

Earl came to New Orleans in 1892 to accept the position of chief engineer with the New Orleans Sewerage Company. This company had a contract with New Orleans to build a sewerage system. The company went into receivership around 1895, but Earl was retained as chief engineer. Earl had done exhaustive studies on the topography of the Crescent City and its sanitary conditions. Therefore, when the Sewerage and Water Board of New Orleans was established in 1900, it appointed Earl as its chief engineer and general superintendent. As such, he oversaw the planning, construction, and expansion of the city's sewerage, and water works systems, and after 1902, of the drainage system also. Earl served in this capacity until his retirement in 1931. He continued on as a private consultant to the Board for some time after that. Charles J. Theard, President Pro Tempore of the Board, declared that George Earl was one of the best engineers in the profession and his service as a public servant had been rendered with "the rugged honesty of a stainless character" (Chambers 1925: 365, Kendall 1922: 1090).

Superintendent Alfred Francis Theard

Alfred Theard was born in New Orleans in 1865, and attended the Jesuit College in that city as well as Spring Hill College in Alabama. In 1893, he obtained employment with the Engineering Department of the City of New Orleans. In 1896, he became affiliated with the New Orleans Drainage Commission, first as a draftsman and later as assistant engineer. When the Commission was consolidated with the Sewerage and Water Board in 1902, Theard began his long association with that body. From 1913 until 1934, he served as Principal Assistant Engineer in Charge of Drainage. In 1934, he became General Superintendent of the Board (American Society of Civil Engineers n.d.:1).

In addition to his activity in the field of engineering, Theard worked as an architect. He prepared plans for completion of the Chalmette Monument at the site of the Battle of New Orleans and prepared plans for the Louisiana Memorial Monument in the National Military Park at Vicksburg, Mississippi. In 1937, Theard's achievements were recognized by the American Public Works Association which awarded him its Veterans Plaque for his "long and faithful services" to the City of New Orleans (American Society of Civil Engineers n.d.:1-2). Alfred F. Theard died in 1939.

Superintendent Albert Baldwin Wood

The only comprehensive account of the life and work of Albert Baldwin Wood (Figure 82) is an unpublished manuscript by Ray M. Thompson (n.d.). The manuscript is on file in the Manuscripts Division of the Howard-Tilton Memorial Library. The biography of Wood presented below is derived largely from that document. A shorter version of Thompson's manuscript was published in *New Orleans Magazine* (Thompson 1973).

When the present systems of drainage, water supply, and sewerage were proposed for the City of New Orleans, they had to be designed with pumps that were available at the time. None of these pumps were particularly satisfactory for the demands of the system. Fortunately, Albert Baldwin Wood began to work for the Sewerage and Water Board during its first year of operation. His work for the Board would result in new pump designs that were subsequently adopted throughout the world.

Wood was born in New Orleans in 1879. On his mother's side, he was a descendant of Don Francisco de Bouligny, who was a governor of Louisiana during the Spanish colonial period. His father's family was from Pennsylvania. He attended Tulane High School and then enrolled in the engineering department of Tulane University. His talent for invention was apparent even during his college career. He and a classmate, after reading an article by Marconi, built a wireless set and established communication between two Tulane classrooms. In 1899 he graduated with honors, and received the Glendy Burke Award in mathematics (Thompson n.d.:1, 5).

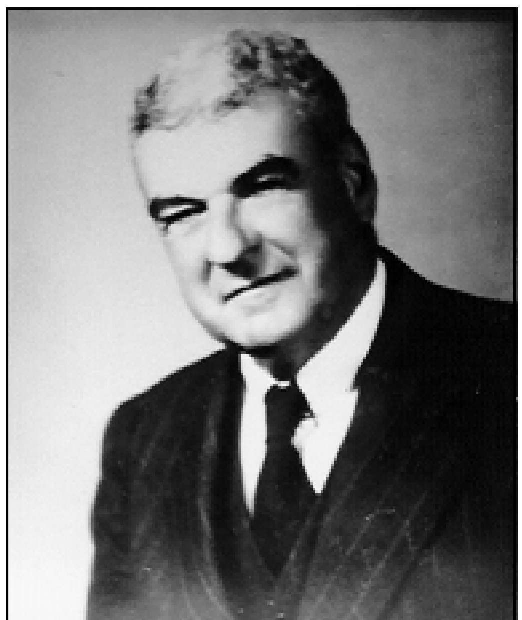


Figure 82. Albert Baldwin Wood, General Superintendent of the Sewerage and Water Board, 1939-1956 (courtesy of the Sewerage and Water Board of New Orleans),

After graduation from Tulane, Wood accepted a job with the Red River Packet Line. He remained with that firm for only a few months. In 1899, Wood entered the service of the New Orleans Drainage Commission as Assistant Manager of Drainage (Sewerage and Water Board 1956:11). In 1902, Wood became a mechanical inspector for the New Orleans Sewerage and Water Board, when it merged with the Drainage Commission. He continued his association with the Sewerage and Water Board until his death in 1956. For a time he served as assistant manager of drainage under Alfred Raymond. In 1907, Wood was promoted to the position of mechanical engineer for the Board. In 1908, he was placed in charge of the water works pumping station and the various sewerage stations. When Raymond died in 1915, Wood was placed in charge of drainage operations. In 1939, after the death of Alfred F. Theard, Wood was elected general superintendent of the Board. He served in that capacity until 1956. During his association with the Board, he refused offers from other cities and countries, even when those offers would have resulted in an income ten to twenty times more than that which he received in New Orleans (Thompson n.d.:5-6,9; 1973:42).

As a new engineer in charge of testing electrical equipment for the Board, Wood examined sewerage pumps slated for installation in the pumping station at St. Louis and North Broad. He refused to accept the pumps, and ordered them rebuilt. This was the beginning of his reputation as a man who demanded near-perfection of mechanical and electrical equipment. When equipment failed to meet his high standards, he often developed new designs that would do so (Thompson n.d.:10, 1973:43).

At first, Wood did not patent his inventions, but he began to do so when he realized the necessity for protecting his ideas. At the time of his death, he was credited with 38 patents. Use of his inventions around the world, as well as fees he received for serving as a consulting engineer, produced a substantial income. However, Wood never collected royalties for the use of his inventions by the New Orleans Sewerage and Water Board (Thompson n.d.:10, 1973:43).

In 1906, Wood invented a six-foot centrifugal pump which better met New Orleans' need for large capacity, low head drainage pumps than models previously available. At the time, this centrifugal pump was the largest of its kind in the world. A short time later, he invented "flapgates" to stop water from backing up when the pumps were stopped. These flapgates soon became the industry standard. In about 1912, Wood invented a hydraulic meter testing machine. At a later date, he conceived of 'half-soling' sewer pipes which were worn through on the bottom due to constant use. This latter invention resulted in substantial savings for the Sewerage and Water Board (Thompson n.d.:11, 1973:43).

In 1912, as discussed in Chapter 4, Wood presented plans for his 12' screw Pump. He gave the Sewerage and Water Board perpetual rights to use the design (Thompson n.d.:11, 1973:43). The 12' screw pump was to be the largest and most powerful in the world, and it attracted the attention of engineers both in the United States and abroad (Thompson n.d.:12-13, 1973:43). The Wood pumps were installed beginning in 1915, first at Drainage Pumping Station No. 1, and then at Station No. 6, and then the others. Wood's designs came to be highly regarded worldwide. By 1919, Wood was "the man the whole engineering world had come to recognize as the authority on heavy duty pumps" (quoted in Thompson 1973:76).

In 1916, Wood patented his Trash Pump which revolutionized the sewerage system in New Orleans and throughout the world. He designed it to solve the problem of rags and trash, which were being introduced into the sewers and clogging the system. The invention alleviated the need for on-site attendants to unclog the screens needed on the pumps then in use. As a result, New Orleans' sewerage system was the first in the United States to become automatically operated (Thompson n.d.:15, 1973:43). This revolutionary pump works in the following manner:

> Sewage is not screened before entering the Wood Trash Pumps as they allow the passage of objects as large as a 12 inch diameter ball without impairing the efficiency of the pumping mechanism, and the pump operates efficiently when han-

dling water carrying rags and other debris that would cause ordinary pumps to clog and stop. The impeller design is the feature of this centrifugal pump. It is known as an enclosed side, suction type impeller enclosed in an involute housing. The impeller is free of sharp corners which would catch fibrous material… Instead of many sharp blades they had but two rounded blades on the runners. There was no sharp edge on which a bit of trash could find lodgement [Thompson n.d.:15].

The new pumps functioned extremely well. Three years after installation, a report stated that:

Unscreened sewage is pumped by them with a higher efficiency than clear water by the original sewage relifting pumps, and there has not been a single case of pump obstruction or decrease of pump efficiency due to trash clogging (Thompson n.d.:15).

Wood's sewerage pump design became the industry standard:

Up to a little over ten years ago, more or less standard water pumps with closed or open impellers were used for pumping sewage. Because of the comparatively small passages through the impellers, clogging occurred and satisfactory operation was obtained only by screening the sewage fairly fine before it entered the pumps.

…However, there are in some cases objections to the use of screens with close spacing and a pump that can handle practically unscreened sewage has been demanded. *A little more than ten years ago such a pump was put on the market by the Fairbanks-Morse Company using a design originated with A.B. Wood of New Orleans*. The overhung impeller of this pump was of the single suction type, with two vanes, the thickness of which diminishes from center to periphery [Figure 14, this report]. The width of the impeller passages was such that spheres one to two inches smaller in diameter than the discharge nozzle could go through the pump. In response to the increasing demand for so-called non-clogging pumps, most pump manufacturers undertook the development of such pumps, giving them various trade names such as "Freeflo," "Clogless," etc. Except for varying design of details, all of these pumps are similar, with overhung, single inlet impellers having wide passages for the liquid…

The most vital part of a sewage pump is unquestionably the impeller… [Peterson 1938:214, emphasis added].

When Hamilton, Ontario built a new sewerage pumping station in the early 1930s, use of Wood trash pumps eliminated the need for screens (Wilson 1932:21-22). Similarly, non-clogging pumps were used for the 1933 World's Fair in Chicago (Municipal Sanitation 1932:502) and for an underground sewerage pumping plant in Los Angeles that was reported on in 1935 (Municipal Sanitation 1935:295). These are only a few examples of systems that had adopted Wood's design by the 1930s:

Due to this improvement in design and construction it is now possible to secure centrifugal sewage pumps that will pass solids about one pipe size smaller than the pumps and give very little trouble from clogging and at the same time maintain efficiencies of from 40 percent for the smaller size to 65 percent for the larger sizes. As a result, centrifugal pumps are now being used for nearly all sewage pumping except where special conditions make some other type desirable [Municipal Sanitation 1935:48].

Even today, "The so-called 'nonclog pumps' are all based on an original development of Wood in New Orleans…" (Karassik et al. 1986:9.28)

During construction of the Inner Harbor Navigation Canal in the second decade of the twentieth century, Wood developed a special trash pump for use by G.V. Goethals and Company, which was the contractor for dredging the canal. The company had previously served as consulting engineers for construction of the Panama Canal. Goethals was using the same type of dredging equipment which had been employed to create Gatun Lake in Panama, with centrifugal pumps equipped with runners. The dredges and pumps chopped up solid matter which was then thrown out along with a stream of water. The equipment worked well at the Inner Harbor site until three layers of "primeval cypress swamps, one on top of the other," were encountered. The equipment in use successfully cut through the wood, but then the solid material piled up on the runner blades, thereby clogging the pumps. It was necessary for workmen to clean the pumps, which reduced the daily rate of dredging from about 75 feet or 80 feet to 20 or 25 feet (Thompson n.d.:19; 1973:43,74).

Wood designed a special trash pump for Goethals, mounted on the dredge boat. During the 44 days prior to installation, 95,000 cubic yards had been dredged. Wood's pump allowed the dredging of 223,000 cubic yards during the 38 days after installation. This resulted in a savings of $221,000.00 (Thompson n.d.:19-20, 1973:74).

Wood was also instrumental in the reclamation of the Zuyder Zee by the Dutch government. The Zuyder Zee was a shallow body of water about the size of Rhode Island. Holland sent a representative to meet with Wood about his Screw Pump, which was becoming well-known in the engineering world. Wood reached an agreement with the Werkspoor Company, the leading pump manufacturer of Europe, headquartered in Amsterdam. The Werkspoor Company received exclusive rights for the manufacture and sale of Wood Screw Drainage Pumps in continental Europe. Wood himself refused to go to the Netherlands, but engineers involved with the project visited him when problems arose (Thompson n.d.:20-21, 1973:74).

Between 1910 and 1920, Wood also served as consulting engineer for a number of projects in the United States. In 1913, his services were engaged during construction of a pumping station to protect North Memphis during flooding of the Mississippi and Wolf Rivers. The following year, Wood designed two 78-inch pumps for Funk Farms Corporation which was engaged in land reclamation at Paradis, Louisiana. In 1917, the Chicago City Water Works appointed Wood as consulting engineer. They paid him a considerably greater amount than did the New Orleans Sewerage and Water Board despite the fact that he remained in New Orleans. In 1919, the Sanitary District of Chicago decided to replace an inadequate sewerage drainage canal with a pumping system. Recognizing that their sewerage problem was similar to that of New Orleans, they engaged Woods' services (Thompson n.d.:23; 1973:74,76).

Wood was a consulting engineer for many other agencies as well. These included the Memphis District of the Army Corps of Engineers as well as public and private agencies in Chicago, Illinois; Jacksonville, Florida; Ontario, Canada; Milwaukee, Wisconsin; Baltimore, Maryland; and San Francisco, California. He designed pumps for the U.S. Government Docks in Seattle, and served as a consultant for the London Waterworks. Wood Screw Pumps were installed in China, India, and Egypt. However, Wood visited these places only very briefly, if at all, preferring to remain in New Orleans (Thompson 1973:76).

After a severe downpour in 1927, the New Orleans Sewerage and Water Board decided to double its drainage capacity. Wood designed a fourteen-foot version of his Screw Pump, and the first of these was completed in 1929. With a capacity of one million gallons every five minutes , the 14' Wood screw pump was then largest pump in the world. These pumps remain the heart of the present-day drainage system for the City of New Orleans, and they may well represent Woods' greatest engineering achievement.

Wood died in 1956. The Sewerage and Water Board adopted a resolution of regret which included a biographical summary and tribute:

Many honors were conferred on Mr. Wood during these years. The young Men's Business Club presented him with a silver membership and in 1955, citing him for having made outstanding contributions to the welfare and development of New Orleans through the invention of various heavy duty water pumps and other hydraulic needs of our community; prior to this, in 1939, Tulane University, his alma mater, awarded him the degree of doctor of engineering; in 1940, the Chamber of Commerce presented him a plaque for his outstanding civic work; and in 1954 the City of New Orleans presented to him a plaque in honor of his 55 years of service with the board.

His was a life of achievement and usefulness. That public, private, technical and educational groups paid tribute to him testifies to his important role and indicates the degree of New Orleans' loss. He rendered our city one of the greatest services it has ever received from an individual.

