UTILITIES
for *Historical Statistics of the United States Millennial Edition*

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Table and figure references in angle brackets (< >) refer to data tables that will appear in a number of different chapters in *Historical Statistics of the United States, Millennial Edition*. The format was devised, in collaboration with Cambridge University Press, to meet specialized, technical needs and to facilitate the transmission of over 100,000 files from the Historical Statistics editorial office in the Center of Social and Economic Policy at UC Riverside to Cambridge University Press. The format was not optimized for the general user. A full list of data series is shown in the appendix.

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Utilities take their name from the usefulness of the services they provide. These include tap water, sanitation, electricity, gas, telephone, and transportation. Today, "utilities" are virtually synonymous with "public utilities." As the latter name suggests, utilities are often owned by government and, when they are in private hands, they are most often regulated by government.

In the United States, the appearance of utilities was spurred by the development of urban places, although the forces that produce utilities are similar wherever network infrastructure is significant. In rural areas, individuals supplied their own utilities. In cities such individual procurement was ineffective and counterproductive. One person's water supply was another's latrine; one person's yard was another's garbage dump. Foraging chickens, pigs, and goats meant animal waste and dead animal carcasses on streets and vacant lots. Individuals were poorly situated to address these problems. One reason is what economists refer to as the "public goods" aspect of such situations. Clean water at my neighborhood watering hole benefits not only me, but everyone else. The incentive for me to clean up is less than the value of such cleanup to the community as a whole. In an environment where individuals are responsible for their own cleanup, such services are under-provided.

Technological considerations were another reason for the appearance of public utilities. Water provision, waste disposal, and electricity, gas, telephone, and transportation services involve an extensive network of pipes, wires, and distribution, collection, or disposal routes. Utilities are extremely expensive if they are not networked in this fashion. At the same time, a second competitive network would be redundant. In economic terms, this characteristic makes utilities "natural monopolies." As such, a single company can offer services at lower cost than two competitors. Market pressures push for the elimination of all but one provider. Once a single firm is the sole provider in a market, however, that firm has an incentive to charge customers high rates. Since the service is necessary and there is no competition, consumers have little choice except to pay.

Because of their tendency toward natural monopoly, public utilities have historically been owned by governments, and these governments have traditionally held prices close to costs, including what would be a fair or normal return on the capital invested. When held privately, utilities have been heavily regulated in order to control prices, including a fair rate of return. Whether publicly or privately held, utilities traditionally have been charged with an obligation to provide services to all citizens, even those for whom service might come at high cost. An example is the rural electrification program begun in 1935 that built over a third of a mile of electrical line for each customer serviced, considerably more line per customer than in densely-packed urban areas (see series <TW.K.1.4> and <TW.K.1.5>). By the 1950s, over 95 percent of rural residents had access to electricity (series <GW.E.9.6>). Troesken (2001) develops evidence that public water companies provided black communities with better service than did private water companies.

The ownership and regulation of utilities are often matters of intense public debate. Conditions that seem to justify regulation during one phase of history may change because of new technologies and new industries offering substitutes. The development of government ownership and regulation of utilities is the subject of a large literature. See, for example Demsetz (1968), North (1990), Troesken (1996 and 1997) and Williamson (1985). For an analysis of the recent *deregulation* of utilities see Hirsh (1999).

An important characteristic of utilities is their "networked" character. Utilities themselves are "networks," that is, complex, large-scale systems that cross and interconnect in ways that require coordination and management. In addition, utilities form part of even larger networked systems that include housing, industry, technology, civic organization, labor, and more. The interconnectedness of utilities with other institutions, combined with their physical durability, give *history* a role in the impact of utilities on any particular region's economic and social development. The contrasting suburban developments surrounding Boston verses Los Angeles is one example. Boston's high-density suburbs reflect the impact of the trolleys that dominated intra-urban transit at the time of its growth in the late-nineteenth century; Los Angeles's post-World War I growth with its suburban sprawl reflects the impact of the automobile.

