

CHAPTER 2

SEWAGE COLLECTION - FROM CESSPITS TO SEWERS

The first city sewers in Sydney were constructed in the 1850s beneath the main city streets so as not to interfere with private property. They discharged the raw sewage directly into the Harbour at Fort Macquarie (now Bennelong Point, the site of the Opera House) near the Governor's residence. (see figure 2.1) At that time the use of piped water to transport the sewage was perhaps the only method of removal that was taken seriously. The use of flush toilets and water to transport wastes was an old idea dating back as far as 2800 BC to the Minoans and also the Chalcolithics.¹ Despite the antiquity of such systems, referred to as 'water carriage' systems, they were relatively new in 19th century Britain and were considered to be a modern, progressive method of dealing with wastes.

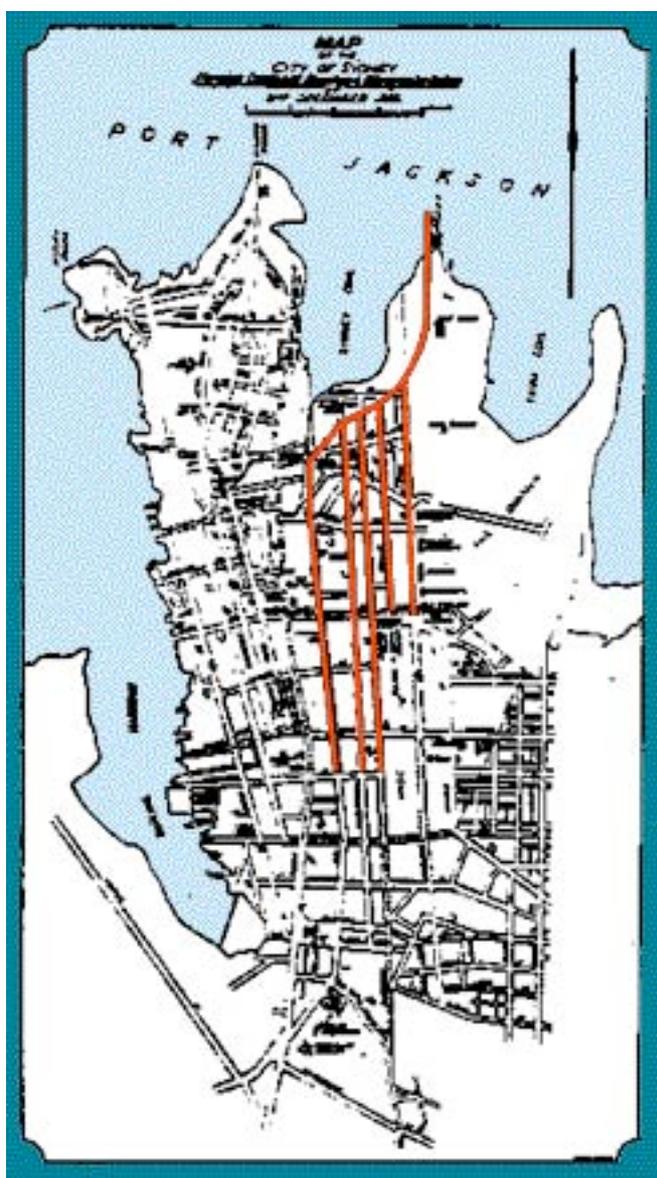


Figure 2.1 Sydney's First Sewers

Source: F.J.J. Henry, *The Water Supply and Sewerage of Sydney*, Halstead Press, Sydney, 1939.

At first sanitary reform was virtually synonymous with water-carriage sewer construction because British sanitary reformers were demanding sewers as a reform measure. Britain provided the model of sanitary science during the nineteenth century not only in Australia but also in the United States and engineers from these countries would be sent to visit British sewerage works as part of their information gathering duties.²

In the latter half of the nineteenth century water-carriage methods were challenged by those who preferred dry conservancy methods of dealing with the human wastes. The movement against water-carriage gained much of its impetus from community dissatisfaction with the gross

¹ Reginald Reynolds, *Cleanliness and Godliness*, George Allen & Unwin, London, 1943, pp13-20.

² Joel Tarr et al, 'Water and Wastes: Retrospective Assessment of Wastewater Technology in the United States, 1800-1932', *Technology & Culture* 25(2), 1984, p234.

environmental pollution which early sewer systems had been responsible for.

COMMISSIONERS, SELECT COMMITTEES AND THE FIGHT FOR CONTROL

Sydney's sewerage system was conceived in the midst of much debate about how much it would cost and how it should be paid for and, because the actual construction of such sewers was so tied up with cost considerations, the first sewers were built amidst arguments about control and competency. The City Engineer, W.B. Rider, who was responsible for this work suffered from this and also from political attempts to discredit the City Commissioners. Throughout his short term of office, Rider, was subject to criticism and public doubts about whether he was a suitable person for the position of City Engineer.³ Such criticisms probably had some foundation. Rider had been a railway engineer and it seems that he, like so many of the engineers who designed the first sewerage systems, had no previous experience in sewerage works.⁴

In the Select Committee report of 1854, before any sewers had actually been constructed, Rider was criticised for having spent so long on a trigonometric survey of the city and thereby delaying the construction of the sewers. His methods were also criticised. The Committee argued that he had determined a maximum size for the main sewers without working out the areas to be drained, the gradient at which they would be laid out or the amount of rain water they would be expected to carry. They assumed that he had used English sizes despite the geographical, demographic and climatic differences that might be expected between the two countries.⁵

The Select Committee also questioned Rider's integrity. They pointed out that he had recommended that the sewers be built of brick whilst at the same time he owned a brick yard. Although it was generally agreed at this time that bricks were an appropriate material for sewer construction, when this conflict of interest was brought to the public attention in parliament, the City Commissioners were forced to acquire the brick yard on behalf of the city.

The City Commissioners did not escape criticism. The Select Committee accused them of leaving all sewerage decisions to the City Engineer, not requiring him to report fully to them and not availing themselves of the opinions of other engineers. The Commissioners, on the other hand, felt such matters should be left to the engineers because sewerage works were "so essentially of an engineering description" and involved so many technical questions.⁶

The Select Committee did not criticise the choice of the harbour as a point of disposal.⁷ This disappointed the Sydney Morning Herald which had warned a

³ Select Committee, Sydney Sewerage and Water Appropriation Bill, NSW Legislative Assembly, Notes and Proceedings, 1854, p890.

⁴ Select Committee on the City Commissioners Department, NSW Legislative Assembly, Notes and Proceedings, 1856.

⁵ ibid.

⁶ First Yearly Report of the Commissioners, NSW Legislative Assembly, Notes and Proceedings, 1855, p4 of report.

⁷ Select Committee, Sydney Sewerage and Water Appropriation Bill

few years earlier that an outlet into the Harbour would have disastrous consequences. Pointing out that the city was surrounded on three sides by harbour water the Herald feared that harbour disposal would create a health risk to those living near the water and to sailors aboard ships in the harbour. It was also feared that the evaporated sewage would be blown back over the city.⁸

The same wisdom which, fortunately for us, has laid down that a man shall not with impunity become a nuisance to his neighbour, declares that we have no right to expose the lives of even a minority of the public for the benefit of the whole.⁹

Rider survived the criticisms of the Select Committee (and of the Herald) and went on to build Sydney's first sewers. His main opposition came from the Governor General, Sir William Denison, who disliked the idea of a sewage outfall near his residence. Although the Governor put up some good arguments about the nuisances and pollution that such an outfall would cause for the Harbour, Rider, as the City Engineer, was able to meet these objections with "expert" predictions about why this would not happen and to thereby mute the considerable influence of the governor.¹⁰ He argued that Fort Macquarie was the best point of discharge because of the strong seaward current there. Also, he said, sewage should be removed from residential areas to protect public health and Fort Macquarie was so removed. Any point closer to Sydney Cove would be too close to habitation, a nuisance to ships in port and would require the harbour to be regularly dredged.¹¹ It is ironic that some of the predictions made by the governor (in his own interests) turned out to be more valid than those of the city engineer (who also had his own objectives).

A further government select committee a year later, again criticised the City Commissioners and the City Engineer. They recommended that the Commissioners be dismissed and that Rider and his assistant be immediately sacked and considered incapable of being employed in the public service. Their criticisms centred around the quality of the sewer construction work, the tendering process and the financial management of the work.¹² This report was highly controversial and judged by some to be politically motivated. The chairman of the committee, James Martin, (who will again feature in this story), was accused by the Herald of having ambition extending "to every department of knowledge."¹³ The newspaper defended the experts (Rider and assistant) in the following terms,

it is intolerable to find characters of men jeopardised by the petulant presumption of a novice who dabbles in everything and understands nothing.¹⁴

⁸ Sydney Morning Herald, 29th March 1851.