Our present water, sewerage and drainage systems stand as a monument to his genius and guidance throughout the years of his service. The principles of design and the policies of operation that he created in the Sewerage and Water Board will continue to live, and the shadow of his influence will continue to inspire and guide us for years to come [Sewerage and Water Board 1956].

The annual report of the new General Superintendent E.F. Hughes began with the simple but eloquent statement that "The sudden death of Mr. Albert Baldwin Wood on May 10, 1956 brought to an end an era of engineering ingenuity" (Sewerage and Water Board 1956).

CHAPTER 6
NRHP EVALUATION OF DRAINAGE PUMPING STATIONS NOS. 1, 3, 4, 6, AND 7 AND OF THE NEW ORLEANS DRAINAGE SYSTEM

Engineering Description of the New Orleans Drainage System

Background. New Orleans is located in a crescent-shaped bend of the Mississippi River, lying between the river to the south and Lake Pontchartrain to the north. To the east of the city is Lake Borgne, which connects to the Gulf of Mexico. Land near the river has an elevation several feet above sea level, and there are natural and artificial levees separating the land from the river. From the natural river levees, the land slopes toward Lake Pontchartrain, with elevations falling below sea level closer to the lake. Bayou Metairie and Bayou Bienvenue, both with natural levees rising to some five feet, originally crossed the area that is now encompassed by the city. In the nineteenth century, navigation canals that bisected the city from Lake Pontchartrain almost to the river were excavated.

At the time of the design of the New Orleans drainage system (1895), the land on the lake side of the city was mostly swamp, beginning about halfway between the river and the lake. Most of the inhabited area of the city was close to the river, and drainage consisted of open ditches extending from the slightly elevated land near the river to the swampy area behind the city. The available pumping machines appeared similar to riverboat paddlewheels and pushed the rain water into outfall canals. Drainage was slow, and the flow very polluted because there was no treatment of sewage. Flooding was frequent, and the area below lake level could not be developed. Such was the general situation when the New Orleans Mayor and City Council decided that something should be done to dramatically improve drainage. In 1893, an advisory board of engineers was appointed to plan a comprehensive drainage system for the city. In 1895, the plan was submitted to the City Council and adopted. The 1895 Drainage Plan presented a unique solution to New Orleans' drainage problem, which included natural conditions probably unparalleled anywhere in the world. This drainage system is still operational today, utilizing the major plan features and operating principles of the 1895 plan.

Design Constraints. The were many constraints imposed on the design of the system. The foremost constraint was the necessity of designing a system that would drain land below sea level, and convey the drained water to a discharge point at or above sea level. The subtropical climate and rain pattern of New Orleans dictated that the system handle minor daily rainfall and storm rainfalls of several inches, falling at the rate from three inches per hour to nine inches per hour in a single storm. The system would have to contend with several navigation canals crossing the area. There were only three possible outlets for the water. All of them were located at elevations higher than the land to be drained.

Then too, a major constraint upon the system designers was the foresighted recognition that the system should cause as little pollution to Lake Pontchartrain as possible. There were elevated residential camps in both Lake Pontchartrain and Lake Borgne, and these lakes were an important source of seafood for the city. Normally, the first few moments of a rainfall wash a heavy pollution load into any drainage system. Fortunately, the problem of polluting Lake Pontchartrain would be minimized by the development of a sewerage system for the major part of the city, which was begun almost simultaneously with construction of the drainage system.

Naturally, cost was an important consideration to the designers of the drainage system, as was the feasibility of construction. Lack of information plagued the designers. No significant rainfall and runoff statistics were available, nor were statistics available on infiltration characteristics of the various soils within the area. As much information as could be obtained in a short time was used by the Drainage Commission in their calculations, but they wisely decided that provision be made for much increased flows in the future. Increased flows would occur both as the system was built over time and as the city grew in population and development.

As better information was obtained, the system was modified and expanded, but the original concept did not change. Some of the performance constraints recognized after the initial design of the drainage system were derived from new data on severe rainfalls, and recognition of the possibility of extreme lake tides caused by hurricanes.

The topography of the city was significantly changed in the 1930s, when the city was expanded to Lake Pontchartrain. Large areas adjacent to the lake were filled to several feet above sea level. This changed the drainage flow towards the center of the city. The original plan exhibited substantial foresight in that this problem could be solved without changing the overall system plan. In addition, the pumps initially installed in the several drainage stations soon proved inadequate to the capacities required by the developing city of New Orleans. An entire family of pumps was developed which was capable of handling large flows, lifted to low heights, for discharge.

In summary, the design constraints imposed upon the New Orleans drainage system included both inalterable natural laws and dynamic conditions. Meteorological and hydrographical knowledge has grown since the system was designed, and drainage demand and capacity have increased. The concept and design of the original system, however, remain identifiable and valid.

System Description. The New Orleans drainage system as designed in 1895 (Figure 6) was a combination or overlay of two systems; one acting during light daily rainfall, and another operating during heavy storm rainfall. Because of the pollution potential during small flows, such as is caused by light rainfall, the drained water was collected throughout the city and directed to an outfall at Bayou Bienvenue, which connects to Lake Borgne. Lake Borgne connects directly with the Gulf of Mexico, so this outfall avoided the pollution of Lake Pontchartrain. Water draining from the surface was collected into a system of closed and open canals, leading to pumping stations. These intermediate lift pumping stations (Pumping Stations Nos. 1, 2, 3, and, as proposed, 4) would lift the water into one main canal, which ultimately emptied into Bayou Bienvenue, and subsequently, into Lake Borgne. Acting in series, the first intermediate lift station (Station No. 1) would lift the water from its inflow or suction basin and pump it into the Main Canal. The water would flow by gravity from the lift elevation of the pumping station discharge through the main canal toward the second station (Station No. 2). As the water flowed from the discharge basin of one station to the suction basin of the next, it would be augmented by flows from local canals. This combined flow would then be lifted by the next pumping station in the series (Station No. 3), and discharged to run by gravity to the final intermediate station (Station No. 4, proposed but never built), also augmented by local inflows. Finally, the water would be pumped from the main outfall station (Station No. 5) into the Bayou Bienvenue. In order to cross the two major navigation canals into the city, it was necessary to build siphons under these canals. These were not difficult design items.

In the event of heavy storms, the flow pattern would change. Flow from the upper portion of the city would be rerouted at Drainage Pumping Station No. 1 and discharged into an outfall canal leading to Lake Pontchartrain. This storm water was deemed not to be heavily polluted and not significantly damaging to the lake perimeter. Each station lifting water into the main canal was designed to have the ability to divert its major storm flow into a discharge outfall canal leading to Lake Pontchartrain. The stations pumping into the relief outfall canals (Station Nos. 3, 6 and 7) were placed in locations roughly halfway between the developed portions of the city and the lake. This resulted in a better canal configuration and efficient discharge. These discharge canals have a unique design between the intermediate lift and outfall pumping stations. Because the daily flow is opposite to the storm flow, the bottom slopes back to the intermediate lift stations on the main canal.

The Main Canal of the New Orleans drainage system runs along Broad Street and Florida Avenue. One notable feature of the Main Canal is that it is essentially a flat canal, with only minor slopes from one station to the next. The canal elevation drops only about five feet between stations. All low points of the canal at the suction basins of the intermediate lift stations are at an elevation of approximately 3 ft Old Cairo Datum (-18.26 ft. mean sea level or NGVD, new geodetic vertical datum).

It is interesting to note that consideration could not be given to discharging into the Mississippi River because, at times, the river could be as high as 37' CD (15.74' NGVD). With the ground sloping upward towards the river, this would have created impossibly high demands on any pumping equipment handling the high rates of flow produced in rainstorms.

Several extensions and alterations of the drainage system have been required. The first and foremost was the replacement and augmentation of the original pumping machinery with higher-capacity units. The pumps available in the 1890s provided much greater pumping capacity, within the developing drainage system, than had the earlier drainage machines. However, within a decade and a half of the design of the system, it was evident that the original pumps were of insufficient capacity. Superior pumps were designed by Albert Baldwin Wood, a Mechanical Engineer with the Sewerage and Water Board. The Wood horizontal screw pumps have been designated National Historic Engineering Landmarks. The drainage system would fully meet its design promises only after the development of the Wood pumps.

In the 1930s, the landfill adjacent to Lake Pontchartrain added new drainage problems, and the system had to be enlarged. As New Orleans grew, land usage changed throughout the city. Originally the development level of land in the city had been classified as dense, medium, sparse, or rural, each with a different rate of runoff utilized to calculate drainage requirements. For example, 300 acres with a slope of 0.003 ft/ft would have a runoff of 455 cfs if development was designated as dense, 370 cfs if medium, 290 cfs if sparse, and only 11 cfs if rural. Since the original design of the drainage system, almost all of the city has come to be characterized by dense or medium development, with consequent greater demands on the system. In the 1920s, a large canal, the Inner Harbor Navigation Canal (or Industrial Canal), was dredged directly across the Main Canal, so a siphon had to be built under this canal.

Engineering Descriptions of Drainage Pumping Stations Nos. 1, 3, 4, 6 and 7

Drainage Pumping Station No. 1. The pumping equipment at Station No. 1 consists of two 12' Wood screw pumps rated at 550 cfs, which were installed in 1915; three 14' Wood screw pumps rated at 1,000 cfs, which were installed in 1930; two smaller vertical shaft screw pumps rated at 250 cfs installed in 1965, which replaced two similar-sized pumps that were installed prior to the station's opening in 1904; one 30" Wood constant duty screw pump, which was installed in 1912; and one vertical constant duty pump installed in 1965. The six Wood pumps are the most significant engineering objects at the station. These pumps were designed by Albert Baldwin Wood, who is recognized as an important figure in the history of American engineering for his pump designs. Associated with these pumps are the auxiliary equipment such as vacuum pumps for priming (starting) the main pumps, switchgear for starting and operating them, and other minor features. The electrical motors driving these pumps operate on 25 cycle electrical current. The current is created by a generating station which is part of the larger drainage system or, in emergencies, by a frequency converter station. The need for such low operating frequency is due to the inherently low operating speed of the pumps.

Drainage Pumping Station No. 3. The pumping equipment at Station No. 3 consists of two 12' Wood screw pumps rated at 550 cfs, installed in 1918; three 14' Wood screw pumps rated at 1,000 cfs, installed in 1931; and two pairs of horizontal centrifugal constant duty pumps, each pair rated at 80 cfs and installed ca. 1930. The five Wood screw pumps are the most significant engineering objects at the station. Associated with the Wood pumps are auxiliary equipment such as vacuum pumps for priming the main pumps, switchgear for starting and operating them, and other minor features. As is the case at Station No. 1, the Wood screw pumps at Station No. 3 operate on 25 cycle electric current, which is generated by a central generating station. In an emergency, a frequency converter station connected to Entergy generators can be utilized for current supply.

Drainage Pumping Station No. 4. The pumping equipment at Station No. 4 consists of two horizontal centrifugal pumps rated at 320 cfs, installed 1945-1946; one Worthington 14' screw pump rated at 1,000 cfs, installed ca. 1960; two Allis-Chalmers 14' screw pumps, rated at 1,000 cfs, installed in the 1960s; and one vertical trash pump for constant duty, rated at 80 cfs, installed 1963-1964. The screw pumps are later variations of the basic Wood screw pump design and operate in a similar fashion. These main pumps have auxiliary equipment such as vacuum priming pumps, switchgear, and other minor features associated with them. This station has more modern 60 cycle current supply for all pumps.

Drainage Pumping Station No. 6. The pumping equipment at Station No. 6 consists of two 12' Wood screw pumps rated at 550 cfs, installed in 1916; four 14' Wood screw pumps rated at 1,000 cfs, installed in 1930; three Worthington 14' screw pumps, one rated at 1,000 cfs and two rated at 1,050 cfs, installed 1986-1989; four vertical centrifugal constant pumps rated at 250 cfs, installed 1985-1988; and two vertical centrifugal constant duty pumps rated at 90 cfs, installed ca. 1930. The Worthington screw pumps are later variations of the basic Wood screw pump design and operate in a similar fashion. The six Wood screw pumps are the most significant engineering objects at the station. Associated with the Wood pumps are auxiliary equipment such as vacuum pumps for priming the main pumps, switchgear for starting and operating them, and other minor features. As is the case at Station No. 1, the Wood screw pumps at Station No. 6 operate on 25 cycle electric current, which is generated by a central generating station. In an emergency, a frequency converter station connected to Entergy generators can be utilized for current supply. The pumps at this station installed during the 1980s have more modern 60 cycle current supply.

Drainage Pumping Station No. 7. The pumping equipment at this station consists of one 12' Wood screw pump rated at 550 cfs, installed in 1917-1918; two 14' Wood screw pumps rated at 1,000 cfs, installed in 1931; three vertical centrifugal pumps rated at 250 cfs, installed 1898-1900 (not in use); one vertical constant duty pump installed in 1911 (not in use); and two constant duty vertical trash pumps rated at 70 cfs, installed in 1931. Associated with the Wood pumps are auxiliary equipment such as vacuum pumps for priming the main pumps, switchgear for starting and operating them, and other minor features. Two of the Wood screw pumps at Station No. 6 operate on 25 cycle electric current, which is generated by a central generating station. One of the 14' Wood screw pumps at Station No. 7 operates on 60 cycle current.

The three vertical centrifugal pumps at Station No. 3 are the only examples in the system representing the original pumping technology utilized in initial construction of the system and drainage pumping stations, 1897-1903. As such, these three pumps and the three Wood screw pumps are the most significant engineering objects at the station.

Architectural Descriptions of Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7

Drainage Pumping Stations Nos. 1, 3, 6, and 7 were all designed ca. 1895-1899 as part of the construction proposed for the Drainage Plan of 1895. Certain aspects of the stations were not constructed as originally designed. In particular, Stations Nos. 1, 3, and 6 were not built in the physical locations proposed in 1895.

In the 1895 Drainage Plan, Drainage Pumping Station No. 4 was proposed for a location at the intersection of Lafayette and Florida Avenues. Station No. 4 was not built at this location.

Instead, a station designated Drainage Pumping Station No. 4 was designed in the late 1930s and constructed in 1945-46 at Prentiss Avenue and the London Relief Outfall Canal. Thus, the architecture of Drainage Pumping Station No. 4 is unrelated to that of Stations 1, 3, 6, and 7. In the following architectural description and discussion of the stations, Stations Nos. 1, 3, 6, and 7 are discussed together as well as separately.

Drainage Pumping Stations Nos. 1, 3, 6, and 7. Drainage Pumping Stations Nos. 1, 3, 6, and 7 (along with Station No. 2, and the now-demolished Algiers station, Drainage Pumping Station No. 8) were nearly identical structures when they were built between 1897 and 1902. All except the Algiers station were originally eight bays long, and all have been extended longitudinally at least once. These extensions have been made in a manner which reproduces the original construction so well that it is difficult to find the point of change between building episodes. Slight differences in brick and mortar color must be used to visually define the extensions. The original eight-bay units can be identified by foundation stones, carved with the date "1899" and the name of the chief engineer, B.M. Harrod, among the others credited with the system's construction. The stones are identical on all stations except for the name and number of the station engraved at the top.