Another example developed by Norris Hundley, Jr. concerns the consequences of water rights laws in affecting the differential growth of Los Angeles and San Francisco. It is surprising today that these two cities' size and structure are so different. In many ways, their growth and development followed similar routes. Initially, both cities relied on local water resources. As they grew, their semi-arid environments meant that they had to develop more distant water-supply sources. San Francisco ultimately found water by damning the Toulumne River in the Hetch Hetchy Valley, 170 miles to the east of the City, and Los Angeles did so by diverting the Owens River, 235 miles to the north and on the eastern side of the Sierras. At the same time, certain differences in the legal environments in which they operated produced important differences in city size and organization. By the time San Francisco city officials appreciated the need for distant water resources, a private company, Spring Valley Water Works, had already gained control over the local water supply. Much of the drama of that city's growth during the late-nineteenth and early-twentieth centuries involved the process of establishing public control over this private company. By contrast, Los Angeles, which developed much later, possessed control of its local water resources from the beginning. Growth of the city took place in a legal environment that permitted sale of local water to city residents only. The superiority of the Los Angeles River flow in Southern California combined with the legal restriction on sale to city-residents prompted a large number of neighboring communities to apply for absorption into the rapidly-sprawling metropolis. Today, when much of Los Angeles's water comes from distant sources not covered by the initial agreement, the city still governs a large geographic area. For a comparative history of San Francisco and Los Angeles water procurement see Hundley (1992, Ch. 4, pp. 121-202).

The essay in **Chapter Cf** discusses the development of electricity and its impact on the layout of manufacturing plants, machine design, and the organization of work. Similar stories could be told about the impact of municipal water provision. For overviews see Baker (1899), Armstrong (1976), Tarr (1996), Jacobson (2000), and Melosi (2000). For region- and city-specific histories, see Cain (1978) on Chicago; Hundley (1992) on California; Taylor (1926) on San Francisco; Ostrom (1953), Kahrl (1982, 1993), and Mulholland (2000) on Los Angeles; and Weidner (1974) on New York.

Information on utilities may be found in several chapters of *Historical Statistics*. Electricity and gas are discussed in **Chapter Cf**; railroads, public transportation, and roads in the **Chapter Df**; and the telephone and telegraph in the **Chapter Dg**. The purpose of this essay is to bring together these disparate elements, to discuss data on utilities as a whole, and to comment on those utilities not treated elsewhere.

Water works

Waterworks emerged as the first utility, their growth and development following that of urban places. It is easy to understand why this was the case. The rural practice of procuring water directly from local wells and streams worked poorly in cities. In sparsely-populated rural environments, natural ground water collectors would carry over water from wet years into dry so as to permit a continuous flow. In densely-populated urban regions, growing populations quickly drained groundwater reserves from wet years, creating crises during dry seasons. In an effort to combat the problem, cities developed public waterworks that dammed rivers, tapped distant resources, and recycled nominally undrinkable water for public water supplies. As early as

1652, the basic structure of Boston's public water-works was already in place. By 1800, fully 16 American cities, or half of all urban places, boasted water-works plants (table <TW.M.3>).

As the urban population expanded in the eighteenth and early-nineteenth centuries, many of these city water systems became contaminated with human, animal, and industrial waste. Water contamination and accumulations of refuse bred disease. Periodic urban epidemics killed rich and poor and young and old alike. In the late-eighteenth and nineteenth centuries, massive cholera and yellow fever epidemics hit major U.S. cities. In 1793, over 5,000 died in a yellow fever epidemic in Philadelphia. In 1832, cholera took the lives of over 3,000 people in New York and over 4,000 in New Orleans. In 1853 and again in 1867, yellow fever killed over 7,000 and 3,000 persons respectively in New Orleans (Rosenberg, 1962). As medical theories of disease contagion gained acceptance over the nineteenth century, people came to appreciate the environment as a source of disease and city governments began to take on responsibility for water purity. The surge in city waterworks beginning in 1870 is shown in table <TW.M.2>.

