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London and its main drainage, 1847-1865: A study of one aspect of the public health movement in Victorian England

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LONDON AND ITS MAIN DRAINAGE, 1847-1865: A STUDY OF ONE ASPECT OF THE PUBLIC HEALTH MOVEMENT IN VICTORIAN ENGLAND

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PREFACE

This paper was begun with the distinct purpose of examining the "Great Stink" of 1858 and how it resulted in legislation that provided for the effective drainage of London. However, because of the parallel between 1858 and the ecology crisis of today, this study was expanded to examine the role of the Government in allowing such a situation to develop and its attempt to correct the problem.

The author wishes to express his deep appreciation to Dr. A. Stanley Trickett, Chairman of the Department of History, for his guidance, patience, and friendship over the years. This thesis could not have been completed without his invaluable help and encouragement. Also, many thanks to Mrs. Leon Bailey (the former Miss Ella Jane Dougherty) and formerly the Inter-Library Loan Librarian at the University of Nebraska at Omaha for her efforts in obtaining much of the material used in this paper. Last, but not least, to my wife, Ruth, who has had to put up with drains and sewers for too long a period of time.

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CHAPTER I

LONDON: SANITATION AND DRAINAGE DEVELOPMENT TO THE EARLY NINETEENTH CENTURY

The term "main drainage" originally referred to the manner by which the waters of a country would pass off, by its streams and rivers, to its ultimate destination—the sea. The natural unit or division of the earth's surface for such drainage purposes is the "river basin," otherwise known as the catchment area, watershed, or drainage area. The "run-off" from any such area is governed by such conditions as climate, contour of the ground, geology, vegetation, and, in the end, by the development of the land.

The rain that falls on the drainage area of a river is partly evaporated and partly absorbed, either by the soil or by the vegetation. The remainder, which naturally varies, runs off over the surface according to the contours of the ground until it finds its way into the streams, rivers, and the sea. If the sides and floor of a valley consist of clay or other types of impervious strata, a negligible part of the rainfall is absorbed by the soil. In the lower-lying and flatter

parts of the area more of the water is absorbed and held owing to the gentler slopes and grassy or reedy vegetation usually found in such places.

The river basin, in its virgin state and untouched by man, is generally the most favorable agent for reducing the amount and for curbing the rate of such run-off. If the normal channels are not sufficient enough to carry off the whole of the natural flow within its banks, adjoining lands become flooded. This land serves as a natural reservoir until the water can be "passed-away" with a lowering of the level of the water below. Many of these low-lying parts of the valley become boggy and water-logged areas. They are liable to flood especially if they are located near the swampy lands associated with the mean-tide level of the river.

Man, in prehistoric times, probably had no material effect on the flow of the rivers and streams or the rate of run-off. Of course, the clearing of small areas of forest would tend to increase the amount of discharge, but the cultivation of crops would also absorb moisture and tend to counterbalance such an event. As the number of inhabitants increased in any given locale extensive forest clearing would, if not accompanied by equivalent cultivation and reduced rainfall, lead to a more rapid flow to the rivers and, consequently, to more extensive flooding than before.

Man, as he gradually ascended the ladder of

civilization, began to make use of the flow of the streams and rivers for such purposes as the driving of mills and for irrigation. He began to use the millstream, weir, sluice, and lock to regulate the flow of the water to suit his needs and, by encroachment and reclamation of land, to curtail the limits of areas liable to flood.[1] All of these works, while necessary in the development of civilization, tend to restrict the discharging capacity of natural run-off channels and make it more and more difficult to get rid of surface water rapidly and effectively.

Although these changes affected the general drainage problem (and man added his share to it) and although past generations had suffered the inconveniencies in connection with ineffective methods of sewage disposal, it was not until the first half of the last century that drainage problems became matters of vital importance which required serious consideration. The major factors contributing to this state of affairs were the spread of intensive urban developments, the need for efficient systems of a piped water supply, and the demand for improved

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[1]Sir George W. Humphreys, The Main Drainage of London (London: London County Council, 1930), p. 6. Cited hereafter as Humphreys, London Drainage. It is not definitely known when the river walls in and near London were constructed, but it is believed that they were commenced along the lower channels of the Thames during the Roman occupation. Mills, locks, and weirs date from Norman times.

sanitary conditions.

Concentrated urban development plus the advent of roofs and pavements meant converting what were previously retentive areas into impervious ones, thereby increasing the quantity of water and the rate of such surface run-off. The same can be said for the paving of roads, which, when applied to the country as a whole, also greatly aggravated the condition.

At the same time civilization encroached upon, and even over, watercourses, into which were dumped all types of filth and refuse. This diminished or narrowed the waterway and reduced its capacity for getting rid of the ever-increasing flows, due mainly to the extra pressure from the growing and crowded population.

The demand for improved quality and quantity of water also grew with the population. This in turn led to the necessity of disposing of the constantly increasing amounts of waste water.

Therefore, the term "drainage and sewerage of a populated center" consists of "leading away that quantity of water after use which has been brought into that center by human agencies, together with the rain which falls on the center."[2] Not only must provision be made for the adequate disposal of such waste but methods must be devised

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[2] Ibid., p. 3.

to prevent unnecessary pollution of the natural drainage channels into which the waste-waters must be discharged. In the case of London, this natural drainage channel is the Thames River.

The river, beginning about one hundred and sixty miles west of London, grows in size as it is fed by the streams that empty into it until it passes through a gap in a range of hills at a place now called Goring, in Oxfordshire. The Thames flows into the London Basin and continues to grow as it collects the run-off from the hills to the north and south of it. The river, which "winds in serpentine curves as its channel widens and deepens towards the sea,"[3] is the main artery of the London Basin as it passes through the basin on its way to the sea.[4]

The Thames, which flows across the area almost centrally from west to east is fed by sixteen independent

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[3]T. P. Frank, Sir George W. Humphreys, and J. R. Taylor, Report on Greater London Drainage (London: His Majesty's Stationery Office, 1935), p. 10. Cited hereafter as Frank, Humphreys, and Taylor, Report.

[4]T. W. Freeman, The Conurbations of Great Britain (London: Manchester University Press, 1959), p. 20. Cited hereafter as Freeman, Conurbations.

At this time it is necessary to point out to the reader that the Thames is a tidal river for the first one-third of its length from the sea. London, divided by the Thames and inside the tide-limit, was seriously affected by the ebbing and flowing of the polluted river in 1858.

tributary rivers and streams. They are, from west to east, the Colne, Brent, Lee, Roding, Beam, Ingebourne, and Mar Dyke on the left or north bank and the Bourne, Wey, Mole, Hogsmill, Beverly Brook, Wandle, Ravensbourne, and Cray on the right or south bank. These arteries of water form the natural drains of the particular valleys and districts through which they pass.[5]

A number of streams drain the area which is the present site of London. The principal ones, from west to east on the north side of the river, are Stamford Brook, Counter's Creek, Ranelagh (Westbourne), King's Scholars Pond (Tyburn), Fleet, Wellbrook, Shoreditch, Hackney Brook, and Black Ditch. The main streams on the south side, also from west to east, are Beverly Brook, Wandle, Graveny, Falcon Brook, Effra, and the Ravensbourne.[6] These streams drained into the Thames.

It is generally accepted that London began her existence on the left side of the river between two of the streams, the Fleet and the Wallbrook, about forty miles from the sea. It was located at the first convenient crossing-place of the river. The gravel terraces on both

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[5]Frank, Humphreys, and Taylor, Report, p. 15.

[6]Humphreys, London Drainage, p. 6. See also: G. Laurence Gomme, London in the Reign of Victoria (New York: Herbert S. Stone and Company, 1898), pp. 30-42. Cited hereafter as Gomme, London.

sides of the Thames were utilized, with the north side being the most important from the beginning.[7] Other small communities and villages sprang up at various neighboring places such as Westminster and Chelsea on the north and Rotherhithe, Southwark, and Lambeth on the south.

It would require too much archaeological labor and too much space to describe in detail the growth and expansion of London and the other towns of England up to the nineteenth century. Suffice it to say, from the time that the Romans landed and permanently stayed, London was a center for trade and commerce. She held her supremacy through Anglo-Saxon and Danish times and by Norman times was the greatest town in England.[8] London, by medieval times, had acquired a diversified level of importance as a manufacturing center, a distribution center, and the place where the Court and the wealth were situated. These factors, plus the fact that the parliament and government offices were located there, made London the center of attention.

London, as it grew in size and importance, was

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[7]It was here that the heart of the City and Westminster were to be located.
H. E. Priestley, London: The Years of Change (London: Frederick Muller Ltd., 1966), pp. 15-16. Cited hereafter as Priestley, London: Change.

[8]Freeman, Conurbations, pp. 22-3; Priestley, London: Change, p. 17.

faced with the social evils and problems that were also experienced, albeit to a lesser degree, by the other towns that were gradually taking shape. Among these annoyances was "the old difficulty . . . of getting rid of filth and refuse."[9] Since "the first absolute necessity of any sanitation whatever is the deportation . . . or destruction of all the filth daily made or left by man,"[10] Londoners followed the accepted practice of dumping their refuse into the nearest stream, open ditch, or open "sewer." This proved to be a much better solution than merely piling the refuse in a corner or just outside the individual's building or residence.

This refuse-disposal issue was a major problem faced by all of the villages and their governing bodies. It became so serious that in the year 1065 King Edward the Confessor issued a decree concerning the four "royal" rivers of England—the Severn, Trent, Yorkshire Ouse, and Thames. He ordained that "mills and fisheries be destroyed, [and] the waters repaired. . . ." This is apparently the first government regulation against stream pollution although "such action is apt to be among the earliest of tokens that communities are acquiring

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[9]Sir John Simon, English Sanitary Institutions (London: Cassell and Company, Limited, 1890), p. 82. Cited hereafter as Simon, Institutions.

[10]Henry Jephson, The Sanitary Evolution of London (Brooklyn, New York: A. Wessels Company, 1909), p. 14. Cited hereafter as Jephson, Evolution.

civilization; and probably there had been such in England from time immemorial."[11]

As far as London was concerned, this necessity had "been very lightly regarded. . . ."[12] Londoners only followed the traditional procedure of constructing their drain-off channels to discharge directly into the Thames.[13] The origin of this practice is lost in the early history of the city but the Romans found and expanded the system and it remained as the most applicable solution to the problem of filth removal.[14]

The unsanitary conditions in London had, by the thirteenth century, attracted the attention of the law-makers for the city. A regulation passed in 1281 ordered that swine be kept off the streets; this law was made stricter in 1297 when pigsties in the streets were ordered

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[11]Simon, Institutions, p. 70. For instance, sections xv. and xvi. of the Great Charter indicate that towns and landowners had been accustomed to maintaining certain embankments of rivers and section xxxix. required all weirs in the Thames "should be destroyed"; this prohibition was repeated in many other later statutes. Simon lists them on pages 70-71.

[12]Jephson, Evolution, p. 14.

[13]Ibid., pp. 15-6; Gomme, London, p. 60; Humphreys, London Drainage, p. 5; Priestley, London: Change, p. 25. See also: Great Britain, Hansard's Parliamentary Debates, 3d ser., Vol. 151 (1858), 29. Cited hereafter as Hansard.

[14]Walter Thornbury and Edward Walford (eds.) Old and New London (London: Cassell, Petter, and Calpin, n.d.), IV, 234. Cited hereafter as Thornbury and Walford, Old and New London.

removed and any wandering pigs were to be considered "fair game." Offensive trades such as tallow-melting, fur-scouring, horse-flaying, and the slaughtering of oxen, sheep, swine, and other large animals were banished by law from the city and its growing suburbs. The casting of filth from the houses into the streets and lanes of the City was prohibited in 1309.[15] Similarly, in 1357, by a royal order of Edward III, the dumping of filth into the Thames was forbidden due to the need ". . . for avoiding the filthiness that is increasing in the river and upon the banks of the Thames, to the great abomination and damage of the people."[16] But the practice of using the Thames as a sewer was, in spite of more orders and laws, growing in intensity as London expanded.

The authorities of the City of London were, from the earliest of times, cognizant of the necessity for preventing and removing nuisances, for safeguarding the purity of the Thames, and for cleaning the streets. This is demonstrated by the existence of numerous orders and decrees designed to achieve these objectives. The first Act of Parliament in these matters was not passed until

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[15]Simon, Institutions, pp. 39-40. The term "City" refers to the original square-mile site of London, called the "City."

[16]Ibid., p. 40. See also: Frederick Clifford. A History of Private Bill Legislation (London: Buttersworth, 1887), II, 45, 221. Cited hereafter as Clifford, Private Bill; Priestley, London: Change, pp. 37-39.

1388. This Act prohibited the "corruption and pollution of ditches, rivers, waters, and the air of London and elsewhere and required that all dung, filth, and garbage and entrails of beasts killed should be carried away instead of being placed where such refuse would become a source of nuisance."[17]

Removal of these nuisances was the daily task of a contingent of workers hired specifically for this purpose. The origin of the job of "street scavenger" or "raker" is not definitely known, but every parish, village, and town eventually employed men to perform the duties of keeping the streets clean. With the massing of populations in the growing towns accompanied by the fact that there were no effective building regulations, houses sprang up with mushroom-like rapidity with no regard for such things as building-lines, street widths, or the accessibility of air and light. The narrow ways left to foot travel and the steadily increasing wheeled traffic were unpaved, uneven, and full of holes in which garbage and water accumulated. Due to the uneveness of most of the streets a series of dirty puddles ran down the middle of each roadway. These puddles,

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[17]Humphrey, London Drainage, p. 3; Sir Percy Harris, London and Its Government (London: J. M. Dent and Sons, Limited, 1931), p. 113. Cited hereafter as Harris, Government. It should be noted that 12 Richard II, c. 13 is the first English general statute against nuisances near cities and towns.

in times of rain, became a stream of decomposing filth. Before provisions were made for street cleaning and filth removal, the garbage and dung accumulated in great quantities. There were, of course, no effective sewers in the modern definition of the word.[18]

Until the scavengers became paid workers for the various parishes, wards, and towns, the individual householders were responsible for the removal of their garbage.[19] Unfortunately, with the condition of little or no municipal control, the problem grew worse. Even though numerous enactments were passed ordering that "the highways should be kept clean from rubbish . . . dung and other refuse . . ." and "each householder was to clear away all dirt from his door . . . and no one was to throw anything . . . into the streets . . ." the situation steadily worsened.[20]

The idea of street cleaning evolved from the

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[18]A sewer, according to the old authorities, was "a fresh Water Trench or little River, encompassed with Banks on both sides." This according to: Webb, Sidney and Webb, Beatrice, English Local Government: Statutory Authorities for Special Purposes (London: Longmans, Green, and Company, 1922), p. 105. Cited hereafter as Webb and Webb, Statutory Authorities.

[19]The wealthier districts were fortunate in that their refuse could be carted off some distance away and left. In most of the towns, however, at least before the establishment of the "dustpiles," the filth was left wherever it was dumped.

[20]Humphreys, London Drainage, pp. 3-4.

medieval conception of a common nuisance. If streets were not to become impassable, some way had to be found to deal with the "active nuisances."[21] The primary method was to treat the heaps of soil, dung, dirt, ashes, and garbage as ordinary obstructions of the highways and to prohibit all citizens from casting or leaving such filth on the surface of the streets. The local authorities could enforce this "code" as long as there existed some waste-place nearby—a running river, a backyard, or vault—where each day's refuse could be disposed of. The shrinkage of these available areas, the diversion of watercourses from the streets, the extinction of the rare backyards and gardens, and the growing disproportion between the number of "ashpits" on the one hand and the increased population on the other led to the inevitable practice of dumping the refuse in the streets.

Confronted by the steadily growing problem, which prohibitions and inadequate enforcement failed to curb, one authority after another adopted the use of the scavengers and rakers in order to keep the streets clean. London's scavengers were originally appointed "to take custom upon the scavage (i.e., showage). . . . Later it became

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[21] A "passive nuisance" was something like a broken pavement caused by the innocent activity of the body of citizens as opposed to a "common" or "active" nuisance which was the result of an individual householder's or dweller's action of throwing his refuse into the streets. Webb and Webb, Statutory Authorities, pp. 316-7.

their duty to supervise the repair of the pavements and the cleaning of the streets."[22]

The "scavenger" was an unpaid officer, chosen annually, whose duty was to see that the "law against indiscriminate casting of filth or ashes into the streets" was obeyed.[23] The actual work of "sweeping" the streets and carrying away all deposits was entrusted by London's City Corporation[24] to specially appointed "rakers." These rakers collected payment from each individual householder for whatever they carried away to the dumping sites set aside for such purposes. These "laystalls," as they were called, were set "as far as may be, out of the City and common passages"[25] and anyone could use them to dispose of their garbage.

As the city expanded it grew more and more

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[22]Humphreys, London Drainage, p. 4. They were also employed to see that houses were protected against fire (this was a rudimentary precautionary check of construction). See: Clifford, Private Bill, II, 234.

[23]Webb and Webb, Statutory Authorities, pp. 318-9.

[24]For a complete and detailed history of the City Corporation the reader should consult: Joseph F. B. Firth, Municipal London (London: Longmans, Green, and Company, 1876), pp. 1-225. This includes the origin of the Corporation, all of the charters given London, the duties of all the major offices, the obligations of the courts, the voting procedures, and other general information. Cited hereafter as Firth, Municipal London.

[25]Webb and Webb, Statutory Authorities, p. 318.

difficult to find suitable sites for the laystalls. This necessitated the use of vacant areas as temporary places of deposits. The expansion also resulted in an increase in the number of rakers and their carts on the streets. But even with such an increase the cleaning of the streets was grossly inefficient. With the population and refuse growing in geometrical proportions, the situation in the streets worsened instead of improving.

The streets were equipped with "kennels" along each side which served as "sewers."[26] Their main purpose was to get rid of the rain water; their secondary purpose was to carry off whatever sewage accumulated in them in spite of the acts forbidding such a practice. In time the minor watercourses draining into the Thames were utilized as open sewers. These received as much of the water and garbage that could pass through the drains and outfalls of the streets. As long as there was enough rain

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[26]Humphreys, London Drainage, p. 3. In 1189 a series of ordinances, known as Fitsz-Alwyne's Assize, were issued to regulate building in the city of London. While there was no mention of kennels in them, they probably existed, for there were precise directions as to the gutters which carried water from houseroofs, and as to "easements" [sewers?] thereby acquired. Kennels for carrying off sewage and rainwater are mentioned in city by-laws about a century and a half later, though. Clifford, Private Bill, II, 229,233-4. Even up to about 1531, sewers were not thought of as useful for the discharge of offensive matter, or for any sanitary end, except that as would accidently occur by draining off storm or river water which might otherwise become stagnant and noisome.

to keep the "sewers" and watercourses adequately scoured, and as long as the population was small enough to keep the quantity of refuse relatively low, this system proved acceptable. The continued dumping of refuse into the "sewers" soon made them unequal to the task of efficiently sewering the growing city because they soon became blocked with the "deposits" of the city. Intermittent cleaning operations, further futile regulatory acts, and general apathy to the dangers of the situation were the result as London continued to grow on and in its own refuse.

In 1532 Parliament passed an Act which provided for the institution of Commissioners of Sewers for all parts of England. This "Bill of Sewers" was the culmination of local laws and customs which were controlled by temporary commissions and justices whose purpose was to survey and inquire into the needs of different districts. These laws and customs were "partly fortified and partly superseeded by a series of Parliamentary enactments."[27] The consummation of these was the "Bill of Sewers" which definitely established the authority of the King's Commissions of Sewers and of the Courts of Sewers held by

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[27]Webb and Webb, Statutory Authorities, p. 19. For a list of these statutes see Webb and Webb's footnote 1, p. 19. It is needless to point out that the King's right to issue a Commission of Sewers in no way depended on these statutes. Any time an emergency arose, the King could issue temporary Commissions, Juries, and Courts of Sewers. Clifford says that their statutory history begins with 6 Hen. VI, c. 5., in 1428. Clifford, Private Bill, II, 10-11.

them. It formulated a semi-fixed constitution and established procedures for a particular phase of rudimentary sanitary control. They became, in reality, permanent local governing bodies.[28]

The preamble to the Act of 1532 (the Bill of Sewers) explained the circumstances by which the Act was deemed necessary. It related the extent of damages and losses caused by the unnecessary flooding of the sea and the inundation of meadows, pastures, and other low grounds adjoining rivers and other watercourses. The prescribed form of the Commission was a comprehensive authorization and command to do, or cause to be done, all which the locality might need, within the appointed area of the jurisdiction of each "court of sewers." In addition to giving powers of inspection, construction, amendment, and removal, it also gave powers to tax, to appoint officers, to impress the labor of man and beast, and to enact statutes, ordinances, and provisions in order to get the work done.

The Commissions of Sewers were institutions which, as long as they kept their respective districts dry,

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[28]It must be noted that the statute seems to have been an experiment of sorts since its operation or direction was only for twenty years. It was later made perpetual. Clifford, Private Bill, II, 283. "The Statute (6 Hen. VI, c. 15) . . . directs Commissions of Sewers to be issued . . . for a limited period . . . to inquire about damages. . . ." Humphreys, London Drainage, p. 7.

conduced to the healthiness of England.[29] The particulars of the phrase "keeping their districts dry" refers to the specific maintenance duties needed, namely to repair and amend walls, ditches, sewers, banks, bridges, gutters, and streams. They were also compelled to clean and purge the trenches, sewers, and ditches wherever necessary. No sewerage, in the modern definition of the word, was contemplated by the Act, although it did anticipate that offensive matter would find its way into the open sewers in and near the towns which would necessitate the cleaning as the Act called for. These sewers were still regarded as channels for the carrying-off of only surface water, which was comprised of excessive rainfall and the run-off from the fields, roads, and streets of each area.[30]

The "Bill of Sewers" Act embraced large tracts of the country, which was subdivided into about eighty rural districts. London was, for a change, included in the

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[29]6 Hen. VI, c. 5. and 8 Hen. VI, c. 3. had hinted at these institutions by providing for the appointment and powers of Commissions of Sewers for a short, specific term. Simon, Institutions, p. 21.