Drainage Pumping Stations Nos. 1, 3, 6, and 7 are visible to the public from their southern or city-facing facades. Three of the stations, Nos. 1, 3 and 6, present an imposing presence in their neighborhoods which effectively monumentalizes the pumps within and emphasizes the meaning and importance of the drainage system to the city of New Orleans. Station No. 7 is less visible because it is wedged between a railroad embankment and the U.S. Interstate-610 overpass within City Park. The eastern end of Station No. 7 can be seen from a nearby picnic ground. Stations 3, 6, and 7 cannot be viewed readily by the public from the north or lake side. The outfall side of the Metairie Relief Outfall Canal and the London Outfall Canal are open canals, bordered by floodwalls on top of levees. These floodwalls effectively prevent access to the outfall canals and mask the stations from pedestrian viewing. Drainage Pumping Station No. 7 is at the end of the Orleans Outfall Canal. The discharge basin side of this station is visible from the I-610 overpass bridge, but this is a vantage point where pedestrian access would be unusual if not impossible. The discharge basin of the Station No. 7 is visible from the levee of the Orleans Outfall Canal, but the greater part of the Station is obscured from view at this point by the I-610 overpass.

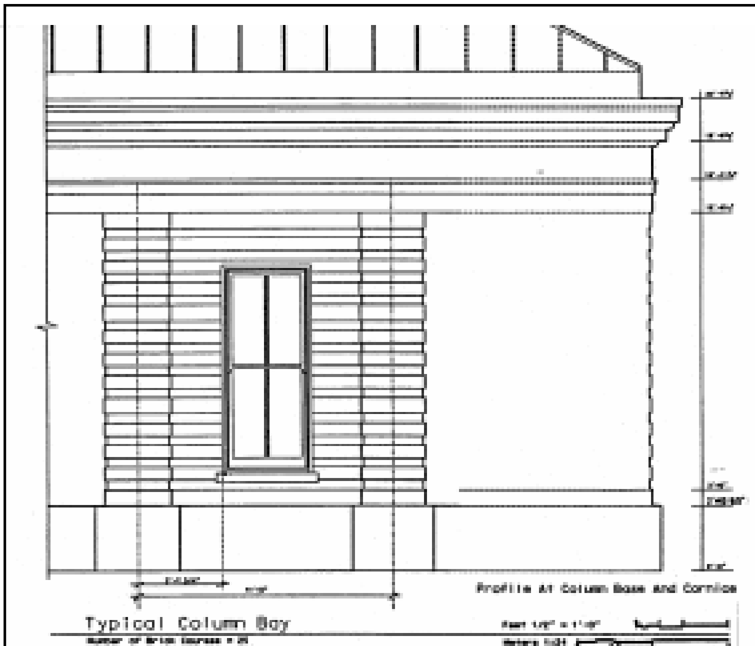


Figure 83. Typical column bay, Drainage Pumping Station No. 6. The bay proportions are uniform for Drainage Pumping Stations 1, 3, 6, and 7 (from Historic American Buildings Survey 1992).

Stations Nos. 1, 3, 6, and 7 are utilitarian brick sheds with steel trusses spanning the interior, and hip roofs with monitors on the ridge. All originally had decorative terra cotta crests on the monitor ridges. The exterior wall design shows a remarkable application of the classical language of architecture. The walls are divided into bays by rusticated or banded pilaster-like wall segments, formed of projecting and receding brick courses (Figures 83 and 84). At the top, the pilasters meet an entablature defined by projecting and receding brick courses. These

Figure 84. Drainage Pumping Station No. 1. View of east facade, showing brick depth and projection.

Figure 85. Drainage Pumping Station No. 1. View of upper portion of east facade of building, showing pilasters, wall, and entablature, quarter-round bricks at transition to cornice, and decorative cast-metal false keystone on window.

step out to imitate the fascia of an Ionic architrave, recede into a flat zone for the frieze, and then join a quarter-round molded course as a transition to the copper cornice (Figures 85 through 88). Ornamental cast copper squares are placed in the frieze just above the banded pilasters (Figures 86, 88, and 89). The wall and pilaster bases project from the walls and pilasters, and the top course of this projection has end-laid bricks with beveled top edges (Figure 90). Originally, Stations 1, 3, 6, and 7 all had decorative terra-cotta crests on the monitor roof peak (Figures 91 and 92).

The bay divisions reflect internal workings. Behind each banded pilaster stands a projecting brick pier topped by a “capital” built of stepped-out brick courses. Above the capitals are, or were in some cases, metal abaci supporting the steel girders which run the length of the building to guide the traveling cranes utilized for moving machinery. The subtle architectural intentions on the exterior walls became even more purposeful and apparent when seen in the context of the monumental Central Power Station No. 1 (now Sewage Pumping Station D) (Figure 93), constructed

Figure 86. Drainage Pumping Station No. 1. View of upper portion of southeast corner of building, showing projection of fascia brick courses and decorative metal castings.

Figure 87. Drainage Pumping Station No. 1. View of upper portion of southeast corner of building, showing special round bricks, corner treatment of architrave, and quarter-round brick course below cornice.

Figure 88. Drainage Pumping Station No. 1. View of roof on eastern side of building, showing decorative terra-cotta crest on monitor. The joint between the 1899-1904 masonry and 1915 construction is visible above the central pilaster.

Figure 89. Drainage Pumping Station No. 1 View of west side of south facade, showing door and shuttered transom window.

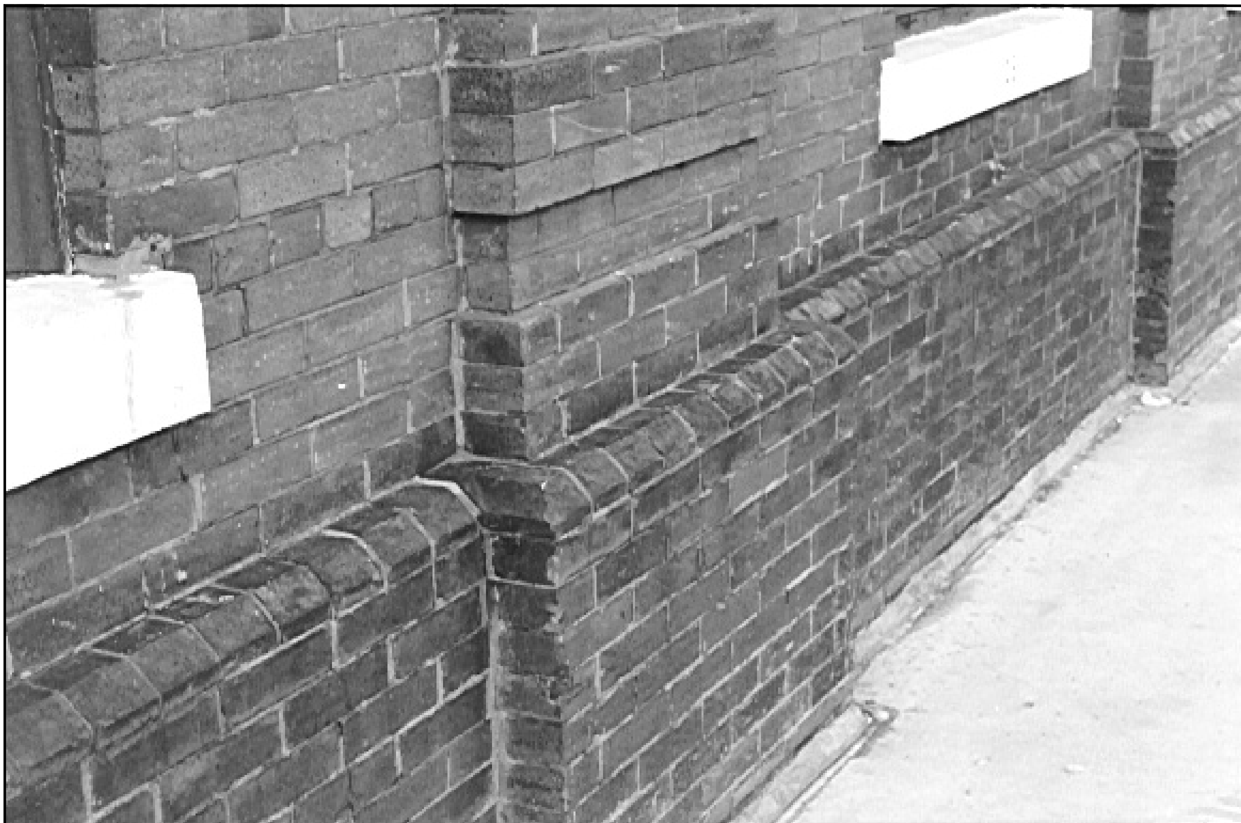


Figure 90. Drainage Pumping Station No. 1. View of east facade pilaster base, showing course of beveled bricks.

Figure 92. Drainage Pumping Station No. 1. View of the monitor roof peak at the northern end of the building, with terra-cotta crest and finial.

Figure 93. Drainage Pumping Station No. 1. View of lower portion of northwest corner of building, showing special round bricks and pilaster bases at corner.

at the same time as Drainage Pumping Stations Nos. 1, 3, 6, and 7. This original system power station is now part of the sewerage system, not the drainage system. The smaller pumping stations read as architectural offspring of this large and particularly well proportioned structure, with its pediment over the central three bays and the same adaptation of the classical orders, in brick, to articulate the walls. The same foundation stone inscriptions occur on the Central Power Station except for an earlier date (1898). The Central Power Station was designed by an architect familiar with eighteenth century French architecture or its academic representations. It is one of the finest classical designs in the city.

Drainage Pumping Station No. 1. Drainage Pumping Station No. 1 is a nineteen bay one-story utilitarian brick shed with monitor (now blocked) on a hipped roof. It is ennobled by excellent proportions and by a remarkable translation of the classical language of architecture — from rusticated pilasters and full entablature and cornice — into the same brick as the rest of the wall (Figures 85 through 88). The architrave has fascias made by slight projections of ascending brick courses (Figures 86 through 88). There are quarter-round molded or cut bricks making the transition to the cornice (Figures 86 and 88). Such detailing shows the hand of a knowing designer, probably the drainage system's engineer, Benjamin Morgan Harrod (1837-1912).

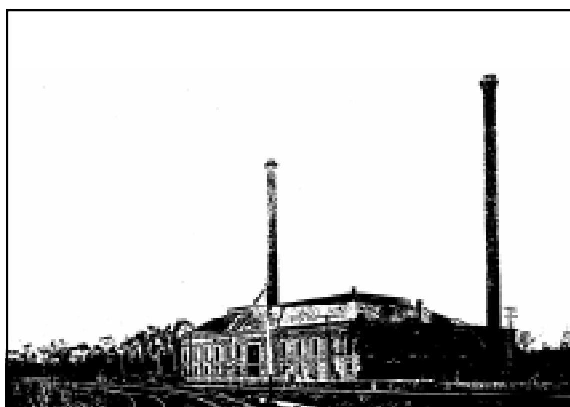


Figure 93. The Central Power Station (No. 1), built 1897-1899 (courtesy of the Sewerage & Water Board of New Orleans.

Drainage Pumping Station No. 3. Like Stations Nos. 1 and 2, Drainage Pumping Station No. 3 is particularly visible from heavily traveled Broad Street. The three work together in series to visually articulate the drainage system as a sequence of elements. Station No. 3 was built in three stages (1901-1903, 1917, and 1930-1931) with the original eight bays in the center of the current structure The view from Broad Street of the two westernmost bays of the main facade is partially blocked by the narrow, two-story, concrete control annex structure. According to drawings dated October 1994, the building at that date still had operable monitor windows, slate main and monitor roofs, with decorative terra cotta cresting on the former. At present there is a seamed copper roof covering the monitor roof and main roof. Unlike the interiors of Stations Nos. 1, 6, and 7, the interior of Station No. 3 has a line of blue glazed bricks between the lower part of the wall, faced with brown glazed bricks, and the upper part of the walls, faced with red brick.

Drainage Pumping Station No. 6. Construction of Drainage Pumping Station No. 6 began in August 1897. The south or city-facing long facade is partially visible to the public. Originally the station was more visible from the south, prior to the construction of the dramatic trash-screen rake mechanism in the 1980s (Figures 55 and 56).

The original eight bays are the center portion of this long building, which was constructed in four stages. Additions to the original building were made in 1914-1915 and 1928-1930, consistent with the original design and construction. A two-story addition of 1986-1989 changes the proportion of the walls to the roof, but adapts the brick wall system reasonably effectively (Figure 58). The early parts of the interior of this station do not have the usual stepped brick "capitals" between the interior piers and the steel beam crane track seen in Stations 1, 3, and 7.

Like Drainage Pumping Station No. 7, the monitor of Station No. 6 was set within the hipped roof in such a way that the ridge of the lower, main roof joins, or is near, the eaves of the monitor roof, thus blocking the monitor glazing on the two narrow ends of the building. The monitor is now enclosed in seamed copper roofing and the main roof, also clad in seamed copper roofing, has lost the terra cotta cresting. Drainage Pumping Station No. 6 is the best site for public interpretation of the drainage system and pumping stations because it is so large, the vicinity is free from vehicle traffic, and because the trash screen rake mechanism is so engaging.

Drainage Pumping Station No. 7. Construction of Drainage Pumping Station No. 7 began in 1897 and was completed by 1900. The eight bays making up the western portion of the structure can be identified by the foundation stone on the southwest corner as the original part of the building. The station is now eighteen bays long (Figures 61 through 64). As is the case with Station No. 6, the monitor ends were set within the hipped roof, not on it (see description of Drainage Pumping Station No. 6, above) (Figures 65). The monitor is covered with plywood, and the roof has been clad in composition shingles.

Other than the alteration of the monitor, this station is, perhaps, the best preserved of all the early stations with many all-wooden windows, doors, and, remarkably, an early double-leaf wooden vehicle doorway with elaborate metal hinges (Figures 66). This is the only original vehicle door observed at Stations Nos. 1, 3, 6, and 7. Although Station No. 7 is in an unpleasant location between the I-610 overpass and a railroad embankment, the east end of the building faces Marconi Drive and can be seen from a picnic ground situated beneath the overpass.

Drainage Pumping Station No. 4. The building is constructed of stucco-covered concrete block with a sheet metal roof. It once had wooden sash windows, which have been blocked, and roofing of composition shingles. The building was constructed 1945-1946. A different architectural approach underlay the design of this station than that of Stations Nos. 1, 3, 6, and 7. It makes no attempt to look like the older pumping stations in materials, massing, or any other aspect of the design. Engineering features of this station also produce an appearance radically different from the stations designed in the 1890s. Most dramatically, the greater part of the pumping machinery at this station is not enclosed within the fabric of a building, reducing the architectural relevance and impact of the relatively small station building.

Drainage Pumping Station No. 4 is a purely utilitarian building without distinguishing architectural features. It is out of character with the earlier architectural excellence of the original Drainage Pumping Stations (Nos. 1, 2, 3, 6, and 7).

Evaluation of the Integrity of Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7

As seen above, Drainage Pumping Stations Nos. 1, 3, 6, and 7 were all constructed in the same style during the period 1897-1902. While all of the structures have been expanded, these longitudinal extensions have been consistent with the original design to the point that it is often difficult to distinguish the older construction from the new. The result is that the architectural character of these structures has been maintained over time despite alterations, and the structures still convey a strong sense of their past associations. Thus, Drainage Pumping Stations Nos. 1, 3, 6, and 7 all exhibit architectural integrity:

> A property important for its expression of architectural design and construction technology is eligible if the principal features of its design and construction are sufficiently intact to convey that significance [National Park Service 1982:39-40].