⁹ ibid.

¹⁰ First Yearly Report of the Commissioners, pp27-28 of report.

¹¹ ibid., pp28-29 of report.

¹² Select Committee on the City Commissioners Department, NSW Legislative Assembly, Votes and Proceedings, 1855.

¹³ Sydney Morning Herald, 15th December 1855.

¹⁴ Sydney Morning Herald, 17th December 1855.

The Commissioners survived this further attack on their competence but Rider was replaced as City Engineer by Edward Bell. Bell was asked to investigate the work of his predecessor and found little fault with it.¹⁵ Yet another Select Committee the following year went over the same ground yet again and found that Rider's conduct had been "most unsatisfactory" and his unfaithfulness, carelessness and the trust put in him by his Commissioners had led to an "excessive and improper expenditure" of public money. The Commissioners, they said, had not maintained proper control over their engineers, although it was admitted that it was not easy "to draw the line clearly between a proper and an improper interference with professional men in carrying out engineering works." Nonetheless there were areas they could have been more aware of and they should have realised something was wrong when costs were so much in excess of estimates.¹⁶

This latest report was adopted by the government except for the allegations about the unfitness of the Commissioners. Shortly afterwards one of the Commissioners resigned because of the bankruptcy of his personal business and since the Sydney Corporation was about to be restored, he was not replaced and the two other Commissioners were given other government appointments.¹⁷

Rider, as City Engineer, had taken a large part of the blame for what was seen as overspending on sewerage works. Engineers who followed him were not slow to learn the lesson that costs were all important. Bell, in his first year of office, assured the Commissioners in writing that whilst working on the city's drainage he had complied with their desire "so strongly expressed" that he would "keep in view the strictest economy combined with the greatest efficiency".¹⁸

Ironically it was Rider's choice of the cheapest solution for disposal of sewage which caused the most problems several years later. By the time the Sydney Sewage and Health Board reported to the government in 1875 there were sewage outlets at five different points in the Harbour and each was causing a nuisance (see figure 2.2). A committee appointed by the Board to examine the outlets found that at Rushcutters' Bay an extensive and stinking mud flat had formed which was exposed at low tide. At Woolloomooloo Bay a large bank had formed and sewage floated on the surface of the salt water, oscillating back and forth with the movement of the tides. At Fort Macquarie a "considerable bank" had formed and certain winds blew effluvia over "a considerable area of the northern part of the city." The water flowing from the Tank Stream into Sydney Cove was inky in colour, "apparently putrescent, and floated on the surface of the Bay" for a considerable distance. Finally at Darling Harbour, the committee described accumulating banks of "filthy and putrid mud".¹⁹

¹⁵ NSW Legislative Assembly, Votes and Proceedings, 1856-7, vol 1, p762.

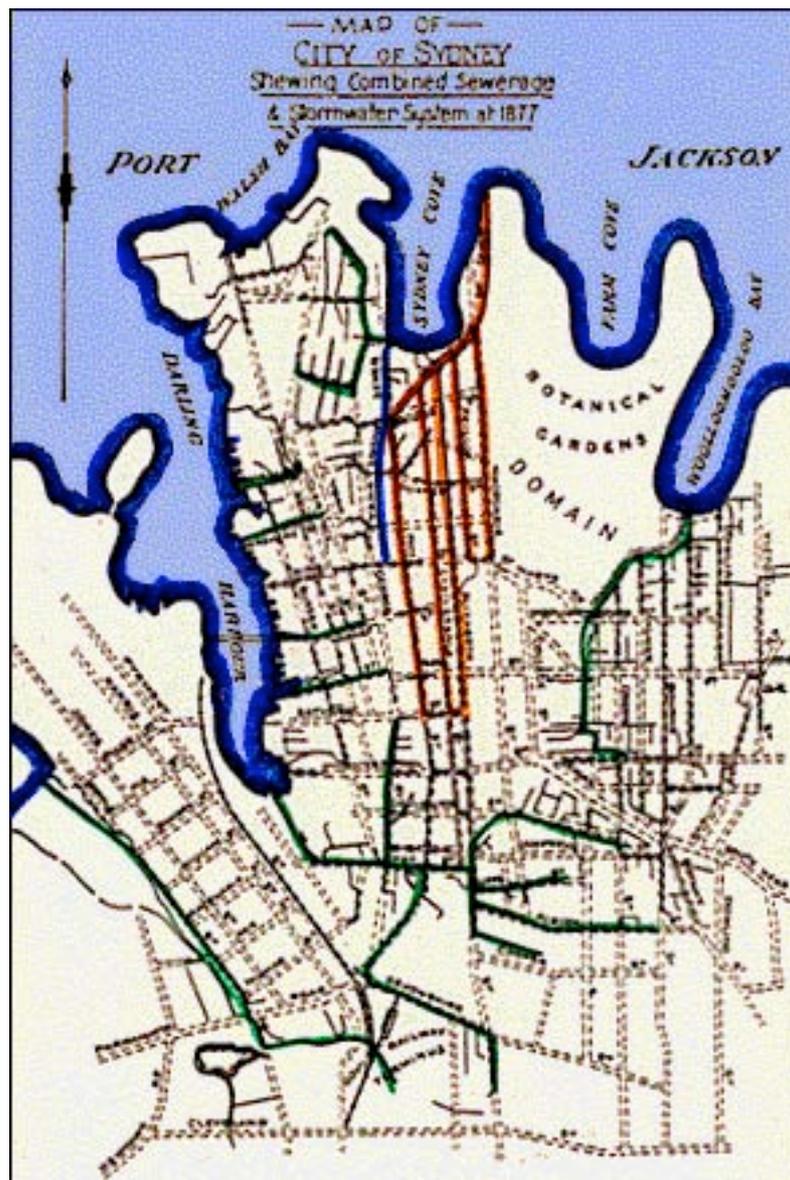
¹⁶ Select Committee on the City Commissioners Department, NSW Legislative Assembly, Votes and Proceedings, 1856, pp3-7 of report.

¹⁷ F.A. Larcombe, The Origin of Local Government in New South Wales 1831-1858, Vol. 1, Sydney University Press, 1973, pp152-4.

¹⁸ Second Yearly Report of the Commissioners, NSW Legislative Assembly, Votes and Proceedings, 1856-7, vol III, p6 of report.

¹⁹ Report of the No 7 Committee Appointed by the Sydney City and Suburban Sewage and Health Board, 1875.

Figure 2.2 Sydney Sewers in 1877



Source: F.J.J. Henry, The Water Supply and Sewerage of Sydney, Halstead Press, Sydney, 1939.

Various petitions and personal visits to members of parliament had been made in the 1870's. A petition signed by 3,800 people complained that the existing system of sewerage

has resulted in depositing all the filth of the city in the harbour, rendering all business occupations upon its shores disgustingly offensive, largely increasing the sickness of the citizens, and silting up year by year navigable water to a large extent.²⁰

The petitioners complained that the state of the harbour was well known overseas and was "discouraging immigration and hindering trade". Owners of waterside properties were especially disadvantaged by having the "excreta and

²⁰ NSW Legislative Assembly, Votes and Proceedings, 1876-7, p685.

offscouring of a hundred thousand people" cast upon them. "The sewer evil" had been caused by the government and should be cleaned up by the government.²¹

Complaints had also been received from the Imperial naval authorities, about the unhealthiness of the anchorage-grounds. Early in 1875 typhoid fever had broken out on board a moored "man-of-war" ship and they attributed it to noxious gases coming from the sewer outlet at Fort Macquarie.²²

The Sydney Sewage and Health Board recommended that the dry-weather sewage at three of the outlets be carried into deeper water "as the only measure immediately available for effecting any mitigation of the evils at the outlets of those sewers".²³ The Sewage and Health Board recommended that in the long term the city sewage be intercepted and diverted. They proposed that the north draining sewage be piped to Bondi and discharged into the sea at Ben Buckler Point and that the south draining sewage including that of Surry Hills, Redfern and Newtown be piped to a sewage farm, either on the lower part of Shea's Creek (now Alexandria Canal) near Botany Bay or on Webb's Grant on the Southern edge of Botany Bay.²⁴

THE WATER-CARRIAGE DEBATE

This decision, which was supported by an English engineer, W.C.Clark, brought out to the colony to advise on water and sewerage matters, prompted public debate over the merits of water-carriage technology which was as fierce in Sydney as anywhere in the world if we are to go by the observation of Gustave Fischer, a local civil engineer. In a paper which he read before the Engineering Association of New South Wales in 1884 Fischer compared the feelings on the issue to those of religious faith.