[30]Clifford, Private Bill, II, 284-5. Humphreys says that "these sewers were originally banked-up watercourses, intended solely for the purpose of carrying-off the surface drainage." Humphreys, London Drainage, p. 5.

provisions of the Act.[31] This inclusion, though, was sketchy and relatively undefined. The areas contained were the City (which almost retained its entire autonomy), and what later became the specific districts of the city: "Westminster, Holborn and Finsbury, the Tower Hamlets, St. Katherine, Poplar and Blackwall, Greenwich, and one for parts of London that overlapped into the present-day counties of Surrey and Kent."[32]

Sanitary improvement for London, even with the provisions of the Act, was almost a hopeless task because of the rapid increase in the population of the city. In Henry II's time, the population was estimated to be 40,000; prior to the plague of 1349, the number was put at 90,000. It had declined to 35,000 in 1377 due to severe ravages of the plague in 1361 and 1369. By 1590 the number had risen to about 160,000.[33] Coincidental was the number of

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[31]One of the few instances, insofar as London was concerned, in this matter occurred as early as 1307, when a "commission of sewers" order was directed to the mayor and sheriffs of London, ordering them to clean the Fleet River, which, even as early as this date, had become the principal channel for conveying the "sewage" of the town into the Thames. See Clifford, Private Bill, II, 281; Thornbury and Walford, Old and New London, IV, 234.

[32]Clifford, Private Bill, II, 285-6. See also: Gomme, London, p. 64; Webb and Webb, Statutory Authorities, pp. 84-5 (these pages are important because they summarize, in a sense, the inefficiency and corruption that gradually developed in the Commissions' Courts of Sewers and allowed the situation to worsen in leaps and bounds up to the middle of the nineteenth century); Firth, Municipal London, pp. 226-7; Humphreys, London Drainage, p. 5.

[33]Frank, Humphreys, and Taylor, Report, p. 13.

buildings erected to house these people. The situation had become so critical by 1580 that Queen Elizabeth I was compelled to issue a proclamation forbidding any new buildings within the City or within three miles of its gates.[34] Other proclamations followed, but they did little good in curtailing the spread of the city.

Most of the houses and buildings were provided with cesspools. These were dug in the basement or, in the case of the semi-tenement buildings, at the end of the row of structures, or in the backyards. These cesspools, with "privies" set over each one, usually leaked and stank.[35] The cesspools were considered as the "proper receptacle for house drainage."[36] They were supposed to be emptied regularly, but such a practice was never fully put into operation. Many times, after the cesspools were full and overflowing, they were just covered over, a new hole dug, and the privy moved over. Some cesspools were constructed so that the liquid matter would overflow into the nearest open kennel while the solid matter remained even though,

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[34]Simon, Institutions, p. 84.

[35]G. M. Young, Early Victorian England (London: Oxford University Press, 1934), II, 85. Cited hereafter as Young, Early Victorian England.

[36]Humphreys, London Drainage, p. 1.

at this time, it was illegal to connect cesspools to the "sewers."

The London Commissions of Sewers were authorized to make new vaults and "sewers," to cut into any drain, and to alter, amend, and scour any common sewer. They were also to remove all kinds of nuisances. They used the same methods as the scavengers and rakers did, even using "dung-boats."[37] These were barges of various types that were loaded with refuse and floated down the Thames where the filth was shovelled into the water.

The very frequency of the orders and decrees in regard to sanitary matters makes it probable that they went unheeded. The conditions which existed, in spite of the attempts of the various authorities provided a fruitful breeding ground for disease. London was subject to periodic incursions of the plague, typhus, smallpox, and in the nineteenth century, cholera. The chief precautions against them were the cleaning of streets, the shutting-up of infected houses, restricting gatherings of people, and piecemeal attention to some of the regulations against overcrowding and overbuilding.[38] Regardless of the measures attempted, London was decimated by severe ravages of the plague in 1349, 1361, 1580-3, 1603, 1606-7, 1625, 1629-31,

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[37]Clifford, Private Bill, II, 250.

[38]Humphreys, London Drainage, p. 4.

1636, and 1664.[39]

The city authorities were uncertain as to how to curb or eradicate the plague. They touched upon some possible causes: the increase in buildings, the slaughterhouses located inside the city boundaries, the overcrowded burial sites within the city, the filthy streets, yards, and "sewers." But they offered no real cure.

The Great Plague appeared in 1665 and occupies a prominent position in the sanitary records of London. It started early in the summer and spread quickly.[40] By August and September the epidemic was at its peak, claiming from six to ten thousand victims per week. As the death toll mounted, great numbers of people fled to the country.

The cooler weather of autumn helped slow down the infection, but the epidemic continued during the winter and spring of 1665-6. The weekly death rate dropped.

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[39]Priestley, London: Change, pp. 39, 47-48, 54, 73. The plague of 1603, just before James I assumed the throne, was so severe that about one-fifth of the population of London was carried-off by it. So general was the sickness that it was not considered safe to summon Parliament for nine months after the coronation.

[40]The plague first appeared in London in the suburban parish of St. Giles-in-the-Fields. For detailed accounts of both the Plague and the Fire, see the diaries of Daniel DeFoe, A Journal of the Plague Year (London: J. M. Dent & Sons Ltd., 1957; John Evelyn (ed. by E. S. DeBeer), The Diary of John Evelyn (Oxford at Clarendon Press, 1955), 6 Vols.; and Samuel Pepys (ed. by Henry B. Wheatley), The Diary of Samuel Pepys (London: G. Bell and Sons, Ltd., 1928), 7 Vols. Priestley, London: Change, pp. 71-150 is a good account of the Plague and pp. 151-179 of the Fire.

People returned to the city but, as the summer continued, the plague began to make further inroads into the already-besieged city. Londoners feared a more severe renewal of the plague, but they were saved by the appearance of an effective disinfector.

The Great Fire of 1666, while lasting only four days, left the city in ruins. The area of destruction measured about 450 acres and some 13,300 dwelling places were destroyed.[41] The fire was actually a blessing in disguise because the parts of the city which burned were its more ancient sections. It was in these areas that successive generations of people had lived, befouled the ground, and been buried. There were no wide streets for the wind to blow through and to circulate the air. Alleys were more prevalent than streets. The surface of the ground was packed with all types of excrement and refuse. The pestilence lingered and periodically tried to escape from its surroundings.

The houses, constructed mainly of wood and plaster, had hereditary accumulations of ordure in their vaults, and cesspools located beside or beneath them. These unventilated buildings had been saturated with generations of excrement and filth; their walls, floors, and even the furniture stored an infinity of infection. The Fire was a

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[41]Priestley, London: Change, p. 178.

turning point in the sanitary condition of London due to the fact that it swept away the accumulated filth of centuries. Unfortunately "full advantage was not taken of the opportunity which then presented itself."[42]

The Fire gave London a fresh start in its sanitary affairs but the gains were not of a permanent nature. Some of the worst evils which the Fire burned away were the kind that would reaccumulate by degrees if proper action were not taken, and it was not.

In the discussion for the rebuilding of London, Sir Christopher Wren submitted a plan that called for the construction of wide streets running in parallel lines from east to west. His plan was the best offered from the public health viewpoint but it was not accepted. The Act for the rebuilding of London was passed in 1667 and did contain much that was of importance to the health of the city.

The official origin of the Commissioners of Sewers for the City of London seems to lie in the rebuilding Act of 1667.[43] This body was entrusted with the sanitary well-being of the City, an arrangement which lasted almost two hundred years. The act conferred upon them substantial powers in connection with sewerage and paving. These powers were extended from time to time by further acts

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[42]Humphreys, London Drainage, p. 4.

[43]See footnote 37, p. 21.

dealing with sewerage, paving, cleaning, lighting, dust removal, and the like. The Commissioners could also enlarge, clean, and scour any old vaults or common sewers.

By 1662-6 the practice of constructing underground courses for the carrying-off of rainwater had been adopted. This was a necessary public convenience because of the increase in the number of houses and the subsequent propagation in the amount of rainfall from the roofs. The open sewers and watercourses were, in spite of all prohibitions, polluted along with the vaults and sewers. A growing population made it gradually expedient, and even essential, that the ancient "sewers" should be converted into liquid-refuse carriers. Various streams were converted into sewers—the King's Scholar's Pond (Tyborn Brook), Bayswater Brook (West Bourne), Counter's Creek, Stinking Ditch, Long Ditch, Westminster, the Fleet, and Wall Brook.[44] The rebuilding act also provided for the designing of and the "setting out" of a number of places for all common sewers and drains. Buildings were supposed to be made of brick and regulations were supposed to be followed so that a repetition of the previous conditions would be avoided.[45]

Whatever the sanitary gains that may have resulted from the destruction and subsequent rebuilding of the city

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[44]Gomme, London, pp. 40-1; Clifford, Private Bill, II, 188.

[45]Priestley, London: Change, p. 187.

were, London was, even by the end of the eighteenth century, an unhealthy place of residence. Without the basics of efficient sewage disposal and water supply, with no systematic method of refuse removal, and with conditions ripe for the accumulation of even worse conditions, London was not immune to diseases which associate themselves with filth and dirt. The primitive methods of sanitation that existed did not meet the demands of the times as the population continued growing and adding to the problems.

Since the beginning of the nineteenth century the availability of a constant supply of water has been closely connected with the sewerage and sewage disposal problem of London.[46] The introduction of the water-closet, in about 1810, and its subsequent widespread usage, was dependent upon a constant supply of water.[47] The water-closet was to make a very great and lasting impression upon the sanitary development of the city: it offered

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[46]The history of the water supply of London is an interesting study in itself. For good general histories the reader should see: Clifford, Private Bill, II, 36-169; Firth, Municipal London, pp. 381-407; F. W. Robins, The Story of Water Supply (London: Oxford University Press, 1946). Cited hereafter as Robins, Water Supply; Priestley, London: Change, pp. 57-64.

[47]In 1596 Sir John Harington is supposed to have invented a water-closet: "A water-adaptation . . . though not . . . a modern water-closet, [which] was effectual enough for its purpose." Simon, Institutions, p. 81. See also: Robins, Water Supply, p. 159. It was largely confined to relieving the problems of the houses of the wealthy. For a humorous and, to some extent, informative look at the history of the water-closet, see Glenn Brown, Water Closets. A Historical, Mechanical, and Sanitary Treatise (New York: The Industrial Publication Compay, 1884).

facilities for the entire removal of sewage from the immediate premises.[48]

At first the water-closets were constructed to discharge into those ancient receptacles of refuse, the cesspools. Already overtaxed and overfed, these soon overflowed. Overflow drains that ran from the cesspools into the street sewers were constructed, even though up to about 1815 it was a penal offense to discharge any offensive matter into the sewers. This law made the adoption of the water-closet somewhat slow but with the relaxation of the law after 1830 the use of the water-closet rapidly increased.

These two events—the introduction and usage of the water-closet and the change in the law prohibiting the connecting of cesspools to the sewers—transformed the whole main drainage problem of London. They gave urgent and immediate importance to the question of the pollution of the Thames River. But even more significantly "the main natural drainage artery of London, the Thames, had now become the main sewer; and one, owing to tidal action, of a particularly obnoxious type."[49]

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[48]Humphreys, London Drainage, p. 5.

[49]Frank, Humphreys, and Taylor, Report, p. 16.

CHAPTER II

EDWIN CHADWICK AND THE SANITARY PROBLEM

London's population, which increased from 958,000 in 1801 to 2,362,000 in 1851, brought sanitary problems much too novel and complicated for the antiquated and archaic administrative units that constituted the sanitary authorities for the city.[1] The Parish Vestries, Boards of Guardians, the innumerable local boards for paving, lighting, and cleaning, the nine water companies, and the eight joint-stock cemeteries split the sanitary government of London (about 115 square miles) into

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[1]The rapid deterioration of health conditions in London went, somewhat paradoxically, hand-in-hand with an increased attention (although limited) to public health and sanitation by some of the local authorities. The work and organization of the Improvement Commissions, whose aggregate number increased dramatically in the late eighteenth and early nineteenth century, is best described in Webb and Webb, Statutory Authorities, chapter IV. See also: B. Keith-Lucas, "Some Influences Affecting the Development of Sanitary Legislation in England," Economic History Review (2d Ser.) VI, No. 3 (1954), 290-296; E. P. Hennock, "Urban Sanitary Reform a Generation Before Chadwick," Economic History Review, (2d Ser.) X, No. 1 (1957), 113-120. For the population figures see: H. Price-Williams, "The Population of London, 1801-1881," Journal of the Royal Statistical Society, XLVIII (1885), 398-399.

multiple competing fragments.[2] These local bodies, each clinging with "grim determination to their microscopic segment of power and dignity" and "with the object it seems . . . of keeping out other authorities" rather "than of conferring benefits on the population beneath its care"[3] obstructed any serious attempt at reducing the chaos, which grew worse year by year. The sewerage and drainage was left as an inefficient service in the inept control of the City Commissioners and the seven Crown-appointed Commissions.[4]

These Commissions were independent entities: each sat within its boundary and jealously guarded its jurisdiction against the encroachments of the rest. They had almost unlimited powers in their respective districts

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[2]For example, there were 78 vestries and over 300 local boards operating under about 250 separate statutes. Hansard, 3d ser., Vol. 127 (1855), 711-712; R. W. Bell and Sir G. Gibbon, History of the London County Council (London: Macmillan and Co., Limited, 1939), pp. 19-20. Cited hereafter as Bell and Gibbon, London Council. See also: Great Britain, Parliament, Sessional Papers, ed., Edgar L. Erickson (230 vols., New York: Readex Microprint Corporation, n.d.). (Cited hereafter as B.S.P.) (House of Commons), 1834, Vol. XV (Reports, Vol. 11), "Report from the Select Committee on Metropolitan Sewers." It was estimated that these bodies contained more than 10,000 vestrymen, commissioners, trustees, and other officials.

[3]R. A. Lewis, Edwin Chadwick and the Public Health Movement (London: Longmans, Green, and Co., 1952), p. 151. Cited hereafter as Lewis, Chadwick and Health.

[4]Besides the City, there were Commissions for Westminster, Holborn and Finsbury, the Tower Hamlets, Poplar and Blackwall, Surrey and Kent, Greenwich, and St. Katherine.

but none at all outside of it. Each had its own peculiar method of conducting business.[5] Each had its own independent staff of engineers, clerks, surveyors, and other assorted officers. Each carried out their drainage works under their own regulations as to the size of drains, rates of inclination, method of execution, and cost. There was no uniform system.

Such an environment provided a fertile breeding ground for a new and frightening disease. Cholera first appeared in Britain in 1831-2 and, while it never reached the proportions of the bubonic plague of the fourteenth century, it took a number of lives in a short period of time. The epidemic galvanized the moribund authorities into temporary and frantic activity.[6] Unfortunately, cholera, the results of which put a wholesome fear of filth into the governing classes, went as quickly as it came. Memories were short, proposed municipal plans expensive, the activity was piecemeal, and the good

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[5]All of the Commissions received written complaints in the office of the district board; these were handled by the district surveyor and clerk who usually met once a month to read the books.

[6]A Central Board of Health, with medical superintendents and with mandatory powers, was temporarily established to advise the numerous ad hoc Local Boards of Health set up to combat the epidemic. See: C. Fraser Brockington, Public Health in the Nineteenth Century (London: E. and S. Livingston Ltd., 1965), pp. 66-94. Cited hereafter as Brockington, Public Health.

intentions soon disappeared.[7]

The pollution of the Thames could not be ignored so easily and the condition of the river gradually worsened. This dilemma, along with the "state of the metropolis," was dramatically pointed out by numerous Parliamentary reports on the water supply, sewage, and by Edwin Chadwick's Report on the Sanitary Condition of the Labouring Population of Great Britain. These emphasized the deplorable conditions caused by the defective drainage system of the city and by the divided management of the eight sewers commissions. They hinted at the need for a uniform type of drainage program, but in vague and irresolute terms. The later Royal Commission on the Health of Towns and the Health of Towns Association also concurred, although in stronger language.[8]

General drainage bills had been introduced in the House of Commons in 1841 and 1842 but postponed because of the general political climate at the time.[9] Peel's

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[7]Cholera was to return in 1837, 1848-9, 1854, and 1867. Typhus, consumption, and tuberculosis were more deadly but cholera can be credited with furnishing the major impetus for the general and wide-spread public health movement which was begun in the 1830's.

[8]S. E. Finer, The Life and Times of Sir Edwin Chadwick (London: Methuen and Co. Ltd., 1951), pp. 229, 232-242. Cited hereafter as Finer, Chadwick. Chadwick was the staunchest supporter of this view; he wanted to cut through the numerous authorities and set up a strong central body to handle all health matters. See Lewis, Chadwick and Health, p. 151; Finer, Chadwick, p. 309.

[9]Lewis, Chadwick and Health, pp. 39, 106-7; Hansard, 3d ser., Vol. 56 (1841), 138-9; Vol. 59 (1841), 474; Vol. 62 (1842), 639.

Government, newly formed after the elections in 1843, passed up the introduction of a Government Bill and, instead, set up the Health of Towns Commission. Its recommendations were largely incorporated in a Bill introduced into the House of Commons by Lord Lincoln in 1845.[10] Lincoln introduced it with the knowledge that it would be postponed until the following year. Lincoln's Bill was put aside in 1846 because of the resignation of Peel's Government due to the Corn Law crisis.

During the session of 1847 Lord Morpeth introduced another Bill on drainage into the House of Commons.[11] It was also based upon the recommendations of the Health of Towns Commission and was similar in most respects to Lincoln's earlier Bills.[12] Morpeth was forced to withdraw his Bill due to the strong opposition that was raised against him, primarily from various vested interests, anti-sanitarians, anti-centralists, and particularly the City Corporation of London. Morpeth tried to save the Bill but not even the dropping of London from its provisions could guarantee it from the threat of being rewritten and

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[10] Hansard, 3d ser., Vol. 82 (1845), 1077; Finer, Chadwick, p. 240. Lincoln was Peel's Commissioner of Woods and Forests.

[11] Hansard, 3d ser., Vol. 89 (1847), 617-45. Morpeth was Russell's First Commissioner of Woods and Forests; Finer, Chadwick, p. 311.

[12] Hansard, 3d ser., Vol. 89 (1847), 624.

ultimately defeated.[13] Morpeth re-introduced the Bill later in the session. It became the Public Health Act of 1848 only after much political manipulation and only after cholera reared its ugly head again.[14]

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[13] Ibid., Vol. 96 (1847), 391, 414-417, 981; Finer, Chadwick, p. 295. The Government apparently decided to deal separately with the City Corporation, which had introduced its own Sewers Bill, and to incorporate its Sewers Commission into a unified metropolitan one. The Times (London), February 25, 1848.

[14] The story of the eventual passage of the Act began ten years earlier with the 1838 investigations of the Poor Law. Its final form was affected by the political, social, and economic philosophies of the times. Those who favored a centralized administration armed with adequate powers were adamantly opposed by those who feared the creation of such an institution, by the vested interests, by those who would be financially affected (for example, the landlords), by many town councils, and by the City Corporation of London. The public and the press, in general, supported and wanted the Bill.

The Act's major weakness was that it was a permissive, rather than a compulsory one. It did not come into force until the adoption of its provisions by each respective district or town. The General Board of Health that was established by the Act had limited powers and its overall effectiveness is shown by the fact that its life was short: after the first five years it ceased to exist for all practical purposes. The Act laid the foundation of the Public Health service and led to the creation in all areas of a body of skilled administrators—medical officers, inspectors, and the like—who would eventually bring about a sanitary revolution by the end of the nineteenth century.

It would be impossible to give a full and detailed account of the struggle for the Act of 1848 within the scope of this paper. In order for the reader to achieve some knowledge of the complexities of the issues, the personalities of those involved, the temper of the times, and the engineering problems of drainage that were being proposed, he is advised to consult: Brockington, Public Health, pp. 136-150; Finer, Chadwick, pp. 235-242, 297-438, 458-472; W. M. Frazer, A History of English Public Health: 1834-1839 (London: Bailliers, Tindall, and Cox, 1950), pp. 33-49. Cited hereafter as Frazer, Public Health; W. I. Jennings,

The exclusion of London, especially in the face of an impending cholera epidemic was, sanitarily speaking, inexcusable, even if the political situation dictated it.[15] As a result, the Government appointed a Royal Commission to compensate for the exclusion of London. It was under Chadwick's control. The Metropolitan Sanitary Commission was charged to inquire into the sanitary condition of London; in actuality the purpose of the investigation was to convict the works and administration of the various

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H. J. Laski, and W. A. Robson (eds.), A Century of Municipal Progress the Last Hundred Years (London: George Allen and Unwin, Limited, 1935), pp. 41-45, 47. Cited hereafter as Jennings, Laski, and Robson, Municipal Progress; Barbara Hammond and J. L. Hammond, The Age of the Charterists, 1832-1854 (London: Longmans, Green, and Company, 1930), pp. 292-310; Royston Lambert, Sir John Simon: 1816-1904 (London: MacGibbon and Kee, 1963), pp. 61-63, 65-73. Cited hereafter as Lambert, Simon; Simon, Institutions, Chapter X, "Public Health Legislation of 1848," and Chapter XI, "General Board of Health, 1848-58"; Elie Halevy (trans. by E. I. Watkins), Victorian Years 1841-1895, Vol. IV (6 vols., A History of the English People in the Nineteenth Century), (New York: Barnes and Noble, Inc., 1961 ed.), pp. 176-179; Lewis, Chadwick and Health, Chapter IV, "Health of Towns Commission, 1843-45," and Chapter VIII, "Public Health Act, 1848"; Frazer's Magazine, "The Public Health Bill: Its Letter and Its Spirit," Vol. XXXVIII, No. CCXXVI (October, 1848), pp. 444-464; M. W. Flinn (ed.), Edwin Chadwick: Report on the Sanitary Condition of the Labouring Population of Great Britain: 1842 (Edinburgh: Edinburgh University Press, 1965), pp. 66-73. Cited hereafter as Flinn, Chadwick: Report.

