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'A monument to defective administration'? The London Commissions of Sewers in the early nineteenth century

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ABSTRACT: The paper investigates the activities of the eight London Commissions of Sewers during the period 1800–47. It is argued that the criticisms of the Commissions made by Edwin Chadwick and later historians are undeserved. The Commissions were efficient, innovative and honest, and successfully kept pace with the ever-changing sanitary needs of the capital. Although they operated under severe statutory constraints, they constructed many miles of sewer and can be seen as the true instigators of the nineteenth-century sanitary revolution.

In common with the rest of London government, the responsibility for the capital's sewers in the early nineteenth century was divided amongst a number of bodies.[1] Until 1847 and the appointment of the Metropolitan Commission of Sewers (MCS), sewerage was administered by eight sewer Commissions, seven of which were appointed by the Crown and the eighth, responsible for the City, by the City Corporation.[2] Sewers cut by individuals on their own land, however, were the responsibility of the landowners concerned, and natural water courses and those channels not under individual or Commission ownership were managed by the vestries.[3] The Commissions, which had their origins in the ad hoc drainage committees set up in the reign of Edward 1 (1272–1307), were established by statute in the second half of the sixteenth century to control surface drainage.[4] They began to deal with sewage only from 1800 when the rapid expansion of the capital's population, increased densities and the arrival of the water closet placed overwhelming

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1 J. Davis, *Reforming London: The London Government Problem 1855–1900* (Oxford, 1988), 10.

2 The Crown Commissions were Westminster, Surrey and Kent, Holborn and Finsbury, Poplar, St Katherines, Tower Hamlets and Greenwich.

3 G. Kearns, 'Cholera, nuisances and environmental management in Islington, 1830–55', in W.F. Bynum and R. Porter (eds), *Living and Dying in London* (London, 1991), 100. Fearing ratepayer agitation, the vestries generally ignored their sewerage responsibilities.

4 R. Weinstein, 'New urban demands in early modern London', in Bynum and Porter, *Living*, 30–1.

pressure on the city's cesspools.[5] Acting on their own initiative, they began to construct, repair and cleanse public sewers, and to introduce and enforce various regulations designed to ensure that drains, the responsibility of householders, were built to a sufficiently high standard.

The accepted historical view of the Commissions, that their 'technical and administrative practices' were 'corrupt and inefficient', is derived from Edwin Chadwick's 1842 sanitary report and two subsequent parliamentary enquiries, which were much influenced by Chadwick.[6] After a long recitation of the supposed defects of the Commissions, the 1842 report found metropolitan sanitation to be 'a vast monument of defective administration, lavish expenditure and extremely defective execution'.[7] The first report of the 1847–48 parliamentary enquiry concluded that the works built by the Commissions were 'uncertain, erroneous and defective in their general principles of construction, injurious in their actions and unduly expensive'.[8] This negative impression of the Commissions, however, was far from universally held. Five years before Chadwick's report, a further parliamentary enquiry had found that the Commissions were administered with 'good faith and integrity', and that since the turn of the century they had undertaken 'considerable improvements'.[9] Moreover, in 1848 John Walker, the President of the Institution of Civil Engineers, declared that the efforts of the Commissions had led to the construction of a sewer system that was 'infinitely superior to any other city in the World', and two years earlier even Chadwick had accepted that it was 'possible' that London was better drained than any other capital in Europe.[10]

[5] From 1800 to 1851 the population of the County of London rose from 959,000 to 1.949 million: B.R. Mitchell, *British Historical Statistics* (Cambridge, 1988), 30.

[6] C. Hamlin, 'Edwin Chadwick and the engineers 1842–54: system and anti-system in the pipe and brick sewer war', *Technology and Culture*, 33 (1992), 685–7; E. Chadwick, *Report on the Sanitary Condition of the Labouring Population of Great Britain* (London, 1842). All page numbers refer to the 1965 edition, which was edited by M.W. Flinn; Parliamentary Paper, 1844, xvii, First Report of the Inquiry into the State of Large Towns and Parliamentary Paper (hereafter PP), PP 1847–48, xxxii, First Report of the Metropolitan Sanitary Commission. Similar views to Hamlin's are expressed in S.E. Finer, *The Life and Times of Sir Edwin Chadwick* (London, 1970), 225–6; R.A. Lewis, *Edwin Chadwick and the Public Health Movement 1832–54* (London, 1952), 154–5; A. Brundage, *England's 'Prussian Minister': Edwin Chadwick and the Politics of Government Growth 1832–54* (London, 1988), 121; D.D. Jones, 'Edwin Chadwick and the early public health movement in England', *University of Iowa, Studies in the Social Sciences*, ix (1931), 101; F. Sheppard, *London 1808–1870: The Infernal Wen* (London, 1971), 254–6; and I. Darlington, *The London Sewer Commissions and their Records* (pamphlet, London, 1970), 6.

[7] Chadwick, *Report*, 127. The Surrey and Kent Commission believed this to be 'a capturing and beautifully turned period without an atom of truth in its composition nor the smallest foundation in fact': London Metropolitan Archive (hereafter LMA), SKCS 919, 'Report relating to the sewage with reference to the observations of the Poor Law Commissioners', 1843, 45.

[8] PP, 1847–48, xxxii, 49.

[9] PP, 1834, xv, Select Committee on Metropolitan Sewers, iii.

[10] *Institute of Civil Engineers* (hereafter *ICE*), *Minutes of Proceedings*, 7 (1848), 104; PP, 1846, x, Select Committee on Metropolitan Sewage Manure, q. 1538. In 1846 London had at least 405 miles of sewer, as compared to Paris's 71 miles (L. Chevalier, *Labouring Classes and*

The paper seeks to determine whether the Commissions during the period 1800–47 were indeed corrupt, inefficient and incompetent. Section one examines Chadwick's possible motives for wanting the replacement of the Commissions, and the validity of his criticisms of their construction methods. Section two considers their supposed administrative defects, and the final section discusses their construction record.

Chadwick's attacks on the Commissions

Chadwick's interest in sanitation partly arose from his work at the Poor Law Commission. His view that filth led to disease was developed as an alternative to the belief that illness was directly related to poverty, from which it followed that the new Poor Law and the associated destitution was a major cause of ill-health.[11] Sanitation was also a new field in which he could easily achieve a dominant position and thus rejuvenate his moribund career.[12] While in the early 1840s, when his finances were at a low ebb, it no doubt held out the promise of monetary gain. In 1842 Chadwick launched the Town Improvement Co., the first national private utility venture, which promised returns of 6.5 per cent.[13]

Chadwick's solution to the perceived sanitary problem was the construction of a capital-wide sewer system comprising new types of sewer, which, along with improvements in water supply, would allow wastes to be transported to outfalls on the edge of the City. Here, the diluted sewage would be sold to agriculture and transported to the fields in iron pipes. The capital would thus be freed from the effluvia of decomposing matter that led to disease, and the profits from the sale of wastes and the savings in the cost of cesspool cartage would allow the system to be progressively improved and extended at no loss to the taxpayer. In addition, the scheme would have more wide-ranging effects. By increasing agricultural productivity, it would overcome Malthus' vision of a population that had outstripped its food supply, cut the country's dependence on imported fertilizers and grain, and, by reducing food prices and disease, lessen the moral degradation that stoked revolutionary anger.[14]

Dangerous Classes in Paris During the Nineteenth Century (London, 1973), 464–5, n. 5; 466, n. 12).

[11] C. Hamlin, *Public Health and Social Justice in the Age of Chadwick* (Oxford, 1998), 90–1.

[12] Although Secretary of the Poor Law Commission, he had little influence on policy making and his attempts to become a Commissioner ended in failure: *ibid.*, 89, 153.

[13] Brundage, *England's 'Prussian Minister'*, 101–8. At the end of 1843 Chadwick lost most of his savings on the American stock market: *ibid.*, 101. The company, of which he was to be Managing Director, failed to raise the £1m. capital it required to trade successfully: *ibid.*, 107–8; University College, London, Chadwick Papers (hereafter CP) 12181/5, Chadwick to Hawksley, 11 Aug. 1844.

[14] Hamlin, *Public Health*, 142–50; J. Sheail, 'Town wastes, agricultural sustainability and Victorian sewage', *Urban History*, 23 (1996), 193–4.