An out-and-out water-carriage advocate would go to the stake in support of his views, while the advocates of the different systems are equally bigoted in their own way... This excessive orthodoxy... tends to make men narrow-minded and bigoted, and incapable of taking a broad and impartial view. ²⁵

The debate was not confined to engineers or professionals however. The newspapers regularly published letters to the editor and editorials arguing the advantages and disadvantages of water-carriage schemes and dry conservancy schemes. The issue was covered almost every day in the Herald in March 1880.

The alternatives to water-carriage technology which were put forward at the time did not include an improved cesspit system. Cesspits were not considered as a serious alternative because they were closely identified with insanitary conditions and disease. Although regulations were established to ensure that

²¹ ibid.

²² Sydney City and Suburban Sewage and Health Board, Sixth Progress Report, 1875, p8.

²³ ibid., p5.

²⁴ Sydney City and Suburban Sewage and Health Board, Twelfth and Final Report, 1877.

²⁵ Gustave Fischer, 'Water-Carriage System of Sewerage, Its Disadvantages, as applied to the Drainage of Cities and Towns', paper read before the Engineering Association of New South Wales, Sept 11, 1884, p2.

they were more adequately constructed, appropriately sited and regularly cleansed, the idea of continuing with a cesspit system was out of the question. Reforms had been called for and politically, drastic changes were required. No-one trusted the cesspit system any longer.

The dry conservancy systems which were put forward as serious alternatives included dry closets, pan systems, and pneumatic systems. The dry closet (often referred to as the earth closet), named in contrast to the water-closet or flush toilet, did not use water to wash away the excrement but rather was a means of collecting the solid excrement in a container. (see figure 2.3) The addition of earth, ashes or charcoal after each visit to the closet deodorised the excrement which was periodically collected at night by cart and taken to a processing plant where it was dried out for use as manure.

The pan system consisted of having a pan under the toilet seat which was collected by night-men at regular intervals and replaced with an empty one. The pan was able to take urine as well as faeces and did not require the use of earth for deodorising. One version of the pan system was described at an 1889 meeting of the Engineering Association of N.S.W. by E.W.Cracknell.²⁶ A collection pan would be fitted to the toilet seat forming an air-tight joint which would prevent the escape of noxious gases. The full pans would be carted to a Poudrette works where the pans would be emptied, washed out mechanically and returned with a measure of deodorant. This would overcome the nuisance and disease that was spread when pans were not cleaned out and would eliminate the need for householders to have to cope with ashes or dry earth.²⁷

At the poudrette factory the night soil would be strained. The liquid would be chemically treated to remove the ammonia and then passed into the sewer whilst the solid portion was dried to make cakes of manure called Poudrette. Such a process was already in operation at Botany at the premises of the NSW Poudrette and Ammonia Company and, he claimed, produced no unpleasant smell and the poudrette was sold at a profit as fertiliser.²⁸

The first pneumatic system was merely a means of emptying cesspits using air power rather than hand labour. Later Captain Liernur developed a pneumatic system for transporting dry wastes through pipes by means of a partial vacuum created in those pipes. The waste products would be sucked to their destination. It was argued that Sydney was ideally suited to the Liernur system because of its small depth of soil and the consequent difficulty and expense of excavating through solid rock to enable water-carriage sewers to follow the necessary straight lines and gradients that a gravity dependent system requires.²⁹

²⁶ E.W.Cracknell, 'Sanitary Improvements', Proceedings of the Engineering Association of NSW IV, 1888-9, p94.

²⁷ ibid., p96.

²⁸ ibid., p95.

²⁹ T.B.Belgrave quoted in W.C.Clark, Report on Drainage of the City of Sydney and Suburbs, 1877, p28.

CONSERVING A VALUABLE FERTILISER

The main advantage put forward for all dry conservancy systems was their ability to utilise the waste as fertiliser. There was an element of the population in Sydney, as in Britain, that found the idea of utilising the sewage to be an attractive one. Such utilisation was practiced informally in many parts of the world including the industrialising countries.

Figure 2.3 Earth Closet Advertisement



MASSEY'S
PATENT
EARTH CLOSET.

WHOLESALE AGENTS:
M'LEAN BROS. & RIGG, Limited,
IRONMONGERS,
SYDNEY, MELBOURNE, ADELAIDE, LONDON,
and NEW YORK.

ADVANTAGES: A Certainty of Action; Ease of Action;
Storage of Deodorising Material; Proper Distribution;
Non-liability to Derangement; Any Material may be used.

It had been the hope of some of the early sanitary reformers that the sewage collected in sewers could be utilised on sewage farms. Chadwick, in Britain, had observed that sewage in Edinburgh was in much demand by the farmers and in his 1842 report and afterwards he persistently advocated the utilisation of sewage. At this time the Herald reasoned that the fact that sewage does not easily mix with sea water was evidence that it wasn't supposed to be put there. Rather it should be used as fertiliser; "We shall not always be able to rob the soil, and give it nothing in return" they warned.³⁰

Despite the popularity of this idea sewers often discharged into watercourses rather than on to sewage farms. In Sydney in the 1850s the City Engineer, conscious that some people would have liked to have seen him utilising the sewage, claimed he had "paid due regard" to the possibility of turning sewage

³⁰ ibid.

into manure and that he realised that this could determine sewage disposal options. Since the use of sewage for manure was so "enveloped" in uncertainty, he had designed the system so that the sewage could be easily discharged to sea if it was found that fertiliser manufacture was not profitable. However Rider was reluctant to engage in manure production because of the uncertain economics and the probable extra cost and lack of immediate profitability of such an operation.³¹ Rider's successor as City Engineer, Bell, found it necessary a couple of years later to at least plan for the interception of sewage for use as fertiliser in the future because the Governor General was in favour of it.³²

Dry conservancy adherents wanted to see human wastes being utilised as fertiliser but they argued that by mixing water with sewage, as occurred in water-carriage systems, the "constituent parts" were spoiled.³³ Moreover, they argued, the use of water-carriage technology limited the area over which fertilizer could be used whereas dry conservancy methods allowed the manufacture of poudrette cakes which could be transported where required. Dry conservancy ensured that "the whole agricultural value of the excrement" was retained and that the resulting manure was in a form in which it could be stored and transported easily.³⁴

Dry conservancy methods were also conservative of water, even if sewers were used for other household wastes, because water would not be required for toilet flushing.³⁵ This was no minor consideration in Sydney which had a history of inadequate water supply. (A Royal Commission into the water supply in 1867 had revealed that some of the most peopled parts of the city were dependent on wells and water carts and that the main supply of water, the Botany swamps, might not be able to meet rapidly accelerating demands for water. When the Sewage and Health Board reported in 1875 they claimed there was a need for drastic improvement in the city's water supply. A scheme to get water from the Nepean River was begun in 1879.³⁶)

The Sanitary Reform League, originally named the League for the Prevention of Pollution of Air and Water, was formed in Sydney in 1880 to press for alternatives to the Sewage and Health Board scheme. They claimed that they were not committed to any system in particular but, in response to the proposed scheme of intercepting the existing sewers and conveying the sewage to the sea, they merely wanted

to ascertain whether, by the light of recent experience in other countries where this question has been carefully considered, another and less objectionable scheme can be devised in place of that adopted by the colonial Government.³⁷

³¹ First Yearly Report of the Commissioners, p28.

³² Second Yearly Report of the Commissioners, p6.

³³ First Yearly Report of the Commissioners, p28.

³⁴ U.R.Burke, *Sewage Utilization*, 2nd edition, E.&F.N.Spon, London, 1873, p21.

³⁵ *ibid.*, p13-21.

³⁶ David Clark, 'Worse than Physic': Sydney's Water Supply 1788-1888 in Max Kelly (ed), *Nineteenth-Century Sydney: Essays in Urban History*, Sydney University Press, 1978, pp62-63.

³⁷ *Sydney Morning Herald*, 4th May 1880.

Many of the League's members including their founder, Sir James Martin, the NSW Chief Justice, favoured dry conservancy methods and were prominent in pushing the case for dry conservancy.

Part of the push for not throwing away a fertiliser came from utilitarian values. But the economic value of sewage was not universally accepted. The Sydney Sewage and Health Board argued that the manure would be of little value when mixed with the dried earth.³⁸ This was denied by dry closet enthusiasts such as Martin who claimed personal experience of its value on his own property in the country.³⁹ Promoters of the pan system argued that their system increased the value of the product because it was not mixed with earth. They also argued that the value of the resultant manure meant that the pan system generally covered its costs.⁴⁰ In a letter read before the Sanitary Reform League Benjamin Backhouse quotes an English sanitary expert:

high authorities, have repeatedly shown the great agricultural value of the ingredients contained in faecal matters, proving by history, analysis, and innumerable experiments, how absolutely indispensable it is to national welfare and to the highest condition of health and life that this great agricultural treasure should not be lost.⁴¹

The desire to see sewage utilised seems to have gone deeper than just the utilitarian reason that it might be an economic way of doing things, however. The idea appealed to deeper values, that may have harked back to an agrarian heritage or perhaps a commonsense distaste for wastage. It seems to be a constant theme even in modern day debates over sewage disposal and is not confined to environmentalists.