[15]The difficulties of fitting London into a Public Health Act underlined the obvious advantages to be gained by setting up a Royal Commission on this intricate and politically dangerous issue.

Sewers Commissions.[16]

The Commission declared that the control of the sewers should be placed in the hands of a single board. A central system of administration was thought to be the best solution because the division of drainage service among several independent authorities was extravagant and inefficient and because the system made it impossible to instigate improved works of drainage. The Commission also emphasized the practicality of combining responsibility for the water supply with control over the main drainage, sewage, and refuse disposal services.[17] The Commission's plan, though, was thwarted by the opposition that the City Corporation was able to raise. A compromise was finally

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[16]Lewis, Chadwick and Health, pp. 151-152. Its reports were actually unnecessary rewritings of what were the already-known deficiencies of the sewerage facilities of London.

The members of the Commission were Chadwick, Southward Smith, Lord Robert Grosvenor, Richard Lambert Jones, and Professor Owen, all members of the early sanitary movement. Chadwick had the majority on his side with the result that the reports emphasized all of the contentions, proposals, and plans of his London program. See also Finer, Chadwick, pp. 309-310.

The Commission was to investigate house drainage, main drainage, street cleaning and paving, water supplies, and scavenging; it was also to inquire into the best means of using the existing works and also of erecting new works. The Commission was also supposed to find the most equitable methods of rating and assessment.

[17]B.S.P. (House of Commons), 1847-48, Vol. XXXII (Reports, Vol. 8), "First Report of the Metropolitan Sanitary Commission," pp. 49-50. Cited hereafter as B.S.P., Vol. XXXII, "First Report . . . Sanitary Commission." The Commission made three reports which, on the whole, were disappointing as far as their recommendations were concerned.

reached after much debate.[18]

The new authoritative body was to be called the Metropolitan Commission of Sewers. It would consist of the seven consolidated Commissions of Sewers plus the City Corporation's Commissions of Sewers which, for political reasons, retained its identity. The Corporation would have to accept the decisions of the majority in regard to drainage in the square mile of the City.[19]

The act under which one Commission of Sewers was

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[18]It was obvious that the problems of the metropolis would have to be solved in installments and not by a single Act of Parliament, as many thought was possible. See Finer, Chadwick, pp. 328-29.

[19]This was a particularly difficult bone for the City to swallow. Its jealously-guarded independence and its considerable, often-used political power had exempted it, for example, from the Municipal Corporations Act of 1835. Its unusual position was further enhanced at this time due to the fact that its Parliamentary representative was the Prime Minister, Lord John Russell.

The City Commission of Sewers, established in 1669, began to build its own sewers in the 1770's. Because of various reasons (the prime ones being cost, size, and the leisurely attitudes of the authorities) there were less than ten miles of sewers laid down by 1832; but, by 1843, the City, no doubt spurred on by the growing "outside" sanitary criticism, had constructed an additional thirteen and a half miles of the huge cavern-type sewers. The City shunned the idea of using the newer and experimental water-scoured earthenware tubes. Responding again to the incessant criticism of the "sanitarians" the City had, by 1848, built an additional twenty-one and a half miles of sewers. This left only three and three-quarters miles to be finished, according to the plans of its engineers. By 1848 the City had restored seven miles of its ancient sewers and had connected about 4,000 additional houses to the sewer mains. The Times (London), November 17, 1848; October 24, 1849.

established for the whole metropolis was passed in 1847, and put into operation in January, 1848, with the meeting of the first Metropolitan Commission of Sewers. By this Act, London, for the first time in its history, had an administrative body directly charged with the responsibility for planning and constructing public works for the whole of the metropolitan area, with the exception of the City.[20] Such a course of action was not as unusual as it sounds and it was in the direction of the centralism which Chadwick proposed for London:

> The central Government had long been accustomed to intervene in the administration of London, stepping into the breach left by the absence of organs of municipal government. The police, roads, cemeteries, and markets of the capital had all in turn received special attention from Parliament, while plans for metropolitan improvement had been considered by a Select Committee in 1838 and a Commission in 1844. Chadwick's plans for London were in the direct line of this tradition.[21]

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[20] On November 30, 1847, six of the Commissions were superseded; St. Katherine's was superseded five days later, with the City Corporation retaining its status quo. The Times (London), December 1, 3, and 5, 1847; Lewis, Chadwick and Health, p. 157; Finer, Chadwick, p. 355.

[21] Lewis, Chadwick and Health, p. 156. The problem posed by the capital had been "dealt" with in the Second Report of the Royal Commission on Municipal Corporations in 1837. B.S.P. (House of Commons), 1838, Vol. XXV (Reports, Vol. 5), "Second Report of the Commission appointed to inquire into the Municipal Corporations of England and Wales," p. 1-391.

The issue of either a Government Commission or a municipal government for London was not decided at this time.

The importance of Chadwick's London plan cannot be minimized for it dominated not only the actions of the Metropolitan Commission of Sewers but also all future thinking on plans for the drainage of the metropolis. By 1847 Chadwick's early recommendations, briefly outlined in the 1842 Sanitary Report, had been reinforced and filled out to his satisfaction by the collection of new information and by further experience.

According to Chadwick's plans one single, Crown-appointed Commission would replace the vestries, paving boards, water companies, and sewers commissions for London. The Commission's first duty, after the consolidation of house and main drainage, street paving and cleaning, would be to conduct an ordinance survey of the entire metropolitan area. The Commission would then proceed to purchase the private water companies because, until an adequate supply of water was available, there was no point in proceeding to the heart of the problem—the main drainage. Until the survey and water company purchase were complete, the Commission would begin to systematically replace the brick drains with the newer self-scouring drains. These drains would empty their contents into the existing sewers of deposits, which would be flushed with whatever water was available into the Thames. Since Chadwick felt that the water in the river was unfit to drink anyway, any further pollution would not matter. Once the

Commission assumed control of the water companies, its immediate task would be to find and secure a purer source of water supply than the Thames. The river would become a temporary sewer until the survey was complete and a system of main drainage begun. In the meantime, each house would be equipped with an adequate supply of water for its sink and water-closet and its self-acting drains would be ready to spew their contents into the main system. The location of the main outfall for the new system would be the concluding segment in Chadwick's scheme.[22]

Chadwick, in formulating his plan, was faced with some unavoidable problems concerning the sewers. In many districts there were no sewers. Where there were sewers the discharge from them polluted the river. The existing sewers were constructed in such a manner that deposits accumulated easily and gave off noxious fumes and gases. Chadwick believed that if the sewers could be improved then the water-closet which was by far the cleanest, most convenient, and most economical way of getting rid of house refuse, could be used extensively. To Chadwick, then, the key to the whole refuse-disposal problem was not the mere removal of the deposits but its immediate removal, before it had time to stagnate and rot.

The sewers, though, were not built to conduct the

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[22]Finer, Chadwick, pp. 309-10.

solid matter. Street sewers were immense brick caverns, flat-bottomed and flat-sided, washed only occasionally by a feeble trickle of water. Built on the hypothesis that deposits would accumulate, the sewers were made of brick so that they could be easily entered; they had to be large enough for the cleaners to enter them. Every five or ten years the sewer-men would excavate the tunnel-like sewers and the scavengers would cart the filth away. In those sewers where there was enough water to wash the sewage to the outfalls, the shape and rough brick sides were enough to impede the flow of the water, reduce its pressure on the solid sewage, and leave behind a trail of solid deposits. House drains were also made of brick and, in construction, were no better than extended cesspools. They were also fitted to retain deposits rather than carry them away.

Rarely in the design of sewers and house drains was there any recognition of the elementary principles of hydraulics: no one had taken them out of the text-books and applied them to town drainage.[23] Self-acting gravitational sewers were built to run uphill. Sewers were built with right angles. Larger sewers were connected to, and discharged into, smaller ones. Many were built higher

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[23]Lewis, Chadwick and Health, p. 52; Finer, Chadwick, p. 299.

than the area they were supposed to drain. Fittings and connections were often faulty, thus allowing much of the liquid sewage to ooze back into the basements of the buildings they drained.[24]

These cardinal defects in the construction of sewers and drains were theoretically remedied by the discovery of John Roe, the engineer to the Holborn and Finsbury Commission of Sewers.[25] He found that a new type of sewer that was well supplied with water could sweep away any solid matter within it, cheaply, immediately, and with no trace of deposits. The discovery was the egg-shaped sewer used in association with a steep gradient. Roe's egg-shaped sewer was shaped like the cross-section of an egg. It was cheaper to build and less expensive to maintain

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[24]Vivid descriptions of the results of the haphazard system of drainage that London was built upon are easily obtained. The Sanitary Report (See Flinn, Chadwick: Report, pp. 75-425) is full of accounts of overflowing cesspools, public privies, offal-covered courtyards, tainted water supplies, and other similar items. The Reports of the Health of Towns Commission (B.S.P. [House of Commons], 1844, Vol. XVII (Reports, vol. 2), "First Report of the Royal Commission on the Health of Towns." Cited hereafter as B.S.P., 1844, Vol. XVII, "First Report . . . Health of Towns" and B.S.P. [House of Commons], 1845, Vol. XVIII (Reports, vol. 5), "Second Report of the Royal Commission on the Health of Towns." Cited hereafter as B.S.P., 1845, Vol. XVIII, "Second Report . . . Health of Towns.") are other rich sources.

[25]Roe, appointed in 1820, had succeeded in introducing a number of improvements in his district in spite of the extreme conservatism and cheapness of his employers. He had devised a system of flushing which had cut the cost of cleaning the sewers in half.

because it was smaller and stronger than the conventional types of sewers. Its major importance lay in the shape of its pinched-in base. The base formed a narrow and relatively deep channel through which the sewage water had to force itself. The water's velocity was so increased that all solid sewage, even loose bricks, cats, and rats were swept rapidly to the outfalls.[26]

Chadwick proposed the complete resewerage of towns with Roe's egg-shaped sewer. He would connect them to the water-closets, which were cleaner and more economical than the maintenance and cleaning of private cesspools.[27] He would clean the streets in the same way. The slow and expensive removal of the surface refuse by cartage would be dispensed with and the refuse would be carried away by the method found to be the most rapid, less expensive, and most convenient in dealing with the refuse from houses "by sweeping it [with water from nearby stand pipes] at once

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[26] The Sanitary Report, Appendix I, pp. 373-79, quoted in Finer, Chadwick, p. 221.

Chadwick took this development and adapted it to his fledgling plan: connected to these new sewers, the water-closet would discharge its contents directly into them and the refuse would reach the river in a few hours. This became the pivotal point of Chadwick's system of town drainage.

[27] The Sanitary Report, p. 48, quoted in Finer, Chadwick, p. 222.

Chadwick always emphasized the cheapness of his method because he knew that, for sanitary reform, the factor of expense was of the first importance. Lewis, Chadwick and Health, p. 136.

into the sewers and discharging it by water."[28]

Chadwick presupposed a constant supply of water.[29] In Chadwick's plan, the water supply, house drainage, street drainage, street cleaning, and the main sewerage formed a gigantic sanitary circle. Water flowing at a high velocity was the mainspring of Chadwick's system.

But there was a flaw in it. Even Chadwick acknowledged that his plan contained a major, although not insoluble, defect. What was to become of the sewage that caused the "pollution of the water of the river into which the sewers are discharged?"[30]

The proposed arterial system would carry the sewage in suspension away from the town and into the river. Chadwick thought that this was a waste of valuable liquid manure. He was convinced that the sale of the liquid sewage could pay for the re-sewerage of the towns and, eventually, become profitable. He was obstinate in his belief that this was the most practical solution, from both the economic and engineering points of view. "With the public sewers as the arteries pumping out the rich

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[28]The Sanitary Report, p. 54, quoted in Finer, Chadwick, p. 222; Flinn, Chadwick: Report, p. 126.

[29]See: Finer, Chadwick, pp. 403-405, 407-12, 502-503.

[30]The Sanitary Report, p. 48, quoted in Finer, Chadwick, p. 223; Flinn, Chadwick: Report, p. 120.

town guano [to the farms and fields] and the water pipes as the veins returning the excess moisture of the countryside to the place where it was most needed [i.e., the towns] . . . the whole scheme was fascinating in its simplicity. . . ."[31]

The apparent simplicity of Chadwick's program showed, in fact, crucial defects in his overall thinking. According to his ideas of hydraulics, the largeness of the main sewer could not be determined until the total length and the sum of the capacities of the house drains and their capilaries were known.[32] His ideas on the cause of disease meant that the removal of deposits was the major remedy,[33] hence the importance he placed upon the immediate removal of the deposits in the drains.[34] His insistence on the use of sewage manure effectively closed his

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[31]Lewis, Chadwick and Health, pp. 54-55.

[32]Finer, Chadwick, p. 310.

[33]Chadwick's medical and engineering approaches were linked together and formed the basis for the justification of the sanitary measures he advocated. He accepted the doctrine of the "epidemic atmosphere": "All smell is . . . acute disease." B.S.P. (House of Commons), 1846, Vol. X (Reports, vol. 6), "Report on the Metropolitan Sewage Manure Company," p. 651; Frazer, Public Health, pp. 14-15, 18-19.

[34]Chadwick's solution centered upon deposits, decomposition, and water, and it necessarily dictated a special sanitary program: cesspools must be abolished, sewers must be flushed out into the river, and they must be replaced immediately, even before the sites of the outfalls were determined. His "sanitary cycle" could be interrupted by several factors: water-closets without pipes,

mind to any other type of drainage plan. His administrative changes were based on his engineering solution.[35]

Everything in Chadwick's plan was correlated through the engineering proposals that he believed in so strongly. However, regardless of his best literary urgings, his engineering solutions could go only so far as the existing sanitary science would allow. The Sanitary Report and Chadwick's proposals were, in fact, only general and hypothetical, not doctrinal. The Report raised many specific questions but did not attempt to factually answer them. The arterial system was still a theory: could water be supplied constantly and with adequate pressure? Was the practicality of Roe's sewers real? Could liquid manure be used as Chadwick thought or was that idea impractical? Were the administrative changes acceptable to the Government? Further enquiries were needed because of these questions, their political implications, and the heavy financial expenditures that were involved. Practical experiments in all aspects of sanitary engineering were needed because of the primitiveness of the state of sanitary science prior to 1847.

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pipes without sewers, sewers without water, and water-closets without water.

[35]His sanitary authorities would administer the whole drainage basin of the area and undertake all the sanitary services within it. The Sanitary Report, pp. 58, 233, 303, 356, quoted in Finer, Chadwick, pp. 224-28.

The Government appointed a Royal Commission to examine Chadwick's proposals; in practice its work was to elaborate on his plans.[36] Chadwick, while not a member of the Health of Towns Commission, practically dictated what it would examine, how it would do business, and what it would recommend. The Commission was to see whether glazed-stone drains were better than brick drains; it was to determine the correct draft and inclination of sewers; it was to examine the feasibility of supplying a constant stream of water under high pressure; and it was to elaborate on the details of the public administration.[37]

Chadwick's role meant that the Commission reiterated his contentions that public health administration was a matter for lawyers and engineers, not the medical profession.[38] The Commission was channelled away from curative medicine and concentrated on the field of engineering. Chadwick was even allowed to pick his witnesses with the result that the accepted list of witnesses leaned heavily

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[36]Frazer, Public Health, pp. 19-20; Finer, Chadwick, p. 229; Flinn, Chadwick: Report, p. 67.

[37]Finer, Chadwick, p. 232. For Chadwick's contributions to the Commission, see Lewis, Chadwick and Health, pp. 86-105.

The Health of Towns Commission's findings and recommendations laid the foundation for all the subsequent sanitary legislation of the 1840's and 1850's.

[38]Finer, Chadwick, pp. 232-33.

in his direction.[39]

The Health of Towns Commission presented two reports. The first was brief and merely outlined the conclusions suggested by the wealth of evidence it gathered. It made little impact upon the public since it could not repeat the jolt that The Sanitary Report had made because it seemed as if nothing new had been brought out by the inquiry.[40] Nevertheless, the report laid the foundations for Chadwick's reforms more firmly than did The Sanitary Report and it also showed that some of his propositions had advanced beyond the stage of suggestion into the realm of demonstration.[41]

Although it investigated the conditions of fifty of England's largest towns, the Commission made the investigation of London its first order of business.[42] Chadwick's obsession with the sanitation of London and his desire to discredit the city's sanitary authorities biased the

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[39]Lewis, Chadwick and Health, pp. 89-93, particularly p. 92. The preventibility of disease by engineering rather than by curative medicine was one of Chadwick's cornerstones.

[40]Ibid., p. 88. Chadwick agreed that the medical witnesses did little more than elaborate on earlier testimony. But the evidence on water supply, which would revolutionize sanitary engineering, was, he said, the most important that he had ever taken.

[41]Ibid.

[42]Finer, Chadwick, p. 235.

reports. His interrogation carefully followed a line of questioning designed to complement his own proposals and ideas while ridiculing the existing system.[43]

The conclusions of the Commission denounced the Metropolitan Commissions of Sewers in the strongest language that Chadwick could use. The system and practice of administration, not only for London but for most towns, was criticized as extortionate, inefficient, and corrupt. The Report presented convincing evidence which showed that sanitation was cheap: that Chadwick's type of program was cheaper than the existing system.[44]

The Second Report outlined the proposals for future legislation.[45] It was hurriedly written in February, 1845, with the hope that immediate legislation would follow: having reported, the Commission put the burden of sanitary reform upon the Government.[46] Peel's Government introduced Lord Lincoln's Bill but postponed any action until

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[43]See, for example, the interrogation of Richard Kelsey, the surveyor for the City Commission in: B.S.P., 1844, Vol. XVII, "First Report . . . Health of Towns," pp. 203-231.

[44]Finer, Chadwick, p. 236.

[45]See Lewis, Chadwick and Health, pp. 93-110; B.S.P., 1845, Vol. XVIII, "Second Report . . . Health of Towns," pp. 1-3.

[46]The Queen's speech of that year indicated that sanitary legislation would be introduced.

1846.[47]

But the Irish Famine and the nation-wide spasms over the Corn Laws came in 1846. The political climate pushed both Lincoln's Bill and Peel aside. The new Government of Lord John Russell introduced Lord Morpeth's Bill into the Commons late in the session.[48] It could go nowhere.[49] Russell, after withdrawing it, promised to reintroduce the Bill in the session of 1848.

No one could truthfully deny the need for sanitary reform. Ten years of reports and activities by such organizations as the Health of Towns Association had brought this about.[50] Yet, in spite of all the strenuous efforts made, especially from 1844, in spite of the reports of the Health of Towns Commission, in spite of numerous other sanitary organizations, and in spite of almost three years

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[47]The Government had no intention of passing the Bill at this time.

[48]Hansard, 3d ser., Vol. 91 (1847), 617, 645.

[49]Finer, Chadwick, pp. 294-95. Morpeth was an ally of Chadwick and an early member of the public health movement.

[50]Its importance and effectiveness is attested to by the frequency with which it was mentioned in the Commons during the debates on the Public Health in 1847 and 1848. The reader should see Dr. Robert G. Patterson, "The Health of Towns Association in Great Britain, 1844-1849," The Bulletin of the History of Medicine, Vol. XXII, No. 4, July-August, 1948.

of continuous debate, the year 1847 ended with no public health act. But it did end with the approach of cholera and the Royal Commission on London Sanitation.[51]

The approach of cholera, while it diverted the attention of the Commission from its original assignment, drainage, gave additional urgency to the need to set up a new sanitary authority for the metropolis. Both Chadwick and Morpeth wanted the immediate superseding of the existing Commissions of Sewers. Russell refused any such action. He wanted, instead, to base his recommendations on the Commission's report. Cholera forced a change in his thinking and Russell bowed to the pressure of Morpeth and Chadwick. The issue then narrowed to the form of the new authority. Russell could either abolish all of the Commissions in favor of a single new one or he could reissue separate Commissions but to members of the old Commissions.[52] Russell adopted the latter procedure in order to avoid any legal disputes that might develop over the debts and contracts of the old Commission. It was a temporary measure designed to last only until the status of London was defined in the promised legislation of 1848.

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[51]It must be remembered that cholera was an ever-present danger throughout 1848 and 1849. For a journalistic "history" of the cholera the reader should see The Morning Chronicle, December 1, 1849.

[52]Lewis, Chadwick and Health, p. 156.