In addition, all of the pumping equipment at Stations Nos. 1, 3, 6 and 7 is maintained in excellent condition. The pumps possess a high degree of integrity; there have been no repairs to the main pumping equipment which has altered their original condition. Then too, the maintenance procedures necessary to keep the auxiliaries up-to-date with present standards also have not affected the integrity of the Wood pumps. Finally, Drainage Pumping Station No. 7 is unique in the system for having its original ca. 1897-1899 250 cfs vertical centrifugal pumps and motors, representing the original main pumping equipment of the New Orleans drainage system. Thus, Drainage Pumping Stations Nos. 1, 3, 6, and 7 all possess engineering integrity.

Drainage Pumping Station No. 4, as noted above, lacks the high level of architectural excellence exhibited by the other four stations. In addition, it has undergone substantial renovation, in that the windows have been covered over. Thus, Station No. 4 does not possess architectural integrity. The pumps at Drainage Pumping Station No. 4 do exhibit integrity in that they have been maintained in their original condition since the time of their installation. However, it should be noted that the pumps in and of themselves are not significant; no Wood pumps are present at this station.

Evaluation of the Integrity of the Drainage System

As we have seen, expansion of New Orleans both in terms of area and population has placed increasing demands upon the drainage system since its original design in 1895. Nonetheless, the concept and design of the original system remains identifiable and functional today. As such, the New Orleans drainage system is not only a historically significant engineering complex, but because it remains fully operational, it is a working museum of drainage progress.

Under the National Park Service's (1982:5) definition, the New Orleans drainage system can be classified as a district:

> A district is a geographically definable area… possessing a significant concentration, linkage, or continuity of sites, buildings, structures, and/or objects united by past events or aesthetically by plan or physical development.

Elements of such a district might include the drainage stations themselves, as well as the associated pumps, piping systems, canals, and power stations. Because the importance of the system includes its organic, evolving character which is necessitated by steadily increasing demands on drainage as well as the interrelationships of the elements, the district would include elements that in and of themselves might not be eligible for inclusion on the National Register, or that could not be considered contributing elements to the district other than that they are functionally interconnected with the system. However, for the purposes herein, the focus of our assessments of integrity and of significance (below) is the status of Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 and their associated canals as contributing elements to a drainage system district.

As discussed above, Drainage Pumping Stations Nos. 1, 3, 6, and 7 all possess both architectural and engineering integrity, and along with Station No. 2, were all constructed in the same architectural style. Unlike these structures built during the period 1897-1902, the more recent Drainage Pumping Station No. 4 lacks architectural integrity. While the pumps at Station No. 4 are in their original condition, they lack significance in and of themselves. Thus, Station No. 4 can not be considered a contributing element to a drainage system district on the basis of either architectural or engineering merit, despite the fact that it possesses engineering integrity.

As indicated in Chapter 4, none of the major canals in the drainage network are in their original condition. All of the major drainage canals have been altered to some degree, by deepening, reshaping, relining, covering, or re-covering since construction began on the system in 1897. This repair, redesign, and improvement of the drainage canals, which have continued up to the present and will very likely continue into the future, have been a functionally necessary result of the increasing drainage demands of the city.

In terms of the canals which are directly connected with suction and discharge basins of Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7, the Metairie Relief and Relief Outfall Canal, the Upper Protection Canal, the Palmetto Canal, the Washington Avenue Canal, the Orleans Relief Canal, The Florida Avenue Canal, the London Avenue Outfall and Outfall Relief Canal, the Prentiss Avenue/Calhoun Avenue Canal, and the Broad Street Canal between General Taylor and Drainage Pumping Station No. 1 have all been widened or deepened to increase their drainage flow capacity within the last 50 years (Mr. Young Lee, personal communication 1996). Thus, these canals only possess integrity of location. However, because improvement to drainage is the primary function of the evolving drainage system, these canals' integrity of location, which preserves and illustrates the interrelationships between the stations, is sufficient for the purposes of a drainage system district:

> All properties change over time. The retention of integrity depends upon the nature and degree of alteration or change. It is not necessary for a property to retain *all* the physical features or characteristics that it had during its period of significance. However, the property must retain the essential physical features that enable it to convey its past identity or character and therefore its significance [National Park Service 1982:40].

However, that portion of the Broad Street Canal between Drainage Pumping Station Nos. 1 and 3 has not been modified within the last 50 years (Mr. Young Lee, personal communication 1996). Construction was begun on the Main Canal-Broad St. Canal elements of the system in 1897, and the Broad St. Canal has been modified and enlarged by several construction episodes. The last major modification of the Broad St. Canal (with the exception of modifications to the suction and discharge basins at Stations Nos. 1 and 3) occurred in the period 1938-1940. Thus, this portion of the Broad Street Canal, in addition to possessing integrity of location, exhibits integrity of design, materials, and workmanship for the period prior to World War II, although it has been altered since its original construction.

The National Park Service states:

> In order for a district to have integrity as a whole, the characteristics that make the district significant must be intact. The majority of the components that make up the district's historic character must possess integrity even if they are individually undistinguished. *The relationships among the components must be substantially unchanged since the period of significance*, and the majority of components within the district must be historic [National Park Service 1982:40-41; emphasis added].

In terms of the drainage pumping stations and associated canals under consideration here, a drainage system district has integrity as a whole. The original design of the system is clearly evident and still functioning. Because they possess integrity of location, the canals illustrate the interrelationships of the elements of the system. Furthermore, four of the five drainage pumping stations exhibit both architectural and engineering integrity.

It is recommended below that Drainage Pumping Stations Nos. 1, 3, 6, and 7, are individually significant in terms of association (Criterion A), architecture (Criterion C) and engineering (Criterion C). In addition, it is recommended that the drainage system as a district is significant under these same criteria, and that Stations Nos. 1, 3, 6, and 7 are contributing elements to this district.

Statement Of Associative Significance (Criterion A)

New Orleans began construction of its present-day drainage system, including Drainage Pumping Station No. 1, 3, 6, and 7, between 1897 and 1904. In doing so, city administrators were not only addressing dire local needs for adequate drainage and flood protection, but following a national trend which held city officials responsible for the well-being of their citizenry. A corollary of this was the development of public utilities systems throughout American cities in the late-nineteenth and early-twentieth centuries.

The establishment of the New Orleans drainage system and its subsequent improvement through the engineering genius of A.B. Wood not only provided adequate drainage for the then-developed portions of the city, they permitted the city to expand. Mortality rates for the city's inhabitants dropped as a result of improved health; improved drainage decreased the mosquito population. Further, the construction of the drainage system stimulated the establishment of sewerage and water systems for the city.

Thus, the New Orleans drainage system as a whole is associated with the theme of settlement and expansion of the city. However, to be considered eligible for listing on the National Register under Criterion A,

> …[a] particular property should be a good representative of the theme and of the specific event or events. To be a good representative, it must have strong associations with the event or events and it must possess integrity [National Park Service 1982:17].

Drainage Pumping Station Nos. 1, 3, 6, and 7 are good representatives in that they were among the first stations constructed in the drainage system. In addition, and perhaps more importantly, the first 30", 12', and 14' Wood screw pumps were installed at Station No. 1, and they are still in place and in use today. Additional 12' and 14' Wood screw pumps are located in Stations Nos. 3, 6, and 7. Then too, Drainage Pumping Station No. 7 still has its original ca. 1897-1899 250 cfs vertical centrifugal pumps and motors, which represent the original main pumping equipment of the New Orleans drainage system. Finally, the stations exhibit the quality of integrity. Drainage Pumping Station Nos. 1, 3, 6, and 7 are therefore individually eligible for nomination to the

National Register under Criterion A. Because they are individually eligible under Criterion A, Drainage Pumping Stations Nos. 1, 3, 6, and 7 are also contributing elements to a drainage system district under Criterion A.

In comparison to Stations Nos. 1, 3, 6, and 7, Drainage Pumping Station No. 4 is not a good representative of the theme of settlement and expansion of the City of New Orleans. It was constructed at a later date than the other four stations, and both the equipment and architecture of the station are unremarkable. Thus, Drainage Pumping Station No. 4 is not eligible for inclusion on the National Register of Historic Places in and of itself under Criterion A. Within the context of a drainage system district, Station No. 4 would be a contributing element under Criterion A only in that it is functionally interconnected with the remainder of the system.

Similarly, the canals associated with the five drainage pumping stations under consideration here cannot be considered good representatives of the theme of settlement and expansion of the City of New Orleans. All are undistinguished in and of themselves, and all but a portion of the Broad Street Canal have been modified within the last 50 years. In addition, that portion of the Broad Street Canal which has not been modified since 1938-1940 is not in its original condition. Therefore, they are not individually eligible for the National Register under Criterion A. However, within the context of a drainage system district, all would be contributing although individually undistinguished elements under Criterion A because they possess integrity of location, and thereby illustrate interrelationships of system elements:

> A district is different from the other categories of historic properties because a district may be significant as a whole even though it may be composed of components — sites, buildings, structures, and objects — that lack individual distinction. A district's identity results from the grouping of features *and from the relationships among those features* [National Park Service 1982:25; emphasis added].

Statement of Architectural Significance (Criterion C)

Drainage Pumping Station Nos. 1, 3, 6, and 7 are individually and as a group significant for their architectural excellence. As architectural entities, they embody distinctive characteristics of a "type, period, or method of construction," that being an early-twentieth-century New Orleans drainage station. As such, they "enhance our understanding of the class of resources of which [they are] a part" (National Park Service 1982:22). They, along with Station No. 2, all exhibit similar architectural style and detail; they are distinguishable as a unified group of buildings. Stations Nos. 1, 3, 6, and 7, as well as 2, were probably designed by a local architect of considerable merit who was chief engineer of the drainage system, as well as an engineer of national reputation at the time the stations were constructed.

While no signed drawings or other sure means of attribution for the pumping and central power station designs have appeared to date, it is reasonable to assume that they were drawn by the chief engineer of the Drainage Commission, Major B.M. Harrod. Harrod was both an engineer and an architect. At the time Drainage Pumping Stations 1, 3, 6, and 7 were designed, Harrod was practicing architecture with his former employee, Paul Andry. The firm of Harrod and Andry had just completed the first buildings of the new Tulane University campus in the mid-1890s. The drainage station designs are consistent in character with the Tulane buildings and with the few glimpses we have of Harrod's earlier work. When writing about himself, Harrod most often referred to himself as an engineer. When written about by others, Harrod was considered a distinguished engineer with a national reputation. Moreover, Harrod left a substantial body of architectural work which as yet has remained largely unstudied.

Although we do not know a great deal about the work of this Harvard-educated Louisianan, he was clearly a man of excellent talents in both architecture and engineering. He appeared as an architect in Notarial Archive contracts in 1866, and continued in that capacity for a good ten years. His work included both residences and warehouses, as well as the school for the Hebrew Education Society, and the Confederate Monument to mark a mass grave for 600 soldiers at Greenwood Cemetery. During the late-1880s and early-1890s, he served as city engineer, designing a fire station which was built several times throughout the city. As the senior member of the design firm of Harrod and Andry, he won the competition for the first three buildings of the new Uptown Campus of Tulane University, Gibson Hall and the two orange brick buildings behind it, F. Edward Hebert Hall and the Richardson Building. The sensitive dimensioning of molding profiles on the last two structures is similar in effect to the brick detail on the drainage pumping stations.

Thus, Drainage Pumping Station Nos. 1, 3, 6, and 7 are individually eligible for the National Register of Historic Places because of the excellence of their design and their integrity. They, along with Drainage Pumping Station No. 2, which was constructed during the same period and in the same style, would therefore be contributing elements to a drainage system district on the basis of architectural significance.

By contrast, Drainage Pumping Station No. 4 is not significant in terms of architectural merit. Drainage Pumping Station No. 4 is a purely utilitarian building without distinguishing architectural features. It is out of character with both the earlier architectural excellence of the original Drainage Pumping Stations and the newer buildings of the Sewerage and Water Board, which have utilized some of the materials and evocative details of the earlier buildings. Similarly, because of its lack of architectural distinction, Drainage Pumping Station No. 4 would not be a contributing element to a drainage system district on the basis of architectural significance.

The canals associated with Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 are also without architectural distinction. Furthermore, all but a portion of the Broad Street Canal have been modified within the past 50 years, so they only exhibit integrity of location. They are neither individually significant in terms of architecture, nor can they be considered contributing elements to a drainage system district on the basis of architectural significance.

Statement Of Engineering Significance (Criterion C)

The New Orleans drainage system is unique in that it operates, for the most part, below sea level and in a subtropical rainfall environment. This drainage system is made possible by the use of a series of pumping stations. Drainage Pumping Station No. 1 is the first lift station in a system of series lifts which carry drainage water from the city to a discharge area. Conduit pipes collect the water from street drains and convey it to the pump suction basin by the effect of gravity. The station lifts the water several feet and discharges it into a canal, which leads to another gravity canal, which eventually leads to the outfall stations. Drainage Pumping Station No. 5, not considered in detail in this report, discharges the dry weather flow into Bayou Bienvenue. Drainage Pumping Stations Nos. 3, 4, 6, and 7 are lift stations which discharge the drainage water during storm flow into the outfall relief canals which flow directly into Lake Pontchartrain.

Table 3 indicates the pumping equipment at Station Nos. 1, 3, 4, 6, and 7 and the years of their installation The 12' Wood pumps at Drainage Pumping Station No. 1 have been named American Engineering Landmarks. These pumps were designed by Albert Baldwin Wood, who is recognized as an important figure in the history of American engineering for his pump designs. Wood pumps are also present in Drainage Pumping Stations Nos. 3, 6, and 7, however, Station No. 4 does not include any original Wood pumps. In addition, the three vertical centrifugal pumps at Station No. 3 are notable in that they are the only examples of the original pumping technology utilized in the system during the period of its construction. These, pumps however, are no longer in use.

Table 3. Pumps in Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7.