PROTECTING THE ENVIRONMENT

Dry conservancy advocates criticised water-carriage as a technology that was not only wasteful but also detrimental to the environment and public health. Martin, in a series of letters published in 1880 in the Sydney Morning Herald under the heading "The Pestilence That Walketh in Darkness", criticised the proposed scheme of sewerage because of the air and water pollution it would cause.⁴² Air pollution was a particularly damning accusation since it was believed that "miasmas" were responsible for many of the life-threatening diseases around at that time.

Sewer gas was a big problem in the nineteenth century when knowledge of how to trap the gas and prevent its return back into homes and city streets was scarce and workmanship in sewer construction often cheap and shoddy. In Britain some towns imposed fines if houses were connected to main sewers for this very reason and in Manchester the town was converted to "the apparently

³⁸ The Sydney City and Suburban Sewage and Health Board, Third Progress Report, 1875, p3.

³⁹ Sydney Morning Herald, 19th March, 1880.

⁴⁰ W.H. Corfield, A Digest of Facts Relating to the Treatment & Utilisation of Sewage, MacMillan & Co, 1871, p57.

⁴¹ Sydney Morning Herald, 15th May 1880.

⁴² Sydney Morning Herald, 9th March 1880.

safer and more effective dry conservancy method."⁴³ A letter writer to the Herald argued,

A well sewered town may be described as supplied with a system of subterranean retorts, so arranged that the fluids in passing give off the largest volume of gases, which are carefully collected, and then by means of chimney pipes (for house drains serve admirably that purpose), conducted into the very heart of the dwellings.⁴⁴

In many parts of the world early sewers had been built to carry off stormwater drainage and when they were converted to take sewage they did not cope very well. They were often large diameter (big enough for a person to walk through) brick construction which meant that flows were slow and sometimes stagnant. They were frequently obstructed by large objects or a build up of solids, and faulty joints permitted a substantial amount of subsoil leakage.

In Sydney it was found in 1875 that of 5,400 water closets supplied by mains water, 4,500 had a direct connection between the toilet pan and the water pipe supplying flushing water so that when the water supply was cut off, as it frequently was, toilet waste could be sucked back into the water mains.

The certain consequence of this most unusual arrangement is, that the water supplied to the inhabitants for household purposes is polluted with matter which some high authorities consider too offensive to be admitted even to the public sewers.⁴⁵

The other big problem associated with water-carriage technology was the nuisance generally created at the point of discharge. Because of cost constraints and a certain measure of ignorance, and particularly because water carriage meant that there was a substantial liquid component to dispose of, most early sewers were discharged into the nearest watercourse. This rapidly led to the fouling of that watercourse which was generally quite close to the town and often the source of water supply for that town or one downstream. In Sydney it was the Harbour which was polluted and this was considered to be a public health threat because of the "miasmas" which were coming off the harbour waters and shores.

The pollution from sewer gases and untreated discharges therefore sullied the reputation of water-carriage systems and a letter to the Herald warned

what a pity then, if youthful blooming Australian cities were to begrime themselves with European folly in the shape of sewage by water carriage with their inevitable melancholy train of cholera, typhus, and exhaustion of the soil.⁴⁶

One of the main premises of those who advocated dry closets was that the faecal matter was the most dangerous part of the human excrement. Sir James Martin

⁴³ Anthony S. Wohl, Endangered Lives: Public Health in Victorian Britain, Harvard University Press, Cambridge, 1983, p102.

⁴⁴ Sydney Morning Herald, 15th May 1880.

⁴⁵ Sydney City and Suburban Sewage and Health Board, Progress Report, 1875, p1.

⁴⁶ Sydney Morning Herald, 15th May 1880.

wrote, "Nothing is better known than the fact that it is the solid matter that produces the typhoid fever germ - the liquid, by itself, never."⁴⁷

By keeping this dangerous component out of the sewers, they argued, the sewers could then be safely used for the remaining liquid portion of the household wastes. In a text used in Sydney in the nineteenth century, U.R. Burke, an English Barrister, reasoned that the remaining sewage could be more easily dealt with at its destination because of its lesser strength and volume. Additionally, Burke argued that faeces, because of their "greasy and highly tenacious nature," made drains difficult to clean.

Although water-carriage was associated with some public health problems the association of dry conservancy methods with the old cesspit system was understandable. Water-carriage at least removed the source of the problem from the home, quickly and efficiently. It was thought that if the sewage was allowed any time to putrefy or decompose it would give rise to 'miasmas'. Therefore if the sewage was allowed to sit around waiting for collection for the purposes of utilisation it would only cause the very problems which sanitary reform was supposed to solve.

The first government committees to consider the disposal of wastes in Sydney used exactly this argument.

Your committee are of opinion, that the use of the Sewers is to carry the filth of the City into the sea as speedily as possible, and that the saving of the sewage [as fertilizer] is a subsidiary matter,..The expense, and to a certain extent, the danger of accumulating matter in Sydney, would in the opinion of your Committee, more than counterbalance any advantages which it could afford.⁴⁸

Later, in 1875, the Sydney Sewage and Health Board came to similar conclusions about dry conservancy schemes.

Such plans, moreover, all violate one of the most important of sanitary laws, which is that all refuse matters which are liable to become injurious to health should be removed instantly and be dealt with afterwards. With all these plans it is an obvious advantage on the score of economy to keep the refuse about the premises as long as possible.⁴⁹

This principle that sewage must be rapidly removed is also alluded to and emphasised in many learned papers given before the Royal Society of N.S.W. and the Australasian Association for the Advancement of Science up to the turn of the century.⁵⁰

⁴⁷ Sydney Morning Herald, 19th March 1880.

⁴⁸ Select Committee, Sydney Sewerage and Water Appropriation Bill, 1854, p6.

⁴⁹ Sewage and Health Board, Third Progress Report, p6.

⁵⁰ for example, Joseph Bancroft, 'Various Hygienic Aspects of Australian Life', Australasian Association for the Advancement of Science I, 1887, pp532-3; George Gordon, 'Household Sanitation', Australasian Association for the Advancement of Science II, 1890, p688; J.Trevor Jones, 'Sanitation of the Suburbs of Sydney', Royal Society of NSW 20, 1886, pp362-3; J.

ARGUMENTS OVER EFFICACY

The relative merits of the various schemes being proposed were difficult to evaluate because they were all fairly new and therefore experimental. One Sydney engineer complained that almost all books and pamphlets on the subject were biased, producing "the most hopelessly confusing discrepancies in all values and quantities."⁵¹ The confusion was not only because of bias but also because there was no agreed upon criterion for such an evaluation. Whilst scientists may judge their theories according to how closely their empirical results accord with those predicted, technology has no intrinsic goal and therefore no intrinsic measure of efficacy. Evaluation policies develop as a field of technology matures and according to David Wojick, these may include scientific theories, engineering principles, rules of thumb, legislation, professional standards and moral precepts.⁵²

The efficacy of a technological process or the question of whether it "works" are concepts that are relative to social objectives and the aims and purposes of those who advocate the technologies involved. What counts as working has to be socially negotiated⁵³ and criteria of effectiveness vary depending on a person's domain of interest.⁵⁴ Often technologies are assessed according to set standards or what Edward Constant has called "traditions of testability". Such traditions embody norms such as the overt commitment to objective, scientific, replicable and public testing. He argued that traditions of technological testability permit practitioners to know which designs and modifications represent progress by helping them to see how closely they are approaching the ideal.⁵⁵

It is important to note that traditions of testability or standards must either result from a consensus of opinion or be imposed by a body, whose authority is commonly accepted. Unfortunately when there is no agreement about competing technologies, or even the primary objectives of such technologies, as was the case with water-carriage and dry conservancy technologies, then agreement about standards and criteria of efficacy cannot be reached and the relative worth of each technology cannot be decided on the basis of "efficacy" alone.

There were places in Australia and overseas that were using the earth-closet system to some degree but these examples were used by people on both sides of the debate to prove the success and the failure of such a scheme. Burke, for example, claimed that earth closets of the type invented by Mr Moule, which automatically dropped the earth onto the excretion, had been used successfully in India and he quoted an English report that listed the advantages of the earth

Ashburton Thompson, 'Sewerage of Country Towns: The Separate System', Royal Society of NSW 26, 1892, p133.

⁵¹ Sewage and Health Board, Third Progress Report, p6.

⁵² David, Wojick, 'The structure of technological revolutions' in George Bugliarello & Dean Boner (eds), The History and Philosophy of Technology, University of Illinois Press, 1979, p240.