CHAPTER III

LONDON: THE METROPOLITAN COMMISSIONS OF SEWERS

The new Commission of Sewers, even though all members were to be Crown-appointed was, with a few exceptions, packed with Chadwick's nominees.[1] By November of 1847, Chadwick was the virtual leader of London sanitation. Confident that London would be included in the statute of 1848, Chadwick began to organize the ordinance survey of London. He also continued the work of the Royal Commission, issuing an interim Report in February, 1848.[2]

Chadwick's plans were almost upset when London was excluded from Morpeth's Public Health Bill[3] but he wisely agreed to accept Morpeth's London Bill, which called for the continuance of the nominated Commissions of Sewers and the inclusion of the City of London within the Commission.

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[1]There were twenty-three members. It was larger than what Chadwick wished for but better than nothing. Considering Chadwick's personality it is surprising that he did compromise.

[2]It was primarily concerned with cholera. B.S.P. (House of Commons), 1847-48, Vol. XXXII (Reports, vol. 8), "Second Report of the Metropolitan Sanitary Commission," pp. 253-336. Cited hereafter as B.S.P., 1847-48, Vol. XXXII, "Second Report of the Metropolitan Sanitary Commission."

[3]See Gentleman's Magazine, Vol. 183 (March, 1848), p. 296 and (June, 1848), p. 649.

The City Corporation, upset at the intrusion of its territory and fearful for its independence, protested in vain. After much deliberation Russell announced that he planned to consolidate the City with the Metropolitan Commission.[4] The City and Morpeth compromised. The City retained its separate Commission of Sewers in return for agreeing to accept the majority decisions of the Metropolitan Commission where it concerned the City.[5]

The Metropolitan Commission, by the middle of 1848, was falling behind Chadwick's original schedule for assimilating the complex business of street paving and cleaning. The investigations of the water-supply system were lagging and the Royal Commission's report was not ready. The reason given was the lack of staff. But the truth was that an anti-Chadwick party, although small in number, obstructive in manner, and present when the Commission was formed, had begun to make its views known to the public.[6]

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[4] Hansard, 3d ser., Vol. 98 (1848), 710-43.

[5] The Times (London), September 15, 1848; Lewis, Chadwick and Health, p. 218.

[6] The anti-Chadwick party never numbered more than a half dozen. Its nucleus was a small group of old Commissioners who hated Chadwick for what he had done. They were John Leslie (the leader), Frederick Byng, John Bidwell, and R. L. Jones. They had been included by Morpeth in the interests of "metropolitan harmony." They resented the usurping of their power and did everything possible to discredit Chadwick and his plans. Finer, Chadwick, pp. 356-58; Lewis, Chadwick and Health, pp. 225-26.

The consolidation of the Commissions of Sewers and the publication of the First and Second Reports of the Commission on London's sanitary condition received good public support and a good press. Even The Times was favorable to Chadwick.[7] Public opinion strongly approved of the new Metropolitan Commission of Sewers. This was of vital importance because it was necessary for the program to start out with a strong basis of support in anticipation of the concentrated opposition which would be launched against it by the advocates of the old order. And it did.

Chadwick had repeatedly pointed out that the main drainage would have to be deferred until the general survey was completed.[8] While the survey was being conducted the Commission would begin to flush out the sewers and begin piecemeal works in the worst slum areas. It would also conduct experiments which the Metropolitan Sanitary Commission recommended.[9]

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[7] The Times was, perhaps, Chadwick's severest critic.

[8] See B.S.P., 1847-48, Vol. XXXII, "First Report . . . Sanitary Commission," p. 43; Sir Joseph Bazalgette, "The Main Drainage of London," The Proceedings of the Institute of Civil Engineers, Vol. XXIV, 1865, p. 332. Cited hereafter as Bazalgette, "Drainage of London."

[9] Such as finding the cheapest and most convenient types of sanitary apparatus, finding out the rate of flow of liquids in pipes, and finding out the best ways to utilize liquid sewage manure.

The general survey was necessary because no complete picture of London's subterranean geography could be pieced together from the materials in the offices of the old Sewers Commissions. Sanitary cartography was less than five years old at the time that Chadwick put the survey of London into the hands of the Board of Ordinance.[10] The survey would be concerned primarily with the triangulation and the levelling of all the districts and would take eight months to complete.[11] Chadwick thought that there was no need to delay any immediate drainage works while the survey was in progress; the new main drainage could not be started until the survey was complete, but work already in progress, or repairs, or new sewers that were planned, would continue.

The Commission sanctioned the survey on the recommendation of Lord Morpeth, who said that the Government would pay for the cost of it. Chadwick was delighted when the military surveyors moved in on St. Paul's and people were astonished to see common soldiers using theodolites

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[10]The general survey would include the entire drainage surface of London, while the subterranean survey would examine all the existing sewers that could be found and measured. Lewis, Chadwick and Health, p. 219.

[11]The plan adopted for the survey would cost £37,000; it would include London and its suburbs for eight miles around St. Paul's. The Times (London), January 13, 1848; Gentleman's Magazine, Vol. 184 (July, 1848), p. 82.

in the streets.[12] But, within two months, the survey came to an abrupt halt. The first public signs of dissension within the Metropolitan Sewers Commission appeared, not in their meetings but in the Commons. The survey was unnecessary, many members said; in any case, why should the whole country bear the expense of a survey for London?[13]

On March 24, the Government, forced by a combination of provincial jealousy and metropolitan hostility, refused to authorize any further funds from the Treasury for the survey.[14]

This situation, after much delay and added expense, was referred to the law offices of the Crown for settlement. The Commission's (i.e., Chadwick's) proposal to levy a rate on the city for the survey was found to be legal,[15] although Chadwick's enemies on the Commission kept the issue alive for a few more weeks.[16] This political maneuvering, in addition to wasting six weeks of good weather, stripped the survey of all but the bare essentials, so much so that it would take at least a year to complete

A dispute over the status and salary of the permanent officials developed even as the settlement of the

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[12]Lewis, Chadwick and Health, p. 220.

[13]Hansard, 3d ser., Vol. 97 (1848), 1014-17.

[14]The Times (London), March 25, 1848.

[15]Ibid., April 3, 1848. [16]Ibid., May 26, 1848.

survey problem neared its final decision. The Commission, on a proposal by Leslie, had divided the metropolitan area into two districts, each under an engineer of equal status. The two officers, Roe and John Phillips,[17] carried on separate programs without consulting each other about their plans. Although both men were capable engineers, they were dealing with a new system, one which was vastly different from the type that their experience had made them familiar with. Of great importance was the fact that both, while supporting the consolidation, were former officers of the old Commissions and, as such, could not completely readjust their mental habits, formed by over twenty years of practice under the old system. Their jealousies, constant arguments, and disagreements over sewer-flushing and steam-pumping sewage from lower levels to higher levels forced Chadwick to turn to Henry Austin, the Consulting Engineer to the Commission, to act as co-ordinator of their work. Chadwick's opposition denounced this as an unfair act against the incumbent engineers.[18]

The obstructive minority also demanded an increase

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[17]See Lewis, Chadwick and Health, pp. 152-53.

[18]Austin, although quite capable, lacked the character to dominate the two engineers and to silence the vocal minority on the Commission. Roe, in spite of being snubbed by Chadwick, remained loyal; Phillips, an appointee of Leslie, seceded to the opposition. Ibid., p. 230.

in the salaries of the officers. This was refused but the wasted time and the futile and ceaseless bickering upset the Commission and made the public aware that the Commission was not running as smoothly as predicted.

While the internal squabbles were being settled, the survey progressed slowly, block by block. At the same time a series of experiments and trial works was begun; their purpose was to determine the details of domestic drainage. This was a field of widely disputed principles and contradictory practices; Chadwick, in his attacks on the existing systems, had declared that the problems of drainage were primarily a matter of gauging and measurement which, if properly conducted, would remove all doubt and differences of opinion. His experiments were designed to verify this belief.

Earthenware pipes were brought from Switzerland and their prices and quality compared with English pipes.[19] The production cost of bricks was analyzed and the price charged by contractors shown to be higher; the bricks supplied were shown to be of inferior quality.[20] The flow in the sewers was gauged.[21] It was demonstrated that house-drains need not be larger than four inches in diameter

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[19] Ibid., p. 223.

[20] B.S.P., 1847-48, Vol. XXXII, "First Report . . . Sanitary Commission," pp. 28-31.

[21] Ibid., p. 28.

since a pipe of that size was sufficient to carry off the sewage from at least a thousand people.[22] Tests were made to determine the quantity of water actually consumed in the city and the quantity which would be required for the new system of drainage.[23] Plans, estimates, and trial surveys were drawn up to show the practical advantages of the combination of water supply and drainage.[24] Barges took sewer-water to farmers for experiments and the reports that were sent back tended to prejudge any future proposals.[25] Sources of drinking water other than the Thames were tested and reported on.[26]

These experiments continued even though they were ridiculed and declared unnecessary by the anti-Chadwick faction of the Commission. The effect of so much opposition forced Chadwick, by September, 1848, to backtrack on his original deadline dates. He now hoped to be able to consider plans for the main drainage by July, 1849. By October, 1848, his immediate concern was about the make-up of the new Commission of Sewers.[27]

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[22]Bazalgette, "Drainage of London," p. 334.

[23]Ibid., pp. 336-38. [24]Ibid.

[25]Lewis, Chadwick and Health, p. 223.

[26]Ibid., pp. 223-24.

[27]Gentleman's Magazine, Vol. 184 (October, 1848), p. 412; The Times (London), September 15, 1848. A new Commission was necessitated by the terms

The new Commission was named in November, 1848. Its membership had increased to thirty-four and Chadwick's majority, in spite of the fact that his enemies remained on the Commission due to political necessity, had risen.

When the new Commission met in January, 1849, Chadwick used his majority to secure the appointment of a number of Committees. From the business point of view this was the only way to handle such an intricate task as the administration of London's sewers; this was comprised of such diverse administrative and technical matters as the assessment of rates, the supervision of a large clerical and engineering staff, the preparation of surveys, estimates, the trial works, and experiments of new materials and devices. The consequent subdivision into specialized committees was the only adequate way to cope with the myriad of details on which policy had to be made. The committee system also afforded Chadwick the opportunity to curtail and, in some instances, silence his opponents. Separate from the General Purposes Committee, which was a committee of the whole Commission, were three separate Committees: one for Bylaws, one for Finance, and another

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of the recently passed Sewers Act.

The Commission, seriously impeded in the first six months of its life, received additional duties from the Sewers Act. Their jurisdiction over house drains was extended, additional borrowing powers were granted (for the works that Chadwick hoped would be able to begin within a year), and they obtained special permission to work by committees.

for Works, which was the most important of them all.[28]

Chadwick appointed his supporters to the Works Committee and its subcommittees. The Works Committee was responsible for the survey, for materials, for the determination of the sizes of the sewers, and for the ultimate decisions as to the utilization of sewage.[29] It also had control over the staff of engineers and surveyors. Chadwick put his opponents on the relatively powerless Finance Committee, where they could do little damage. Chadwick, in spite of Morpeth's warnings, had no intention of structuring the committees along representative lines—the old Commissioners were completely shut-out from the Works Committee.[30] This embittered, excluded minority began to openly and publicly fight Chadwick on every issue. And, by the middle of 1849 they had the majority on the defensive.

Two factors entered into this dramatic and sudden change of events. First, the survey was almost complete, thus making it possible to lay down the principles for the drainage of the entire metropolis instead of individual areas or districts. Secondly, with the ripples of the

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[28]Finer, Chadwick, p. 365.

[29]Subcommittees were set-up to deal with these areas: the Ordinance Survey, the Trial Works, the Disposal of Refuse, and the Construction of Roads.

[30]The Times (London), August 3, October 1, 1849.

cholera epidemic widening, with the Commission seemingly content with abolishing and filling-in cesspools and connecting house drains to the sewers, with the slowness of the survey and trial works, and with the constant arguments among the officials, the public and The Times lost all patience with the Commission. The works of the Commission, while important, valuable, and necessary, lacked the appeal to keep the imagination and interest of the ratepayers that a grand engineering scheme, such as the main drainage of London, would have provided. It was boredom unrelieved,[31] and it was in this atmosphere that the transformation took place.

The clash came in June, although it had been building to a head since January, when Roe had retired. Phillips, because of his seniority, had expected to be named as the Commission's Consulting Engineer. Chadwick passed over him in favor of Austin. Embittered by this rebuff, Phillips became even more anti-Chadwick. Nevertheless, he submitted his scheme for the drainage of London, ready since February, to Chadwick and the Commission.

Phillips' plan, in its essentials, called for the construction of about twenty miles of intercepting sewers, running from Kingston in the west to the Kent or Essex

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[31] The Times sarcastically said that it was tired of seeing the Commission's time and money wasted on such things as the measurement of house drains and the offering of prizes for patent commodes. The Times (London), July 2, 1849.

marshes in the east, parallel to the course of the Thames and acting as a substitute for it. His "artificial Thames" would be at a depth of about one hundred feet below the river bed, and the sewers would discharge into it by gravitation, even though there was no apparent fall provided for. Since his plan had, as its primary objective, the purification of the Thames, the outfalls for his system would be located at some distance below London.[32] Phillips' idea was not new; as early as 1834 John Martin had designed a plan which called for the embankment of the Thames on both sides and the construction of an intercepting sewer in each embankment for the purpose of collecting the sewage and conveying it to points in the river below the city.[33] Martin's plan had been rejected then, as was Phillips' at a later date. Chadwick then turned to Austin for a plan.

Austin's plan was a masterpiece of imagination.

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[32] B.S.P., 1847-48, Vol. XXXII, "First Report . . . Sanitary Commission, Minutes of Evidence, John Phillips," pp. 58-59.

[33] B.S.P., 1834, Vol. XV, "Report from the Select Committee on Metropolitan Sewers," pp. 371-76.
Martin was a famous painter who turned more and more towards the sanitary movement as it developed. His proposal was examined but was in advance of its time and was laid aside; it was periodically resurrected by others in later years. This plan, although in a greatly modified form, would later form the basis for Bazalgette's plans for the main drainage of London.

London would be divided into districts, each having a sump constructed at the most advantageous site for access to the countryside. Pipe sewers would converge from all sides into these sumps, which would be sunk very deep in order to give the sewers that fed into them the necessary declination to be self-scouring. Steam engines and pumps would force the sewage away from these "reservoirs" towards the country and the farmers. Unlike Phillips' plan, Austin's scheme did not have to follow the course of the river. His sewers and pipes radiated to all of the surrounding areas. Moreover, he used pipe drainage wherever possible and built his system around the use of sewage as manure.[34] Chadwick naturally preferred this plan.

Chadwick sent Austin's plan to the Survey Committee where it remained for six weeks. While it was being discussed, the Commission continued with its program of experiments, remedying the domestic drainage wherever possible, and flushing the sewers regularly into the Thames.[35]

This dubious practice was regarded by Chadwick as the greatest contribution that the Commission could make

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[34] B.S.P., 1847-48, Vol. XXXII, "First Report . . . Sanitary Commission, Minutes of Evidence, Henry Austin," pp. 118-24.

[35] Lewis, Chadwick and Health, p. 231.

to defeat the cholera. He felt that it was the lesser evil to discharge the noxious matter into the river than it was to store the refuse in the midst of a dense population as the sewers tended to do.[36] With this policy he came into collision with those who held that the Thames was London's greatest nuisance and Londoners' greatest danger. The most influential of these was The Times, the paper that was read, and believed, the most. The Times rapidly passed from an occasional criticism to permanent hostility in regard to this particular phase of the Commission's overall plans.

The flushing by the Sewers Commission relieved parts of the city, but because the flushing of the fresh infected faeces of the cholera victims together with the daily discharge of two million people occurred at a point opposite to the main intake of London's water supply, the water supply of the entire metropolis was poisoned.[37] The Thames was described as a "single cesspool . . . reaching from Richmond to Gravesend, with an exposed surface averaging a quarter of a mile in breadth."[38] But in spite

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[36]The Times (London), January 14, 1848.

[37]Ibid., September 14, 1848. The water supply of the city came primarily from the river; it had never been completely and adequately filtered by the water companies which supplied London. Reform of the water supply system was a major part of Chadwick's crusade.

[38]Ibid., October 7, 1848.

of such opposition, which was growing in intensity and size, the flushing continued even as the epidemic spread.

The controversy between Austin and Chadwick on the one hand and Phillips and the anti-Chadwick Commissioners on the other also spread as they continued to deride each other's scheme.[39] Public opinion was brought into the controversy when The Times published Phillips' plan[40] and then Austin's reply.

The Times decided against "no filth in the sewers—all in the river."[41] Long an advocate of making the cleansing of the Thames the first object of a comprehensive plan for metropolitan drainage, The Times decided that Phillips' tunnel-intercepting plan did this more effectively than Austin's converging system. Chadwick and Austin attempted to change the opinion of the paper but failed.[42] Thereafter the paper never stopped in its attack on Chadwick, with each issue seemingly more critical than the

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[39]Lewis, Chadwick and Health, p. 233.

[40]The Times (London), June 22, 1849.

[41]Ibid., October 7, 1848.

[42]Ibid., July 6, 1849. They argued that the intercepting sewer idea was wasteful and uneconomical; the plan was to drop the sewage a hundred feet down, then pump it back up and send the sewage back in the direction from which it had come; the sumps were not cesspools; and in wet weather only the storm water would be dumped into the Thames, not sewage.

last:

> Eighteen months have elapsed . . . what has been done?[43]

> Expenses of this ineffective body . . . squandered . . . in 'scientific' juggling or scandalous jobbing. . . . All the details of pipes, pans, drains, pools, and reservoirs might have been left to the ingenuity of contractors or the skill of artisans. What the Commissioners had to do was determine some great outfall for the drainage independent of the Thames and to make the machinery pay its own expenses, if possible, by means of distributing manure.[44]

> Instead of working together . . . the Commission subdivided itself into private committees, which carried on a number of disconnected and inconclusive experiments, costly to the public and bearing only in a remote and significant degree upon the great question at issue . . . the grand principles of drainage. . . .[45]

Chadwick's position, as well as the Commission's, began to slowly crumble under the relentless attack of The Times and the opposition. The first breakdown came in July when the debate begun by Phillips and Austin was thrown open to the whole engineering profession. The anti-Chadwick party forced the issue by demanding that the Commission should be open to receive any plan or proposal, instead of the two under discussion. It was a victory for The Times over Chadwick when the Commission fixed a date

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[43] Ibid., June 30, 1849.

[44] Ibid., July 17, 1849. The Times, it appears, was inconsistent at times.

[45] Ibid., July 21, 1849.

for the reception of any plans for London's main drainage.[46]

In the following two months the Commission, with every resolution becoming a battleground for the opposing parties, appeared as "nothing better than a beargarden."[47] The Committee system, the Trial Works, the Sewage Manure experiments, the main outfall question, the flushing of the sewers--all were severely criticized and ridiculed. The month of August ended with another defeat for Chadwick when he was forced, as a gesture of appeasement, to open the Works Committee to all members of the Commission.[48] September ended with Chadwick appealing to the Government to recast the Commission.[49] The Government

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[46] Ibid., July 26, 1849. Chadwick, in spite of the opposition to him, still insisted that no comprehensive plan could be laid down until the survey was complete. Furthermore, he continuously pointed out that, since the Commission was already engaged in undoing the work of the civil engineers, it was futile to seek the designer for London's drainage in their ranks.

August 20th was the date chosen for the opening date for the month-long reception period. At the end of this period referees would be chosen to consider the plans and to pick the best one.

[47] Ibid., September 24, 1849.

[48] Ibid., August 9 and 10, 1849.

[49] Lewis, Chadwick and Health, p. 235; Finer, Chadwick, pp. 376-77.

agreed but only on the condition that neither of the principal parties in the recent disputes would be reappointed. Chadwick had little choice but to accept these terms if he wanted to save any part of his program.

The Times did not hesitate in writing an obituary notice on Chadwick and his London plan:

> If it had been considered that Mr. Chadwick was the most efficient representative on such subjects of the science of the metropolis the proper course of action would have been to have invested him at once with a sanitary dictatorship and to have recognized in his single person those powers in the clandestine acquisition of which so much precious pains have been wasted. This however was not done . . . and . . . he has neutralized all schemes for improvement which did not originate with himself. . . . But in the meantime the original objects of the Commission have been set aside, and . . . not one single step has been made toward the efficient drainage of the city of London.[50]

When the second Metropolitan Commission of Sewers

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[50] The Times (London), October 1, 1849. Harsh as this judgment seems, it is, to a degree, accurate. While it appears that all that Chadwick's Commissions had done was to flush thousands of tons of refuse into the Thames and conduct a series of dubious experiments (see The Times (London), July 21, September 21, October 3, 1849; March 8, 1850; and February 14, 1851) the critics failed to recognize that some degree of caution must be taken; it was not merely a matter of sending out a gang of laborers with shovels to trench and tunnel a passage for London's relief. Chadwick was correct when he insisted that a survey be completed before a general scheme of main drainage could be undertaken. Bazalgette's system was planned according to Chadwick's large-scale survey.

succumbed to its internal disorders in September, 1849, it was succeeded by a smaller body of thirteen members.[51] Dominating the Third Commission were the "folk-heroes" of mid-Victorian England—the engineers, particularly the railroad engineers.[52] They were more than mechanical engineers; these railway builders drove tunnels, built locks, bridges, viaducts, and drained marshes. Names such as Robert Stephenson, J. M. Rendel, Robert Rawlinson, and William Cubitt stirred the public imagination. It was felt that these men would be able to set matters right and begin work on the construction of the metropolitan main drainage.