Drainage Pumping Station No.	Pump Type	Pump No.	Size	CFS	Electrical	Year Installed	Pump Mfgr.
D.P.S. 1	Wood screw	A	12'	550	25 Hz	1915	Nordberg Mfg. Co.
D.P.S. 1	Wood screw	B	12'	550	25 Hz	1915	Nordberg Mfg. Co.
D.P.S. 1	Wood screw	C	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 1	Wood screw	D	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 1	Wood screw	E	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 1	vertical	1	5'	200	25 Hz	1965	
D.P.S. 1	vertical	2	5'	200	25 Hz	1965	
D.P.S. 1	constant duty	1	3'	40	25 Hz		
D.P.S. 1	constant duty (Wood screw)	2	30"	30	25 Hz	1912/1913	
D.P.S. 3	Wood screw	A	12'	550	25 Hz	1918	Nordberg Mfg. Co.
D.P.S. 3	Wood screw	B	12'	550	25 Hz	1918	Nordberg Mfg. Co.
D.P.S. 3	Wood screw	C	14'	1,000	25 Hz	1931	Dibert-Bancroft-Ross
D.P.S. 3	Wood screw	D	14'	1,000	25 Hz	1931	Dibert-Bancroft-Ross
D.P.S. 3	Wood screw	E	14'	1,000	25 Hz	1931	Dibert-Bancroft-Ross
D.P.S. 3	r & l constant duty	1	30" x 63"	80	25 Hz	ca. 1930	
D.P.S. 3	r & l constant duty	2	30" x 63"	80	25 Hz	ca. 1930	
D.P.S. 4	vertical	1		320	60 Hz	1945-1946	
D.P.S. 4	vertical	2		320	60 Hz	1945-1946	
D.P.S. 4	screw	C		1,000	60 Hz	ca. 1960	Worthington
D.P.S. 4	screw	D		1,000	60 Hz	1960s	Allis-Chalmers
D.P.S. 4	screw	E		1,000	60 Hz	1960s	Allis-Chalmers
D.P.S. 4	constant duty [trash pump]			80	60 Hz	1963-1964	
D.P.S. 6	vertical	1		250	60 Hz	1985-1988	Patterson Pump Co.
D.P.S. 6	vertical	2		250	60 Hz	1985-1988	Patterson Pump Co.
D.P.S. 6	vertical	3		250	60 Hz	1985-1988	Patterson Pump Co.

Table 3, Continued.

Drainage Pumping Station No.	Pump Type	Pump No.	Size	CFS	Electrical	Year Installed	Pump Mfgr.
D.P.S. 6	vertical	4		250	60 Hz	1985-1988	Patterson Pump Co.
D.P.S. 6	Wood screw	A	12'	550	25 Hz	1916	Nordberg Mfg. Co.
D.P.S. 6	Wood screw	B	12'	550	25 Hz	1916	Nordberg Mfg. Co.
D.P.S. 6	Wood screw	C	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 6	Wood screw	D	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 6	Wood screw	E	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 6	Wood screw	F	14'	1,000	25 Hz	1930	Dibert-Bancroft-Ross
D.P.S. 6	screw	G	14'	1,000	60 Hz	1986-1989	Worthington
D.P.S. 6	screw	H	14'	1,050	60 Hz	1986-1989	Worthington
D.P.S. 6	screw	I	14'	1,050	60 Hz	1986-1989	Worthington
D.P.S. 6	constant duty	1	30" x 63"	90	25 Hz	1930	Hardy-Tynes Mfg. Co.
D.P.S. 6	constant duty	2	30" x 63"	90	25 Hz	1930	Hardy-Tynes Mfg. Co.
D.P.S. 7	Wood screw	A	12'	550	25 Hz	1917/1918	Nordberg Mfg. Co.
D.P.S. 7	Wood screw	C	14'	1,000	25 Hz	1931	Dibert-Bancroft-Ross
D.P.S. 7	Wood screw	D	14'	1,000	60 Hz	1931	Dibert-Bancroft-Ross
D.P.S. 7	constant duty [not in use]	[1]			25 Hz	1911	Camden Iron Works
D.P.S. 7	constant duty [trash pump]	2	30" x 63"	70	25 Hz	1931	Hardy-Tynes Mfg. Co.
D.P.S. 7	constant duty [trash pump]	1	30" x 63"	70	25 Hz	1931	Hardy-Tynes Mfg. Co.
D.P.S. 7	vertical [not in use]	4		250	25 Hz	1898-1900	E.P. Allis Co.
D.P.S. 7	vertical [not in use]	5		250	25 Hz	1898-1900	E.P. Allis Co.
D.P.S. 7	vertical [not in use]	6		250	25 Hz	1898-1900	E.P. Allis Co.

The primary consideration in determining the significance of engineering objects is the extent to which the design concept, or the methods of manufacture and application, represent a technological advancement. It is an affirmation of the engineering significance of the Wood pumps in Stations Nos. 1, 3, 6, and 7 that they are still in use and still represent technological state-of-the-art. In addition, all of the equipment at Stations Nos. 1, 3, 6, and 7 is maintained in excellent condition. Thus, the pumps possess a high degree of integrity.

Drainage Station Nos. 1, 3, 6, and 7 are each individually eligible for nomination to the National Register of Historic Places as engineering structures because they exhibit the quality of integrity, and because they both embody the distinctive characteristics and are each a good example of a particular type of engineering structure (drainage pumping station) and a period of construction (early-twentieth century). Although all of the stations contain smaller pumps that have replaced older pumps of similar size and function, the Wood pumps all retain their historic configuration and pattern of organization. Also, the Wood pumps present in the stations are significant objects in and of themselves. The National Park Service defines an object as:

> …a thing of functional, aesthetic, cultural, historical, or scientific value that may be, by nature or design, movable yet related to a specific setting or environment [National Park Service 1982:7]

The 12' Wood screw pumps and the 14' Wood screw pumps in Stations Nos. 1, 3, 6, and 7, and the one 30" Wood constant duty screw pump in Station No. 1, are all objects of historical significance because of their age and functional importance. Thus, both Stations Nos. 1, 3, 6, and 7 as engineering structures, and the Wood pumps as objects would be contributing elements to a drainage system district in terms of engineering significance.

Drainage Pumping Station No. 4 is not eligible on the basis of engineering significance. The station was constructed in 1945-1946 and has been modified to an unusual plan since original construction. The engineering features of the station are neither characteristic of post-World War II New Orleans drainage pumping stations nor are they technologically innovative. The station is not therefore considered to be good example of a particular type of engineering structure and a period of construction. It would not be a contributing element to a drainage system district in terms of engineering significance.

The canals associated with Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 also lack engineering significance. As noted previously, all but a portion of the Broad Street Canal have been modified within the past 50 years, so they only exhibit integrity of location. They are neither individually significant in terms of engineering, nor can they be considered contributing elements to a drainage system district on the basis of engineering significance.

Levels Of Significance

In terms of association, the New Orleans drainage system and Drainage Pumping Stations Nos. 1, 3, 6, and 7 are of local significance. The system was responsible for dramatic improvements to the health and living conditions in the city, and it enabled expansion of the city. Stations Nos. 1, 3, 6, and 7 are among the original components of this system.

In terms of architecture, the New Orleans drainage system and Drainage Pumping Stations Nos. 1, 3, 6, and 7 are of local significance. The original stations were all built to high architectural standards in the same style, and they form an identifiable, unified group. They were likely designed by New Orleans architect and engineer, Major B.M. Harrod.

In terms of engineering, the New Orleans drainage system and Drainage Pumping Stations Nos. 1, 3, 6, and 7 are of local significance. The great achievement of the system is that through the use of the pumping stations, the system is able to drain a city situated primarily below sea level and that receives subtropical rainfall levels. Stations Nos. 1, 3, 6, and 7 were among the first pumping stations opened, and as such, are an integral component of this engineering achievement. Similarly, the Wood pumps within these stations are of local significance, and the 12' Wood Screw Pump at Station No. 1, which has been named a National Engineering Landmark, is of national significance because of the important technological achievement represented by this pump, the first of Wood's 12' screw pumps to be installed.

CHAPTER 7
RECOMMENDATIONS

It is recommended in Chapter 6 that Drainage Pumping Stations Nos. 1, 3, 6, and 7 should be considered eligible for nomination to the National Register of Historic Places. Furthermore, it is recommended that these stations along with their associated canals should be considered contributing elements of a drainage system National Historic District. Thus, the effects of Southeast Flood Control Project and the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project on these structures, their associated engineering apparatuses, and canals must be evaluated.

Effects Of Proposed Improvements

Drainage Pumping Station No. 1. The work to be conducted on Drainage Pumping Station No. 1 under the Southeast Flood Control Project consists generally of an enlargement of the station, installation of two new pumps in the building addition, cosmetic alterations to the existing building, and alteration of the existing drainage basin. Figure 94 shows a plan of the areas of potential effect on Drainage Pumping Station No. 1. Figure 95 shows an overall view of the Station after proposed construction.

The addition to the existing structure consists of an extension, measuring 105’ 11” by 53’ 8”, attached to the to the south end of the building. The existing south wall, constructed ca. 1930 for installation of the 14’ Wood screw pumps, will be removed. Two 11’ horizontal screw pumps are to be installed in the new addition to the structure, while the arrangements of pumping equipment in the existing station will not be altered. Other alterations will be made to the present building structure. Proposed plans call for reroofing the existing building main roof and monitor by removing the asphalt roofing and replacing it with standing seam copper roofing, consistent with the new construction. The wooden siding currently covering the monitor windows is to be

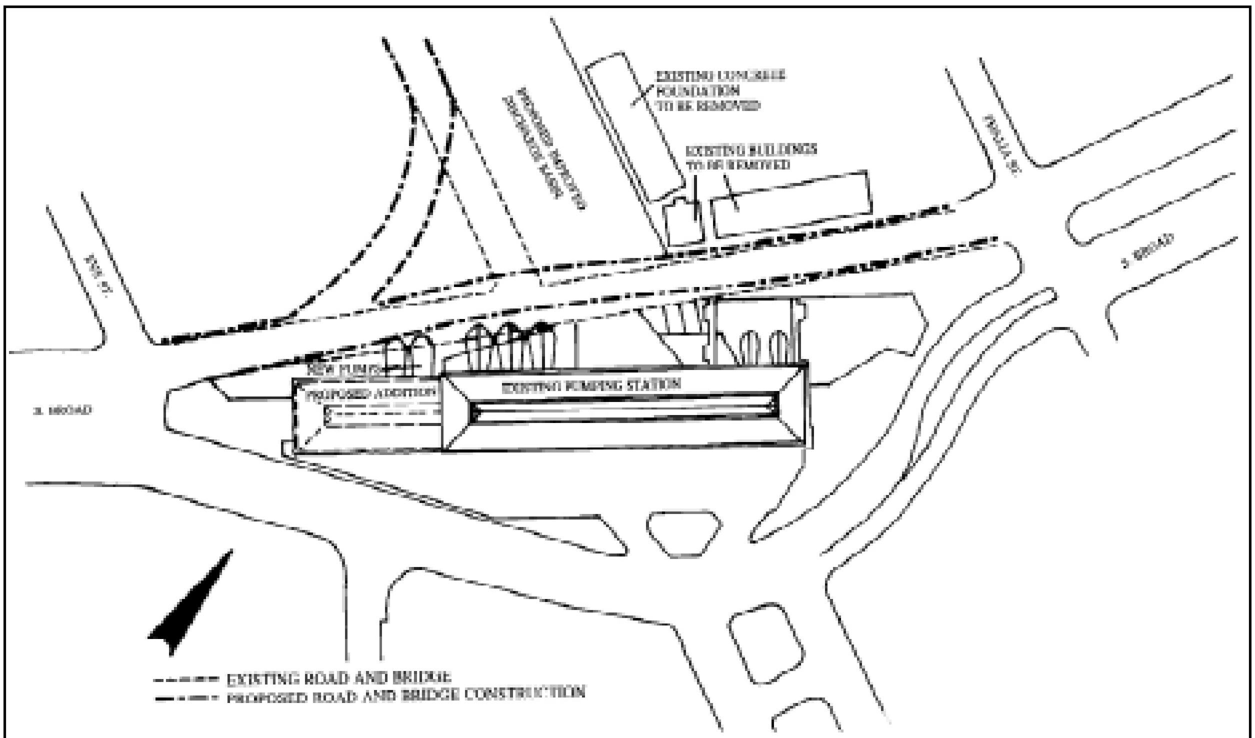


Figure 94. Drainage Pumping Station No. 1. Plan showing areas of potential effect. No scale Available (NODCOE).

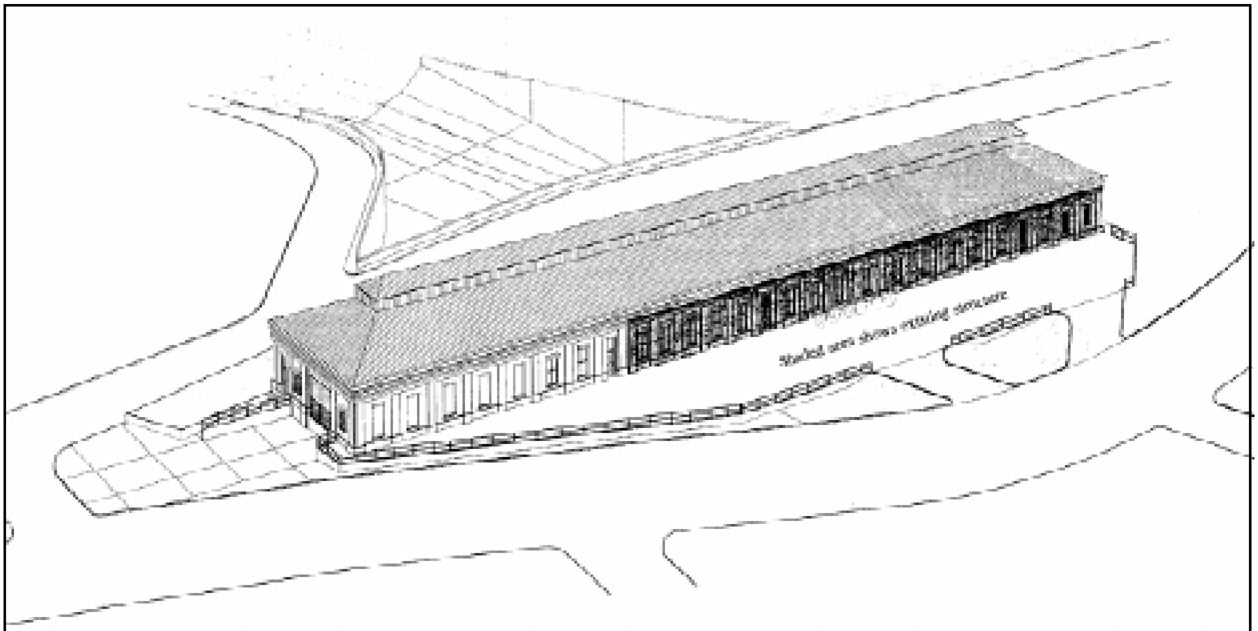


Figure 95. Drainage Pumping Station No. 1. Elevation showing areas of potential effect. No scale available (NODCOE).

replaced with standing seam copper siding. The existing galvanized iron roof guttering is to be removed and replaced with copper guttering. The current plywood one-piece window shutters are to be removed and roll-up shutters installed on most windows of the existing structure. Four sliding-sash windows in the existing structure will be replaced with fixed aluminum louvers.

The existing discharge basin is to be altered by the removal and replacement of 8' 11" flap valves and removal and reuse of 48" flap valves. The southern side of the discharge basin is to be enlarged by relocation of Martin Luther King Blvd. at its intersection with the southbound lanes of S. Broad Ave., creating a bend in Martin Luther King Blvd. where it currently intersects S. Broad Ave. in a perpendicular fashion. The currently straight S. Broad Ave. bridge over the discharge basin is to be replaced by one of greater length to span the enlarged basin, and which will curve slightly to provide greater distance between S. Broad Ave. and of the 14' Wood screw pump discharge tubes.