In order to carry out his 'sanitary idea' and fulfil his own personal ambitions, Chadwick needed to destroy the validity of the *status quo*. The Sewer Commissions stood in the way of a London-wide body that was required for the full implementation of his scheme and that would give him the dominant position that he desired. Their vilification would also generate sufficient anger and dismay amongst the ordinarily apathetic public that reform would become inevitable. In his various reports and investigations into the capital's sanitation Chadwick, 'a clever man but perfectly unscrupulous', consequently took every opportunity to undermine the reputation of the Commissions. His 1842 report is largely a litany of unsubstantiated allegations against them, many of which are misquoted from previous government investigations and contradictory.[15] As regards the later parliamentary enquiries, Chadwick made recommendations as to the membership of the 1844 State of Large Towns commission, helped to direct its evidence and to select its witnesses, accompanied several of its members on tours of inspection, and wrote part of its first report.[16] His private correspondence of the period leads Finer 'to suppose that … [the Commission's] … first purpose was to discredit the sanitary authorities'.[17] The 1847 enquiry was also deliberately biased against the Commissions, the government making very little attempt to conceal that its main aim was to justify to the public their reorganization.[18] Three of Chadwick's four fellow commissioners held views similar to his own, leading questions were asked of witnesses, evidence favourable to the Commissions was deliberately omitted, and all the Commission officials who attacked their employers were Chadwick supporters and expected and 'immediately got strong berths' in the MCS.[19]

[15] For example, the report quotes the Tower Hamlets surveyor's Health of Towns committee evidence that his Commission cared little about the health of its residents and charged a high sewer connection fee, but omits his later affirmation of the importance of health in sewer construction decisions and his explanation that the connection charge recompensed surveying costs: Chadwick, *Report*, 370; PP, 1840, xi, Select Committee on the Health of Towns, q. 2036–40, 2068. A further surveyor's confusion over the meaning of a question asked by the same committee is taken as an example of his lack of knowledge of the geography of his district: Chadwick, *Report*, 371; PP, 1840, xi, q. 1433–7, LMA, THCS 533, 'Report of the Committee on Some of the Statements Contained in the Appendix of the Report of the Poor Law Commissioners', 1843, 17. In the space of four pages the report criticizes the Commissions both for underpaying and overpaying their surveyors: Chadwick, *Report*, 369, 373.

[16] Finer, *The Life*, 234–5.

[17] *Ibid*., 235.

[18] Lewis, *Edwin Chadwick*, 151–2.

[19] J. Toulmin Smith, *Government by Commissions Illegal and Pernicious* (London, 1849), 216, 221–4. John Roe, the Holborn and Finsbury surveyor, who considered himself 'one of the family, even as a brother' to Chadwick and was a Town Improvement Co. engineer, became one of the MCS's two chief surveyors: CP 1704, Roe to Chadwick, 9 Mar. 1852; CP 50; Finer, *The Life*, 315, 358. John Phillips, Westminster's chief surveyor, who owed his appointment to Leslie, became the MCS's second chief surveyor: Finer, *The Life*, 358. John Leslie, a Westminster Commissioner, became a MCS board member. Lewis Hertslett, Wesminster's clerk of works whose 1847 evidence directly contradicts his favourable

Criticism of construction methods

Chadwick's primary criticism of the Commissions was that their inadequate construction methods and failure to cleanse sewers properly led to large accumulations of excreta, and that the smells from these and the many uncovered sewers spread cholera. The miasmic doctrine was an article of popular faith until the 1860s, and, by arguing that sewers generated and spread gasses, Chadwick was assured of strong support from the politically influential middle classes who lived in the best sewered areas.[20] His criticism of the Commissions' construction methods were that they had failed to adopt the innovations introduced by the Holborn and Finsbury surveyor John Roe, a failure Roe blamed on their 'apathy ... and prejudice against anything new' and the influence of 'the various interests affected'.[21] Instead of adopting egg-shaped tunnels, the Commissions built sewers with straight sides and flat bottoms (Figure 1). Using more bricks, these cost £1,116 more per mile to build and required 30 per cent more excavation.[22] Their flat walls were far less strong than curved sides and made them more prone to collapse in 'clayey and slippery ground', and their flat bottoms 'by spreading the water impeded the flow and caused matter to be deposited'.[23] Similarly, the Commissions built excessively large sewers, again increasing costs, and joined them at angles, often right angles, 'which increases eddies and deposits of sediment that would otherwise pass off with the water'.[24] They also failed to arch, i.e. cover channels, or reduce sewer smells by means of gully traps, etc., and, with few plans of their districts and unaware of the levels or contours of the land, constructed sewers 'entirely ... with reference to the locality, to drain to the nearest outlet and not on an extended view for the whole district'.[25] As a result, the fall or slope of sewers was often too shallow, and when new houses were built the existing sewer often had to be replaced.

In fact, the vast majority of the capital's sewers had long possessed semi-circular bottoms. Of the 45 miles of sewer in Tower Hamlets, merely nine miles, all built prior to 1790, had flat floors.[26] In Westminster

1844 Large Towns committee evidence, became chief clerk: PP, 1847–8, xxxii, no. 12; PP, 1844, xvii, q. 2302–2580; Finer, *The Life*, 363. Before co-operating with Chadwick, Roe, Phillips and Hertslett all received assurances of 'emancipation and security': CP 1055, Chadwick to Howard, 5 Aug. 1867.

[20] M. Pelling, *Cholera, Fever and English Medicine 1825–65* (Oxford, 1978), 60; Hamlin, *Public Health*, 240. The sewer Commissions never supported the doctrine, pointing out that those who worked in sewers showed no increased susceptibility to the disease: SKCS 919, 27; THCS 533, 42.

[21] Chadwick, *Report*, 375. Indeed, Roe believed that his methods would never 'become general in the metropolis during my lifetime': *ibid*.

[22] PP, 1844, xvii, q. 5820–1.

[23] Chadwick, *Report*, 127–8.

[24] *Ibid*.

[25] *Ibid*., 128.

[26] THCS 533, 20, 49.

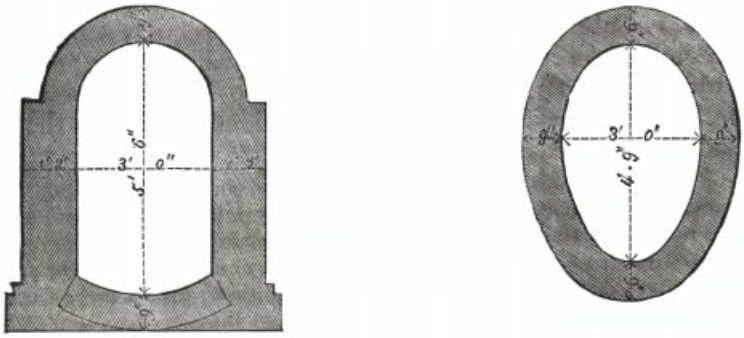

Figure 1: Conventional and egg-shaped sewers
Source: PP, 1847/48, xxxii, 34

only those tunnels dating from the eighteenth century, roughly a third of the total, were flat bottomed, all Surrey and Kent's sewers had circular bottoms, and the City had built curved-bottomed sewers since 1769.[27] All the Commissions accepted the advantages of semi-circular floors, and Tower Hamlets, Westminster and the City, when repairing their older channels, always added a curved bottom. Likewise, sewers were rarely joined at angles. Tower Hamlets had last used angles in 1817, and, previous to this date, had usually adopted curved junctions.[28] Westminster had always built polygonal cants, slanting tunnels, which were as effective as regular curves and easier and cheaper to construct, and Surrey and Kent had never used angles.[29] In the City, curved junctions had been constructed since 1668, except in very narrow streets, in loose artificial earth, or when a sewer would otherwise run under dilapidated buildings and threaten their safety.[30] In such cases the bottom of the sewer was curved downwards at the join, 'which turns the water down easily'.[31]

Roe's censure of the Commissions' failure to arch sewers and their lack of knowledge of levels was equally inaccurate. In the City all sewers were covered, and in Westminster and Tower Hamlets respectively 96 per cent and 82 per cent of channels were arched.[32] Sections of sewer remained uncovered because they ran through non-residential areas or districts with many industrial concerns or no mains water, where closure