Unfortunately, their ideas on town drainage were uncertain and prejudiced. The engineers and their organization, the Institute of Civil Engineers, had been repeatedly attacked and denounced by Chadwick. They therefore openly supported the anti-Chadwick party in the Commissions and were, in a sense, responsible for Chadwick's

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[51]The numbering of the various Metropolitan Commissions of Sewers has confused a number of authors. The First Commission was to have been in operation for two years, but it was necessary to supersede it; its life-span was from November 30, 1847 to January 5, 1849. The Second Commission was in office from January 5, 1849 to October 8, 1849, when it was dissolved. The Third Commission assumed office on October 8, 1849, and lasted until December 31, 1849. B.S.P. (House of Commons), 1850, Vol. XXXIII (Accounts and Papers, vol. 25), "Reports from the first Three Metropolitan Commissions of Sewers," pp. 445-66.

[52]Finer, Chadwick, pp. 439-40.

downfall. When the engineers assumed control of the Commission they began to dismantle all of Chadwick's works.

Their first order of business was to classify and investigate the merits and feasibility of the two hundred or so plans submitted for London's drainage.[53] All of the plans were examined and rejected.[54] The principle of the intercepting sewer, advocated by Phillips, was preferred and the Commission's engineer, Frank Forster, was instructed to prepare a more workable scheme. Forster was a believer in tunnel sewers and his proposals showed this. In August his plan for the interception of the sewage on the South side of the Thames was accepted and in January, 1851, a similar plan for the districts on the North bank was accepted.[55] The approval of these plans meant that the tunnel scheme had won over the other types.

Chadwick's trial works and the experiments on the flow of liquids through pipes were halted at the same

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[53]Varying numbers exist as to the total number of plans submitted. Plans were still accepted after the official reception period had expired. Bazalgette, "Drainage of London," p. 284; B.S.P. (House of Commons), 1841, Vol. XLVIII (Accounts and Papers, vol. 18), "Report of the Metropolitan Commission of Sewers," p. 76. Cited hereafter as B.S.P., 1851, Vol. XLVIII, "Report . . . Metropolitan . . . Sewers."

[54]The Times (London), March 16, 1850. Austin's plan was rejected for depending too much on machinery and the storage of sewage; Phillips' because of "bad engineering."

[55]B.S.P., 1851, Vol. XLVIII, "Report . . . Metropolitan . . . Sewers," p. 78.

time.[56]

The Commission, after successfully establishing its position and authority, enthusiastically embarked on the first step towards the ultimate drainage of the metropolis. This was the drainage of Westminster, long a battlefield between the Chadwickian segment of the Commission and the anti-Chadwick party, and between Austin and Phillips.[57] The Third Commission resurrected a plan dismissed by Chadwick and decided to build an immense tunnel sewer for the drainage of Westminster.

The Victoria Street Sewer was to have brought much glory to the Commission. It brought, instead, the wrath of the people down on their heads.[58] Forster awarded two contracts for the construction of the sewer; the total estimates for the cost being £13,354.[59] The work progressed very slowly as overlooked obstacles and poor construction techniques nearly halted construction several

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[56]Lewis, Chadwick and Health, p. 334.

[57]This particular phase of the dispute is described in Finer, Chadwick, pp. 364, 367-68.

[58]The fact that the engineers attended only intermittently to their unpaid public duties (this was a major source of the trouble) and that much of the business of the Commission was held up, delayed, or forgotten for lack of a quorum did little to help the situation.

[59]B.S.P. (House of Commons), 1850, Vol. XXXIII (Accounts and Papers, vol. 25), "Estimate of the Total Cost of the new Sewer in Westminster, called the Victoria-street Sewer," pp. 703-04.

times.[60] Amidst this trouble about the Victoria Sewer the Commission, due to its overall inactivity, was dissolved because of public pressure.

The new Commission that was named was identical with the deceased Third Commission. Politics dictated its dissolution and necessity its reappointment. Matters went from bad to worse because the Commission was limited to a 3d. rate and because of public opposition to the constant demand to raise the rates. The proposed main drainage had to be deferred because the Commission could not raise enough money due to the limit on its borrowing power imposed by the 3d. rate.[61] The Commission, already in debt, went further into debt as they continued to "contract-out" segments of sewer-building and construction jobs at extremely high costs.[62] Ironically, the Commission continued the survey begun by Chadwick.[63] The

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[60] B.S.P. (House of Commons), 1851, Vol. XLVIII (Accounts and Papers, vol. 18), "More Comment on the Victoria Sewer," pp. 129-30. The sewer had to make an unplanned curve in order to avoid bodies in a church graveyard; the measurements in the sewer at no place matched those in the specifications; and distortions and crushings of parts of the sewer occurred regularly.

[61] B.S.P., 1851, Vol. XLVIII, "Report . . . Metropolitan . . . Sewers," pp. 78-80.
They had, by this time, determined a course for the metropolitan main drainage.

[62] Ibid., pp. 76-80.

[63] Ibid., pp. 76, 80. The survey had already cost £23,630 and averaged about £5,000 per year.
Even more remarkable is the fact that they seemed to change their minds about the importance and necessity

Victoria Sewer, when it was completed, cost more than £33,000 which was almost triple its original estimate.[64]

As Londoners watched, their rates increased and their streets and houses remained in the same filthy conditions that had greeted the First Metropolitan Commission of Sewers. The Times, the vestries, and the Metropolitan Members of Parliament became even more vocal and impatient in their complaints directed towards the new Commission than they had been towards the old ones.[65] And to complicate matters even more, the Victoria Sewer collapsed. Crown buildings and private buildings suffered extensive damage. The compensation paid was extremely high and a large additional outlay of funds was needed for repairs.[66]

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of the survey; the "high value of the survey has been strikingly manifested in the preparation of the scheme of the drainage of the metropolis." Ibid., p. 80.

[64] B.S.P. (House of Commons), 1854, Vol. LXI (Accounts and Papers, vol. 23), "Reports and Communications by the Board of Health to the Home Secretary on the Drainage of the Metropolis," pp. 115-16. Cited hereafter as B.S.P., 1854, Vol. LXI, "Report by Board of Health . . . on . . . Metropolis."

[65] For the most often cited example, see Sir Benjamin Hall's attack in Hansard, 3d ser., Vol. 116 (1851), 1063-71; Vol. 118 (1851), 1468 and 1700.

[66] B.S.P., 1854, Vol. LXI, "Report by Board of Health . . . on . . . Metropolis," p. 116. There had been a great deal of trouble with the buildings along the route of the sewer; it seems that this part of the trouble could have been avoided if care had been exercised. See B.S.P., (House of Commons), 1851, Vol. XLVIII (Accounts and Papers, vol. 18), "The estimate of the Victoria-Street Sewer along

Six months later the metropolis was still enraged because the sewer remained in ruins. In June the engineers quit, only to be reappointed by the Commission. Then the Commission was superseded and in July, 1852, a new Commission was appointed. Bazalgette was named as Chief Engineer. This Commission was even more obscure than its predecessors and even more conservative in their views towards drainage.[67]

The engineers retained their confidence in the strength and durability of the brick tunnel-sewer in spite of the Victoria Sewer episode and the constant attacks by Chadwick. Chadwick and his devoted band of followers exploited the cost-factor to the fullest, knowing that the economic aspect of sanitation was more appealing to the rate-payers than were the scientific and hygenic aspects.

But no part of Chadwick's theories more thoroughly aroused the public, and especially the engineers, than did his advocacy of pipe-sewers. The various Commissions headed by the engineers were as determined in their efforts to ban pipe-sewers as Chadwick was to have them accepted. They shuddered at the thought of the intestinal troubles that would occur in the complicated maze of narrow pipes

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with the report of the engineer," pp. 143-44. Forster resigned after this disaster and after it appeared that the Commission was going to accept the plans for draining London drawn up by another member.

[67]Finer, Chadwick, p. 442.

that would be laid down if Chadwick had his way.[68] And, much to their disgust, pipe-sewers were being laid down in ever-increasing amounts.[69]

Failures were bound to occur in the early experimental days and, when they did, the engineers were quick to point them out.[70] Such an event took place in October of 1852. The Commission received a report from St. Giles which stated that the stoneware pipes laid down three years earlier by the First Metropolitan Commission of Sewers had stopped-up and were accumulating deposits. In November the pipes were pulled up and replaced with brick

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[68] B.S.P. (House of Commons), 1852-53, Vol. XCVI (Accounts and Papers, vol. 40), "Copy of the Reports of Mr. Bazalgette to the Metropolitan Commission of Sewers relating to the Application, State and Examination of Tubular-pipe Drains or Sewers," pp. 40-41. Cited hereafter as B.S.P., 1852-53, Vol. XCVI, "Bazalgette . . . and Tubular-pipe Drains."

It has been said that the engineering departments of the Board of Health and the Commission were in a state of civil war. The London Observer, August 12, 1855.

[69] By 1848 only 104 miles of pipes had been manufactured; by 1852 it was estimated that 50 miles of sewer and drain pipes were being produced weekly.

Bazalgette admitted that pipes should be used under certain conditions. See The London Observer, November 18, 1855.

[70] Pipes were frequently manufactured from unsuitable materials, thin, brittle, and crudely fashioned; when connected, pipes of similar dimension often showed an unevenness of more than an inch. Pipe-layers frequently laid them in sandy soils, without protection and with an insufficient fall.

drains and sewers.[71] In addition, the Commission decreed that, in the future, all main sewers were to be constructed of brick and pipe was never to be used in lengths greater than 500 feet.[72] Back-drainage in London was also forbidden by the Commission.[73]

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[71]Bazalgette gave as his reason the number of stoppages and the cost of removing the obstructions. B.S.P., 1852-53, Vol. XCVI, "Bazalgette . . . and Tubular-pipe Drains," p. 76.

Bazalgette's report had a marked effect on those who did not know all of the circumstances surrounding the issue: that the failures had occurred in a block of buildings with a deficient water supply and that the buildings were mostly common lodging houses. Most importantly, what Bazalgette failed to mention was that the failure in the forty-eight houses amounted to a very small fraction of the 27,000 houses in London which, by now, were being drained by about 346 miles of pipes of various sizes. See: B.S.P. (House of Commons), 1854-55, Vol. LXV (Command, 1891), "Comments from the General Board of Health, and Reports from the Superintending Inspectors of the Board, made to the Secretary of State, in relation to the Reports of the Engineer of the Metropolitan Sewers Commission, in respect to the Operation of Pipe Sewers," p. 303. Cited hereafter as B.S.P., 1854-55, Vol. LXV, "Communications . . . Pipe Sewers."

[72]The Times (London), January 19, 1853.

[73]Back-drainage was a system whereby house-drains were taken from the rear of the house, where the water-closet was usually situated, and led into a branch sewer that was directly behind the back door; the branch sewer being common to the whole row of houses. Compared to the system in practice at this time it was much cheaper. The present system gave each house a separate drain, but led it from the water-closet all the way under the house, from back to front, to the middle of the street, where it was connected or led into a large brick sewer. This idea and practice is described in B.S.P., 1834, Vol. XV, "Report from the Select Committee on Metropolitan Sewers," p. 253 and B.S.P. (House of Commons) 1845, Vol. V, (Bills, vol. 5), "A Bill for the Improvement of the Sewerage and Drainage of Towns and Populous Districts, and for making

The Commission, given this opening and hoping to justify its thesis, instructed Bazalgette to find out whether pipe-sewers were successful in other areas.[74] Manchester and Leeds offered little assistance in proving the Commission's contention that pipe-sewers were ineffective. Bazalgette found what he wanted right in the Commission's area of jurisdiction—London. After pulling up and examining 122 pipe-sewers, he found that some were completely choked up and blocked, that 23 were cracked or broken, and that 113 contained deposits.[75] The Commission immediately circulated the illustrated report which seriously damaged the pipe-sewer idea.

Even as the Commissioners were congratulating themselves on their "victory" another incident occurred, so dramatic that further argument seemed unnecessary. This was the unfortunate Croydon Case.

Provision for an ample supply of Water, and for otherwise promoting the Health and Convenience of the Inhabitants," pp. 415-16.

[74]They had, of course, no power or authority anywhere except in London. The Commission, dominated by the engineers, was diametrically opposed to the General Board of Health, set up and provided for by the Public Health Act of 1848. It was dominated and run by Chadwick. Their quarrel was extremely bitter and had far-reaching effects—it ultimately played a major role in the final plans for London's main drainage.

[75]B.S.P., 1852-53, Vol. XCVI, "Bazalgette . . . and Tubular-pipe Drains," p. 78.

Croydon had been one of the first towns to petition for, and receive, the arrangements and provisions set forth in the Public Health Act of 1848. Croydon, as these measures were implemented, became a model for the new system. The General Board of Health pointed to Croydon as an example of what the Act and pipe-sewers could do for other towns. But, in November, 1852, this Utopia, supposedly free from every form of zymotic disease, was attacked by an "epidemic of fever." By January the new sanitation was being blamed as the cause of the sickness. The Board sent its most prominent persons to investigate; their report stated that everything was as it should be, with the exception that the workmanship of the pipes was extremely crude and the pipes were too large and too thin.[76] An independent Parliamentary inquiry confirmed the Board's preliminary findings, only in language much more critical of the construction of the system and its operation.

Chadwick replied for the Board and was, naturally, quite skeptical of the Parliamentary report. The stoppages occurred, he said, because the inlets of the pipes were too

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[76] B.S.P. (House of Commons), 1852-53, Vol. XCVI (Reports, vol. 40), "Reports on an inquiry relative to prevalence of disease at Croydon," pp. 40-41. Cited hereafter as B.S.P., 1852-53, Vol. XCVI, "Reports on . . . Croydon."

large, not because they were too small. The pipes were thinner than the Board had specified. Furthermore, only 150 yards of pipe had been broken out of more than sixteen miles of sewers.[77] The idea was not to blame, just the construction in certain sections of the system.

The debate, carried on by reports and counter-reports, continued into the summer of 1854. The main body of evidence presented by the engineers is found in the minutes of evidence of the Select Committee on the Greater London Drainage Bill.[78] The Board answered with a two-pronged reply. The first called the Home Secretary's attention to the Commission's plans by warning him that London's drainage, if executed in brick sewers, would be inefficient and cost three times more than necessary.[79]

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[77] B.S.P. (House of Commons), 1854, Vol. XXXV (Reports, vol. 17), "Report of the General Board of Health on the Administration of the Public Health Act and the Nuisance Removal Act and Diseases Prevention Act, 1848-1854," pp. 50-51.

[78] B.S.P. (House of Commons), 1852-53, Vol. XXVI (Reports, vol. 19), "Minutes of Evidence taken before the Select Committee on the Greater London Drainage Bill," pp. 387-609. Cited hereafter as B.S.P., 1852-53, Vol. XXVI, "Evidence . . . Greater London Drainage Bill."
A private company had promoted this venture which was rejected after much discussion.

[79] B.S.P. (House of Commons), 1854, Vol. LXI (Accounts and Papers, vol. 23), "Copies of any Reports and Communications made by the Board of Health to the Home Secretary in reference to the Drainage of the Metropolis," pp. 113-16. Cited hereafter as B.S.P., 1854, Vol. LXI, "Reports . . . by Board . . . to the Home Secretary."

The second was Austin's faultfinding reply to the Commissioners' Croydon Report.[80] Both of these replies protested the wastefulness and erroneous principles of the works that the Commission was planning to construct. These retorts prompted the Home Secretary to take a more active role in the controversy.[81]

Palmerston, since January, 1853, had carried on an extensive correspondence with the Chairman of the Metropolitan Commission, Richard Jebb. They exchanged more than 130 letters and notes. Many were merely petitions and memorials. A large number of them dealt with financial matters. Another part of them disclosed that Palmerston was determined to obtain a working knowledge of the plans for the main drainage; he had, in fact, gone back to the beginning and had studied many of the plans and had even "worked over" Forster's plans for the Northern and Southern Outfalls. The last category of the correspondence is extremely technical and concerned primarily with the Commission's specifications of the types of sewers they planned to put down.[82]

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[80] B.S.P., 1852-53, Vol. XCVI, "Reports on . . . Croydon," pp. 221-31.

[81] Lord Palmerston, by January, 1853, had decided that he had to take a stand in the dispute between the Board of Health and the Commission.

[82] B.S.P., 1854, Vol. LXI, "Reports . . . by Board . . . to the Home Secretary," pp. 113-332.

Apparently mystified by the contradictory statements of the Commission and the Board on tubular drainage, Palmerston wrote to six local Boards using the pipe-drainage system in order to find out what they thought of it.[83] The replies he received were complimentary to the new system. He forwarded them to the Commissioner of Sewers in November, 1853, to show "the cheapness and efficiency of the tubular system."[84] The Commission then ordered Bazalgette to visit the six towns. His report stated that the cost of pipe drains was considerably greater than what the General Board had stated and that there had been notable failures in the systes.[85] The Commission sent Bazalgette's report to Palmerston.[86] The Board, in order to counteract them, submitted reports from the engineers responsible for the works under consideration; they censured Bazalgette for conducting an extremely hasty and

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[83]The six were Rugby, Sandgate, Tottenham, St. Thomas's, Exeter, and Barnard Castle.

[84]B.S.P., 1854, Vol. LXI, "Reports . . . by Board . . . to the Home Secretary," p. 139. Palmerston had been converted to a pipe-sewer believer by the reports and material he had read.

[85]Ibid., pp. 184-204.

[86]Ibid., pp. 298-320. Surprisingly enough, Bazalgette said that none of them had possessed pipes long enough to give them a fair trial.

superficial examination.[87]

The results of this controversy and quarrel were far-reaching. The Commission resigned, much to Palmerston's dismay.[88] He named a new one (the Sixth) in 1855,

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[87] B.S.P., 1854-55, Vol. LXV, "Communication . . . Pipe Sewers," pp. 295-301.

Bazalgette had a personal hatred of Chadwick. He had applied for the position of Assistant Surveyor to the Commission in 1849 but had been turned down by Chadwick in favor of one of the "pipe-men." Furthermore, Chadwick had included him in his attacks on the incompetency of the civil engineers who were now in control of the Commission. It is necessary to keep these facts in mind when reading these reports.

Because of his hatred for Chadwick, Bazalgette's methods do not speak well of him. The 122 pipeswere sought "in a hurried manner, secretly and after nightfall, by a surveyor and a contractor known to be opposed to the use of pipe drainage." B.S.P., 1852-53, Vol. XCVI, "Reports on . . . Croydon," p. 235.

The engineers operated from what they knew and practiced—their conceptions were above suspicion while Chadwick's were not. Because of this attitude, they took Bazalgette's 122 pipes as proof that pipes could not work; they never considered why more than 250 miles of pipes, laid to more than 20,000 houses in London, continued to work. The engineers continuously exaggerated facts, figures, and statements in most of their reports. They said, for example, that the Board wanted to use nothing but earthenware pipes when, in fact, the Board had approved the use of brick sewers in over half of their plans.

The engineers' "pipe-sewer-tubular-drainage syndrome" is examined in Finer, Chadwick, pp. 448-52.

[88] The Commission, in 1854, directed Bazalgette to prepare a scheme of intercepting sewers. The Commission recommended its adoption but it was not acted upon.

The General Board of Health had proposed a "separate system" of drainage in 1854 but the Commission resigned without giving it any serious consideration. B.S.P. (House of Commons), 1884, Vol. XLI (Reports, vol. 25), "First Report of the Royal Commission on Metropolitan Sewage Discharge," p. 15. Cited hereafter as B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge."

but with the provision that it was only temporary. The Commission, or specifically the engineers, circulated Bazalgette's reports among the members of Parliament. They had a dramatic effect upon the fate of both Chadwick and the Board: Chadwick was "pensioned-off" and the Board, whose life-span under the Act of 1848 had run out, was not renewed.

The Sixth Commission continued to discuss the subject of the main drainage but without coming to any practical decision.[89] It was merely "marking time" until its dissolution and the formation of the Metropolitan Board of Works in 1856, which, under the recently enacted Metropolitan Local Management Act, would construct the works for the main drainage of London.

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[89]The Commissions had proven to be a notable failure. No fixed system of drainage could be agreed upon with the result that it appeared that each Commission was intent upon undoing whatever its predecessor had done. The London Observer, August 12, 1855.

CHAPTER IV

THE METROPOLITAN BOARD OF WORKS AND THE "GREAT STINK"

Prior to 1855 there was no administrative machinery for the local government of the metropolis as a whole. It was not until 1854 that Parliament gave any serious attention to the establishment of a system of local government for the metropolitan area, this in spite of the fact that the Commissioners, upon whose report the Municipal Corporations Act was based, had favored London being treated similarly to other municipalities. Before 1855, the administration of what may be described as the metropolitan area was a "veritable jungle of areas and authorities and a nightmare of inefficiency."[1] No real improvement in social conditions was possible until the chaotic conditions were removed and replaced by an organized system. It was with this in mind that Sir Benjamin Hall introduced a bill providing for the local government of London.[2]

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[1] W. A. Robson, The Government and Misgovernment of London (London: George Allen and Unwin, Ltd., 1949, 2d ed.), p. 55. Cited hereafter as Robson, Misgovernment.

[2] The Times (London), March 16, 1855; The London Observer, March 20, 1858.
Hall was president of the newly constituted (in 1854) General Board of Health. He carried on an extremely energetic campaign for public health after assuming office:

Before the introduction of Hall's Bill many proposals for solving the problem had failed because of an inability to answer certain fundamental questions. One of these questions concerned the size of the metropolis. A second question pertained to the future role of the City Corporation. A third was concerned with the amount of centralization that existing local government bodies would undergo. If there were to be both central and local authorities, how were they and their relations to be defined?