On the northern side of the discharge basin, two buildings adjacent to the basin and to S. Broad Ave. are to be removed. 1431-1433 Broad Street is a two-story frame building which is covered in corrugated metal on the Broad Street side. The first story on the other three sides is 10" or 11" vertical boarding with battens. The second floor has wide horizontal drop siding with several six over six windows with shallow mullions. There are uncovered exterior stairs to the second story. 1415 Broad Street is a long, one-story, gable roof building with a variety of exterior surfacing on the Broad Street side. These include corrugated metal, horizontal drop siding in wood, and artificial brick or stone on the northern half. There is a more consistent building system of a wall midsection with large "shop" windows (four) and vertical boarding which is held by two feet or so, at the top of the wall and bottom, of clapboards on the western half. The rear of this section has vertical boards and battens with horizontal boarding on top. The south end wall is corrugated metal. Both buildings rest on slab foundations and appear to represent mid-twentieth-century vernacular construction. It is likely that they were constructed after 1945, and neither is eligible or potentially eligible for nomination to the National Register of Historic Places.

Drainage Pumping Station No. 3. Proposed improvements to Drainage Pumping Station No. 3 under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project consist of construction of fronting protection across the entire width of the London Outfall Canal, approximately 25' north of the existing station. Portions of the existing concrete discharge basin slab will be removed in the areas where a new sluice-gate control structure is to be constructed. Pile-founded reinforced concrete T-walls and reinforced concrete capped steel sheet pile I-walls will tie the new protection to the existing protection. Each horizontal pump will be provided with its own reinforced concrete discharge tube. Each reinforced concrete discharge tube will be fronted by two gates. Discharge tubes will be grouped together into two major discharge structures; one for the 500 cfs pumps A and B and the second for the 1,000 cfs pumps C, D, and E. A four-gate control structure and a separate six-gate control structure will be constructed at the ends of the two discharge structures for the 500 cfs and 1,000 cfs pumps, respectively. The ten sluice gates will provide emergency closure capabilities in the event of pump failure. Power for all gate operators shall be supplied from the existing "T2" power panel within Drainage Pumping Station No. 3. The T-wall monoliths will be constructed to connect the existing canal floodwalls to the ends of the new gate control structures. The gate control structures will be joined together at the center of the discharge basin by another T-wall monolith. Two I-wall monoliths will join the existing I-walls at the Norfolk-Southern railroad floodgates to the proposed construction (Pepper & Associates 1995). Figure 96 is a plan of Drainage Pumping Station No. 3 as it currently exists. Figure 97 is a plan of the Station after proposed improvements.

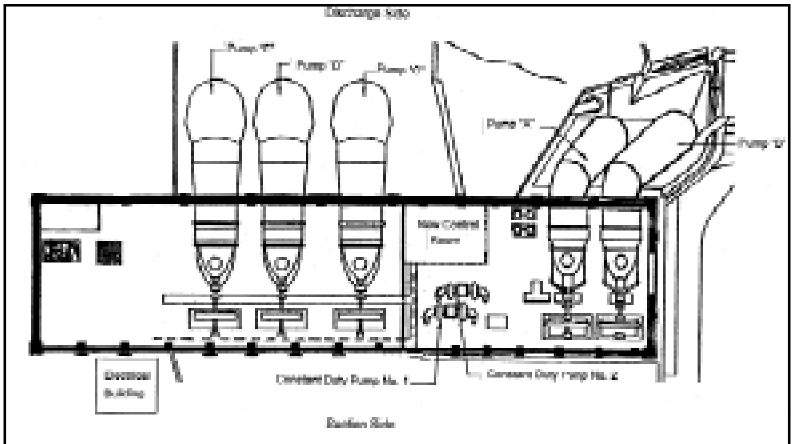


Figure 96. Drainage Pumping Station No. 3. Plan of existing station (NODCOE).

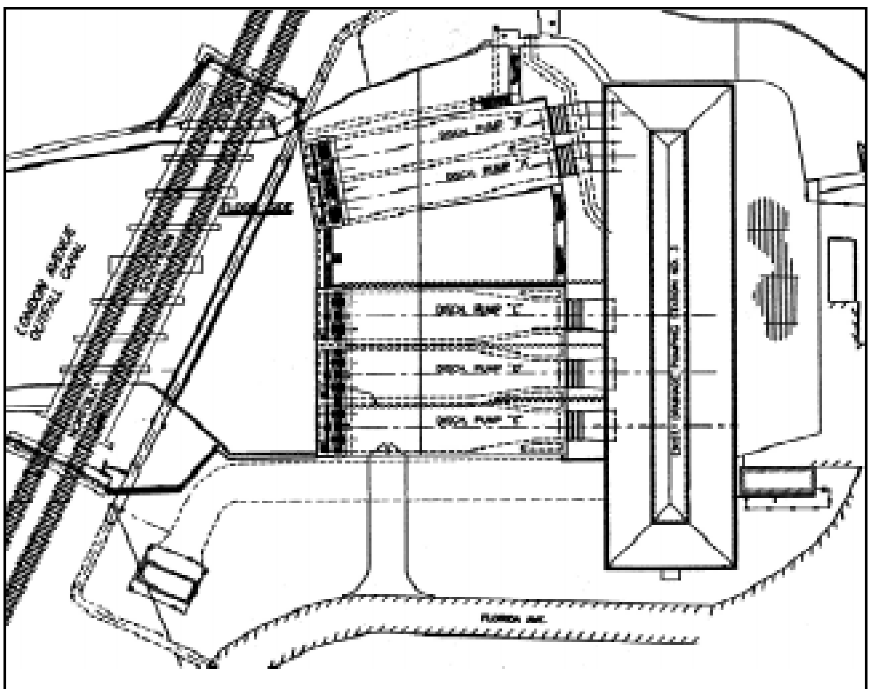


Figure 97. Drainage Pumping Stations No. 3. Plan showing proposed improvements (NODCOE).

Drainage Pumping Station No. 4. Proposed improvements to Drainage Pumping Station No. 3 under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project consist of construction of a continuous line of flood protection which will connect the existing flood protection on each side of the pumping station. These proposed improvements will have limited impact on the existing pumping station. The recommended plan will incorporate use of I-wall, T-wall, and gated monoliths. The pile-mounted gated concrete monoliths will be used in front of the discharge area of the existing pumps. Eight sluice gates will provide

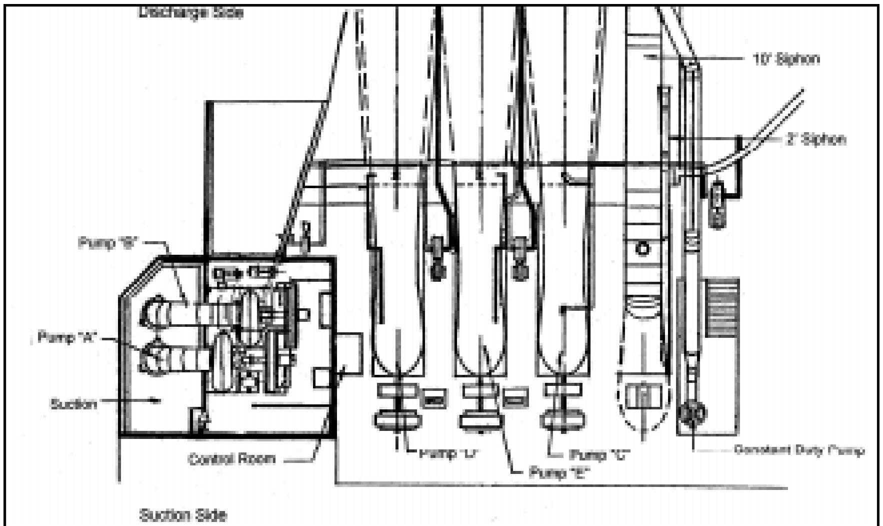


Figure 98. Drainage Pumping Station No. 4. Plan of existing station (NODCOE).

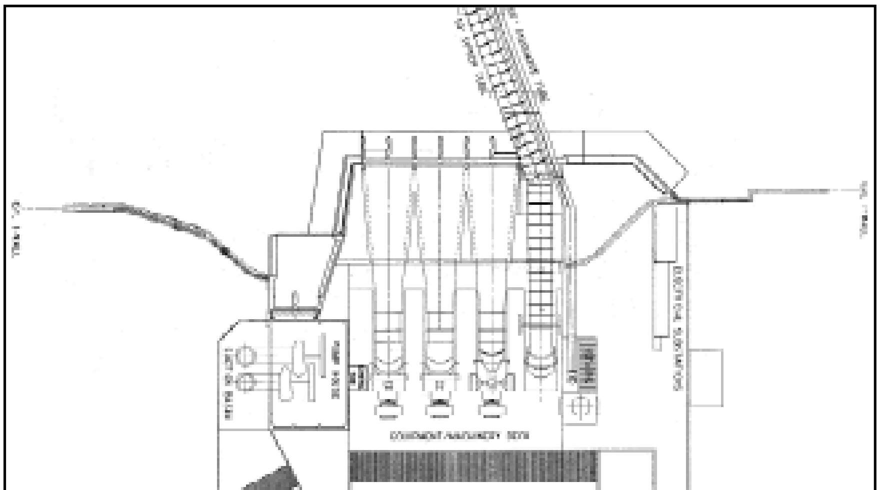


Figure 98. Drainage Pumping Station No. 4. Plan showing proposed improvements (NODCOE).

emergency closure capabilities in the event of pump failure. The single gated monolith in front of the three 1000 cfs horizontal pumps will be built as close as possible to the existing culverts, and will have six sluice gates. Each of the discharge culverts for the three 1000 cfs horizontal pumps will be fronted by two gates. The discharge basin for the two 320 cfs centrifugal pumps will be removed, and a new discharge basin, incorporating two gates at the face of the existing pumping house, will be installed. Concrete T-wall and concrete-capped I-wall will tie the new protection with the protection adjacent to the pumping station. A T-wall will saddle the existing cross-canal siphon. Gate power will be supplied by a separate 25 Hz circuit of an existing Sewerage and Water Board electric switchboard. Portions of the reinforced concrete discharge area liner that are removed during construction will be replaced upon completion of the fronting protection (from United States Army Corps of Engineers 1994:4-6). Figure 98 is a plan of Drainage Pumping Station No. 4 as it exists today, and Figure 99 is a plan of the station after proposed improvements.

As noted in Chapter 6, Drainage Pumping Station No. 4 is not in and of itself eligible for nomination to the National Register of Historic Places. Proposed improvements to this station are only of concern insofar as they affect the drainage system as a whole.

Drainage Pumping Station No. 6. The proposed improvements to Drainage Pumping Station No. 6 under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project consist of fronting protection in the form of pile-founded concrete monolith structures with sluice gates at all of the existing discharge tubes associated with the existing horizontal pumps. Portions of the existing concrete discharge basin slab will be removed in the areas where a new sluice-gate control structure is to be constructed. Each horizontal pump will be provided with its own reinforced concrete discharge tube. Each reinforced concrete discharge tube will be fronted by two gates. The sluice gates will provide emergency closure capabilities in the event of pump failure.

The bottom slab I-walls will provide closure east and west of the two 590 [550] cfs and four 1080 [1000] cfs pumps. The I-walls will complete the closure of the east side pumps. The concrete sluice gate monoliths include center columns and side wall enlargements at the ends of the discharge tubes. Existing narrow common walls between pump tubes are to be widened at the monoliths to accommodate adjoining sluice gate frames. Additionally, center columns are to be installed in each monolith to facilitate the use of two gates at each pump. Figure 100 is a plan of Drainage Pumping Station No. 6 as it currently exists. Figure 101 is a plan of the Station after proposed improvements.

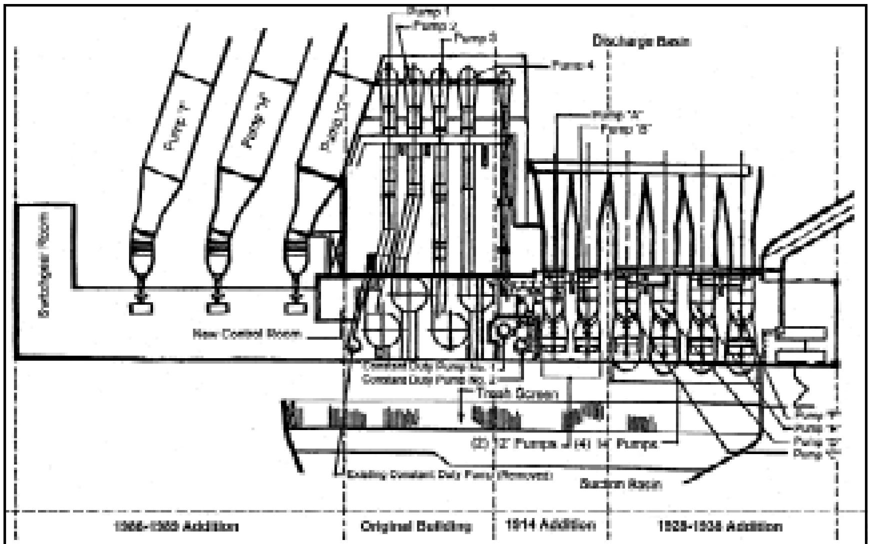


Figure 100. Drainage Pumping Station No. 6. Plan of existing station (NODCOE).

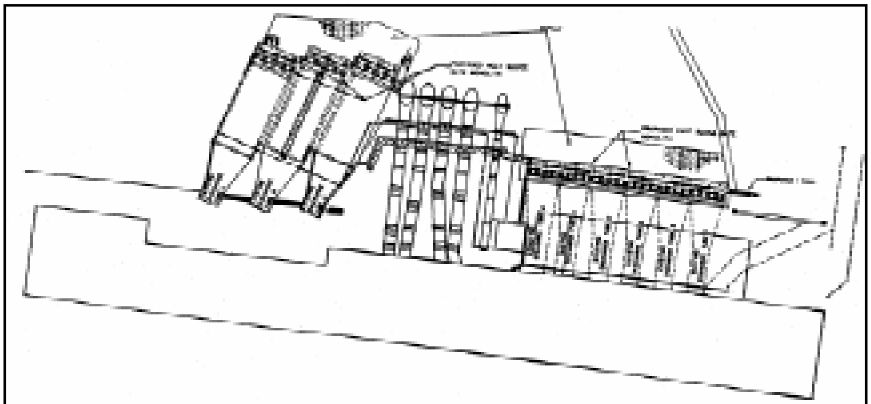


Figure 101. Drainage Pumping Station No. 6. Plan showing proposed improvements (NODCOE).

Drainage Pumping Station No. 7. Proposed improvements at Drainage Pumping Station No. 7 under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project consist of fronting protection in the form of pile-founded concrete monolith structures with sluice gates at all of the existing discharge tubes associated with the existing horizontal and vertical pumps. Portions of the existing concrete discharge basin slab will be removed in the areas where a new sluice-gate control structure is to be constructed. Each pump will be provided with its own reinforced concrete discharge tube. Each reinforced concrete discharge tube will be fronted by two gates. The sluice gates will provide emergency closure capabilities in the event of pump failure. The T-wall monoliths will be constructed to connect the existing canal floodwalls to the ends of the new gate control structures. The gate control structures will be joined together at the center of the discharge basin by another T-wall monolith. The concrete sluice gate monoliths include center columns and side wall enlargements at the ends of the discharge tubes. Existing narrow common walls between pump tubes are to be widened at the monoliths to accommodate adjoining sluice gate frames. Additionally, center columns are to be installed in each monolith to facilitate the use of two gates at each pump. Figure 102 is a plan of Drainage Pumping Station No. 7 as it currently exists. Figure 103 is a plan of the Station after proposed improvements.