[27] Corporation of London Record Office (hereafter CLRO), CSPR 47, no. 4, 'Address upon the Report from the Poor Law Commissioners', 1842, 13; SKCS 919, 25; CSPR 47, no. 1, 'Surveyors' Report as to the Main Lines of Sewer within the City of London', Nov. 1842, 36–48.
[28] THCS 533, 49.
[29] CSPR 47, no. 4, 15; SKCS 919, 50.
[30] CSPR 47, no. 1, 36–48.
[31] PP, 1844, xvii, q. 3384.
[32] CSPR 38, no. 1, 'Report on the Works Executed Since 1832', 1849, 3; CSPR 47, no. 4, 14; THCS 533, 49. In Roe's Holborn and Finsbury only 91 per cent of sewers were covered. Arching involved the construction of brick sides, roof and invert: PP, 1847–8, xxxii, 21.

would respectively force manufacturers to dump their refuse into cesspools, creating an even greater health risk, and deprive residents of their only source of water.[33] Commissions additionally lacked the necessary financial resources to arch, and, as 'the smell seems a very doubtful evil' and arching increased cleansing costs, believed that it was more cost-effective to spend any money available on new sewers.[34] As regards plans and levels, although Commissions were unaware of illegally built private sewers and drains, all had detailed maps of their areas showing the levels and the location of sewers and drains, plus written records of levels and works.[35] All also drained to the lowest outlet and took account of the future needs of their districts.[36] After the removal of the old Tower Bridge, for example, both Surrey and Kent, and Westminster moved many of their outlets to lower positions on the Thames, and in 1817 Westminster built a mile of sewer through an area subsequently occupied by Belgrave Square merely because future residential construction appeared likely.[37]

Few of the Commissions, however, shared Roe's confidence in the benefits of egg-shaped and very small sewers or in gully traps and shafts to prevent the escape of gasses. The City, after constructing egg-shaped sewers from 1769 to 1837 then reverted to the conventional shape, and a Surrey and Kent experimental ovoid sewer built in the Dover Road in the 1820s proved a disappointment.[38] The main drawback of such sewers was that they were more, rather than less, prone to collapse or leakage.[39] To obtain curved walls, bricks had to be laid at angles and the spaces filled with mortar. Construction therefore required a great deal of skill, which was often absent, the mortar made it difficult to detect imperfect workmanship and the use of poor quality or insufficient bricks, and, if the sewer was buried before the mortar had properly set, there was a danger that the weight of the overlying soil would cause the walls to collapse.[40] In addition, if the earth was washed away from the

[33] THCS 533, 49; SKCS 920, 'Minutes of Evidence taken upon a Preliminary Enquiry respecting the Surrey and Kent Sewers Bill', q. 413–20; SKCS 919, 84.

[34] *Ibid*., 75; SKCS 920, q. 444.

[35] CSPR 47, no. 4, 10; PP, 1847–8, xxxii, no. 20; *ibid*., no. 29. Westminster's district plan had a scale of 8 inches to the mile and its section plans scales of up to 26 inches per mile: CSPR 47, no. 4, 13. The City's plan had a scale of 120 inches per mile: CSPR 48, no. 5, 'Health of Towns Bill: The Opinions of the Public Journals' 1848, 58. Most of the Crown Commission maps and records are still in existence and lodged in the LMA.

[36] THCS 533, 27, 49; SKCS 919, 18; CSPR 47, no. 4, 21.

[37] *Ibid*., 21, 30; SKCS 919, 64. Among other outlets, Westminster had moved its Essex Street outlet to Great Russell Street and its Long Acre outlet to New Road: *ibid*., 21.

[38] CSPR 47, no. 1, 36–48; PP, 1847–8, xxxii, no. 21.

[39] In Westminster a number of egg-shaped sewers built by private individuals had failed. In 1830, for example, the Great Western railway was forced to replace a collapsed egg-shaped sewer in the Ranelagh district with a straight-sided one: CSPR 47, no. 4, 17–8. Alternatively, none of Tower Hamlets conventional sewers had ever collapsed, even those buried at a great depth and in loose soil: THCS 533, 21–2.

[40] LMA, WCS 816, 'Report of the Surveyors as to the Forms of Sewers', 1844; CSPR 47, no. 4, 17–18.

top and sides of the sewer by a burst water pipe or underground stream, it was more likely than the conventional design to topple over, damaging its walls and requiring re-excavation. The curved walls were also difficult to clean, made access for supervision, repair and the removal of deposits harder, prevented Commissions increasing the depth of sewers by extending the sides downwards and building a new floor, and had little influence on the flow of the current.[41] The level of water in channels rarely rose above the invert, and, when it did so, the volume was so great that the curvature of the sides had little effect on the speed of its flow.[42]

Commissions were equally suspicious of small sewers and pipes, and Roe, who from 1843–46 actually built larger sewers than his counterparts in Surrey and Kent, himself later accepted their drawbacks (Table 1).[43] The silt that accumulated in tunnels could not easily be removed by water flow, particularly in dry weather, and it was thus important that sewers were sufficiently large enough to allow workmen to enter and clean them. Large tunnels were also required in riverside areas to prevent sewerage from being forced back into cellars and basements at high tide, and to deal with the capital's heavy storm waters, which, due to building and the disappearance of water retaining open land, descended with ever-increasing rapidity.[44] In addition, they avoided the need to build replacements when populations rose, and could be checked for leaks, which went unnoticed in small sewers, be built by tunnelling, and repaired without the overlying road and pavement having to be broken up, which disrupted commerce.[45] The latter was particularly costly and time-consuming, as, except in the City, pavements were under the supervision of 84 Commissions of Pavements and in some areas vestries, all of which had their own rules and regulations. Before a pavement was dug up, permission had to be obtained from the relevant authorities, who having exclusive reinstatement rights often charged excessive fees for their reconstruction.[46]

As for pipes, which Chadwick began to support from 1847, Commissions had begun to adopt them for drainage purposes from the mid-1840s.[47] Most, however, were reluctant to use them as replacements for sewers, as owing to the absence of a constant flow of water they became

[41] *Ibid*.; SKCS 919, 54–6.
[42] CSPR 47, no. 4, 17–8.
[43] Hamlin, 'Edwin Chadwick', 694, footnote 46. Many leading engineers such as Thomas Hawkesley also opposed their use: Finer, *The Life*, 299.
[44] PP, 1847–8, xxxii, no. 22; *ICE, Minutes of Proceedings*, 7 (1848), 106; *Engineers*, 25.
[45] CSPR 47, no. 4, 16; CSPR 48, 9; WCS 135, 'Report of the Special Committee Appointed to make Observations upon the Allegations Contained in a Pamphlet Published by John Leslie', 1845, Appendix 11. Construction without breaking up the overlying pavement/road involved sinking a shaft, from the bottom of which a workman tunnelled, laying bricks as he moved forward.
[46] PP, 1845, xviii, Second Report of the Inquiry into the State of Large Towns, q. 69; PP, 1847–8, xxxii, no. 17.
[47] See, for example, PP, 1847–48, xxxii, 88–9.

Table 1: *Percentage of sewers constructed below 4'11'' in height in Holborn and Finsbury, Westminster, and Surrey and Kent*

Year	Westminster	Holborn & Finsbury	Surrey & Kent
1843	0.3	0.2	56.3
1844	0.8	34.8	73.9
1845	16.7	55.9	55.0
1846	69.8	81.9	94.2
1847	67.7	98.7	48.3

Source: PP, 1854, LXI. Percentage calculated from details of sewers in each parish in the three Commissions.

easily blocked, necessitating long sections to be excavated to discover the blockage and then relaid, which because of alignment problems increased the likelihood of future constrictions. They were also difficult to lay, and, if disturbed, relay; were weak and easily damaged by the weight of the overlying earth or overhead traffic; if joined by clay were prone in dry weather to leaks and if connected with mortar could become blocked with excess mortar; and prevented the admission of subsoil drainage.[48] Not surprisingly, the small bore piping eventually adopted by the MCS proved inadequate,[49] and in 1852 it was decided that all future sewers should be built of brick and be large enough to accommodate a workman,[50] criteria subsequently adopted by the M[etropolitan] B[oard] of W[orks] when they began to construct the capital's new sewer system in 1864.

Effluvia and flushing

As regards sewer gasses, the Commissioners denied that they emanated from accumulations of excretia in sewers,[51] and it was argued that the accretions did not largely comprise effluent.[52] An 1845 chemical analysis of sewer water taken from the Westminster Kings Pond sewer discovered that, of the 55 grains of insoluble material in each gallon, 33 grains were

[48] Hamlin, 'Edwin Chadwick', 704; Hamlin, *Public Health*, 320; *ICE, Minutes of Proceedings*, 11 (1851–52), 11, 416; *Engineers*, 16. In brick sewers, bricks in the upper crown were usually laid dry to allow the percolation of land drainage.