As to the area of the metropolis, Hall proposed "to take the Registrar-General's district and call that

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in addition to introducing the Metropolitan Local Management Act, he also introduced measures to amend the Public Health Act of 1848 and the Nuisances Removal and Prevention of Diseases Acts of 1848 and 1849. These important proceedings were taking place coincidentally with the last stages of the cholera epidemic of 1853-54 and with the investigations into the sanitary conditions of the Army.

It is interesting to note that Hall made a dramatic switch in position in regard to the central-control issue. He had been spokesman for the London Vestries against Chadwick and an avowed opponent of any centralizing tendencies. G. S. R. Kitson Clark, An Expanding Society: Britain 1830-1900 (Cambridge: University Press, 1967), p. 151; Lambert, Simon, pp. 223-24; George Fisher Russell Barker, "Sir Benjamin Hall," Dictionary of National Biography, ed. Sir Leslie Stephen and Sir Sidney Lee (22 vols.: London: Oxford University Press, 1921-1922) VIII, 943-944. Cited hereafter as D.N.B.; Sir Malcolm Morris, The Story of English Public Health (London: Cassell and Company, Ltd., 1919), p. 37.

the metropolis."[3] The Registrar-General's district had its origin in the Bills of Mortality which had been kept for the city since the sixteenth century.[4] The Bills had been extended as London grew and, when the Registrar-General had been appointed in 1836,[5] they continued as the basis for the metropolitan district under his control.

In his Bill, Hall planned to bypass the City Corporation in order to avoid the usually effective opposition that it could raise against any proposal which threatened its autonomy. After the passage of his legislation he planned to introduce another bill calling for the reform of the City Corporation.[6] Hall had dismissed a recommendation for reform made by the Royal Commission on the Corporation in 1854 because of size and costliness. But he adopted the Commission's suggestion for a municipal government for London; the metropolis would be divided

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[3]Hansard, 3d ser., Vol. 137 (1855), 701; The London Observer, July 1, 1855.

[4]The registration of deaths began about 1592-93 under the Bills of Mortality. Freeman, Conurbations, pp. 16-18.

[5]B.S.P. (House of Commons), 1871, Vol. XXXV (Reports, vol. 22), "First Report of the Royal Sanitary Commission," p. 5.

[6]Hansard, 3d ser., Vol. 137 (1855), 718. For an example of the type of interference that the City could raise, see Hansard, 3d ser., Vol. 139 (1855), 410.

into several districts which would be governed by an unspecified type of municipal assembly.[7] Hall did not envisage true central control for these municipal districts, called vestries and district boards, as they would elect, indirectly, a Metropolitan Board of Works to serve as a sort of works contractor for the execution of large programs affecting London as a whole.[8]

This plan, amended and filled out, was the leading feature of the Metropolitan Local Management Act. It was passed in order to provide for better government and to assure "better management of the metropolis in respect of the sewerage and drainage, and the paving, cleansing, lighting and improvements. . . ."[9] The vestries (elected directly) and the district boards (elected indirectly), besides having power to elect the coordinating Board of Works, were entrusted with the management of local sewage and drainage projects, with paving, lighting, watering,

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[7] Ibid., 702, 717-18 and Vol. 138 (1855), 885-87; A. Emil Davies, The Story of the London County Council (London: The Labour Publishing Company, Limited, 1925), p. 17. The Municipal Corporations Act of 1835 had not given London any type of government primarily because of the pressure that the Corporation and various vested interests were able to raise.

[8] Hansard, 3d ser., Vol. 137 (1855), 719-22; The London Observer, July 1, 1855.

[9] B.S.P. (House of Commons), 1854-55, Vol. IV (Bills, vol. 4), "A Bill for the Better Local Management of the Metropolis," p. 133. Cited hereafter as B.S.P., 1854-55, Vol. IV, "Bill . . . Metropolis."

cleaning, and other improvement plans for their parishes, and all other duties and powers connected with the management of sanitary affairs for their localities. The Board of Works was responsible for the provision and maintenance of main sewers and sewage disposal works, the making and widening of streets, the control of buildings, and the making of bylaws on a number of other matters.[10]

The Act, though opposed by some,[11] met with general approval.[12] The Board of Works superseded the Commissioners of Sewers and the area assigned to it was identical with what had been under the jurisdiction of the Commissioners.[13] In addition, the Board took over from the

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[10]Hansard, 3d ser., Vol. 137 (1855), 1475. The powers granted to the Board were, for the most part, similar to those that the Commissioners of Sewers possessed.

[11]Ibid., pp. 723-24.

[12]The Times (London), August 14, 1855, hailed the Act as a "bold and original attempt to supply . . . to two millions and a half of peoples, closely packed together, that organization of which . . . they have . . . been deprived." See also: The London Observer, August 19, 1855, and Dorothy Maxine Corlett, "The Metropolitan Board of Works, 1855-1889" (Urbana, Illinois: University of Illinois unpublished Master's Thesis, 1943), pp. 23-24. Cited hereafter as Corlett, "Board of Works."

[13]There have been many comments made concerning the Act and its definition of London. Two of the most interesting are those by: Asa Briggs, Victorian Cities (London: Odhams Press Limited, 1963), p. 333: ". . . [an] area determined not by human geography but by the network of drains and sewers"; and Freeman, Conurbations, p. 18, quoting Mrs. Margaret Cole, Servant of the County (London: n.p., 1956), p. 36: "to delimit a capital city by Act of Parliament on a

Metropolitan Commissioners and the City Commissioners all drainage works previously vested in them.[14] The Board was explicitly charged to make

> such sewers and works . . . necessary for preventing all or any part of the sewage within the Metropolis from flowing into the River Thames in or near the Metropolis and shall cause such sewers and works to be completed on or before the 31st of December, 1860. . . .[15]

The Board immediately began the first task that was expected of it—to provide ways of dealing with the gigantic quantities of sewage that the metropolis was discharging into the river. The Board appointed Joseph Bazalgette as its chief engineer.[16] He was instructed to prepare a plan for the drainage of the city. In designing a system of main drainage for London, Bazalgette had to take certain factors into consideration: it was necessary

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basis of death registers and main drainage is surely one of the oddest [methods] that can ever have been evolved."

[14]The Board assumed control over 166 miles of main sewer lines. The London Observer, January 13, 1856.

[15]B.S.P., 1854-55, Vol. IV, "Bill . . . Metropolis," pp. 104-05. See also: B.S.P. (House of Commons), 1854-55, Vol. LIII (Accounts and Papers, vol. 24), "Return setting forth the main sewers in the Metropolis to be inserted in Schedule D of the Metropolitan Local Management Act," pp. 275-82.

[16]The London Observer, January 6, 1856; The Times (London), January 1, 1856. It was an interim appointment that was made permanent at a later date. Bazalgette was chief engineer for the Board for its entire life span of 34 years. B.S.P. (House of Commons), 1888, Vol. LVI (Reports, vol. 33), "Interim Report of the Royal Commission appointed to inquire into certain Matters connected with the Working of the Metropolitan Board of Works," p. 372.

to provide ample means for the discharge of the large and ever-increasing water-supply caused by the adoption and widespread use of the water-closet; adequate ways had to be provided to handle the ordinary rainfall and surface drainage at all times, except during severe storms; the low-lying districts had to be provided with a sufficiently deep outfall to allow all houses to be effectively relieved of their liquid refuse; and the outfalls had to be located outside the limits of the city, as stated by the Act.

Within four months Bazalgette had completed his plan and presented it to the Board, where it was accepted.[17] But Hall, now the First Commissioner of Works, refused to sanction the plan. He objected to the location of the outfalls, at Plumstead Marshes and Barking Creek, on the grounds that they were not only near to, but actually within the metropolis, thus contravening the Act of 1855.[18] He also disapproved of the proposed capacity of the intercepting sewers. He sent the plan back to the Board.[19]

Cited hereafter as B.S.P., 1888, Vol. LVI, "Interim Report . . . Board of Works."

[17]See The London Observer, April 6 and 21, 1856 for the discussions held on the plans submitted by Bazalgette; he submitted the plans for the south side first.

[18]Hansard, 3d ser., Vol. 147 (1857-58), 546-47.

[19]The Commissioner of Works had to approve of the plans submitted by the Board of Works. The veto power that he was able to use was in the Act constituting the Board. B.S.P. (House of Commons), 1857-58, Vol. XLVIII (Accounts and Papers, vol. 16), "Report of the Proceedings of the

Later in 1856 the Board submitted an amended plan with the outfalls located two or three miles farther down the river and outside the metropolitan boundary. But Hall rejected the plan because he was of the opinion that the sewage would flow back into the metropolitan area. The Board, after conferring with Hall, proposed another scheme which had Erith Reach and Rainbow Creek as the nearest points at which sewage could be discharged into the river without danger of its return into the city. Hall rejected this plan for the same reasons he had refused all of the Board's other plans.[20]

Hall then referred the problem to three independent advisers named by him.[21] They reported in July, 1857, that the plans recommended by the Board of Works did not provide for the removal of a sufficient quantity of sewage and stormwater and that the outfalls suggested by

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Metropolitan Board of Works for the Year ending 30 June 1858," p. 13. Cited hereafter as B.S.P., 1857-58, Vol. XLVIII, "Report of . . . Board . . . 1858."

[20] Ibid.; B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge," pp. 16-17; Corlett, Board of Works, pp. 25-27. See The Times (London), November 13 and 21, 1856, for conversations between Hall and the Board.

[21] The three advisers were Captain Douglas Galton, Mr. James Simpson, and Mr. Thomas Blackwell, all prominent civil engineers.

the Board were too close to the city.[22] They also submitted a plan which was rejected by the Board because of the additional financial burden it would place on the rate-payers of certain districts.[23]

In November the Board again ordered Bazalgette to prepare another plan for the main drainage of London. His report, submitted in April, 1858, declared that the Government Referees' plan was unfeasible and unworkable. This plan, similar to his previous ones, placed the outfalls at Barking Creek and Crossness Point.[24]

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[22] B.S.P. (House of Commons), 1857 (sess. 2), Vol. XXXVI (Accounts and Papers, vol. 12), "Report of the Government Referees presented to the First Commissioner," pp. 35-38. Cited hereafter as B.S.P., 1857 (sess. 2), Vol. XXXVI, "Report of Referees," Corlett, Board of Works, pp. 27-28.

These "referees," as the Government called them, suggested Sea Reach as an alternative to the question about the location of the outfalls.

[23] B.S.P., 1857-58, Vol. XLVIII, "Report of . . . Board . . . 1858," p. 13; Hansard, 3d ser., Vol. 148 (1857-58), 546-48.

The referees' plan would cost £5,437,265 whereas Bazalgette's estimate was £2,800,000. B.S.P. (House of Commons), 1867, Vol. LVIII (Accounts and Papers, vol. 20), "Return from the Metropolitan Board of Works—Estimate made by the Engineer for the Total Cost of the Main Drainage Works," p. 715.

[24] B.S.P. (House of Commons), 1857-58, Vol. XLVIII (Accounts and Papers, vol. 16), "Report presented to the Metropolitan Board of Works by Messrs. Hawksley, Bidder, and Bazalgette, 1858; with Plans," pp. 145-299. Cited hereafter as B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette." See also: The London Observer, April 25, 1858.

It was later estimated that it would have cost £9,000,000 to extend the sewers to Sea Reach. B.S.P. (House of Commons), 1870, Vol. XL (Reports, vol. 29),

The debate that followed caused much controversy and delay, even though the plans basically agreed on the same objectives.[25] The objectives sought in the execution of the main drainage works were the interception of the sewage, as far as was practicable by gravitation, together with as much of the rainfall as could reasonably be dealt with, in order to divert it from the river near London; the substitution of a constant, instead of an intermittent, flow in the sewers; the abolition of stagnant and tide-locked sewers; and the provision of deep and improved outfalls. The system which the new drainage works would replace was one that was controlled by the tidal action of the Thames River.

The main sewers of London discharged their contents into the Thames at or about the level of low water. By this system, the outlets of the sewers were closed as the tide rose with the result that there were no unobstructed outlets for the discharge of the sewage into the

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"Report upon the Inquiry as to the Pollution of the River Thames at Barking," p. 551. Cited hereafter as B.S.P., 1870, Vol. XL, "Pollution at Barking."

[25] B.S.P., 1857-58, Vol. XLVIII, "Report of . . . Board . . . 1858," pp. 13-38. For example, should the outfalls be on the same side of the river?

The "intercepting" system was the only practical solution; it was easier to adopt the "combined" system of sewers (only one drain per house for the removal of both water and sewage) than to redrain every house with the two pipes as needed by the "separate" system (one pipe for water, one for sewage).

river. Consequently the sewage, flowing from the high ground to the low ground on the margin of the river, was ponded back in the main sewers. This accumulated in the lower lying sections of the system where it remained for long periods of time. During that time sewage continued to be deposited in the sewers. In times of either heavy or prolonged rains, particularly when these occurred at the time of high water in the river, the closed sewers were unable to store the increased volume of sewage and water. The sewage backed up and rose through the house drains and eventually flooded the basements of a large number of houses. Street drains were similarly affected by the system. As the tide rose, water entered the sewers and much of the sewage was carried back into the city, resulting in a "sudden outbreak of stinking . . . sewage . . . as the water runs in and the effluvia backs out, displacing volume for volume."[26]

The sewage that found its way into the Thames contained "every known abomination . . . and many an unknown one. . . ."[27] Fifty-six towns above London cast

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[26] B.S.P. (House of Commons), 1857 (sess. 2), Vol. XLI (Accounts and Papers, vol. 17), "Reports of Correspondence between the First Commissioner of Works and Mr. Goldsworthy Gurney, and the Commissioner of Sewers and the Board of Works respecting the State of the River Thames and the Pollution of the Atmosphere on the banks of the Thames and the Houses of Parliament," p. 265. Cited hereafter as B.S.P., 1857 (sess. 2), Vol. XLI, "Correspondence . . . Gurney . . . Parliament."

[27] The Times (London), June 24, 1858.

their cloacal contributions into the river where it combined with the ninety million gallons of sewage a day from London.[28] This sewage, in addition to containing human and animal deposits, was made up of the refuse from the "noxious trades" and "enormous amounts of dead animals and vegetable matter, the blood and offal of slaughterhouses, gas-liqours, bone-grindings . . . and other nameless pollutions."[29] The sewage entered the river untreated.

The sewers discharged a short time before low water and continued until a short time after low water. The sewage was carried up the river by the tide and was brought back into the city by the following ebb tide, where it mixed with each day's fresh supply. As the tide receded the sewage oozed out of the previously blocked

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[28] Ibid., June 21, 1858; Hansard, 3d ser., Vol. 151 (1858), 426.

There is no lack of facts and figures with which to describe the ecological crisis that London was suddenly confronted with. For example, it was estimated that, due to the increase in horse-drawn traffic in London, some 20,000 tons of horse manure found its way into the Thames. Robson, Misgovernment, p. 125. The solid matter discharged into the river amounted to 250 tons a day. See B.S.P. (House of Commons), 1857-58, Vol. XLVIII (Accounts and Papers, vol. 16), "Observations by Messrs. Bidder, Hawksley, and Bazalgette, on the Answer of the Government Referees to their Report to the Metropolitan Board of Works, relative to the Metropolitan Main Drainage," p. 188. Cited hereafter as B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette."

[29] Jephson, London, pp. 54, 114-15; Simon, Institutions, pp. 253-54.

outlets and deposited itself along the exposed banks of the river. The acres of mud banks were continuously coated with a compound of sewage, filth, offal, and carrion. The Thames constantly regurgitated the mixture that was undergoing the process of fermentation under the hot summer sun of 1858.[30]

The accumulation of the sewage along the banks and sides of the river was aided by a number of natural barriers in its channel. "On looking along the river two black lines may generally be seen stretching along each side of the river . . . these are a series of natural cesspools . . . and water brattices."[31] The middle of the river, where the current was strongest, was "relatively clear and unsmelly."[32] The sewage would sink as it eddied in towards the shore where the current was much slower. A larger portion of the sewage was trapped in

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[30]John W. Dodd, The Age of Paradox (New York: Rinehart and Company, Inc., 1952), p. 407; B.S.P., 1857 (sess. 2), Vol. XXXVI, "Report of Referees," pp. 11-12; The London Observer, July 4, 1858.

[31]B.S.P. (House of Commons), 1857-58, Vol. XLVIII (Accounts and Papers, vol. 16), "Report of Mr. Gurney to the First Commissioner of Works on the State of the Thames In the Neighborhood of the Houses of Parliament," pp. 424-25. Cited hereafter as B.S.P., 1857-58, Vol. XLVIII, "Report of Gurney . . . on the State of the Thames."

[32]B.S.P. (House of Commons), 1857-58, Vol. XI (Reports, vol. 7), "Report from the Select Committee appointed to take into consideration Mr. Gurney's report on the State of the Thames," p. 439. Cited hereafter as B.S.P. 1857-58, Vol. XI, "Select Committee on Gurney."

the numerous underwater holes in the bed of the river because the water-level was much lower than normal due to the unusual heat and lack of rainfall during the spring and summer of 1858. The lack of an adequate quantity of pure water, normally supplied by rainfall rendered the river incapable of diluting and disinfecting the mass of sewage in it. The lack of enough water also affected the action of the tide; the sewage, instead of being carried out to sea, oscillated between Putney and Woolwich. Any progress towards the sea was almost imperceptible.[33]

The progress of the smell was much more noticeable. The action of the tide carried the stench up and down the river within the boundaries of the metropolis. Certain atmospheric conditions increased the odor and discomfort. A gradual fall in the barometer increased the escaping rate of the gas from the sewers and also caused the river to become more turbulent. In calm weather the stench stayed about the river while in windy weather it spread out and covered the entire city.[34]

The deterioration in the general sanitary condition of the Thames, the extremely hot weather, and the stink coming from the river almost caused a panic in the summer of 1858.

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[33] Blackwood's Magazine, "Mephitis and the Antidote," Vol. 85 (February, 1859), p. 223.

[34] B.S.P., 1857 (sess. 2), Vol. XLI, "Correspondence . . . Gurney . . . Parliament," p. 265; Hansard, 3d ser., Vol. 147 (1857-58), 710.

The situation within the Houses of Parliament became critical. The men sitting in the Committeerooms and the Library were unable to remain there because of the smell; their full and complete attention to the affairs of government issues was hampered because of the smell.[35] It was almost impossible for Goldsworthy Gurney, the Officer in charge of Warming and Ventilating the Houses, to keep the smell out.[36] The common practices of hanging

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[35]The Times (London), June 12, 1858; Hansard, 3d ser., Vol. 151 (1858), 1921; Blackwood's Magazine, "The Commons at Cherbourg," Vol. 85 (September, 1858), pp. 352-56. See The Annual Register (1858), p. 215 for the early closing of the session.

[36]Gurney was a self-styled "expert" in sanitary planning and engineering. He was a doctor-turned-engineer who dealt primarily with steam engines and the application of steam. Considered a crackpot by some he did make some notable contributions to mechanical science. George Gregory Smith, "Goldsworthy Gurney," D.N.B., VIII, 801-03.

Gurney had attracted much attention because of an invention of his which he used for withdrawing and decomposing the gaseous effluvia from the sewers in the neighborhood of Parliament. His invention was a type of steam-jet which blew the gases out of one of the most repellent sewers in London—the Friar Street Sewer.

Gurney had been associated with the new Houses of Parliament since 1838. He had found that by using a "coal furnace," with a combination of coke and coal for the fire, he could burn the sewer gas without causing an explosion (sewer gas tended to explode for very little reason—sporadic explosions occurred daily in the sewers). His coal furnace had been in use for four years in the Houses in an attempt to burn some of the gas coming from the lower levels closest to the basement.

Gurney took advantage of the seriousness of the situation and urged the adoption of his pet project; he wanted to trap (cover the ventilating holes) all the sewers in London and run pipes from them to selected high points in the city (he needed at least twelve chimneys, each at least one hundred feet high). By putting his coal furnace

canvas wetted with a solution of chloride of lime and chloride of zinc in the windows and of wetting the curtains with the chloride of zinc to "trap" the smell failed

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in the chimneys he would "suction out" the gas and pass it by his "jet"—the gas would burn and serve a useful purpose; since the sewer gas burned with a blue light it would light up the night sky of London. Gurney had actually laid a pipe from the Victoria Sewer through New Palace Yard and into the newly constructed Victoria Clock Tower. The pipe led the gas from the sewer up to the tower where it was burned by several of Gurney's furnaces. A discovery by Bazalgette prevented Gurney from becoming as famous a figure as Guy Fawkes. The Victoria Sewer was full of a very unstable and highly explosive mixture of sulphuretted hydrogen and coal gas: if the mixture had managed to get at the coal furnace the clock tower, most of the Palace, and most of the Parliamentary buildings would have been blown up.

For a complete picture of Gurney, his numerous proposals, and his own evaluation of the situation together with a great mass of scientific and technical detail and information concerning the "Great Stink," the reader is advised to see the following documents: B.S.P. (House of Commons), 1857 (sess.1), Vol. XIII (Accounts and Papers, vol. 6), "Report made to the First Commissioner of Works by Commander Burctal, R. N., on the State of the Thames from Putney to Rotherhithe," pp. 165-174; B.S.P., 1857 (sess. 2), "Correspondence . . . Gurney . . . Parliament," pp. 263-85; B.S.P. (House of Commons), 1857-58, Vol. III (Bills, vol. 3), "A Bill to Alter and Amend the Metropolitan Local Management Act of 1855 and to extend the Powers of the Metropolitan Board of Works for the Purification of the Thames and the Main Drainage of the Metropolis," pp. 525-37. Cited hereafter as B.S.P., 1857-58, Vol. III, "A Bill to Alter . . . Local Management Act;" B.S.P., 1857-58, Vol. XLVIII, "Report of Gurney . . . on the State of Thames," pp. 423-30; B.S.P. (House of Commons), 1859 (sess. 2), Vol. XXVI (Accounts and Papers, vol. 12), "Returns from the Metropolitan Board of Works, the District Boards, the London Commissioner of Sewers, and the Board of Conservancy, relative to Operations performed for preventing the occurence of noisome Effluvia from the River," pp. 371-455.