⁵³ John Law, 'International workshop on new developments in the social studies of technology', 4S Review 2(4), 1984; p9.

⁵⁴ Ruth Schwartz Cowan, 'The consumption junction: a proposal for research strategies in the sociology of technology' in Wiebe Bijker, Thomas Hughes and Trevor Pinch (eds), The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology, MIT Press, 1987, pp261-280.

⁵⁵ Edward Constant, 'Scientific theory and technological testability: science, dynamometers, and water turbines in the 19th century', Technology and Culture. 24(2), April, 1983, pp183-198.

closet system including the cheaper cost and easier maintenance of earth closets when compared to water-closets and the easier utilisation of the manure.⁵⁶ Sir James Martin and others cite successful uses in New Jersey, Paris and Stockholm and also Balmain.⁵⁷ Conversely the Sydney Morning Herald argued that the earth closet had been tried in Balmain, Manly, Melbourne and Brisbane without success.⁵⁸

Often the criticisms on both sides were based on the worst representative cases of each others schemes; dry-closets that were shared among far too many people; night-soil collection that was not properly supervised nor regulated; poorly constructed sewerage schemes. For example a Sydney engineer advocating water-carriage sewers, J.B. Henson, admitted that the results of many sewerage systems had been unsatisfactory but he argued, these were designed by people who did not understand sanitary principles. The Herald argued

It is not fair to compare the principle of water carriage, when badly worked out with that of the earth-closet system, carried out under imaginary, and in our case unattainable conditions.⁵⁹

The debate should also be considered in the context of crisis. The tendency not to implement new systems of technology in the public sector until a crisis makes it no longer possible to put off the inevitable reforms means that such decisions are made when there is little time or flexibility for pioneering uncertain alternatives.

An objection made by the Sydney Sewage and Health Board against earth closets was that it would be practically impossible to get enough "thoroughly dried and sifted earth of the proper quality." The quantity of refuse, enormously inflated by the earth would be impossible to dispose of. These points were especially true if bedroom slops (liquid excreta) were allowed into the earth closets. If they weren't then sewers would still be required and would be just as contaminated as before.⁶⁰ The advocates of dry conservancy paid little attention to how the urine of the population would be dealt with.

Dry closet advocates did not expect the dry closets to cater for liquid wastes. The problem of obtaining dry-earth was one that was countered by the claim made by an engineer in a letter to the editor that ashes and street sweepings were even better deodorising agents and at that time were available to every household. These ingredients would have to be carted away as refuse anyway.⁶¹

The relative economics of the various schemes was another hotly debated issue. The dry conservationists argued that their schemes were more economical because of the value of the manure which would be sold, the savings in water and the lesser treatment that the remaining sewage would require. The value of the manure was a particularly indeterminate matter, and there was little agreement either on its efficacy in improving farm yields or on the price that it would fetch.

⁵⁶ Burke, Sewage Utilization, pp14-21.

⁵⁷ Sydney Morning Herald, 16th March 1880, 19th March 1880, 24th March, 1880.

⁵⁸ Sydney Morning Herald, 13th March 1880, 9th April 1880

⁵⁹ Sydney Morning Herald, 13th March 1880.

⁶⁰ Sewage and Health Board, Third Progress Report, p3.

⁶¹ Sydney Morning Herald, 24th March, 1880.

Moreover the price that it could be sold for at the time did not reflect the long-term value to the soil. In the relatively young colony of N.S.W. the land had not yet been overworked and deprived of many of its nutrients and fertilisers were not as much in demand then as later. The cost of artificial fertilisers to the farmers was not considered to be a cost that should be attributed to water-carriage systems. The cost of transporting the sewage or poudrette to the farmer, however, was included in the costs of dry conservancy methods and this was one of the key factors in depriving the manure of any value.⁶²

Advocates of the Liernur pneumatic system argued that their system would be cheaper because small pipes could be used with a minimum of excavation and easier access for maintenance of the pipes that would be near the surface.⁶³ The costs of creating a vacuum compared favourably to the cost of pumping the sewage up from low-lying areas and up to the surface for treatment in a water-carriage system. Ventilation shafts would be unnecessary because there would be no build up of sewer gases and flushing of the pipelines would be unnecessary because of the high velocity of any liquids passing through the pipes, thus saving on water.⁶⁴ A water carriage system, excavated deep into the rock would be difficult and expensive to repair. Liernur's system of pneumatic pipes would be cheaper to build, easier to maintain and easier to expand as population grew because its parts were "susceptible of independent action".⁶⁵

On the other hand water-carriage proponents argued that because dry conservancy methods did not deal with the large quantities of liquid household wastes, sewer systems would still have to be built and therefore the cost of dry conservancy methods were always additional to the cost of a sewerage system. This argument was made at a time when it was supposed that a combined system of drainage and sewage pipes would suffice for a city.⁶⁶ Later it was found that separate systems were required and it is uncertain how this consideration may have influenced the argument.

The operating costs of sewers were definitely lower than those of pan and dry closet systems because of the labour involved in the latter, especially when the labour required to enrich the manure and transporting it to farm land were considered. Moreover, sewerage systems were paid for on a completely different basis from cesspit, pan and dry closet systems which were paid for individually. Sewerage systems were paid for by the municipality or city and the capital cost was spread over a number of years through bond issues and loans.

However, the pan system was used in Sydney suburbs for many years, some until quite recently, as a cheaper, 'temporary' alternative to sewers. The very substantial cost of sewerage schemes made it difficult to argue for them on the

⁶² for a U.S. analysis of sewage as fertiliser see Joel Tarr, 'From City to Farm: Urban Wastes and the American Farmer', *Agricultural History* XLIX(4), Oct 1975, 598-612.

⁶³ E.M.de Burgh, *Report on the Liernur Pneumatic System of Sewage Collection*, NSW Legislative Assembly, 1905, p1217.

⁶⁴ *ibid.*

⁶⁵ T.B.Belgrave quoted in W.C.Clark, *Report on Drainage of the City of Sydney and Suburbs*, p28.

⁶⁶ for an analysis of decision-making between separate and combined systems of sewerage see Joel Tarr, 'The Separate vs. Combined Sewer Problem: A Case Study in Urban Technology Design Choice', *Journal of Urban History* 5(3), May 1979: 308-339.

basis of cost savings. However, the fact that Sydney had already invested a large amount of capital in water-carriage technology (and that capital had been extracted from the rate-payers with great difficulty) before these debates came to the fore. Moreover there were people in high positions who would have baulked at starting all over and especially since this would have meant admitting that earlier decisions had been wrong.

Earlier decisions had in fact set in place the beginnings of a technological system which was set to expand and grow. Such a system, as described by Thomas Hughes in his work on electricity generation,⁶⁷ encompasses not only physical equipment but also organisations, professional allegiances, legislative artifacts and scientific components. Such a system develops a momentum that is a powerful conservative force ensuring that development takes place in certain directions that were consolidated early in the system's formation. By the 1870s and 1880s the Sydney sewerage system had accumulated some organisational and financial momentum which made it difficult for dry conservationists to alter its direction.

Another, perhaps more pressing, reason for the triumph of sewers over closets and pans lies in the opportunities they offered in terms of planning and control.

ORDER, SOCIAL CONTROL & PROGRESS

The Sydney Sewage and Health Board argued that Dry Closets were unsuitable for large towns because it was practically impossible to secure proper management of the earth-closets and this was necessary to prevent the closet becoming "a filthy and dangerous nuisance".⁶⁸ Professor Corfield, an acknowledged English authority in sanitary matters and a medical man by training, also pointed to the problems that would ensue if the contents of the earth closet were to become moist because liquids had been added or the air was very damp.⁶⁹ Other management problems included getting people to apply the dry earth or ashes in sufficient quantity and detail to their excrement. Corfield argued that "decent people" managed their dry closets so that they were clean and inoffensive but was of the opinion that

the lower classes of people cannot be allowed to have anything whatever to do with their own sanitary arrangements: everything must be managed for them.⁷⁰

The Herald claimed that the danger with earth closets arose from the "ignorance, the recklessness, or the neglect of the people" which could only be fixed with generations of public education, not just public organisation and regulation.⁷¹ Dry closet enthusiasts admitted that the earth system failed in some places because "of a want of ordinary skill or an absence of efficient supervision such as

⁶⁷ Thomas Hughes, Networks of Power: Electrification in Western Society, 1880-1930, John Hopkins University Press, 1983.

⁶⁸ ibid., p3.

⁶⁹ W.H Corfield, Sewerage and Sewage Utilization, D.Van Nostrand, New York, 1875, p52.

⁷⁰ Corfield, The Treatment and Utilization of Sewage, pp31-2.