[49] LMA, MCS 478, no. 6. An 1853 survey of 122 pipes found that 66 were partly or wholly choked and 23 were cracked or broken: *ibid*.

[50] Finer, *The Life*, 446; D. Owen, *The Government of Victorian London 1855–89: The Metropolitan Board of Works, the Vestries and the City Corporation* (Cambridge, 1982), 47. Finer argues that the evidence presented by MCS engineers against pipe sewers was biased and flawed: Finer, *The Life*, 449. Hamlin claims that Chadwick's evidence was defective: Hamlin, 'Edwin Chadwick', 693.

[51] THCS 533, 37; SKCS 919, 23.

[52] PP, 1847–48, XXXII, no. 29; PP, 1844, XVII, q. 2438.

'earthly substances', mainly lime and sand, and that the material accumulated at the bottom of the sewer was again largely earth and sand and contained 'not a grain in the shape of excrement'.[53] The silt originated from a number of sources. Much came from roads. Owing to the increase in traffic, unpaved highways in wet weather were little more than quagmires on to which residents threw ashes and dust, which, along with the mud, found their way into the sewers.[54] Paved roads were often poorly macadamized and rapidly disintegrated under the iron wheels of coaches,[55] while the contract scavengers employed by vestries to collect and cart away road debris often deposited their sweepings down gullies, thus saving themselves the cost of cartage.[56] A further source of material was the land. Improved drainage greatly increased 'the washings of the country', and in the City accumulations were found to be greatest after a period of heavy rainfall and in those channels that ran through rural areas.[57] A large amount of matter also came from manufacturers, such as tanners, bone boilers, etc., and private residents, who again threw their industrial and household refuse down gullies.[58] Most households lacked dustbins and were not prepared to pay the high fees charged by the contractors employed by vestries to collect refuse.[59] Although, in theory, manufacturers and residents who dispensed with their rubbish in this way could be fined, in general the police turned a 'blind eye' to the practice.[60]

The smells emanating from sewers, which it was stated were much exaggerated, largely came from household drains, which, poorly built and often rarely cleaned, became blocked with decomposing excreta; 'the refuse and filth … discharged by industry'; and leaking gas pipes.[61] Little was done to minimize the problem, as the Commissions had no control over private households or business, and traps, channels and shafts were not believed to be cost-effective. Traps, iron flaps that

[53] PP, 1846, x, q. 765, 825, 827. The analysis was undertaken by William Brande, a Professor at Apothecaries Hall and later the Royal Institution: C. Hamlin, *A Science of Impurity: Water Analysis in Nineteenth Century Britain* (Bristol, 1990), 49. It should be noted that water analysis in the mid-nineteenth century was an inexact science.

[54] MCS 476a, no. 1, 'Report by Jon Phillips, Surveyor, on the Improvement of the Drainage of Westminster', 1848; CSPR 48, no. 9, 'Report on Works Executed in 1851', 23.

[55] PP, 1846, x, q. 1728–9.

[56] MCS 476a, no. 34.

[57] WCS 910; CLRO, PD 70.16, 'Meeting of the Commissioners of City Sewers', 6 Feb. 1849, 3.

[58] MCS 476a, no. 20, 'Report to the Surrey Committee upon the Inspection of Sewers in the Surrey and Kent District', 1848. In 1848 a sewer in Harrow Street in the City was found to contain 110 cartloads of chiefly sand, cinders and fish scales: PD 70.16, 3.

[59] MCS 476a, no. 34.

[60] CSPR 38, no. 2, 'Report of the Transactions and Work Executed by the City Commission in 1849', 31.

[61] PP, 1844, xvii, q. 2554; SKCS 919, 29. Gas pollution was so vile that the Gas, Light & Coke Co. was prohibited from discharging waste from its St Peter's Street gas works into the public sewers and was forced to build its own channel to the Thames: R. Trench and E. Hillman, *London Under London: A Subterranean Guide* (London, 1985), 312.

prevented the escape of gasses from gutter gullies, were expensive at £4 to £5 each, rapidly became corroded, disrupted street drainage, and increased the chances of gas explosions and the penetration of smells into houses.[62] Channels and shafts leading to a grating in the middle of the road where the gases were released were again costly, provided little benefit, as most streets were narrow and the grating constantly became blocked by mud, and led to accidents, the grates being a danger to horses, particularly after the surface of the road had worn down.[63]

Chadwick's criticisms of the Commissions' cleansing of sewers centred around their failure, unlike Holborn and Finsbury, to flush.[64] Flushing involved fixing at intervals in sewers cast iron gates, which were periodically closed and then opened to allow the accumulated water to rush down the tunnels, sweeping away deposits. The result was that cleaning costs were supposedly reduced by 50 per cent, as refuse no longer had to be removed manually and carted away, and drains were less likely to become blocked, encouraging individuals to connect to the network. In addition, Commission labourers were freed from the dehumanizing task of cleaning tunnels, cheaper smaller sewers with fewer manholes could be constructed, the breaking up of pavements and roads and the obstruction of the public thoroughfare was avoided, and residents no longer had to suffer the disagreeable sights and smells associated with manual cleansing.[65] Street sweepers could also tip road refuse down gullies, removing the need for it to be carted elsewhere for disposal.

Again, flushing was not a new practice and had long been adopted by the other commissions.[66] Sewers were also naturally flushed by storm waters and in Thameside districts by the river.[67] Its use was not as widespread as in Holborn and Finsbury because other Commissions did not believe that it was always cost-effective.[68] Manual cleaning, for which there was no shortage of volunteers, was far cheaper than suggested by Roe, as only part of the accumulated material had to be extracted and carted away 'since the very act of removing one portion so diffuses the remainder … [that the] … running stream carries it off by natural means'.[69] The silt removed from open sewers was also often

[62] CP 849, Graham to Chadwick, 15 Mar. 1843; PP, 1834, xv, q. 209.
[63] WCS 779, 'Report of the Surveyors on the Expedients Adopted by the Holborn and Finsbury and City of London Commissions to Prevent Effluvia', 1842.
[64] Chadwick, *Report*, 129–30.
[65] CSPR 47, no. 3, 'Report of the Surveyors to the Court, 1843', 5.
[66] Surrey and Kent and Westminster had been flushing some of their sewers for many years: SKCS 919, 25.
[67] *Engineers*, 16.
[68] The cost per mile of cleansing Westminster and Holborn and Finsbury sewers in 1842 was respectively £14.62 and £14.99 per mile: CSPR 47, no. 4, 14; CSPR 47, no. 3, 5; PP, 1854, LXI, MCS Accounts 1854.
[69] THCS 533, 25. Sewer cleaners were well paid, earning 4*s* 2*d* per day and keeping any objects of value that they found in the tunnels; they worked short hours, generally 8 a.m. to 4 p.m.; and were usually healthy: PP, 1847–48, XXXII, 105.

thrown on to the channel's banks to reduce the likelihood of overflows, which again eliminated cartage costs, and some deposits were sold to builders for the production of mortar.[70] Hand cleansing was additionally more acceptable to residents, who objected to the 'very offensive stench' caused by flushing, which was believed to spread malaria.[71]

Furthermore, the short- and long-term costs of flushing were relatively high. As the force of water released could only carry the accumulated silt 1,000 feet, to flush the whole of a Commission's sewers a large number of gates would be required and any flushing operation would involve numerous attendants.[72] The flushing gates would almost certainly be more expensive than claimed by Roe, and if left closed due to oversight or damage could lead to serious flooding.[73] Unless there was co-operation between Commissions, flushing in districts with no river outlet would also merely block the sewer of an adjacent Commission,[74] while when the flushed deposits reached the Thames they would accumulate around sewer outlets and impede navigation, and thus still eventually have to be removed at the public's expense.[75] Moreover, it was unlikely that the force of the water produced by flushing would be great enough to remove the existing and additional road refuse, particularly in flat districts.[76] Its power, however, would be more than sufficient to undermine the walls and bottoms of older poorly built sewers, and, where the sides of open sewers formed part of the back walls of houses, could lead to the collapse of buildings.[77]