For further reference the reader is advised to see: Hansard, 3d ser., Vol. 151 (1858), 28-36, 423-28, 573-78, 874-77, 1165-71, and 1921; The Times (London), May 26, June 12, 16, 19, 21, 22, 23, 24, 25, 26, and 30, 1858; The London Observer, April 25, May 23, June 27, July 4 and 25, 1858; Frazer's Magazine, "The Thames and Its Difficulties,"

because of the overpowering features of the odor. No satisfactory solution had been found to deal with the smell coming from the Thames in spite of the efforts of numerous individuals and Parliamentary committees to do so.[37] The Government authorized the Board to begin a series of remedial operations in an attempt to combat the odor. The mixing of lime with the sewage before its discharge into the river was regarded as the best solution to the problem, although it was intended only as a temporary measure. It was estimated that between 200 and 250 tons of lime per day would have to be used at a cost of £1,500 per week to have the sewer outlets and the banks of the river "whitewashed."[38] The Board, on June 29th,

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Vol. LVIII, No. CCCXLIV (August, 1858), pp. 167-71; and "A Mad World, My Masters," Vol. LVII, No. CCCXXVII (January, 1858), pp. 133-42.

[37]The fact that so many reports were presented shows that the situation which developed so rapidly in 1858 was not a totally unforeseen one. For details of the situation prior to 1858 the reader should see the following: B.S.P. (House of Commons), 1847, Vol. LVII (Accounts and Papers, vol. 13), "Reports from the Medical Officers on the Experiments on Burnett's, Ledoyen's, and Ellerman's Disinfecting Fluids," pp. 535-60; and B.S.P. (House of Commons), 1854, Vol. LXVII (Accounts and Papers, vol. 29), "Reports of Mr. Walker and Sir Charles Barry in 1850 on the Accumulation of Mud in the River Thames," pp. 399-455.

[38]B.S.P., 1857-58, Vol. XI, "Select Committee on Gurney," p. 518; The Times (London), June 28, 1858; The London Observer, June 28, 1858; and Hansard, 3d ser., Vol. 151 (1858), 576.

The Government, because public opinion to the construction of any form of reservoir or treatment plant within or near the city had been so great, felt that the

adopted the plan proposed by its engineers.[39]

The Board of Works' sudden activity, after such a prolonged period of torpidity, was caused by the political climate as well as by the national scandal that the smell had created. A change of government had occurred in February, 1858, with the defeat of Palmerston.[40] Lord Derby had come in,[41] and Lord John Manners had replaced Sir Benjamin Hall as First Commissioner of Works.[42] Even with friends in the Government the Board had hesitated in undertaking any positive long-range programs until Hall, as a member of Parliament, proposed Governmental action

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deodorization of the sewage was only a stop-gap measure that was needed primarily between the months of May and October. B.S.P., 1857-58, Vol. III, "A Bill to Alter . . . Local Management Act," p. 525; B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge," p. 27; and The Times (London), June 22, 1858.

[39]The Times (London), June 30, 1858; The London Observer, July 5, 1858.

[40]For the details see: Halevy, Victorian Years, p. 422; Asa Briggs, The Making of Modern England: 1784-1867 (New York: Harper Torchbooks, Harper and Row, Pub., 1965), p. 422. Cited hereafter as Briggs, Modern England; D.N.B., John Henry Temple, "Lord Palmerston," XVI, 509.

[41]This was the second Derby-Disraeli Combination; a short-lived Tory minority Government was formed in February, 1852, but lasted only a few months. Briggs, Modern England, p. 422; B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge," p. 27; and D.N.B., John Andrew Hamilton, "Lord Stanley," XVIII, 943-47.

[42]D.N.B., William Arthur Jobson Archbald, "Charles Cecil John Manners, 6th Duke of Rutland," XII, 933.

instead of action by the Board.[43] The Board, scared by this proposal for governmental-decision-making, had passed the resolution of June 29th and had adopted Bazalgette's plan for the main drainage of London.[44] But the construction could not begin until certain provisions of the Act of 1855 had been amended.

The change of Government had brought about a change in policy on the role that the Government would play in regard to the question of the main drainage. The former Government believed that it had a right to be consulted on any plans of such public importance and expense and that it should retain the right to either approve of or to veto any proposal.[45] The Derby Government held a different view and, on July 15, 1858, Disraeli, the Chancellor of the Exchequer, brought in a Bill, the object of which was to relieve the Board from the necessity of receiving Governmental approval on the subject of the main drainage.[46] The Bill, in spite of the opposition raised

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[43] The Times (London), June 18, 1858; The London Observer, June 20, 1858; B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge," p. 27.

[44] B.S.P., 1884, Vol. XLI, "Royal Commission on Metropolitan Sewage Discharge," p. 27.
It was placed before the First Commissioner of Works on July 1.

[45] This belief had been written into the Act of 1855 and the veto had been used frequently.

[46] The London Observer, July 11, 18 and 25, 1858; The Times (London), July 16, 1858.

against it and the lateness at which it was introduced in the session, became law on August 2, 1858.[47] The Metropolitan Board of Works thus became the sole authority for executing the works for the purification of the Thames River. The consent of the First Commissioner was no longer necessary in the formulation of any plans for the main drainage of the city, which had to be completed by the end of 1863.

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[47] B.S.P., 1857-58, Vol. III, "A Bill to Alter . . . Local Management Act," pp. 525-37; Hansard, 3d ser., Vol. 151 (1858) 2369-71; B.S.P. (House of Commons), 1858 (sess. 2), Vol. XXVI (Accounts and Papers, vol. 12), "Report of the Proceedings of the Metropolitan Board of Works for the Year ending 30 June 1859," pp. 275-77. Cited hereafter as B.S.P., 1858 (sess. 2), Vol. XXVI, "Report of . . . Board . . . 1859." The Times (London), August 3, 1858; The London Observer, August 8, 1858; and The Morning Chronicle, August 2, 1858.

CHAPTER V

THE MAIN DRAINAGE OF LONDON

The basic plan for the main drainage of London which the Metropolitan Board of Works adopted on June 29, 1858, was neither original nor complete.[1] Bazalgette's scheme proposed the construction of new lines of sewers, laid at right angles and a little below the level of the existing sewers in order to intercept their contents and convey them, by gravitation and pumping, to outfalls located somewhere outside of the metropolitan boundary. At the outlets the sewage would enter reservoirs situated on the banks of the Thames and placed at such a level that would enable them to discharge into the river at or about the time of high water.[2]

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[1]When Bazalgette, in 1856, submitted his first plans for draining both sides of the river he drew attention to his previous report of 1853—B.S.P. (House of Commons), 1854, Vol. LXI (Accounts and Papers, vol. 23), "Reports from the Engineer to the Metropolitan Sewers Commission, upon the Sewage Interception and the Main Drainage of the Districts North and South of the River Thames," pp. 384-430. Cited hereafter as B.S.P., 1854, Vol. LXI, "Reports from the Engineer . . . Districts"—and to the plans and suggestions sent to the Metropolitan Commission of Sewers in 1849 and said: ". . . I cannot pretend to much originality; my endeavour had been practically to apply these . . . to the . . . districts." B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette," p. 146.

[2]High water means the same as high tide.

The idea of using the intercepting system to solve London's drainage problem had been proposed as early as 1834, and it had figured prominently in Forster's plans presented to the Metropolitan Commission of Sewers.[3] Bazalgette was familiar with the earlier proposals but it was not until 1853 that he fully approved of the intercepting drainage plan. Previous to his conversion he had advocated drainage by gravitation and had opposed intercepting sewers unless provision was made for the removal of soil and rainfall, along with the rest of the sewage, to a suitable distance from the city.[4]

The position of the outfalls to be used in the intercepting plan, along with arrangements to control the time of the discharge of wastes into the river, was the most important of several questions that had to be answered: how near to London could the sewage be discharged into the river without finding its way back into the inhabited parts of the city? Numerous sites had been

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[3]See the evidence presented by John Martin in B.S.P., 1834, Vol. II, "Report from the Select Committee on Metropolitan Sewers," pp. 371-76. For Forster's plans see B.S.P., 1851, Vol. XLVIII, "Report . . . Metropolitan . . . Sewers," p. 78.

[4]Bazalgette's ideas on this type of drainage plan are presented in B.S.P., 1852-53, Vol. XXVI, "Evidence . . . Greater London Drainage Bill," pp. 501-05. As early as 1845 he had proposed outfalls at Barking Creek and the Greenwich Marshes. B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette," p. 276.

recommended in the various plans that the Metropolitan Commissions of Sewers, the Board of Works, and the First Commissioner of Works had proposed. Bazalgette selected Barking Creek, on the north side of the Thames, the Crossness Point, on the south side, as the sites for the outfalls. He based his decision on the results of a series of experiments which demonstrated that it was essential to locate the outfalls at least as far as Barking Creek; any closer location would be fruitless. The same experiments also demonstrated, with regard to the water level at the time of discharge, that the discharge should take place at or as near high water as possible.[5]

Although it was desirable to fix the place of discharge as far below the metropolis as possible there was a practical limit that also helped determine the eventual site of the outfalls. On the north side of the river the advantages gained from a discharge by gravitation made it necessary to maintain a sufficient fall in the sewers; on the south side it was necessary to preserve, as a safety outlet, a discharge by gravitation into the river at low water, in case of accident to the pumps and during times of excessive floods.[6]

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[5]Humphreys, London Drainage, pp. 13-14.

[6]The south side was more "flood-prone" than the northern side.

Once the outfall location was selected the time of discharge was shown to be at high water because:

> The delivery of the sewage at high water into the river at any point is equivalent to its discharge at low water at a point 12 miles lower down the river, therefore the construction of 12 miles of sewer is saved by discharging the sewage at high instead of low water.[7]

A second question, concerning the flow of the sewage in the sewers had to be answered because it was necessary to economize the fall of the sewers in order to save the cost of extra pumping. Thus a sufficient velocity of flow, plus the minimum fall, had to be determined in order to prevent the formation of deposits in the sewers. It was difficult for Bazalgette to find a general rule regarding the flow in the sewers because the conditions in the sewers varied considerably—these being the quantity of deposit passing into them and the ordinary volume of the sewage flowing through them. Bazalgette, after examining the results of numerous experiments, chose a mean velocity of 1½ miles per hour in a properly protected main sewer that was running half full as the minimum velocity needed to prevent the deposit of any matter in the sewers.[8]

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[7] B.S.P., 1854, Vol. LXI, "Reports from the Engineer . . . Districts," p. 396; Bazalgette, "Drainage of London," p. 289.

[8] The 1½ miles per hour velocity (or between 2 and 2½ feet per second) was found to be satisfactory for self-cleaning while also being nondestructive to the conduits. Most sewers are designed to convey their burden while partially filled or barely full. Sewers are not intended

Once the minimum velocity was determined it was necessary to ascertain the quantity of sewage that would be carried off by the system. This quantity varies but little from the water supply with which a given population is provided. The water supply to various districts of London in 1856 varied from 20 gallons to 25 gallons per person per day.[9] Bazalgette contemplated a more liberal supply in the future and based his figures on this assumption. He estimated that a district, when completely built upon, would contain 30,000 people to the square mile; in districts where that figure had been reached the actual numbers were determined, while in those districts where the population was below it provision was made to accommodate that number. Bazalgette proposed a flow to the outfalls of 5 cubic feet (or 31¼ gallons) per head per day.[10] At the time that Bazalgette designed his system

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to flow under pressure—hydraulically, sewers are designed as open channels. Gordon M. Fair, John C. Geyer, and Daniel Okun, Water Supply and Wastewater Removal, Vol. I of Water and Wastewater Engineering (2 Vols.; New York: John Wiley and Sons, Inc., 1966), pp. 3:2-3:9.

Bazalgette, in determining the flow velocity, exercised the option that the chief engineer has in such a situation: "The maximum flow rate will have to be a matter of judgment or calculation by the . . . engineer having regard to the information given him." A. C. Twort, A Textbook of Water Supply (New York: American Elsevier Publishing Company, Inc., 1963), p. 395.

[9]Bazalgette, "Drainage of London," p. 290.

[10]B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette," p. 178.

there were 1,889,300 persons on the north side of the Thames and 696,760 on the south side or a total of 2,586,060; Bazalgette's system was designed to accommodate 3,450,000 persons.[11] The discharging capacity of the sewers was made larger than necessary for the amount of sewage that would be discharged (the total amount of sewage was 108,000,000 gallons: the sewage per day of 24 hours at 31¼ gallons per head times the future population anticipated). This was done because it was necessary to make allowances for the fluctuating flow of sewage at different hours of the day. Experiments had shown that sewage was not discharged into the sewers at a uniform rate throughout the twenty-four hours of any day; it was found that about one-half of the total quantity flowed off in the eight hours between 9:00 A.M. and 5:00 P.M., the remainder entered the system during the other 16 hours.[12]

Bazalgette's plan for the sewers, at the time of the maximum discharge of sewage, made little provision for dealing with rainfall. The amount of rainfall to be carried off by the sewers was a question that had caused

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[11] Ibid., p. 169; Humphreys, London Drainage, p. 12.

[12] Bazalgette assumed that the habits of the population in the metropolis were indicated by the flow of sewage through the sewers—the maximum flow in the more fashionable districts of the West end being two or three hours later than from the East end. Later observations showed that he overestimated in his calculations. Humphreys, London Drainage, p. 13; B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette," pp. 170-71.

considerable difficulty in the formation of the plans for the main drainage. The drainage system that London was built over was the combined drainage system. In this system each house had only one drain for both sewage and rain water. This drain connected with only one local sewer in each street. The local (or branch) sewer, which also took the water off the street, connected with the main sewer which later discharged its combined flow of rain water and sewage directly into the Thames. It was recognized from the first initiation of Bazalgette's plans that to alter the existing drainage system in London by introducing the separate drainage system was impossible and impracticable. The separate system would involve a double set of drains to every house, one for sewage and one for rain water, and the construction and maintenance of a second series of sewers to every street. The major obstacle to its acceptance was that it would involve the re-draining of every house and every street in the metropolis. In a city of two and one-half million people such a project was impossible and too expensive. An alternate system had to be found that could adequately handle the rainfall.

It was necessary to find what the average rainfall amount was because the amount of rain that falls is not constant. Previous observations had shown that there were about one hundred and fifty-five days per annum on which

rain fell in the city. Of these, there were only about twenty-five days upon which the quantity that fell amounted to more than one quarter of an inch in depth in twenty-four hours.[13] From such rainfalls only a small amount reaches the sewers since the larger proportion is evaporated or absorbed. However, in almost every year there are exceptional cases of heavy and severe storms with the rain measuring one inch, and in some instances, two inches in an hour. These rains would have to be provided for, regardless of their rarity. Since it would have been impractical to increase the size of the intercepting sewers in order to carry off the excess rainfall Bazalgette placed overflow weirs at the junctions of the intercepting sewers and the old main sewers, which discharged directly into the Thames. The overflow weirs were designed in such a way that the intercepting sewers, while carrying away any sewage that came down the old main sewers during dry weather, permitted any excessive flow, due to rainfall, to run away partly in the intercepting sewers and partly by short cuts (the old main sewers) to the river.[14]

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[13]Bazalgette, "Drainage of London," pp. 291-92.

[14]This provision for discharging excessive rainfall into the Thames could not be satisfactory all the time because the old sewers were blocked by the tide for a considerable time before and after low water. B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette," pp. 193-94; Humphreys, London Drainage, p. 13; and Bazalgette, "Drainage of London," pp. 292-93.

The total amount of rainfall that Bazalgette made provision for was 286,000,000 gallons per day.[15]

Bazalgette, after determining the quantities of sewage and rainfall to be carried off and the rate of declivity of the sewers required for the necessary velocity of flow, had to determine the sizes of the intercepting and main drainage sewers. The form generally adopted for the intercepting sewers was circular since this shape combined the greatest strength and capacity with the smallest amount of brickwork and the least cost. The egg-shaped sewer was chosen for the district drainage sewer. It was decided to put the narrow part downward for three reasons—the dry weather flow of the sewage was small, the greatest velocity of flow and scouring power is obtained at the greatest hydraulic mean depth at the most advantageous time, and the broader section of the upper part affords room for the passage of storm-water and also for workmen when repairs are needed.[16]

Pumps were necessary to raise the sewage from the lowest levels of the system—those places where the gravitational flow was stopped due to the natural termination of the gradient. Pumps were also needed at the outfalls to

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[15] B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette," p. 170.

[16] Bazalgette, "Drainage of London," p. 284.

lift the sewage up and to discharge it from the system.

The Metropolitan Board of Works, with the settlement of these questions, could begin the construction of the main drainage works for London.[17] Bazalgette's system consisted of three lines of sewers on each side of the river. They were termed the High Level, the Middle Level, and the Low Level Sewers. The High and Middle Level Sewers discharged only with the aid of pumping. The three lines of sewers on the north side of the Thames converged and united at Abbey Mills, where the contents of the Low Level Sewer were pumped into the Upper Level Sewer, and the combined stream flowed through the Northern Outfall Sewer, which was carried in a concrete embankment across the marshes to Barking Creek, where it discharged into the river. On the south side the three intercepting lines united at Deptford Creek where the contents of the Low Level Sewer were pumped to the Upper Level. The Southern Outfall Sewer carried the sewage through Woolwich to Crossness Point where it discharged into the Thames.

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[17]On October 15, 1858, the Board resolved that the Northern High Level Sewer should be begun with as little delay as possible: a main drainage committee was set up for that purpose. See Corlett, Board of Works, p. 35.

There were three different lines of sewers under the control of the Board of Works: the main sewers at right angles to the river, the intercepting sewers parallel to the river, and the outfall sewers. The smaller local sewers in the streets were under the control of the newly-created vestries and district boards.

The High Level Sewer on the north side of the Thames began with a junction with the Fleet Sewer and passed across the Highgate Road.[18] It was carried under the Great Northern Railway and the New River to Highstreet, in Stoke Newington. It passed under several streets to Church-street, Hackney, then under the North London Railway, through Victoria Park to a junction with the Middle Level Sewer.[19] The High Level Sewer was constructed with greater-than-average dimensions in order to be able to carry off the largest and the most sudden rainfalls.

The Northern High Level Sewer was about 7 miles

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[18]The following description of the main drainage system of London has been taken from several sources and considerably simplified and shortened, both technically and territorily. These are: B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette," pp. 145-299; Bazalgette, "Drainage of London," pp. 280-358; B.S.P. (House of Commons), 1867-68, Vol. LVIII (Accounts and Papers, vol. 19), "Report of the Metropolitan Board of Works for the Year 1866-67," pp. 97-104. Cited hereafter as B.S.P., 1867-68, Vol. LVIII, "Report of . . . Board . . . 1866-67." B.S.P., 1857-58, Vol. XLVIII, "Observations by Bidder, Hawksley, and Bazalgette," pp. 193-98; and Corlett, Board of Works, pp. 39-41.

The reader should consult the map at the end of the text in order to locate the reference points mentioned. Some have been omitted because of lack of space and for clarity.

[19]At the junction of the High and Middle Level Sewers, at Old Ford, Bow, a Penstock Chamber was constructed which could divert the sewage either into the two lower channels formed by the discharge of the storm-waters into the River Lea or into the two upper channels constructed over that river, and forming the beginning of the Northern Outfall Sewer.

long and drained an area of about 10 square miles. It intercepted the sewage of Hampstead, part of Kentish Town, Highgate, Hackney, Clapton, Stoke Newington, and Holloway. The form of the sewer was mainly circular; its size varied from 4 feet in diameter to 9 feet 6 inches by 12 feet. It was constructed of stock brickwork and the invert was lined with a type of brick designed to withstand the scour caused by the rapid fall in the sewer from 4 feet to 5 feet per mile at the lower end.

The Northern High Level Sewer was the first completed section of the main drainage works and was in operation by May, 1861.

The Middle Level Sewer on the north side was carried as close to the Thames as the contour of the ground permitted, with the object of intercepting as much sewage as possible by gravitation and of reducing to a minimum the low level area which would be dependent upon pumping. The sewer began near the Harrow-Road at Kensal Green, passed under the Paddington Canal, was carried along Oxford Street and across Clerkenwell Green, then, by way of Old Street Road it connected with High Street, Shoreditch, where it passed under the Regent's Canal and the North London Railway, and met the High Level Sewer at the Penstock Chamber. This sewer intercepted a densely

populated area of about 17½ square miles.[20] The length of the main line was about 9½ miles, not including the minor branches and feeder sewers. The fall of the main sewer varied from 17½ feet per mile at the upper end to 2 feet per mile at the lower end. The sizes varied from 4 feet 6 inches by 3 feet to 10 feet 6 inches in diameter to 9 feet 6 inches by 12 feet at the outlet.[21]

The Northern Low Level Sewer was the main outlet for the western suburbs of London, an area of about 14½ square miles;[22] this area was so low that its sewage had to be lifted a height of 17½ feet at Chelsea into the upper end of the Low Level Sewer.