⁷¹ Sydney Morning Herald, 13th March 1880.

would cause any other scheme to fail."⁷² And indeed proper management was also a problem with water closets when they were first introduced.

The ordinary water-closet is obviously unsuited for careless and wantonly mischievous people. The pans get broken, the traps choked up, the water is left running on continually from the tap, or the tap is broken and leaks wastefully; in frosty weather there is no water, and the consequence is that the closets become filthy and stinking.⁷³

These problems, which were so readily blamed on the carelessness of the poor, arose because poor families were forced to share both earth and water closets with several other families and because of a lack of education about their use. An 1885 British survey found that 90% of houses inspected had broken or unflushable water closets, and five years later it was found that of 3000 houses inspected only 1% did not have plumbing or draining defects.⁷⁴

Despite the problems with water closets, they were being installed by the affluent before water-carriage disposal systems were even available. As the most modern of conveniences they were regarded as a more desirable device. They were relatively simple and automatic to operate and they removed the offensive matter from sight and from inside the home immediately. This was an important consideration given the association of the proximity of excrement and its smells with disease so recently implanted in the minds of the middle classes. Corfield described the reluctance of people in England to use earth closets that had been installed. Many preferred to continue using the privy vaults and cesspits in their back yards because they considered the use of an earth closet close to their dwelling rooms to be unhygienic.⁷⁵

In some ways the introduction of water closets and piped water supplies encouraged the subsequent adoption of water-carriage methods of removal. Significantly, water-carriage systems offered more potential for control and were therefore more attractive to the authorities in Sydney and also in many other cities around the world. Although the actual toilet might remain a private responsibility and therefore be subject to abuse, the automatic nature of the flush toilet removed the need for individual decision making about when and how to remove sewage from the home⁷⁶ and the collection, carriage and disposal was necessarily a centralised, government controlled activity. Jon Peterson, an American writer, observed that the old private-lot waste removal system "epitomized the piecemeal, decentralized approach to city building characteristic of the nineteenth century."⁷⁷

Water-carriage systems, as advocated by sanitary reformers and government authorities, required an integrated system of underground pipes that were

⁷² Sydney Morning Herald, 19th March 1880.

⁷³ Corfield, *The Treatment and Utilization of Sewage*, p118.

⁷⁴ Wohl, *Endangered Lives*, p102.

⁷⁵ *ibid.*, p88.

⁷⁶ Tarr et al, 'Water and Wastes', p234.

⁷⁷ Jon A. Peterson, 'The Impact of Sanitary Reform Upon American Urban Planning, 1840-1890', *Journal of Social History*, vol 13, Fall 1979, p85.

planned, engineered and coordinated with reference to a larger, city-wide plan.⁷⁸ Political boundaries could not fragment a sewerage scheme, rather local councils were forced to give authority to more centralised government bodies in the realm of waste disposal once water-carriage systems were adopted. Water-carriage, with its scale economies, capital intensiveness and need for central administration "was an important factor in facilitating governmental integration."⁷⁹

The visible signs of dirt and disease would be removed from the city streets once and for all and this was an important step in cleaning up and ordering the city environment. A letter to the editor describes how dry closet and pan systems fill the streets with their operations.

The waggons are encountered in the streets, both night and day, and pedestrians, with the utmost unanimity, pass by on the other side, notwithstanding that the men when carrying the pans to the waggons, put on each an iron cover. Letters of complaint frequently appear in the newspaper, also house property in the neighbourhood of the depots has considerably depreciated in value, and numbers of the houses are without tenants.⁸⁰

People didn't like the frequent visits of the scavengers or "night men" who often had to traipse through the house and were said to be an inconvenience to householders.⁸¹ The Sydney Morning Herald went even further, arguing that to retain any measure of control over dry closets it would be necessary for delivery and collection to be by

a process of domiciliary visitation by men armed with authority to see that this portion of the domestic arrangements of every house was properly attended to. The people would live under the visitation and supervision of an army of scavengers.⁸²

Water-carriage offered not only a government controlled solution to sewage collection but also one that was automatic and therefore not dependent on armies of scavengers or night-cart men. The dry earth and pan systems were dependent upon cartage and manual labour. The replacement of a labour intensive system with a capital intensive one seemed to be in line with progress and technological advancement in other areas of life. The Quarterly Review in England argued,

Tube-drainage is therefore cheaper than cesspool-drainage, for the same reason, and in the same degree, that steam-woven calico is cheaper than hand-made lace. The filth and the finery are both costly, because they both absorb human toil; the cleanliness and the calico are alike economical, because they are alike products of steam-power.⁸³

⁷⁸ *ibid.*, p84.

⁷⁹ Tarr et al, 'Water and Wastes', p252.

⁸⁰ Sydney Morning Herald, 19th April 1880.

⁸¹ Corfield, The Treatment and Utilization of Sewage, p 33.

⁸² Sydney Morning Herald, 26th March 1880.

⁸³ F.O.Ward, 'Sanitary Consolidation-Centralization-Local Self-Government', Quarterly Review 88, 1850, p479.

The widespread belief that progress ensued from technological change and modernisation, also linked water-carriage technology to urban progress. Sewers, despite their ancient heritage were seen to be more scientific than dry conservancy systems which seemed in turn to be somewhat primitive. Florence Nightingale observed in an 1870 Indian Sanitary Report that

The true key to sanitary progress in cities is, water supply and sewerage. No city can be purified sufficiently by mere hand-labour in fetching and carrying.

As civilization has advanced, people have always enlisted natural forces or machinery to supplant hand- labour, as being much less costly and greatly more efficient.⁸⁴

The progressive image of sewerage systems and their very real effect in cleaning up cities had a significant effect on the development of a city, especially where it was in competition with other cities for population and investment. It was generally recognised that connection to a sewerage system increased real estate values and it has been argued that businessmen in some places considered sewerage works and water supply as "business investments in the projection of a favourable urban image."⁸⁵ The impact on health, although clear in other cities, was not so marked in Sydney until after 1880 if one considers the death rate. (see figure 2.4)

ENGINEERS AND PROFESSIONAL CONTROL

The image of water-carriage technology as scientific and progressive was fostered by engineers whose professional image was thereby enhanced. The debate over methods of sewage collection was not confined to engineers but was readily taken up by doctors and lawyers, military men, architects and non-professional members of the public.

Water-carriage was almost universally endorsed by government officials, local councils and by the various professional groups in Sydney. The Royal Society of N.S.W. resuscitated its sanitary section in 1886 and in papers given by Trevor Jones, the City Engineer, F.H.Quaife, M.D, J. Ashburton Thompson, M.D, Chief Medical Inspector, John Smail, M.Inst.C.E of the Government Sewerage Department and other doctors and engineers water-carriage sewerage systems were discussed with the assumption that they were the only solution to the problem. Dr Ashburton Thompson did discuss scavenging and poudrette manufacture but he made it clear that such measures were temporary solutions pending the sewerage.⁸⁶

The Sanitary Science and Hygiene Section of the Australasian Association for the Advancement of Science also received papers on matters concerning sewage disposal. These papers were usually given by medical men and engineers,

⁸⁴ quoted in The Sydney City and Suburban Sewage and Health Board, Third Progress Report, 1875, p6.

⁸⁵ Joel Arthur Tarr and Francis Clay McMichael, 'The Evolution of Wastewater Technology and the Development of State Regulation: A Retrospective Analysis' in Joel A.Tarr, ed, Retrospective Technology Assessment-1976, San Francisco Press, 1977, p176.

⁸⁶ J. Ashburton Thompson, 'Aids to Sanitation in Unsewered Districts: Poudrette Factories', Royal Society of NSW 23, 1889, pp450-65.

including government engineers and university professors, who favoured the water-carriage sewerage system. A notable exception was an 1891 paper delivered by Benjamin Backhouse, H.A.R.I.B.A, Chairman of the City of Sydney Improvement Board which favoured Captain Liernur's Pneumatic System.⁸⁷

Obviously engineers did not have a monopoly of control over sanitary decisions at this stage and a person who was trained in almost any field could make their name as a sanitary expert merely by studying the issue carefully and writing about it. Engineers were however closely associated with large-scale public works, the construction of tunnels and the laying of pipes, and overseas engineers were carving out a profession for themselves in the area of sanitation. That sewers had for some time been considered to be an engineering domain, even if the quality of work and financial management of it was subject to question from government, is clearly seen in the early stages of the construction of Sydney's sewerage system.