Early waterworks were most often financed and controlled by private investors. In 1800 among the 16 waterworks nationwide, all but one was privately owned (Baker 1899, pp. 13-14). Over the course of the nineteenth century the number of waterworks increased and, at the same time, their ownership shifted from private to public hands (series <TW.M.2.4>). This transfer of water-works from private to public ownership was evident in all communities, but was especially pronounced in the larger cities. Larger cities developed mechanisms for raising money, especially the right to tax their citizens and to issue bonds. Private utility ownership resulted in high prices and management improprieties (Baker 1899, pp. 31-50). As a consequence, over the course of the nineteenth century, older cities with privately-held water-works purchased them on behalf of the public. New cities were increasingly likely to begin their operation with public services. Case studies of the transfer of water-works from private to public ownership make for lively reading. See for example, Hundley (1992).

Data on public expenditures on waterworks becomes available for the first time in 1900 and are displayed in figure <uitlities.FIG.06>. They indicate substantial growth of real per capita governmental expenditures over the twentieth century. One reason for the growth is that an increasing share of the population was served by these public utilities. Another is that individuals and firms -- both industrial and agricultural -- used more water once it was conveniently supplied by tap. For data on per capita water usage over time see table <GW.A.14>. Third, the shift of population out of the moist east and into the arid west meant higher costs for water delivery.

<utilities.FIG.01> here

Dams, reservoirs, and aqueducts

In 1790 American cities relied almost exclusively on local sources for their water supply. Rapid city growth during the first part of the nineteenth century forced cities to look beyond their boundaries to expand their total supply and to insure additional supplies during dry years. Cities began building dams, creating reservoirs, building aqueducts, and laying pipes to collect and store distant water and make it available to their denizens. Many of the early projects appear to have been initiated after a public emergency such as an epidemic or a fire. Statistical information on the timing and cost of these water-storage and delivery projects are available in the municipal records of individual cities. As far as I am aware, no one has aggregated this information on dams and aqueducts into an overview for the nation as a whole.

Prominent early projects include Boston's aqueduct from nearby Jamaica Pond completed in 1796; Philadelphia's 1801 use of steam engines to shift the city's water supply from the contaminated Delaware River to the sanitary Schuylkill River; New York's 40-mile long Croton Aqueduct, completed in 1842; and Boston's 20-mile long Cochituate Aquaduct completed in 1848 (Blake 1956). Chicago gained world-wide attention in 1871 when it first attempted to reverse the flow of the Chicago River as a way of keeping contaminants out of Lake Michigan. The project finally succeeded in 1900 (Cain 1978).

Settlement of the arid West led to even more ambitious water projects. The small quantity and the strong seasonality of rain in the West required large storage reservoirs capable of capturing winter rains and spring floods for release in the late summer and early fall. More than 600 such projects were launched after the establishment in 1902 of the U.S. Bureau of Reclamation, whose mandate was to "reclaim" Western lands through irrigated agriculture and the provision of family homesteads. Operating in 17 western states, the Bureau of Reclamation quickly became a world leader in dam engineering and construction. Its two most famous projects are the Hoover Dam on the Colorado River, completed in 1936, and the Grand Coulee Dam on the Columbia River, completed in 1942. A hundred years after its founding, the Bureau of Reclamation is the nation's largest water wholesaler and its second-largest producer of hydroelectric energy (Bureau of Reclamation Internet site, Pfaff 2000, and Robinson 1979; also see table <TW.M.9>).

Some cities received their drinking water from the Bureau of Reclamation's water system, but others, most notably San Francisco and Los Angeles, built their own. The merits of these projects remain controversial even to this day. See for example Hundley (1992), Taylor

(1926), Ostrom (1953), Kahrl (1982 and 1993), and Mulholland (2000). For a listing of California's major dams and reservoirs, see the Division of Safety of Dams Statistical File, available from the Internet site of the California Department of Water Resources.