This sewer commenced at the Grosvenor Canal, Pimlico, passed to and along the river side from Vauxhall Bridge. From Westminster Bridge to Blackfriars it was

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[20]In order to enlarge the area drained by gravitation, a branch sewer, 4 feet by 2 feet 8 inches, was carried along Piccadilly, passed through Leicester Square and Lincoln's Inn Fields to the main line at King's Road, Gray's Inn Road.

[21]About 4 miles of the main line and the entire length of the Piccadilly Branch were constructed by tunneling under the streets, at depths varying from 20 feet to 60 feet.

[22]The Western suburbs include Fulham, Chelsea, Brompton, Kensington, Shepherd's Bush, Hammersmith, and part of Acton.

It was originally intended to deodorize the sewage of this district in its own neighborhood but because of the public outcry against this plan the sewage was carried to Barking Creek and the outfalls.

formed as part of the Thames Embankment.[23] At the Abbey Mills Pumping Station the contents of the Low Level Sewer were raised 36 feet by steam power into the Northern Outfall Sewer. The Low Level Sewer had two branches—one from Homerton and the other from the Isle of Dogs. The length of the main sewer was 8¼ miles and its branches were about 4 miles in length. Its size varied from 6 feet 9 inches to 10 feet 3 inches in diameter. Its inclination ranged from about 2 feet to 3 feet per mile. It was provided with storm-overflows to carry any excess water into the river.

The Northern Outfall Sewer was raised in an embankment above the level of its surrounding neighborhood. Its contents were carried by aqueducts over rivers, railways, streets, and roads. The sewer began at a junction with the High and Middle Level Sewers at the Penstock Chamber at Bow. It passed under the rails of the North London Railway, which were carried over it on girders. It then passed under Wick Lane and then over the River Lea by an aqueduct.[24] Four other streams between the River Lea and the Stratford Road were bridged by the sewer's

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[23]The sewer was the last to be completed.

[24]This aqueduct consists of two wrought-iron culverts; over these a roadway was formed. All aqueducts on this line of sewers are constructed to carry a wide roadway of plates and girders on the top of them.

iron tubes. The Outfall Sewer, up to this point, consisted of two culverts placed side by side, each 9 feet by 9 feet. These were built upon a solid concrete embankment which was covered with an earthen embankment and was of sufficient strength to support a railway. From the Stratford Road the double line of sewers continued over Abbey Mill Lane to the Abbey Mills Pumping Station where the contents of the Low Level Sewer were raised 36 feet.[25] From this point three parallel lines of sewers were constructed to the outlet at Barking Creek.[26]

The Barking Reservoir, built almost exclusively above ground, was a large complicated plant that covered about 9½ acres of land. The reservoir was designed in such a way that the sewers form one side of it. Sixteen openings in this side provided the means for the sewage to enter the reservoir, where it was stored until high water.

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[25]The Abbey Mills Pumping Station was the largest one on the main drainage line. It was equipped with 8 engines providing a total engine power of 1,140 Horse Power; they were capable of lifting a maximum of 15,000 cubic feet per minute a height of 36 feet. The engines consumed about 9,700 tons of coal per annum.

[26]The three lines of sewers pass over Marsh Lane, the North Woowich and the Bow and Barking Railways by aqueducts. The railways were lowered to enable the sewer to pass over them—the sewer, needing a minimum fall of 2 feet per mile, could not be raised. This project constituted one of the greatest difficulties in laying out the main drainage because the Northern Outfall Sewer passed through an area that was already closely intersected by public works.

A culvert, connected with the river, was built at the rear of the reservoir with openings into each of its four partitions. These openings were fitted with penstocks which enabled any one of the compartments to be filled with tidal water at the top of the tide and flushed out by its discharge at the period of low water.

The Southern High Level Sewer and its Southern Branch correspond with the High and Middle Level Sewers on the North Side of the Thames. The Main Line began at Clapham and the Branch Line at Dulwich. The area it drained, about 20 square miles, included Tooting, Streatham, Clapham, Brixton, Dulwich, Camberwell, Peckham, Norwood, Sydenham, and part of Greenwich. Both lines were constructed of sufficient capacity to carry-off all the flood-waters in order that they could be entirely intercepted from the low and densely populated area.[27] The storm waters discharged into Deptford Creek, while the sewage and a limited quantity of rain were carried by pipes to the Outfall Sewer.

The two lines united in the New Cross Road and were constructed side by side along that road to Deptford.[28]

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[27]This area was tide-locked and subject to floods.

[28]The sewers of this district were constructed in such a manner that, in case of becoming overcharged, they would be relieved by their neighbor, thus reducing the sewage to a uniform level throughout the district.

The Branch Sewer's size varied from 7 feet in diameter to 10 feet 6 inches by 10 feet 6 inches. Its fall was gradually reduced from 30 feet per mile at the upper end to 2 1/3 feet per mile at its lower end.[29] The Main Line varied in size from 4 feet 6 inches by 3 feet at the upper end to 10 feet 6 inches and its fall from 53 feet per mile to 2 1/3 feet per mile at the outlet.

The Low Level Sewer did not follow the course of the river as it did on the north side. It took a direct line from Putney to the Deptford Pumping Station and drained an area of about 20 square miles—Putney, Battersea, Nine Elms, Lambeth, Newington, Southwark, Bermondsey, Rotherhithe, and Deptford. Much of the surface of this area was below the level of high water; consequently, the sewers throughout this area had but little fall and, except at the period of low water, the sewers were tide-locked and stagnant. They would become overcharged during periods of extensive rainfall and the water and sewage would accumulate for several days before the sewers could be relieved. The lack of fall also caused large accumulations of deposit.[30]

The Low Level Sewer was about 10 miles in length.

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[29]Two subsidiary branches were extended from this sewer at Dulwich—one to Crown Hill, Norwood, and one to the Crystal Palace.

[30]These conditions aided such diseases as malaria and cholera. The southern district was the unhealthiest of the two halves of the metropolis.

Its size varied from a single sewer 4 feet in diameter at the upper end to two culverts, each 7 feet high by 7 feet wide at the lower end. Its fall varied from 4 feet to 2 feet per mile.

The Deptford Pumping Station received the sewage from the Low Level Sewer and the High Level Sewer. The sewage from the Low Level Sewer was lifted 18 feet into the Southern Outfall Sewer while the sewage from the High Level Sewer entered the Outfall Sewer by gravitation.[31] The sewage was conveyed from Deptford through Greenwich and Woolwich to Crossness Point in the Erith Marshes.

The Southern Outfall Sewer was not, like the Outfall Sewer on the north side of the Thames, constructed above the ground level. It was entirely underground for its whole length of 7 3/4 miles. The bottom of the sewer, which was 11 feet 6 inches in diameter and had a fall of 2 feet per mile, was 9 feet below the level of low water at its outlet into the river so that it could discharge by gravitation into the river at or near to low water if necessary. Its normal method of discharge was to be by pumping into the Crossness Reservoir.

The outfall for the sewage on the south side of the

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[31]The Low Level sewage was raised by means of four engines, each of 125 Horse Power and, together, capable of lifting 10,000 cubic feet of sewage per minute a height of 18 feet.

Thames was at the Crossness Reservoir and Pumping Station. The sewage was discharged into the river only at high water but the sewer was at such a level that it could discharge its full volume by gravitation about the time of low water. Its contents were raised by pumping into the reservoir,[32] which was built at the same level as that on the north side. It also stored the sewage except for the two hours of discharge after high water.[33] The outlet into the river consisted of twelve iron pipes each 4 feet by 4 inches, carried into a paved channel formed in the bed of the river.

Bazalgette estimated that the sewage on the north side of the Thames amounted to 10 million cubic feet per day and 4 million cubic feet per day on the south side. He anticipated an increase in the total sewage amount on the north side of up to 11½ million cubic feet per day and 5 3/4 million cubic feet per day on the south side. The rainfall on the north side was estimated to be 28½ million

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[32]The sewage was lifted by four engines, each of 125 Horse Power; the lift varied from 10 feet to 30 feet according to the level of water in the sewer and in the reservoir. The maximum quantity of sewage to be lifted would ordinarily be about 10,000 cubic feet per minute—this figure was reduced at night and nearly doubled during a heavy rain.

[33]The reservoir's height, level, and general construction was similar to the one at Barking. The Crossness Reservoir was about 6½ acres in total area.

cubic feet per day and 17¼ million dubic feet per day on the south side. The total sewage and rainfall provided for was 394,000,000 gallons per day.[34]

The main drainage system, which the Prince of Wales officially opened on April 4, 1865, was comprised of about 90 miles of great intercepting and outfall sewers and about 180 miles of main sewers.[35] The estimated cost of the main drainage works was about £2,800,000 but the actual cost was in excess of £4,100,000.[36] The difference was due to the numerous extensions added to many of the sewers and increases in the cost of labor and materials.[37]

An integral part of the expensive drainage system was the construction of the Thames Embankment. Much of the foulness that resulted from the pollution of the Thames was caused by the wide expanses of mud which were exposed at low water. Many suggestions for reducing this area had

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[34]Humphreys, London Drainage, p. 12; B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette," p. 170.

[35]B.S.P., 1867-68, Vol. LVIII, "Report of . . . Board . . . 1866-67," pp. 101-04.

[36]B.S.P. (House of Commons), 1867, Vol. LVIII (Accounts and Papers, vol. 20), "Returns from the Metropolitan Board of Works—Estimate made by the Engineer for the Total Cost of the Main Drainage Works," p. 715.

[37]Ibid.

been proposed, including embanking the river.[38] It was primarily because of the necessity of finding a site for the Northern Low Level Sewer that the question was again seriously considered.[39] The House of Commons appointed a select committee in 1860 and a Royal Commission in 1861 to study the matter. Both supported the suggestion for embanking the Thames from Westminster Bridge to Blackfriars Bridge on the northern side of the Thames and in 1862 the construction was authorized.[40] Plans were also made for embanking the southern bank of the river.

The Victoria Embankment, completed in 1870, reclaimed 37 acres of land. The embankment, in addition to the Low Level Sewer, carried the Metropolitan District Railway, roads and footpaths, and set apart 11 acres for public recreation. The cost for the 1½ mile embankment was to have been £1,455,672 but an additional outlay of £600,000 was paid for the Charing Cross approach. The total cost of the Victoria Embankment was over

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[38]An embankment was part of Christopher Wren's plan for the rebuilding of London after the Great Fire. Other proposals had been brought forward from time to time. See Corlett, Board of Works, p. 55.

[39]Bazalgette had included a proposal to carry the Northern Low Level Sewer in an embankment in his plans presented in 1856. B.S.P., 1857-58, Vol. XLVIII, "Report of Hawksley, Bidder, and Bazalgette," p. 187.

[40]Corlett, Board of Works, pp. 55-60. For a complete list of the Acts of Parliament under which the works were executed and the money raised, see Firth, Municipal London, p. 239.

£2,000,000.[41]

The Albert Embankment, 4,300 feet in length and located between Lambeth Bridge and Vauxhall Bridge on the southern side of the Thames, was completed in 1869 at a cost that exceeded £1,000,000. The Chelsea Embankment was begun in 1871 and completed in 1874; located between Chelsea Hospital and Battersea Bridge, the embankment was 4,219 feet in length and cost about £300,000.[42]

Improvement in the state of the Thames was noticeable even before the completion of the drainage works and the embankments.[43] The river grew much purer within the city limits since the crude sewage was being discharged at Barking Creek and Crossness Point. However, there were two major objections to discharging the sewage into the river: the formation of banks and pollution.

Even before the drainage system was completed the Board of Works received complaints which charged that mud-banks had formed at the points of discharge at the

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[41]Firth, Municipal London, pp. 237-38; Gomme, London, pp. 155-56; Bell and Gibbon, London Council, p. 33.

[42]Corlett, Board of Works, pp. 55-76; Bell and Gibbon, London Council, p. 33; Firth, Municipal London, pp. 238-39.

[43]This brief mention of the embankments has been necessary because the embankments narrowed the channel of the Thames in the metropolis thus increasing the flow of the current and improving the "scouring power" of the river.

outfalls, that these mud-banks were hindering navigation, and polluting the atmosphere.[44] In 1869 an inquiry was held and its report stated that while there were banks in the river the exact cause could not be determined.[45] Nevertheless, the volume of complaints against the Board and its drainage system increased as the pollution of the Thames increased.[46] In 1882 a Royal Commission was appointed to investigate the matter. Their report criticized the method of disposing of the crude sewage and recommended that some process be applied to separate the solid from the liquid portions of the sewage at the outfalls.[47] The Board began the construction of precipitation works at Barking and Crossness Point; until they were completed, in 1889 and 1891, the sewage was deodorized before its discharge into the Thames. The sludge that remained after the precipitation process was completed was pumped into specially constructed sludge vessels and dumped, first at Barrow Deep

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[44] Hansard, 3d ser., Vol. 190 (1868), 1220.

[45] B.S.P., 1870, Vol. XL, "Pollution at Barking," p. 553.

[46] For example, see The Times (London), October 24, 1878, and August 26, 1881; and The Pall Mall Gazette, December 14 and 21, 1881.

[47] Hansard, 3d ser., Vol. 270 (1882), 840; B.S.P. (House of Commons), 1884-85, Vol. XXXI (Reports, vol. 18), "First and Second Reports of the Royal Commission on Metropolitan Sewage Discharge," p. 406. The Commission also recommended that in any future drainage works the sewage should be separated from the rainfall (p. 407).

and later at Black Deep at the mouth of the Thames, about 57 miles from the outfalls.[48]

The main drainage of London, designed by Joseph Bazalgette, made possible by the Local Management Amendment Act of 1858, and constructed by the Metropolitan Board of Works, was "a great work . . . and it cleared the way for other sanitary reforms which were impossible without an effective general system of sewerage, yet which were essential if a satisfactory condition of public health were ever to be attained."[49]

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[48]Descriptions of the workings of the precipitation works can be found in Humphreys, London Drainage, pp. 15, 24-25, and Sir Maurice Fitzmaurice, The Main Drainage of London (London: London County Council, 1912), pp. 4-7

[49]Jephson, Evolution, p. 159.

CHAPTER VI

CONCLUSION

"The Thames stinks!"[1] was, perhaps, the phrase most frequently used by many Londoners during the 1850's. Smell may have no historical dimension but the "Great Stink," which occurred during the summer of 1858, occupies a unique position in English history: it was directly responsible for legislation which saved London from suffocating in her own refuse and sewage.

By the middle of the nineteenth century the conditions of life in the towns and cities, of which London is the prime example, presented problems which almost overwhelmed the sanitary reformers. Isolated bits and pieces of legislation aimed at correcting individual incidents had proved inadequate, and the first task of the sanitary reformers was to decide where to begin. Hence, during the 1830's and 1840's Parliament and local officers worked through numerous Royal Commissions and Select Committees, who filled reports and papers with statistics and evidence, in seeking to ascertain what should be done. The period of research and planning was a prolonged one, extending well into the 1850's. Solutions to the sanitary problems could only be decided upon after investigation, followed by periods of trial and error.

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[1] The Times (London), June 21, 1858.

And, as is inevitable in such situations, many mistakes were made. The exclusion of London from the Public Health Act of 1848 was a costly ommission of this type.

It was only after the passage of the Metropolitan Local Management Act of 1855 that London was able to deal effectively with her many sanitary problems, the most serious and most noticeable one being what to do about the drainage of the metropolis which polluted the Thames basin. The "twin terrors" of cholera and Edwin Chadwick had drawn attention to the deplorable drainage system that no longer was able to effectively serve London. When it was shown that effective improvements in sewage drainage would greatly improve the overall health of any community, there developed rapidly in London a demand for change.

The Metropolitan Board of Works, created by the Act of 1855, was given the responsibility of constructing the main drainage system, but certain limitations imposed by the Act delayed the adoption of any final plan. One of these restrictions was the veto power held by the First Commissioner of Works: he had to approve of the Board's plan in order for construction to begin. A second limitation concerned the wording of the clause which prohibited any sewage from entering the river within the boundary of the metropolis; this clause formed the basis for Sir Benjamin Hall's rejection of several of Joseph Bazalgette's plans. A third clause restricted the Board's borrowing power.

The exchanges between the Board and Hall and the

debates over the advantages of either pipe sewers or brick sewers wasted three years. The issue was quickly settled when the hot weather, the sewage, and the lack of rain produced the "Great Stink" in 1858. An Act, passed in 1858 to amend the Act of 1855, released the Board from the veto power of the First Commissioner, reworded the "sewage-in-the-river" clause to prohibit "as far as may be practical" any sewage from entering the river within the metropolitan limits, and allowed the Board to borrow three million pounds from the Treasury to finance the main drainage.[2] The drainage system was completed, for the most part, by 1865, and effectively drained London and reduced the amount of sewage dumped into the Thames near the city.

Meritorious as Bazalgette's attempt was, the solution was only temporary as London's population growth far exceeded the mid-century predictions on which the drainage system capacity was based. Later, a new system was completed by the London County Council in 1914, which duplicated Bazalgette's intercepting system and included chemical treatment of the sewage, in order to safeguard Greater London from being overwhelmed by a tragic repetition of the environmental catastrophe of the mid-nineteenth century.

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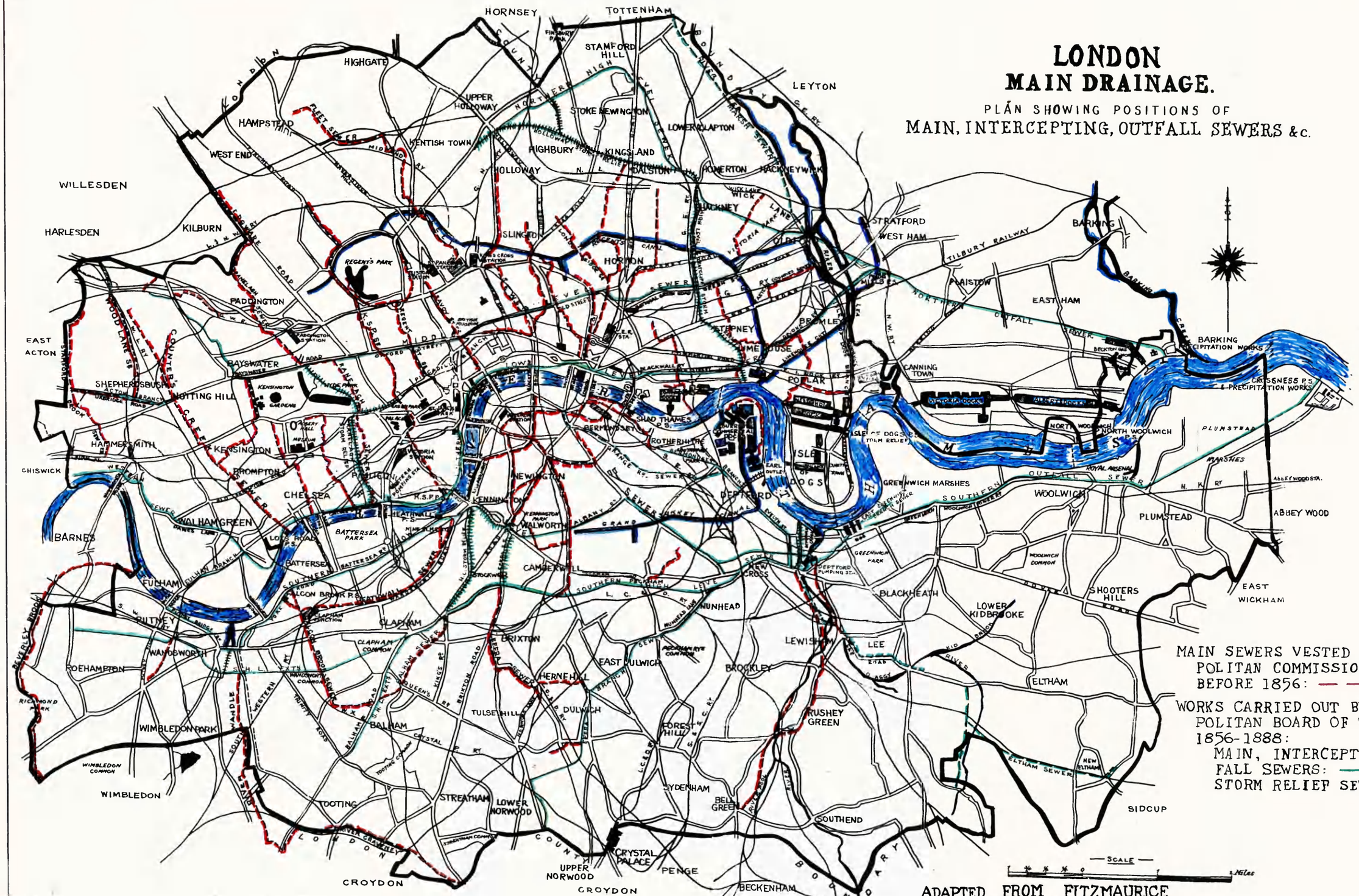
[2] B.S.P., 1857-58, Vol. III, "A Bill to Alter . . . Local Management Act," pp. 525-37.

LONDON
MAIN DRAINAGE.

PLAN SHOWING POSITIONS OF
MAIN, INTERCEPTING, OUTFALL SEWERS &c.



MAIN SEWERS VESTED IN THE METROPOLITAN COMMISSIONS OF SEWERS BEFORE 1856: — — — — —

WORKS CARRIED OUT BY THE METROPOLITAN BOARD OF WORKS FROM 1856-1888:
MAIN, INTERCEPTING, AND OUTFALL SEWERS: ————
STORM RELIEF SEWERS: +++++++

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A SELECTED BIBLIOGRAPHY

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