Organization and honesty of Commissions

Chadwick's primary objection to the organization of London drainage was the existence of a large number of Commissions and Commissioners, and the supposed high wages, incompetence and corruption of their officials. It was first argued that the presence of eight separate Commissions, with boundaries not coexistent with natural drainage areas and different rules and regulations and building techniques, greatly raised costs and led to operational difficulties. The construction of sewers in areas with no Thames outlet, for example, increased the flow of water into riverside Commission sewers, leading to severe

[70] PP, 1847–48, xxxii, no. 29; PP, 1846, x, q. 24, 1754.
[71] WCS 910, 'Memorandum on the Work of the Westminster Commission Written by a Former Commissioner', 1849; CSPR 38, no. 2, 21–4.
[72] CSPR 47, no. 4, 19. Westminster estimated that it would need 707 gates: *ibid*.
[73] Roe claimed that the cost of gates and side entrances was 6*d* to 1 shilling per foot less than the cost of manholes, but in Westminster manholes could be built for 6*d* per foot: CSPR, no. 4. 19.
[74] SKCS 919, 48.
[75] CSPR 47, no. 4, 19.
[76] SKCS 919, 28; SKCS 920, q. 432. In Westminster macadamized road refuse became so solid that cleaners had to 'get it out with a pickaxe': PP, 1844, xvii, q. 2433.
[77] WCS 910; MCS 476a, no. 20.

flooding.[78] Similarly, the appointment of up to two hundred Commissioners per Commission, most of whom had little drainage knowledge, again increased costs and failed to protect ratepayers from incompetence and corruption.[79] 'Self nominated', few Commissioners went to meetings, and many of those who did attend were local architects, surveyors, etc., who stood to gain from the public works constructed.[80]

In fact, the Commissions' geographical areas were far from capricious, permitted their surveyors to gain a great knowledge of the elevations of their districts, and were retained by both the MCS and MBW.[81] There was also a great deal of co-operation between Commissions, helped by the fact that many shared Commissioners.[82] When necessary, Tower Hamlets constructed sewers in partnership with the City, Holborn and Finsbury, and Westminster, and in 1833 and 1839 the City replaced and built channels in anticipation of respectively the lowering of the Holborn Hill sewer and the construction of a new Finsbury branch line.[83] Flooding in riverside Commissions was due to storms and much of the land being below high tide, which meant that the sewers could only discharge their contents into the river for a few hours per day, a problem only solved in 1864 with the construction of the MBW's intercepting sewers.[84]

Commissioners were appointed by the Lord High Chancellor every ten years on the recommendation of the existing Commission, but also by 'his personal selection', and all underwent the 'ordeal of inquiry'.[85] In Westminster, the Lord High Chancellor selected in 1825 94 and in 1835/36 all of the new Commissioners appointed.[86] Those chosen were freeholders and thus had 'the strongest motive for economy and the manufacture of a permanent and efficient sewage', and represented the local elite and a broad cross-section of the community, 'each class' bringing 'its own particular share of practical and theoretical experience and acquaintance with the every day business of life' (Table 2).[87] The inclusion of surveyors, architects, etc., with an interest in the workings of

[78] Chadwick, *Report*, 373.
[79] In 1833 the City had 85 Commissioners, Westminster almost 200, and Holborn and Finsbury 173: PP, 1834, xv, q. 236, appendix.
[80] PP, 1845, xviii, q. 139–41, 184; WCS 135, 4. In 1833 the City had an average attendance of 25 to 30, Westminster, which had more meetings, 11, and Holborn and Finsbury 20 to 50: PP, 1834, xv, q. 298, appendix.
[81] THCS 533, 29; SKCS 919, 41.
[82] PP, 1834, xv, q. 289, 830. The Tower Hamlets Commission, for example, contained the surveyor and two of the clerks of the Holborn and Finsbury Commission: PP, 1823, v, 12.
[83] THCS 533, 27; CSPR 47, no. 1, 31. Commissions also circulated their accounts and printed reports, and their surveyors occasionally met to discuss general problems, such as the prevention of effluvia: CSPR 47, no. 4, 13; WCS 779; WCS 80, 'Orders of Court', nos 86, 262, 399.
[84] Owen, *The Government*, 47.
[85] WCS 910; WCS 135, 4–5.
[86] *Ibid.*
[87] WCS 135, 6; CSPR 47, no. 4, 10. See also THCS 533, 11. In 1886, for example, the Westminster Commission contained the Lord Chancellor, the Bishop of London, the

Table 2: *Occupations of Westminster Commissioners, 1845*

Occupation	Number
Architects and surveyors	30
Magistrates	26
Gentlemen	23
Solicitors and barristers	20
Tradesmen	19
Clerks and public and army officers	10
MPs	7
Physicians and surgeons	6
Noblemen	4

Note: Other lists of Commissioners fail to provide full occupation details. Of the 139 members of the Tower Hamlets Commission in 1823, two were knights, two magistrates, two rectors, two surgeons, six solicitors, three sugar refiners and two merchants. It also contained a grocer, an MP, a weaver, a distiller, an apothecary, a soldier and a ropemaker: PP, 1823, v, 12.
Source: WCS 135, 6

the Commissions is not remarkable. Local government similarly attracted such people, the work of councillors being unpaid and time-consuming.[88] Indeed, their appointment was probably a definite boon to Commissions, as their professional knowledge and experience improved construction decisions, and, wishing to protect their professional reputations, they ensured that projects were well constructed and cost-effective. In addition, they no doubt educated the less technical members of courts, who also obtained help from the Commission surveyors, and, at least in Westminster, gained much knowledge of 'the extent and nature of their jurisdiction and … the construction of sewers' from the annual four-day tour of the district's sewers, to which all Commissioners were invited.[89]

Although there were a large number of Commissioners, most performed their duties for a small fee or a periodic dinner.[90] 'Their number [was also] sufficient to prevent the danger of jobbery.'[91] The majority attended at least one meeting per year and met their fellow Commissioners socially. Any malfeasance would thus become widely known in

Dean of Westminster, 28 members of the aristocracy, 14 MPs, 10 knights, and five clergymen (PP, 1823, v, 28).

[88] E.P. Hennock, *Fit and Proper Persons: Ideal and Reality in Nineteenth Century Urban Government* (London, 1973), 170. The same is probably true today.

[89] CSPR 47, no. 4, 10.

[90] From 1831–45 Commissioner expenses amounted to 1.1 per cent of Westminster's expenditure and from 1812–45 3.1 per cent of Holborn and Finsbury's: PP, 1822, xxi, An Account of all the Sums Rated by the Commissions of Sewers; PP, 1831–2, xlv, An Account …; PP, 1843, xlviii, An Account …; PP, 1846, xl, An Account …

[91] THCS 533, 11. See also WCS 135, 7.

the local community and would damage the culprit's reputation. Moreover, as any hint of corruption would impinge on the reputation of all the Commissioners, particularly that of the elite members, each had a strong incentive to ensure that the others remained honest.[92] To prevent further self-interested behaviour, meetings were generally open to all ratepayers; accounts were audited, submitted to Parliament and again made available to the public; and any ratepayers who believed that the conduct of a Commission had been improper could appeal to the Court of the Queen's bench.[93]

Chadwick's criticisms of the Commissions' officials centred around their abilities, remuneration and honesty. It was claimed that 'very few' surveyors were 'properly qualified by education or otherwise to perform the important duties entrusted to them', which could only be adequately undertaken by 'a practical engineer'.[94] The result supposedly was that not even one main sewer in three was properly constructed. Nonetheless, the surveyors were very well paid, receiving a salary of £50 p.a., plus half a guinea each time a drain was connected to a sewer and a 5 per cent commission on the cost of new works, which encouraged the construction of large expensive sewers.[95] Likewise, Clerks of Works also earned high salaries, rate collectors obtained commissions of up to 9*d* in the pound, as compared to the 3*d* in the pound given to collectors of property tax, and office expenses were excessive.[96]

The criticisms of the surveyors' abilities again appear to be unfounded. The Commissions' claims that they employed qualified and experienced surveyors appear to be borne out by the men recruited.[97] John Walker, the surveyor of the Poplar Commission, for example, was the President of the Institution of Civil Engineers, Joseph Gwilt, a Surrey and Kent surveyor, was the author of the *Encyclopaedia of Architecture*, and Westminster's chief surveyor, George Saunders, had an 'unrenowned reputation in the engineering profession'.[98] In Westminster, all candidates for surveying posts had to provide testimonials and examples of technical drawings, undergo a four-hour interview, in which they were asked to perform elaborate calculations, and from 1844 sit a technical exam.[99] The Chief Surveyor before embarking on large works always obtained the