Canals Associated with Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7. As stated in Chapter 6, the individual canals making up the major features of the New Orleans drainage system network have all undergone alteration since construction began of the system 100 years ago. Nonethe-

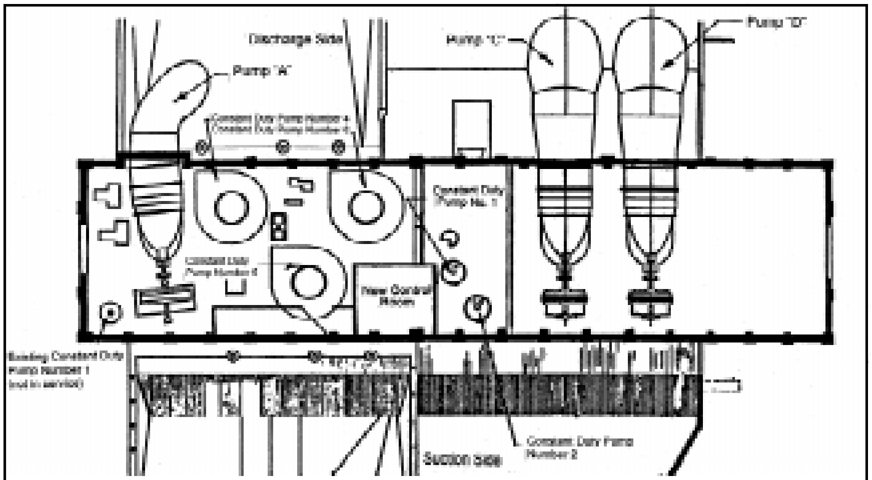


Figure 102. Drainage Pumping Station No. 7. Plan of existing station (NODCOE).

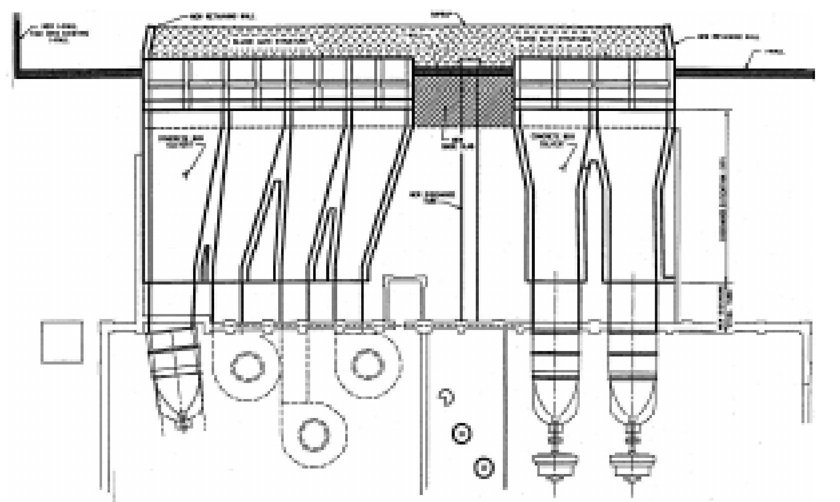


Figure 103. Drainage Pumping Station No. 7. Plan showing proposed improvements (NODCOE).

less, the canals as functional elements of the system remain in place and in use. The proposed improvements to Drainage Pumping Stations Nos. 1, 3, 4, 6, and 7 will have a negligible effect on the drainage network because only the discharge basins of the individual stations will be modified. These discharge basins all have been enlarged and modified several times since their original construction.

Effects of Proposed Improvements on Associative Significance (Criterion A)

The proposed improvements under the Southeast Louisiana Flood Control Project will have no adverse effect on the associative significance of Drainage Pumping Station No. 1. The expansion of the structure will not affect the integrity of either the significant engineering or architectural features of the structure. In addition, the proposed expansion is for the purpose of improving drainage in the city. This emphasizes the strength of the associative significance of this station rather than diminishes it.

Similarly, the proposed improvements under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project will have no adverse effect on the associative significance of Drainage Pumping Stations Nos. 3, 6, and 7. The fronting protection construction will not affect the integrity of either the significant engineering or architectural features of these structures. In addition, the intention of the project is to improve the system by protecting the stations from storm surge, which emphasizes rather than diminishes the strength of the associative significance.

Finally, because their will be no adverse effect on the associative significance of the pumping stations and their associated engineering features and canals as a result of these two projects, we can conclude that there will be no adverse effect on the associative significance of the system as a whole.

Effects of Proposed Improvements on Architectural Significance (Criterion C)

Drainage Pumping Station No. 1. The proposed expansion of Drainage Station No. 1 is, for the most part, well designed and will have no adverse effect on the historic building. The architects of the expansion are to be commended for the care they have taken to replicate Harrod's detailing. As an extension of the overall massing, the architectural rhythms, details, and materials of the existing building, the new fabric will increase the station's monumental presence. Isolated by streets and resting temple-like on its podium next to its canal, the building could stand as a textbook example of the ideal relation between a fine monument and ambient neighborhood of small vernacular units. Only the heavy traffic of Broad Street, which cuts the monument off from its community on the west, and the fact that it is not a public use structure — there is no reason for residents to approach it as they would a library or a market — spoils the illusion.

Extending the drainage station is historically appropriate because the existing building is the result of three separate construction episodes. The first two (1899-1904 and 1913-1915) are almost impossible to distinguish from each other, and the third (1930) is revealed only by a slight change in brick color. It should be noted that the proposed addition, while compatible with the historic character of the existing station, will be distinguishable from the earlier construction as is recommended by the *Secretary of the Interior's Standards for Rehabilitation*. Structural requirements necessitate double pilasters at the junction of the existing and new construction. These then, will serve to demarcate the older and newer parts.

Nonetheless, some of the changes for the proposed fourth extension raise some concerns for discussion. First, the present roof will be replaced with a new copper seamed roof. Historic records indicate that the original roof was slate. While the seamed metal roof is not historically inappropriate, the terra-cotta crests on the monitor ridge on the existing structure will be removed according to the plans. It is recommended that the terra cotta monitor crests be replaced on the new copper roof on both the existing structure and the new addition.

The plans for the addition also indicate the installation of four metal doors and windows with frames in the new construction rather than historically appropriate wooden doors and windows. It would be preferable to maintain the pattern of the existing doors and windows and to duplicate them in wood insofar as is possible in the new construction.

Also, plans call for the addition of exterior metal rolling shutters with projecting casings positioned over the lintel of each window. These are intrusive and will disturb the effect of the subtle profile of projecting and receding bricks. A dark color for both the casings and shutters might help if this equipment absolutely must be utilized. The matte-finish, brown-gray metal utilized for the shutters at the Citrus Pumping Station (No. 10) is recommended for use on Drainage Pumping Station No. 1. Similarly, ventilation louvers should all be manufactured from this matte-finish, brown-gray metal.

The most serious problem with the proposed addition is the new south facade, which does not measure up to the otherwise excellent effort to maintain and extend Harrod's fine design. This side of the structure is the most visible to the community. While the irregular bay scansion of the facade is awkward, it duplicates the existing facade. More problematic are the square, louvered, ventilation windows. Harrod's architectural system — indeed, all of classicism — depends on the consonance of proportions between the windows and the bays in which they rest, rectangle within rectangle. The tops of all doors and windows should align, which is not the case in the present plans. The proposed ventilation windows must be restudied to the proportions of the other windows. It is recommended that the louvers and fans be set into bricked-in "window" rectangles such as are planned for the east facade of the addition. The fans and the louvers should be in the brown-gray, matte-finished metal recommended above for the rolling shutters and casings.

Finally, the proposed aluminum pedestrian door of the south facade is also of concern. The aluminum of this door will contrast unpleasantly with the bricks, and the little window in the middle of the door is awkward. It is recommended that the door on the existing south facade be reutilized on the addition. If this is not possible, it is recommended that a molded metal door of similar appearance (and with a less-obtrusive window) be utilized. The glass of the transom should be set into a wood frame so as not to juxtapose the glass with the brick walls of the structure.

Drainage Pumping Stations Nos. 3, 6, and 7. There will be no adverse affect on the architectural integrity of the three pumping stations from the construction of fronting protection because the modifications are physically separate from the buildings, and the existing structures will not be altered in any way. However, the construction of the fronting protection will result in visual effects which have the potential to adversely impact the integrity of the setting of these significant structures.

Figure 104. Drainage Pumping Station No. 3. Currently existing station viewed from the north.

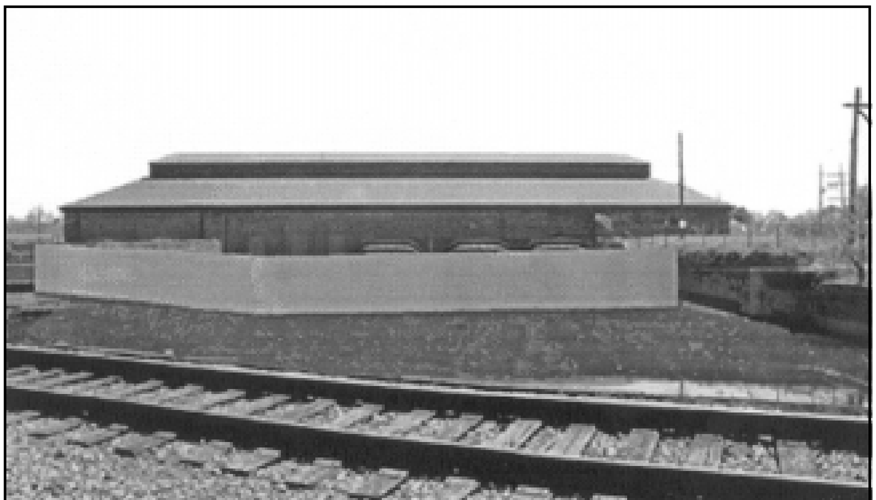


Figure 105. Drainage Pumping Station No. 3. View after construction of proposed improvements.

Visual Effects to Drainage Pumping Station No. 3. Figure 104 presents a view of Station No. 3 from the north. As shown, the view of the pumping station is partially blocked from this vantage point by a pipeline running behind the station. Plans call for the removal and relocation of this pipeline and for the construction of a fronting wall. Figure 105 presents a computer-generated hypothetical view with the fronting wall in place.

Comparison of Figures 104 and 105 shows that the fronting wall obscures the view of station very little more than does the pipeline which is already in place. It may in fact be argued that the fronting wall is more aesthetically pleasing in that it provides a cleaner line than does the existing pipeline. Moreover, the height of the floodwalls constructed along the London Outfall Canal make it difficult to view the station on its discharge basin side. The vantage point of Figures 104 and 105 is not readily accessible, since the Norfolk-Southern Railroad trestle crossing the relief outfall canal at this point is posted as off-limits to pedestrians. The fronting wall will not be visible from the vantage point that the station is seen by most viewers, which is the southern side (Figure 42).

Thus, construction of the fronting wall at Drainage Pumping Station No. 3 does not present an adverse visual effect. The fronting wall will not obscure the view of the station much more than does a currently-extant pipeline. Additionally, access to the vantage point from which the fronting wall will be visible is at best difficult; the area is posted as being off-limits to pedestrians. The fronting wall will not be visible from the vantage point from which the station is most easily viewed.

Visual Effects to Drainage Pumping Station No. 6. Figure 106 presents the view of Drainage Pumping Station No. 6 from along the Metairie Outfall Canal. The height of the floodwalls constructed along the canal make it difficult to view the station on its discharge basin side. Figure 107 presents a computer-generated hypothetical view of the station following construction of the fronting wall. Comparison of Figures 106 and 107 shows that the proposed fronting wall blocks less of the view of the station than does the existing berm and discharge pipes. In addition, the fronting wall will not be visible from the southern side of the station, which is the vantage point from which the station is most easily seen.

Construction of the fronting wall at Drainage Pumping Station No. 6 does not therefore present an adverse visual effect. The station generally cannot be viewed from the angle where the fronting wall will be seen. In addition, the existing berm and discharge pipes block more of the view of the station than does the proposed fronting wall.

Visual Effects to Drainage Pumping Station No. 7. Figure 108 provides the only view of the Drainage Pumping Station No. 7 from which the fronting wall will be vis-

Figure 106. Drainage Pumping Station No. 6 Currently existing station viewed from the north.

Figure 107. Drainage Pumping Station No. 6. View after construction of proposed improvements.

Figure 108. Drainage Pumping Station No. 7. Currently existing station viewed from the north.

ible to pedestrians; the railroad embankment which extends across the relief outfall canal is posted as off-limits to pedestrians. As shown, view of the station is largely blocked by the U.S. Interstate 610 overpass, and only a small portion of the discharge pipes is visible. Figure 109 presents a computer-generated hypothetical view of the station from this vantage point following construction of the fronting wall. Comparison of Figures 108 and 109 shows that while the fronting wall blocks the view of the discharge pipes, the station itself is already obscured by the Interstate 610 overpass.

Figure 109. Drainage Pumping Station No. 7. View after construction of proposed improvements.

Construction of the fronting wall at Drainage Pumping Station No. 7 does not therefore present an adverse visual effect. The station is not readily visible from the angle where the fronting wall will be seen. In addition, the fronting wall will not be visible from the southern side of the structure, which provides the only unimpeded view of the station (Figure 56.

The Drainage System. Because there will be no adverse effect on the architectural significance of Drainage Pumping Stations Nos. 1, 3, 6, and 7 as a result of planned improvements under the Southeast Louisiana Flood Control Project and the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project, either in terms of direct adverse impact to the structures or visual effects that would effect their integrity of setting, we can conclude that there will be no adverse effect on the architectural significance of the drainage system as a whole.

Effects of Proposed Improvements on Engineering Significance (Criterion C)

Drainage Pumping Station No. 1. The Southeast Flood Control Project will add two new horizontal screw pumps to Drainage Pumping Station No. 1. These are rated at 1200 cfs. These will have a different type of electrical motor than the existing pumps, in that they will be driven by 60-cycle current. The motors will be of a higher speed than the pumps, so a speed reducer will be coupled to the pump. These additional pumps will provide the station with greater reliability. In the event that one or more pumps is rendered inoperable in a storm, the additional pumps can handle the storm flow without a reduction in station capacity. However, the station capacity will not be substantially improved, because capacity is limited by what the outflow channel to the next station can carry.

The proposed improvements will have no adverse effect on the existing Wood pumps, which will be left in place and will be unaltered by this project. Similarly, the proposed improvements will have no adverse effect on the complex as an engineering structure, because the new pumps will be contained within an addition, rather than juxtaposed with the existing pumps. Thus, the historic configuration and organizational pattern of the pumps will not be disturbed.