The reform measures pushed by sanitary reformers in the nineteenth century were largely technological and the development of new technologies associated with water supply and the water-carriage of sewage offered the opportunity for a new professional group to form which claimed to have specialised knowledge in the field. In the 1870s two British civil engineers published books with the term "sanitary engineering" in their titles. This was followed shortly after by an American book.⁸⁸

At first sanitary engineering was loosely defined and included plumbers and others in the sanitary field who were not engineers but it soon started to define itself "more explicitly in a scientific and disciplinary sense".⁸⁹ The push for sewerage to be seen as scientific was exemplified at a Sydney meeting where an engineer argued, with respect to the engineering of sewers, that

... it must be borne in mind that these principles and the best methods of applying them have been developed gradually and are the outcome of the experience of the past, combined with the results of scientific research.⁹⁰

Attempts were made to exclude non-engineers from the field and establish sanitary engineering as a profession distinct from other professions. This involved the exclusion of tradesmen on the grounds that they specialised in only one aspect of sanitary matters and were not professionals, and the exclusion of physicians because they were not able to execute engineering works. Public health officials and municipal bureaucrats, the engineers argued, did not have sufficient breadth and depth of training. The base for sanitary engineering was

⁸⁷ Benjamin Backhouse, 'On the Sewerage Question, and the Desirability of introducing the Pneumatic System invented by Captain Liernur.', Australasian Association for the Advancement of Science III, 1891; 408-410.

⁸⁸ Tarr et al, 'Water and Wastes', pp246-7.

⁸⁹ ibid., p247.

⁹⁰ J.B.Henson, 'Sanitary Sewerage', Australasian Association for the Advancement of Science I, 1887, pp530-5.

civil engineering to which a knowledge of physical and natural sciences was added.⁹¹

The sanitary engineer has a treble duty for the next few years of civic awakening. Having the knowledge, he must be a "leader" in developing works and plants for state and municipal improvement, at the same time he is an "expert" in their employ. But he must be more; as a health officer he must be a "teacher" of the people to show them why all these things are to be.⁹²

At the same time medical professionals in the public health area were carving out their own area of expertise. With the changing ideas about disease causation at the end of the nineteenth century physicians tried to exclude those outside the medical profession from the field of public health and to change the emphasis from collective community susceptibility to disease to personal and individual cure of disease with attention being given to specific agents of disease.⁹³ Engineers, on the other hand, retained the idea of the importance of environmental sanitation to health whilst it lent importance to their work.

Environmental sanitation fitted well with the engineering perspective which attempted to impose order on the natural environment, find technological fixes for social problems⁹⁴ and tended to view the urban environment in terms of a series of problems to be solved. In this way,

They adhered to a set of values and procedures which stressed efficiency within a benefit-cost framework, and this appealed to late-19th- and early-20th-century reformers attempting to restructure municipal government along lines of professionalism, efficiency, and bureaucratization.⁹⁵

The engineering priority of finding the least cost solutions, and not being swayed from that by other lesser considerations, also caused them to support the non-sense water-carriage system over other systems that attached some non-monetary value to manure. An engineering text put it quite simply "The all-convincing argument with any but the sentimentalist is that, while there may be manurial value in sewage, no commercially profitable method of utilizing it has been found."⁹⁶

Because water-carriage technology needed to be implemented systematically to ensure effective functioning rather than in the piecemeal or ad-hoc way that dry conservancy methods lent themselves to, it was particularly compatible with engineering ideals since it required planning, engineering expertise and

⁹¹ Tarr et al, 'Water and Wastes'; Martin Melosi, Garbage in the Cities: Refuse, Reform and the Environment, 1880-1980, Texas A. & M. University Press, 1981, p120.

⁹² Ellen Richards quoted in Melosi, Garbage in the Cities, p120.

⁹³ Barbara Gutmann Rosenkrantz, 'Cart before Horse: Theory, Practice and Professional Image in American Public Health, 1870-1920', Journal of the History of Medicine, January 1974, pp63-64.

⁹⁴ Melosi, Garbage in the Cities, p22.

⁹⁵ Tarr et al, 'Water and Wastes', p254.

⁹⁶ A. Prescott Folwell, Sewerage. The Designing, Construction, and Maintenance of Sewerage Systems, John Wiley & Sons, New York, 1901, p8.

centralised management and particularly engineering management.⁹⁷ Engineers approached their work in a systematic way and viewed the city as a large integrated system "with the efficient functioning of one part dependent upon the efficient functioning of the whole." In the United States engineers likened their relationship to the city to that of a family physician to the family.⁹⁸

The problems associated with poorly conceived and constructed sewer systems, especially the problems of seepage and sewer gas, were used by engineers to argue for more expertise to be employed with regard to sewerage systems. Water and sewerage systems, as lifelines for the city, were so important, they argued, that only professional experts should be trusted to build and administer truly comprehensive schemes of sewerage.⁹⁹

Water-carriage systems entailed large-scale public works and large capital outlays and the engineers' association with public works, as well as their ability to minimise costs and to prioritise economic considerations, was an asset under the circumstances. Because of the large capital investment involved in sewerage systems and their relative inflexibility to change, water-carriage systems had to be designed with an eye to the future. It was necessary to predict population levels and changes in land usage some years into the future so that adequate capacities were built into the system. The data collection and planning, as well as the land acquisition, overseeing of construction, daily administration and maintenance work required a permanent bureaucracy.¹⁰⁰ And eventually, as happened in Sydney in the Metropolitan Board of Water Supply and Sewerage, that bureaucracy would be dominated by engineers.

In engineer-dominated bureaucracies all over the world engineers organised themselves into hierarchies with division of responsibility, standardised systems of monitoring costs and organising budgets. Such bureaucracies promised greater efficiency and provided the model for all public works construction and management.¹⁰¹

Although a close working relationship developed between municipal and government authorities and engineers, engineers tried to divorce themselves from local politics and to establish an image of being neutral experts or consultants. They claimed to represent the qualities of the ideal administrator - "expertise, efficiency, and disinterested, incorruptible professionalism".¹⁰² They formed networks and associations with other engineers to exchange information and practices.¹⁰³ The Engineering Society of N.S.W. was formed in 1870 and papers were often given on sanitary engineering topics. Many N.S.W. engineers were members of British Engineering societies and this was put forward as a

⁹⁷ Tarr et al, 'Water and Wastes', p257.

⁹⁸ Stanley K. Schultz and Clay McShane, 'Pollution and Political Reform in Urban America: The Role of Municipal Engineers, 1840-1920' in Martin Melosi (ed), Pollution and Reform in American Cities 1870-1930, University of Texas Press, 1980, p160.

⁹⁹ ibid., pp162-3.

¹⁰⁰ Tarr et al, Tarr et al, 'Water and Wastes', p252; Stanley K. Schultz and Clay McShane, 'To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late-Nineteenth-Century America', Journal of American History LXV(2), Sept 1978, p398.

¹⁰¹ Schultz & McShane, 'Pollution and Political Reform in Urban America', p165.

¹⁰² ibid., p166; Schultz & McShane, 'To Engineer the Metropolis', p399.

¹⁰³ Schultz & McShane, 'To Engineer the Metropolis', p401.

reason for lack of membership and the failure of various colonial societies during the nineteenth century.¹⁰⁴ In Australia, as in the United States, membership of such societies and their publications consolidated the engineering profession, unified their approach to sanitary problems and helped to give them a more cosmopolitan outlook and a certain independence from local politics.¹⁰⁵

Nonetheless, claims of political neutrality did not fit the reality of the situation in which engineers were gaining power in public administration and were employees of municipal councils or government bodies subject to political direction.¹⁰⁶ The claim that sewerage decisions should be left to neutral experts was in line with the general engineering strategy noted by Noble that engineers tend to portray themselves as non-partisan in a bid to "insulate them and their activities from political scrutiny".¹⁰⁷

Whilst pneumatic systems of sewerage offered similar opportunities for engineers and required planning and central administration, they were very experimental. Some engineers did, in fact, favour pneumatic systems. The Engineering Society of N.S.W. heard Gustave Fischer's paper in 1884¹⁰⁸ advocating the pneumatic system but government officials were not enthusiastic. The Sydney Sewage and Health Board quoted an English report that said that such a system was too expensive and, although ingenious, so complicated that it is liable to break down and be difficult to repair. They argued that they knew of no English town in which the adoption of a pneumatic system "would be other than a costly toy".¹⁰⁹

The government report in which the new scheme of sewerage was proposed for Sydney that same year was equally dismissive. The author, advising engineer W.Clark, claimed that Liernur's system did not cater for house-drainage and therefore a system of sewers would have to be built anyway and the Liernur system would then obviously be too costly.¹¹⁰ Versions of the pneumatic system were proposed that would deal with house-drainage; one was entered in a competition in Melbourne and proposed a high pressure pneumatic system which used compressed air and a series of tanks to push rather than pull the sewage.¹¹¹ Indeed there are vacuum systems of sewerage operating throughout the world today and a vacuum system of sewerage is being planned for the Kurnell community in Sydney and Kiama on the South Coast of NSW because of the particularly difficult terrain there.¹¹² But these are seen as minor exceptions to the standard water-carriage system.