The Tennessee Valley Authority (TVA) and the Bonneville Power Administration are two major water projects that were constructed and run independently of the Bureau of Reclamation. These extensive public projects were built primarily to generate hydroelectric power and for flood control rather than for water supply. Both were part of the New Deal legislation of the 1930s. The TVA was launched in 1933 over the entire Tennessee River basin. It came to encompass 31 separate dams (see table <TW.M.9>). The Bonneville system on the Columbia River between Washington and Oregon was built between 1933 and 1943. Both systems are major sources of hydroelectric power generation.

Sewers

Today sewers and water mains are coordinated systems, but in the nineteenth century most cities -- including those with highly-developed water systems -- relied on privy vaults and cesspools for sewage disposal. The differential in expenditures for the two systems is shown in <TW.F.1>.> Sewers were late to develop because at least initially privy vaults and cesspools were acceptable methods of liquid waste disposal and they were considerably less expensive to build and operate than sewers.

Sewers began to replace privy vaults and cesspools as running water became more common and its use grew. The convenience and low price of running water led to a great increase in per capita usage. The consequent increase in the volume of waste water overwhelmed and undermined the efficacy of cesspools and privy vaults. According to Melosi, "the great volume of water used in homes, businesses, and industrial plants flooded cesspools and privy vaults, inundated yards and lots, and posed not just a nuisance but a major health hazard" (2000, p. 91).

Tarr (1996, p. 183) also notes the impact of the increasing popularity of water closets over the later part of the nineteenth century. Water closets further increased the consumption of water, thus contributing to the discharge of contaminated fluids.

Once the decision to build sewers and integrate them with the water mains was made, cities had to grapple with enormous technical, management, finance, and political issues before the systems were successful. Goldman's (1997) detailed study of the building of New York City's sewers illustrates the nature of these problems. Tables <KS.B.8> and <KS.B.13> provide information on water and sewer line construction. Governmental expenditures on sewage are shown in table <JW.A.6>.

Solid Waste

Solid waste disposal is a relatively recent problem. In earlier times, people did not own many objects, and those they did own were pressed into service in a variety of different ways. Thus a broken bottle, excavated from a colonial-era Virginia plantation, was found to have been transformed into a "bowl" and a "funnel" (Strausser 1999, p. 21). Objects discarded by one family were often collected by others. "Swill children" went house-to-house in nineteenth-century cities collecting kitchen refuse to sell for fertilizer and hog feed. Well into the twentieth century itinerant rag-pickers and paper-collectors went house-to-house offering money or housewares in exchange for discards. Susan Strausser (1999) provides a detailed account of the transformation of an early culture that valued the "stewardship of objects" into our modern world in which the plethora of discards has made trash disposal a serious social problem.

The first solid waste disposal problem to attract the attention of policy makers was a consequence of an increase in the use of urban horses over the nineteenth century. Manure was one problem.

> Sanitary experts in the early part of the twentieth century agreed that the normal city horse produced between fifteen and thirty pounds of manure a day, with the average being about twenty-two pounds. In a city like Milwaukee in 1907, for instance, with a human population of 350,000 and a horse population of 12,500, this meant 133 tons of manure a day, or an average of nearly three-quarters of a pound of manure per person per day. Or, as the health officials in Rochester calculated in 1900, the 15,000 horses in that city produced enough manure in a year to make a pile covering an acre of ground 175 feet high and breeding sixteen billion flies (Tarr 1996: 323-324).

The carcasses of dead horses were another:

> A description of Broadway appearing in the *Atlantic Monthly* in 1866 spoke of the street as being clogged with 'dead horses and vehicular entanglements." In 1880 New York City removed 15,000 dead horses from its streets; and as late as 1912, Chicago carted away nearly 10,000 horse carcasses. (A contemporary book on the collection of municipal refuse advised that, since the average weight of dead horses was 1,300 pounds, "trucks of the removal of dead horses should be hung low, to avoid an excessive lift." (Tarr 1996: 327)

Ironically, social critics of the time looked to the development of the "horseless carriage," or the automobile, as a solution to cities' sanitary problems.