Proposed improvements to the canals and suction and discharge basins will not have a substantial effect on the carrying capacity of the outflow canals unless major alteration are performed to improve their conveyance (carrying capacity) under gravity conditions. Minor refurbishing of the canal and basin retaining walls, consisting of re-concreting and removal of plant growth, will have no adverse effect on these structures since they will not alter their visual appearance. Moreover, the expansion of the discharge basin is a functionally necessary result of the addition of the new pumps and is consistent with the history of improvements to the station.

To summarize, proposed improvements to Drainage Pumping Station No. 1 will have no adverse effect on the individual Wood pumps, the complex of pumps within the station as an engineering structure, or the associated canals. In addition, the proposed improvements will provide an increase in station reliability. They therefore should be considered a continuation of the original concepts for both the station and the drainage system as a whole.

Drainage Pumping Stations Nos. 3, 6, and 7. One of the weak points in the protection of New Orleans from hurricane-related flooding are the drainage pumping stations. Recent studies have indicated that hurricane driven waters from Lake Pontchartrain may, under certain conditions, reach levels of 11.9 ft. NGVD (sea level). While most of the outflow pumps can continue to pump against this head of water, there is a possibility of damage to the pumps from electrical overload or water action. Should power be lost, there is a chance of backflow through the pumps causing possible flooding. The designed modifications to the pump outlets proposed under the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project are required to prevent this backflow from happening, and will also add to the soundness of the protective levee system.

A question which must be answered is whether or not this construction will affect the appearance, historical significance, or function of the Wood screw pumps at these three stations. These pumps are axial flow pumps and, when operating, directly connect the suction pool with the discharge pool. The elevation of the discharge pool directly affects the flow through the pumps. Should the elevation of the discharge pool become too great, it could cause water to flow backward through the pump while it is running forward. The electrical demands upon the motor become excessive when the flow through the pump is reduced. If the power would shut off, the pump could become purely a resistance item to the flow, and the flow would siphon back through the pump. The pump would then run backwards and could overspeed, attaining rotational velocities higher than when driven forward under power. This would cause mechanical damage to the pump. There are brakes or ratchets on all of the outflow station pumps to prevent reverse rotation, but their performance is somewhat dubious. Thus, the proposed construction will actually provide improved protection to these significant pumps.

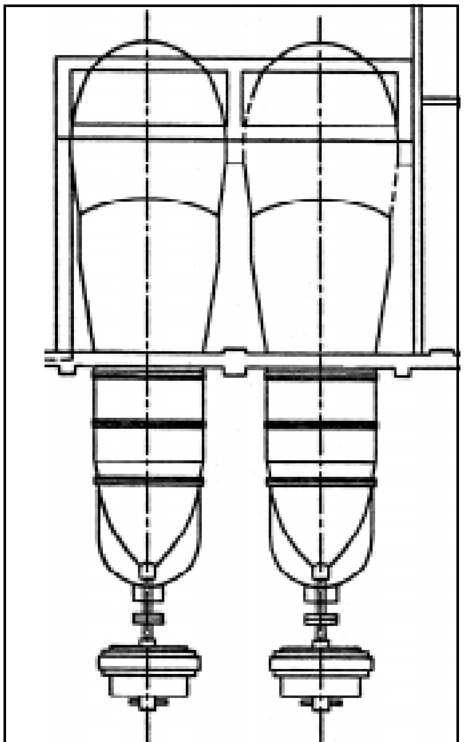


Figure 110. Plan of typical existing horizontal screw pump discharge tube and discharge tube foundation (NODCOE).

With respect to appearance of the pumps, there will be no change to the pumps as they appear on the suction basin side or within the pumping stations. On the exterior of the stations, the pump will look longer on the discharge side and have a gated structure at the end of the discharge pipe. Figure 110 shows a typical discharge tube and discharge tube foundation for a horizontal screw pump. Figure 111 is a plan view of a typical new discharge tube extension, and Figure

112 is an elevation of a typical discharge tube extension and sluice gate, as would be constructed in the proposed improvements. These alterations will not be easily visible to the general public because the discharge pipes of the pumps are obscured from view at most vantage points by the height of the fronting protection and discharge canal floodwalls.

The alterations to the discharge pipes will also reduce discharge output of the pumps. A pump under normal usage will have its discharge responsive to the system into which it is pumping. If the difference between the suction head and discharge head (stages) would be, for example, 10 ft. (as shown in Figure 113), the flow would be that indicated by point A. If the difference in elevations were 13 ft., the flow would be as indicated at point B. Under storm conditions of 11.9 ft. difference between the suction head and discharge head, it would be as low as shown at point C. With the added losses in the proposed outlet charged to the pump, the discharge under a 10 ft head would be reduced from point D to point E (Figure 114). It should be stressed that these calculations are for a typical pump, and the stated values should be taken as merely indicative and not exact. These figures indicate that the variation or tolerance in flow is therefore less affected by reduced discharge output than by water elevation. This is demonstrated in Figure 114.

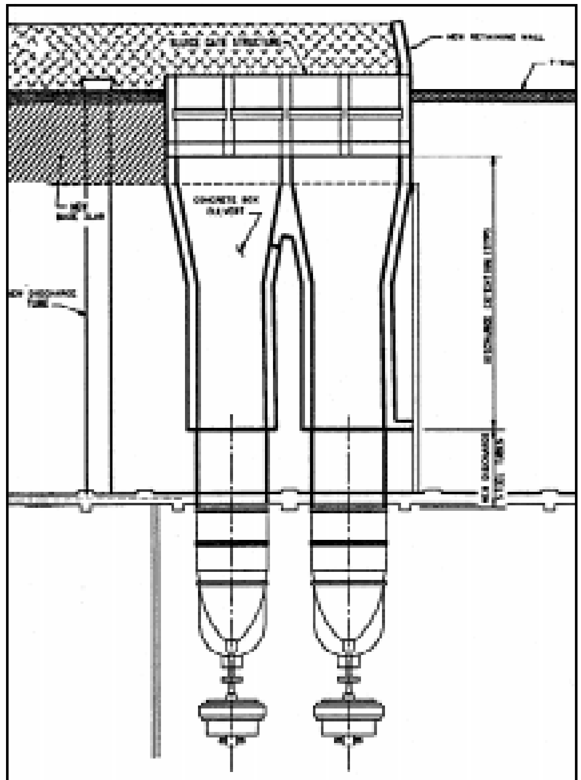


Figure 111. Plan of typical discharge tube extension, as proposed (NODCOE).

Figure 115 illustrates what would happen to the flow if the pump were to lose its electrical power. The flow would reverse, and the rotation of the pump impeller would reverse unless the brakes were applied. This situation will be prevented by the proposed improvements to the fronting protection of Drainage Pumping Stations Nos. 3, 6, and 7.

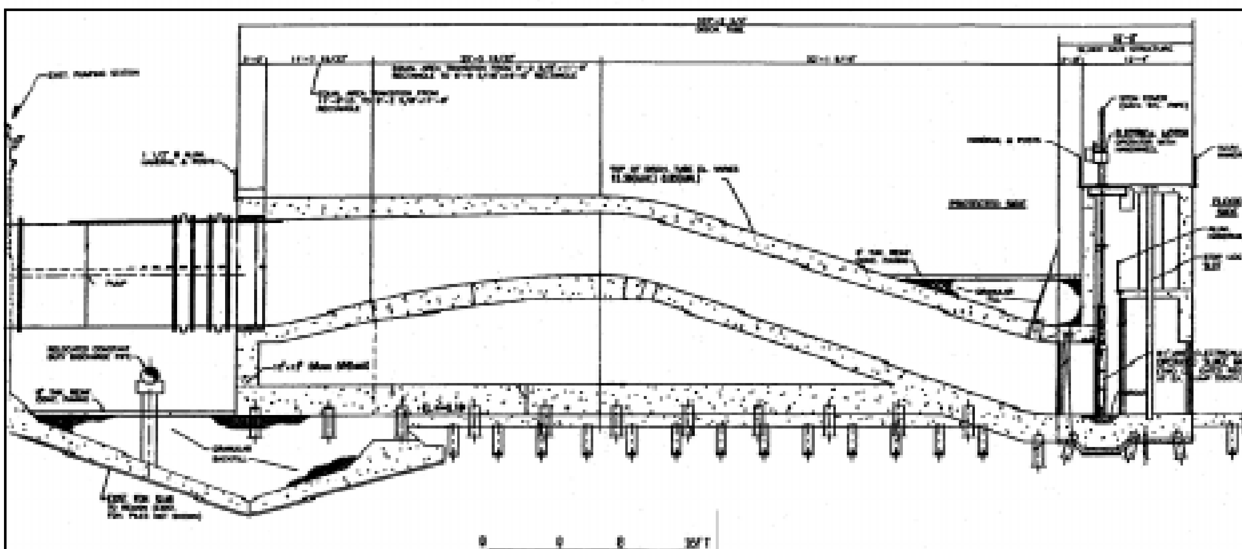


Figure 112. Elevation of typical discharge extension and sluice gate, as proposed (from Pepper & Associates 1995a).

Pump Modification. The modification of the pumping stations by the addition of gates at the outlet of each pump, and the attendant connecting conduit between the pump and the gates, should properly be considered as a pump modification. Pumps of this nature are rated by their capacity flow and the ability to produce a given head (pressure rise or fluid lift) at that capacity. This head is considered to be the rise from the suction flange (inlet) to the discharge flange (outlet), considering all energy losses between as pump losses. This is necessary so as to be able to match pump capability to piping or drainage system requirements, in order to determine the flow which the combined system will produce. In the case of the New Orleans drainage system, which is subject to additional variables such as lake levels, it becomes difficult to predict the actual match flow. The designers of the system allowed for a variation in flow by making the canals as large as was practical and the pumping capacity sufficient to drain the associated land. By doing this, the system was able to carry away as much as possible. Minor changes in the pump capacity, due to reduced discharge output from the additional gates, are unimportant.

Thus, hurricane-driven waters from Lake Pontchartrain could produce tidal stages at the outlet of the existing pumps, which may cause them to allow flow to reverse through the pumps. Flow reversing through the pumps would cause damage to the pumps and possible flooding to the city. The installation of the fronting protection is intended to prevent this from hap-

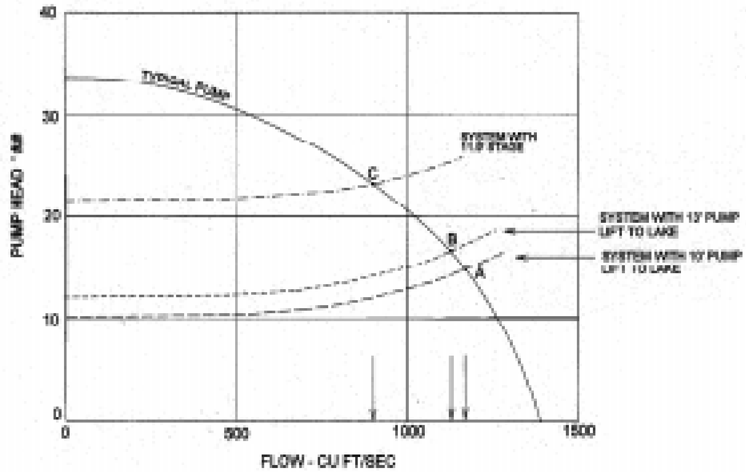


Figure 113. Suction and discharge head levels versus flow rate.

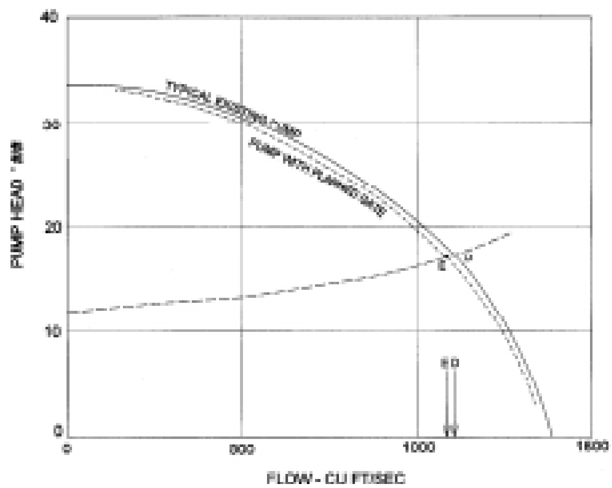


Figure 114. Pump flow rates of existing pump and pump with planned fronting protection sluice gates.

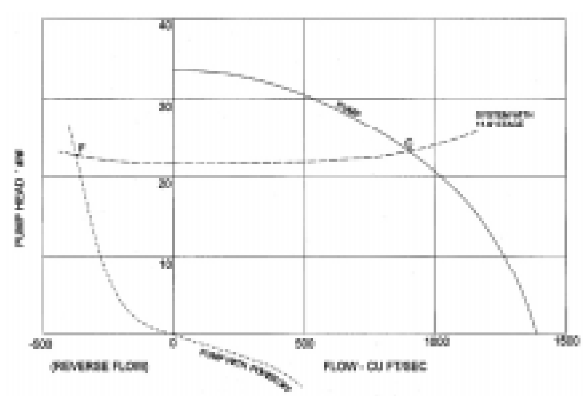


Figure 115. Effect of reverse flow.

pening. These proposed improvements, since they require alteration only to the external discharge tubes of the Wood screw pumps, would not effect the integrity of the Wood screw pumps. They are also appropriate given the history of adaptation and advancement of the drainage system and its constituent pumping capacity.

In sum, proposed improvements to Drainage Pumping Stations Nos. 3, 6, and 7 will have no adverse effect on the individual Wood pumps, which will be left in place. Thus, the complex of pumps within the stations as engineering structures will not be adversely effected, since the historic configuration and organizational relationship of the pumps will be maintained. The proposed improvements will have no adverse effect on the canals associated with the stations. No modification of the canals is included in the proposed improvements. As we have seen, all but one of these canals have all been modified within the last 50 years, and their importance is their locational integrity, which illustrates the interrelationships of the elements of the drainage system. Finally, the proposed improvements will provide an increase in station reliability and serve to protect the significant Wood pumps from damage. They therefore should be considered a continuation of the original concepts for both the stations and the drainage system as a whole.

The Drainage System. Because there will be no adverse effect on the engineering significance of Drainage Pumping Stations Nos. 1, 3, 6, and 7 as a result of planned improvements under the Southeast Louisiana Flood Control Project and the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project, either in terms of direct adverse impact to the structures or visual effects that would effect their integrity of setting, we can conclude that there will be no adverse effect on the engineering significance of the drainage system as a whole.

Summary of Recommendations

Drainage Pumping Stations Nos. 1, 3, 6, and 7 should be considered individually eligible for nomination to the National Register of Historic Places. In addition, these stations along with their associated canals should be considered contributing elements of a drainage system National Historic District. Proposed improvements under the Southeast Louisiana Flood Control Project and the Lake Pontchartrain and Vicinity, Louisiana Hurricane Protection Project will have no adverse effect on the associative, architectural, and engineering significance of these stations or on the drainage system as a whole. However, some of the changes to the historic fabric under the proposed expansion of Drainage Pumping Station No. 1 have raised some concerns for discussion. While these proposed changes, as detailed above, do not themselves constitute adverse effects, it is recommended that their treatment be given the same consideration as is shown by the replication of Harrod's superb detailing in the plans for the extension.

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APPENDIX I