¹⁰⁴ A.R.Haas, 'Nineteenth Century Engineering Societies', in Institution of Engineers Australia, The Value of Engineering Heritage, National Conference Publication No 85/3.

¹⁰⁵ Schultz & McShane, 'To Engineer the Metropolis', p400.

¹⁰⁶ ibid., p408.

¹⁰⁷ David Noble, The Forces of Production: A Social History of Industrial Automation, Knopf, New York, 1984, p43.

¹⁰⁸ Fischer, 'Water Carriage System of Sewerage'

¹⁰⁹ Sewage and Health Board, Twelfth and Final Report, p9.

¹¹⁰ W.Clark, Report on Drainage of the City of Sydney and Suburbs, p11.

¹¹¹ "Lucifer", Pneumatic High Pressure Sewerage for Cities, Towns and Villages: An Essay on the Sewerage Question, pamphlet, Sydney, 1881.

¹¹² Kiama Independent, 4th December 1985; 'End of Era at Kurnell', Aquarian 29, 18th September 1987, p3.

Whilst many books written by acknowledged sanitary experts in the nineteenth century devoted much space to the debate between dry conservancy methods and water-carriage system, the texts written by engineers and for engineers were notably lacking in attention given to the debate. Such well-used texts as Latham's massive volume on Sanitary Engineering barely mention the alternatives to sewers except to dismiss them in a line or two.¹¹³ An important exception is perhaps Colonel Waring who although a member of various engineering associations was originally trained as an agricultural scientist and probably placed a higher priority on utilisation of manure than most engineers.¹¹⁴

The authorities were also quite dismissive of dry conservancy methods. The Sydney Sewage and Health Board, reporting in the 1870's, felt it was necessary to comment on the dry-earth system of sewage disposal because of all the discussion that had taken place and the strong representations on behalf of that system that were made to them from different quarters but they obviously would have preferred to ignore the idea.

the whole matter has we find been so thoroughly tried, considered, and discussed for several years past in Europe and in India, that it seems to us unnecessary to take any further evidence here. ¹¹⁵

And an 1887 report was even more dismissive

At the best, the so-called dry systems are but inferior substitutes for water-carriage, which, if efficiently constructed throughout, is the cleanest and most convenient of all.¹¹⁶

CONCLUSION - ANALYSIS OF A CONTROVERSY

It would be overly simplistic to say that water-carriage technology caused the increased centralisation and bureaucratisation of waste disposal and that the implementation of water and sewerage systems gave rise to the sanitary engineering profession. The technology was favoured by certain sections of the community for the very reason that it was likely to have these results and it was implemented in such a way that it would. Water-carriage technology is an example of what Langdon Winner describes as "inherently political technologies, man-made systems that appear to require, or to be strongly compatible with, particular kinds of political relationships."¹¹⁷

The fight between advocates of water-carriage technology and supporters of dry conservancy technologies was an uneven one from the start. The government and the engineers who advised them generally favoured water-carriage systems because they could be controlled more easily and necessitated a centralised

¹¹³ Baldwin Latham, Sanitary Engineering: A Guide to the Construction of Works of Sewerage and House Drainage, 2nd edition, E & F.N.Spon, 1878.

¹¹⁴ Geo. E. Waring, Jr, Modern Methods of Sewage Disposal, D.Van Nostrand, New York, 1894.

¹¹⁵ Sewage and Health Board, Third Progress Report, p3.

¹¹⁶ George Stayton, Sewerage and Drainage of the Western Suburbs, Department of Public Works, 1887, p7.

¹¹⁷ Langdon Winner, 'Do Artifacts Have Politics?', Daedalus 109, 1980, pp123.

government bureaucracy staffed by experts. Sewers were automatic and took responsibility away from individual householders and landlords and private carters, whom, it was felt could not be trusted. Dry closets especially, depended on proper management in the home as well as regular collection and responsible disposal. Sewers removed the cause of trouble quickly and quietly from under peoples' noses.

And whilst the government could achieve sanitary reform aims, engineers saw the opportunity to establish themselves as experts in a new field of sanitary engineering and to increase their role in city management. Very few engineers participated in the newspaper debate; since this was a matter for experts, public opinion was not of much significance. Advocates of the alternative schemes, though often professional people, doctors and lawyers usually, were nonetheless outsiders since the liaison between engineers and city councils was forged early when the first sewerage systems had been built in the face of almost no opposition.

Given these hidden agendas, the public debate was quite secondary as far as the final outcome was concerned but was necessary to justify the increased control of local councils in a partial removal of essential public services from the see-saw world of political life and to indicate that such arrangements were ultimately compatible with a pluralist, democratic society. For this reason dry conservancy alternatives were addressed in official reports but reluctantly and quite dismissively.

Opposition to water-carriage technology was basically value based. Opponents' central concerns were to do with pollution and conservation of resources, but these concerns were not really addressed. Debate was often focussed on technical issues of economics and efficacy. These issues could not be resolved because there were no standard criteria or test of what it meant for a system to be "working" or effective. Overseas experts and overseas experiences were often referred to in the debates in Sydney by both sides of the debate. As Fischer and Burke before him observed, everyone seemed to be able to conjure up quantities and statistics, costs and measurements to support their case.

we find the most hopelessly confusing discrepancies in all values and quantities which should be but the data and not the deduction of the various authors.¹¹⁸

Nor could economic arguments be resolved when proposed schemes were hypothetical, price frameworks varied from place to place and when dry conservancy advocates wanted to include such factors as the long term productivity of the soil and city officials were more concerned with the immediate first cost of any scheme. Moreover the situation was swayed to a considerable extent by the contention at the time that a combined system of sewers and drains was adequate and that dry conservancy methods would require a set of drains as well as sewage collection. Also the fact that Sydney had already invested a large amount of capital in water-carriage technology before these debates put the economics clearly in favour of the existing system.

¹¹⁸ Burke, Sewage Utilization, px; Fischer, 'Water-Carriage System of Sewerage', p2.

The current theories of disease causation also aided the water-carriage argument and were responsible for a certain amount of distaste in the popular mind for conservancy methods which forced them to accumulate the evil stuff for collection and put up with carts full of it travelling through the streets. Even after the germ theory of disease causation became established engineers were reluctant to completely dismiss the idea of miasmas because of its usefulness to their arguments. In 1901 an engineering text stated

Fresh sewage if not taken into the stomach is neither injurious to health nor very offensive to smell; but from putrescent excreta and kitchen slops come those noisome gases which, if not themselves bearers of malefic germs, at least lower the vitality and render the body more vulnerable to disease.¹¹⁹

The actual evidence that water-carriage methods were safer was less obvious during the 1870s, partly because of the very serious problems associated with poorly constructed water-carriage systems all over the world. Nonetheless many cities had experienced a drop in mortality levels following the construction of sewer systems. The evidence on the side of dry conservancy systems was even less clear cut and the Liernur system was especially risky in its lack of working models and because of its early stage of development.

The attempts by the Sanitary Reform League to inform public opinion about the options were more than counteracted by the calls of the newspapers for sewerage systems. People were encouraged to perceive water-closets as being clean and sewers as being the mark of progress and civilisation. The question of what to do with the sewage once it had reached its destination and the problem of subsequent pollution at the point of discharge were considered by the authorities and the engineers to be a separate and less important question and were not allowed to confuse the issue of how best to collect and remove the sewage. These problems were dealt with as they arose but the dependence of water-carriage technology on waterways for disposal has left a legacy of water pollution problems and it has been argued that

the reliance on incrementalism and retrofit has obscured the high long-term costs of using waterways for waste disposal and prevented the full consideration of radical alternatives to the water-carriage system that the magnitude of the waste problem deserves.¹²⁰

It is perhaps ironic that, although water-carriage technology won the day and became almost universally considered to be the superior solution to sewage removal, sewerage systems were often slow to be implemented because of their high costs and various dry conservancy methods and individualised household treatment systems (septic tanks etc.) were introduced, and have been maintained in Sydney, even until the present day. Whilst research and development has been aimed at improving sewerage systems, until recently, little work has been done on improving household collection and treatment systems because of their supposed temporary nature. As a result, the problems associated with household

¹¹⁹ A. Prescott Folwell, Sewerage. The Designing, Construction, and Maintenance of Sewerage Systems, John Wiley & Sons, New York, 1901, p3.

¹²⁰ Tarr & McMichael, 'The Evolution of Wastewater Technology and the Development of State Regulation', p185.

systems still remain and their reputation is somewhat akin to the reputation of the cesspit system in the nineteenth century.

The next two chapters will consider the subsequent problems of treatment and disposal that followed from the newly instituted water-carriage systems.