[92] In 1834 the Westminster Commission contained the Archbishop of Canterbury, the High Lord Chancellor and 42 members of the nobility: PP, 1834, xv, appendix.
[93] SKCS 920, q. 138–53.
[94] Chadwick, *Report*, 128, 374.
[95] *Ibid*., 368.
[96] *Ibid*., 373.
[97] E.g. THCS 533, 13–4; SKCS 919, 51.
[98] PP, 1847–48, xxxii, 36; *ibid*., no. 20; CSPR 47, no. 4, 24. A further Surrey and Kent surveyor had designed the London dock, another had previously worked for the Corporation of London and Southwark vestry, and another had been employed by HM Commissioners of Roads and Forests and acted for the Imperial Fire Office, the Grocers' Company and the Wax Chandler: SKCS 920, q. 263, 352.
[99] WCS 799; CSPR 47, no. 4, 31.

opinions of leading engineers, and the Commission's largest project, the Kings Pond sewer, had been inspected and approved by most of the top engineers of the day.[100] As for the argument that only engineers possessed the abilities necessary to construct sewers, Chadwick's chief technical advisers in the late 1840s, Roe and Phillips, had no engineering qualifications whatsoever, and in 1847, disillusioned by the profession's failure universally to support his views, Chadwick declared that sewer construction required knowledge 'beyond that of ordinary professional engineering and architectural practice'.[101]

The remuneration the surveyors received for their work also appears to have been reasonable. Their salaries merely covered their supervision of the repair and cleansing of sewers. In return for their connection fees and construction commissions, they respectively surveyed and produced a report on the drain and surveyed the new works, estimated their cost, created a specification, advised on the tender process and supervised construction.[102] Separate payments were made for connections and construction because the number of works undertaken varied from year to year. Surveyors were therefore only paid for the work that they completed, and when there was little Commission construction they were free to take on non-Commission jobs, which increased and widened their skills and knowledge of technical matters and contractor remuneration. The payment of a separate commission based on final cost was the universal method of remunerating engineers and surveyors for the supervision of construction, and was adopted because it encouraged the use of good quality materials and it was often difficult to determine the work involved in a particular project and the problems that may be encountered once construction had commenced.[103] Clerk of Works' salaries and office expenses similarly reflected the amount and type of work performed and the standard of service provided.[104] In Westminster, the Clerk of Works worked from 6 a.m. to 9 p.m., walked 4 to 8 miles per day inspecting sewers, and was regarded as grossly overworked, and

[100] *Ibid.*, 24, 27.

[101] PP, 1847–48, xxxii, 51. Roe had previously built canals: Hamlin, 'Edwin Chadwick', 685. Phillips had started work at the age of eight as a sewer bricklayer and had no other direct experience of sewer construction: PP, 1847–48, xxxii, no. 13.

[102] SKCS 920, q. 233.

[103] PP, 1847–48, xxxii, no. 20.

[104] From 1800–45 Westminster's 'establishment' and 'office expenses' accounted for respectively 8.9 per cent and 1.73 per cent of total expenditure. From 1812–45 Holborn and Finsbury's 'office salaries' made up 10.38 per cent of expenditure and 'expenses' 2.6 per cent. From 1811–45 Surrey and Kent 'office salaries' comprised 8.3 per cent of total outlay, and from 1800–45 Tower Hamlet's 'establishment' and 'office expenses' accounted for respectively 22 per cent and 5.9 per cent of expenditure (for references see footnote 82; PP, 1833, xxxiv, An Account of all the Sums Rated by the Surrey and Kent Commissions of Sewers). In comparison, in 1849 and 1850 respectively 26 per cent and 22 per cent of MCS total expenditure was devoted to 'management': PP, 1850, xxxiii, MCS Accounts in Abstract; PP, 1851, xlviii, MCS … The percentage is lower in the 1851–54 accounts as 'local superintendence of works' is included in 'works'.

the Commission's office was open to the public from 9 a.m. to 4 p.m., an hour longer than any other government office, six days per week.[105] Rate collectors' commissions were high because they often had to pay a security to the Commission and the sums collected were relatively small and difficult to collect, as the rate was not levied annually and residents therefore did not budget for its payment.[106]

The belief that Commissions were corrupt arose from charges made by John Leslie against the Westminster Commission in an 1841 pamphlet and in his evidence to the 1844 Parliamentary enquiry.[107] A fashionable tailor, a member of the Westminster Commission and the Hanover Square vestry and 'a thoroughly unpleasant man, spiteful, offensive and ungenerous', Leslie's primary motivation appears to have been his desire to further his own political career.[108] His main accusations against Westminster were first that the necessity and cost of new works was not sufficiently investigated. Surveyors' reports were hastily drawn up, expenditure approved by the Commissioners without due consideration of their contents, and decisions not ratified by a subsequent court until 1839, when approval was given without discussion.[109] Commissioners were therefore able easily to influence decisions to serve their own interests. In 1807, for example, the route of the King's Pond sewer was supposedly altered so that it ran through property owned by Commissioners.[110] Leslie also criticized the tender and construction process. After a decision to build had been made, contracts failed to be publicly advertised, the Commission instead requesting tenders from a select group of companies. From 1780–1843 the Commission used only six firms, which were owned by three families, some of whose members from 1780–1811 were Commissioners and thereafter friends and relatives of Commissioners. The winning tender often quoted inflated material and works prices, and the contractor at times used sub-standard materials, dug overly shallow trenches and failed to meet deadlines. As a result, the completed sewers were of poor quality and their final cost often exceeded the surveyors' original estimates.[111]

Most of Leslie's criticisms appear to have had little grounding in reality. All proposals for new work were fully investigated and discussed, often 'to the obstruction of business', and, given the number and social background of Commissioners and the fact that all courts were

[105] WCS 790, 'Report of the Special Committee on the Nature and Extent of the Duties of and on Providing for the Exigencies of the Surveyors' Department', 1843; WCS 797, 'Practical Observations of the Clerk on Leslie's Ideas', Dec. 1843. In 1843 Westminster raised salaries and employed another Clerk of Works: WCS 790.
[106] SKCS 920, q. 162; WCS 797; PP, 1834, xv, q. 1148–57.
[107] PP, 1845, xviii, q. 184–277.
[108] Finer, *The Life,* 356. Leslie later criticized the practices of the MCS: CP 1055, Chadwick to Howard, 30 Dec. 1847.
[109] WCS 135, 7.
[110] PP, 1845, xviii, q. 186–207.
[111] WCS 137, 8, 12, 14; PP, 1845, xviii, q. 32–40, 245–6, 249–58.

open to the public, jobbery was unlikely.[112] Prior to 1839, all construction schemes were referred to a special committee of works, which, if it believed a proposal to be worthwhile, required the surveyor to complete a full survey of the area, comment on the need for a sewer and estimate the cost. The surveyor's report was then read by the committee's chairman, who often requested further information or clarification, and then discussed by the whole committee. If it was decided that the proposal should go ahead, the report was then passed to a full court where its merits were again discussed. After 1839, the procedure changed slightly in that the committee's work was taken over by the court, and, to compensate for the loss of the committee, a by-law was introduced that required all works over £10 to be sanctioned by two separate meetings of Commissioners.[113]

The Commission's tendering process can be seen to have been designed to prevent rather than encourage corruption and high-cost poor quality work. Sewer construction required expensive specialized plant and experienced and highly skilled workmen. By abandoning public advertisement, Westminster avoided the problem of adverse selection, the tendency of agents to exaggerate their abilities prior to signing a contract, and ensured that work would be carried out in 'a substantial and workmanlike manner'.[114] Such restricted tendering was not unusual and had been adopted by the Admiralty, the Commissioners of Woods and Forests, and other Commissions.[115] Similarly, awarding contracts to a small number of firms with close personal connections to Commissioners discouraged moral hazard, the tendency of agents to act in their own interests after a contract has been signed. 'Concealed from the public eye', sewer construction was particularly prone to 'scamping', which 'no superintendence can prevent'.[116] Long associations ensured that contractors found to be acting fraudulently and dismissed would lose the future gains of subsequent transactions with both the Commission and those clients encouraged to use their services by their status as Commission contractors, and would be left with physical and human capital highly specific to the Commission for which there was little demand. They additionally allowed Commissions to predict the existence of moral hazard, and, through repeated interactions, build up social ties and a store of goodwill that discouraged dishonesty. Again, the Commission's actions were not unusual. Government institutions such as the Crown Agents for the Colonies, the Surrey and Kent, the City and the Holborn and Finsbury Commissions and even the MCS all

[112] WCS 135, 7.
[113] *Ibid*., 11.
[114] *Ibid*. Adverse selection and moral hazard are discussed in P. Milgrom and J. Roberts, *Economic Organisation and Management* (New Jersey, 1992), chs 5 and 6.
[115] SKCS 920, q. 247–8. Surrey and Kent believed that public tenders put 'the rogue upon a level with the highest man': *ibid*., q. 243. Today, restricted tendering is normal practice.
[116] WCS 135, 11; SKCS 920, q. 243.

awarded contracts to a small number of firms.[117] As regards the employment of relatives and friends, this again minimized adverse selection, ensured that dishonest contractors would lose not only future work, but also their social/familial reputations, and increased monitoring, in that contractors could be used to monitor the activities of surveyors, material suppliers, clerks of works, etc.

To further prevent malfeasance, all tenders had to conform to the surveyor's specification, contain prices for all materials used and works undertaken, be recorded on the official tender form, and returned sealed by a specified date and time. On opening the tenders, the Commission only chose the lowest bid if the completed works were likely to be of the required quality, and always checked the successful tenderer's various costs with those of previous projects undertaken by the Commission and other organizations for which the surveyor worked.[118] Once construction began, contractors were constantly monitored by the surveyor, who measured the depth, length and width of every trench dug, and, in order to check the contractor's quarterly accounts, daily recorded the materials and time taken to complete each job.[119] Estimates were generally exceeded because, 'owing to the difficulties of anticipating the obstructions which present themselves in underground construction' and to facilitate the identification of overruns, surveyors only estimated the cost of the ordinary work of construction and excluded contingencies. Overexpenditure in fact was relatively low, averaging in the seventeen works completed in 1841/44 24 per cent, 21 per cent if the largest overrun is excluded.[120]

Failure to construct sewers

According to Chadwick, the Commissions' high building costs, office expenses, incompetence and corruption resulted in the construction of an inadequate number of sewers that were excessively expensive. In fact, the Commissions' record of construction was impressive. By 1847 Holborn and Finsbury, Westminster, the City, Tower Hamlets and Surrey and Kent contained at least 405 miles of sewer (Figure 2, Table 3), and by

[117] D. Sunderland, 'Principals and agents: the Crown Agents for the Colonies 1880–1914' (Oxford University D.Phil thesis, 1996); LMA, HFCS 69, 'Description and Particulars of Sewers Built by Petition or Contract'. From 1812–47 62 per cent of Surrey and Kent contracts were awarded to firms owned by two families: SKCS index. In 1850 over half of the MCS contracts for special works were awarded to just three firms: PP, 1851, xlviii, Return of the Rates Made in the Years 1845–51.

[118] WCS 135, 9, 12. Low tenders, for example, were rejected in 1822 and 1826 because the contractors had respectively intended to use poor quality bricks and had omitted the cost of carting away superfluous earth: *ibid*. In Surrey and Kent, if all the tenders received exceeded the estimate the surveyor undertook a further survey: SKCS 920, q. 95–122.

[119] WCS 135, 14; WCS 790.

[120] WCS 135, 8, appendix 2.

Table 3: *Sewer construction to number of households*

Commission	Miles of sewer	No. of houses per mile of sewer	Population per mile of sewer
Tower Hamlets	45	1,225	7,720
Surrey and Kent	71	778	5,824
Holborn and Finsbury	109	487	3,411
Westminster	134	395	2,768
City	47	374	2,660

Source: Miles of sewer: City (1848 figure): CSPR 47, No. 2, p. 26; Westminster (1842): CSPR 47, no. 4, p. 14; Holborn and Finsbury (1843): *ibid.*, no. 3, p. 5; Tower Hamlets (1843): THCS 533, p. 44, 49; Surrey and Kent (1844): PP, 1847–48, xxxii, no. 20, no. 21, no. 22. *Household numbers (1845)*: PP, 1845, xviii, 114

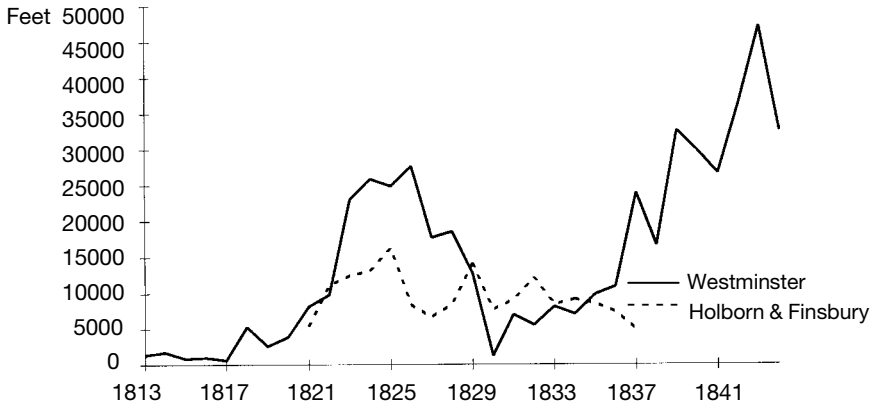

Figure 2: Sewer construction in Holborn and Finsbury and Westminster, 1813–44
Source: Holborn and Finsbury: HFCS 69, HFCS 70, 'Sewers Built by Petition or Contract 1821–37'. No figures available for 1813–20 or 1838–44; Westminster: WCS 748, 'Register of New Sewers, 1813–22'; WCS 749, 'Registers of New Sewers, 1823–34'; WCS 135, p. 18. A number of entries fail to give lengths. Annual figures relate to the year in which permission to construct was given

1845 Holborn and Finsbury, Westminster, Tower Hamlets and Surrey and Kent had spent a minimum of £1.591m. on works (Figure 3).[121] Moreover, the cost per foot of sewer in Holborn and Finsbury, Chadwick's model Commission, in 1846–47 was actually greater than in Westminster, which, lacking its counterpart's 'maiden soil', had to contend with the 'extraordinary obstructions which present themselves in old districts', and from 1844–47 was higher than in Surrey and Kent,

[121] See references in footnote 104. Expenditure includes spending on construction, repair and cleansing.

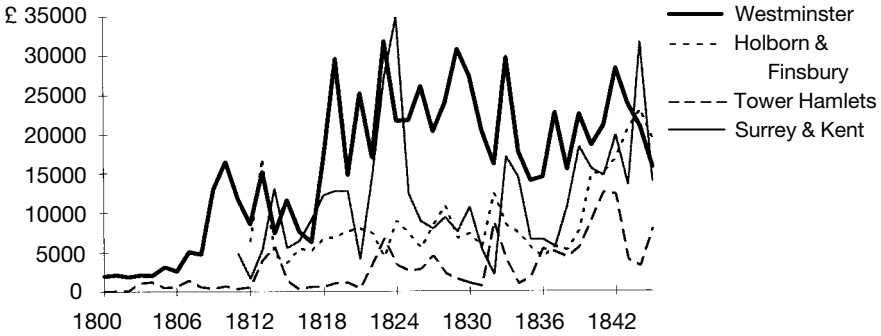

Figure 3: Expenditure on works, 1800–45
Source: For references see footnotes 90 and 104. Surrey and Kent: expenditure = 'new works' + 'old works'. 1819 and 1820 average expenditure over two years. 1832 six months only

which had silt and clay soils that forced the use of relatively expensive cast iron sewers (Table 4).[122]

That more sewers were not built is partly the result of legal and other constraints and partly due to a lack of demand for improved drainage. Until 1833, Commissions were merely permitted to maintain channels for the removal of surface water.[123] Under the 1833 General Sewers Act they were then allowed to construct new sewers, but only if they obtained the written consent of three-quarters of the householders of the district affected.[124] To overcome these constraints, Surrey and Kent, the City, and Holborn and Finsbury obtained local parliamentary Acts, which enabled rates and in some cases loans to be raised for the construction of new sewers. These, however, gave Commissions no power to compel residents to connect to new sewers, the poorly drawn up Holborn and Finsbury Acts continued to make construction difficult, and the Surrey and Kent statutes covered only the most populous parts of the district. The other Commissions 'stretched their powers to the utmost', generally making 'new trunk lines by a free interpretation of the act as to the diversion of old sewers'.[125] All also encouraged private construction, providing builders with technical help, contributing to the cost of those sewers that could be made 'subservient to the general sewerage', constructing the sewers themselves in return for a fee, and taking over the maintenance of completed works.[126]

Other factors that impeded the building of new works were opposition from tradesmen, whose businesses would be disrupted, and house-

[122] WCS 910; SKCS 919, 81.
[123] PP, 1834, xv, ii.
[124] SKCS 919, 11. The act also failed to specify how consents were to be obtained or who constituted a householder: *ibid*.
[125] WCS 910; PP, 1834, xv, q. 131.
[126] *Ibid*.

Table 4: *Cost per mile of new sewers constructed in Holborn and Finsbury, Westminster, and Surrey and Kent, 1843–49 (£)*

Year	Westminster	Holborn and Finsbury	Surrey and Kent
1843	1.34	0.71	1.47
1844	1.86	1.18	1.07
1845	1.71	1.65	0.20
1846	0.94	1.20	1.02
1847	0.87	1.03	0.98
1848	1.33	0.64	0.95
1849	0.35	0.33	0.28

Source: PP, 1854, lxi. Average calculated by adding and then dividing the length and cost of new sewers constructed in each parish in the three Commissions. The figures exclude the cost of gullies, air shafts and side entrances built separately.

holders fearing subsidence; 'the expected construction of docks, railways and other undertakings', which would make any channels built redundant and 'materially alter … the level'; and high housing densities, which made construction difficult without 'interfering greatly with the private property of individuals'.[127] More importantly, there was generally little demand for sewers. Until the early 1800s, many Commissions had few residential areas, and, in others, population densities were relatively low and the existing forms of sewerage more than adequate.[128] When population and densities rose, many residents were unable (if their houses were below the level of sewers) or unwilling to buy water closets and build drains, preferring to continue to use independent cesspools, privy middens, whose pans were collected every day, or cesspool drained water closets.[129] From 1834–43 only 876 households connected to the sewers in Surrey and Kent (Figure 4), and in the St Margaret and St John districts Westminster rebuilt and extended sewers only to find that fewer than a handful of residents wished to use them.[130]

This reluctance, which affected rich and poor alike, was due to two factors.[131] The benefits of connection were first 'very doubtful'.[132] Householders were subject to flooding during storms and high tides; constant blockages, often caused by the failure of others to clean main drains; and

[127] PP, 1844, xvii, q. 3094; THCS 533, p. 33; WCS 881, 'Report on the Portions of the District Densely Inhabited', 1839. The construction of the new London bridge and the 1845 Tottenham to Hatton Garden railway both forced the relaying of sewers: PP, 1844, xvii, q. 3344; UC, CP 1135, Kelsey to Chadwick, 14 May 1845.

[128] SKCS 919, 13. Even in 1844, only 47 per cent of the 7,006 acres drained by Westminster were 'urban': PP, 1846, x, appendix 1.

[129] PP, 1834, xv, q. 283.

[130] PP, 1844, xvii, q. 2784; WCS 881.

[131] PP, 1847–48, xxxii, no. 20, no. 28.

[132] PP, 1847–48, xxxii, no. 4.

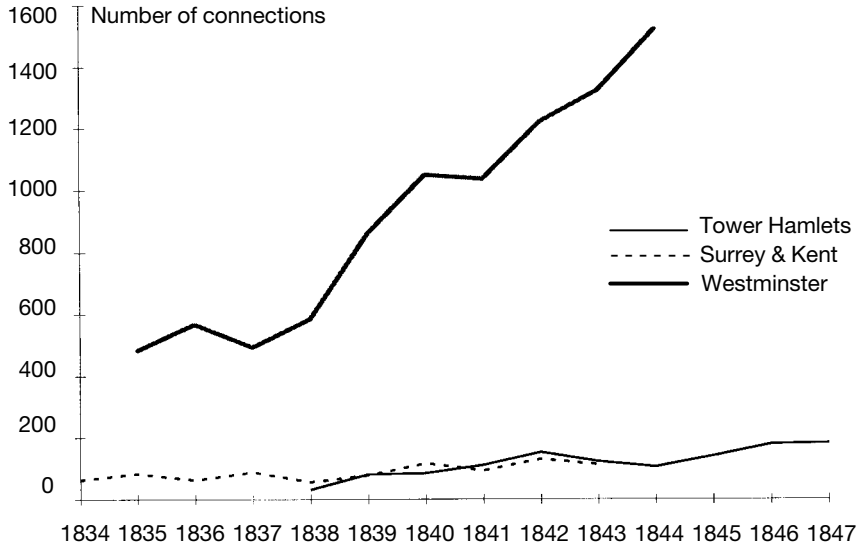

Figure 4: Connections to sewers in Surrey and Kent, Tower Hamlets and Westminster
Source: PP, 1847–48, xxxii, no. 28; *Parliamentary Papers 1844*, xvii, q. 2784; WCS 135, p. 18

effluvia, which made their homes 'more disagreeable to live in' and was believed to carry cholera and other diseases.[133] Second, connection, along with the cost of the water closet, water and cleansing, was expensive, and many residents were reluctant to undertake the large outlay. Tenants and those who did not expect to remain long in a property failed to obtain any long-term return, and landlords received no direct non-pecuniary benefit and recouped their investment slowly, the extra rent making their properties less desirable to potential tenants.[134] Costs were high, due to the various fees demanded by the sewer and paving Commissions, and overcharging by builders, who took advantage of residents' lack of knowledge.[135] In addition, Chadwick claimed that expenditure was raised by the Commissions' insistence that main drains that connected to sewers should be large enough to admit a crouched man, and subsidiary drains at least 12 inches in diameter.[136] Such circumferences, by slowing the flow of water, also supposedly encouraged the deposition of materials and increased cleaning costs, smells and the likelihood of obstruction. The Commissions, however, argued that large subsidiary drains, able to accommodate household refuse, were less likely to become blocked. Big main drains allowed later

[133] PP, 1847–48, xxxii, no. 20.
[134] PP, 1847–48, xxxii, no. 28.
[135] PP, 1845, xviii, 69; Chadwick, *Report*, 377.
[136] PP, 1847–48, xxxii, no. 17.

subsidiary drains to feed into them and thus be relatively short and cheap; extended the life of sewers by minimizing the number of times they were broken into; could be built by tunnelling, which reduced construction costs; and, able to be cleaned manually, were again less likely to be obstructed.[137]

Conclusion

The downfall of the sewer Commissions came about, not because they performed their duties inadequately, but as a result of the propagation by Chadwick and others for their own ends of epidemiological, social, economic and technical theories that ultimately proved to be false. Disease eventually was found to arise from poverty rather than the effluvia of filth. Revolutionary anger was stoked, not by moral degradation, but by the unfair distribution of wealth. Malthus' forebodings on population growth were not justified, while Chadwick's technical innovations were ill-conceived and recycling discovered to be unprofitable.[138] Given their many constraints, the performance of the Commissions was more than adequate. Efficient, honest, innovative and receptive to the needs of their ratepayers, they kept pace with the ever-changing sanitary needs of the capital and built a sewer system far more advanced than that of any other urban area either in Britain or abroad.[139] In comparison, their immediate successors performed poorly. The MCS had the power to build new sewers, force households to connect to them and to dispose of their refuse in a proper manner, and could require the water companies to provide a constant water supply. Instead of taking advantage of these freedoms, however, the Commissioners wasted valuable time surveying the capital and in technical argument. Exasperated by their performance, the government in 1850 forced Chadwick and his associates to resign. Unfortunately, their replacements performed no better, and in 1855, when the MCS was in turn replaced by the MBW, little had been achieved. Piecemeal work had been undertaken in the worst slum areas, but sewers were still subject to blockages and effluvia, relatively few connections had occurred, and, with no storm sewers, those with drains continued to suffer regular flooding.

[137] PP, 1844, xvii, q. 2717–20.
[138] Sheail, 'Town wastes', 202.
[139] See A.S. Wohl, *Endangered Lives: Public Health in Victorian Britain* (London, 1983), 108.