By this time, scientists had already made the connection between cleanliness and health, publicly managed water and sewer systems were the norm, and Progressive social reform movements had identified cleanliness with civic pride and good government. Thus recognition of the trash problem rather quickly led to the appearance of public solid waste disposal systems. See Melosi (2000, Ch. 13 and 20).

The rise of per capita real income and the development of a "consumer society" over the twentieth century intensified the garbage problem. Rags, paper, and other such items that commanded a market in the nineteenth century were transformed into garbage during the twentieth. An increasing fraction of purchases, especially food products, were dispensed in packaging formats that were disposable. Strasser (1999) offers a detailed and highly readable account of the process as a whole and of individual products that were emblematic of the transformation. Statistics on per capita solid waste generation indicate that the average American was generating 2.68 pounds of solid waste per day in 1960, and that this statistic rose by two-thirds over the next thirty years.

Alarmed by these developments, counter-culture groups began to practice waste restriction and recycling in the 1960s. Over time these efforts gained supporters and led to an overall reduction in solid waste production per capita and to a rapidly rising share of solid waste that is composted and recycled. Beginning in 1960, the U.S. Environmental Protection Agency reported statistics on solid waste disposal by type. These statistics are provided in tables <GW.G.6> and <TW.F.2> and are shown in figure <utilities.FIG.02>.

<utilities.FIG.02> here

References

Armstrong, Ellis L., ed. *History of public works in the United States, 1776-1976*. American Public Works Association: The Association, 1976.

Baker, M. N. "Water-Works." In Edward W. Bemis, ed. *Municipal Monopolies*. New York: Thomas Y. Crowell, & company, 1899, pp. 3-52.

Blake, Nelson Manfred. *Water for the cities; a history of the urban water supply problem in the United States.* Syracuse, N.Y.: Syracuse University Press, 1956.

Cain, Louis P. *Sanitation strategy for a lakefront metropolis : the case of Chicago.* DeKalb : Northern Illinois University Press, 1978.

Demsetz, Harold. "Why Regulate Utilities?" *Journal of Law and Economics* 11 (1968): 55-65.

Goldman, Joanne Abel. *Building New York's sewers : developing mechanisms of urban management.* West Lafayette, Ind. : Purdue University Press, 1997.

Hirsh, Richard F. *Power loss: the origins of deregulation and restructuring in the American electric utility system.* Cambridge, Mass.: MIT Press, 1999.

Hundley, Norris. *The great thirst : Californians and water, 1770s-1990s.* Berkeley : University of California Press, 1992.

Jacobson, Charles David. *Ties that bind : economic and political dilemmas of urban utility networks, 1800-1990.* Pittsburgh : University of Pittsburgh Press, 2000.

Kahrl, William L., "Aquisitions and aqueducts : how California's water system evolved." *Pacific discovery*. Vol. 46, no. 1 (Winter 1993) p. 21-25.

Kahrl, William L. *Water and power : the conflict over Los Angeles' water supply in the Owens Valley*. Berkeley : University of California Press, 1982.

Melosi, Martin V. *The sanitary city : urban infrastructure in America from colonial times to the present.* Baltimore : Johns Hopkins University Press, 2000.

Mulholland, Catherine. *William Mulholland and the rise of Los Angeles.* Berkeley: University of California Press, 2000.

North, Douglass. *Institutions, Institutional Change, and Economic Performance*. New York: Cambridge University Press, 1990.

Ostrom, Vincent. *Water & Politics: A Study of Water Policies and Administration in the Development of Los Angeles.* Los Angeles: The Haynes Foundation, 1953.

Pfaff, Christine. *The Bureau of Reclamation and the Civilian Conservation Corps, 1933-1942*. Denver: Dept. of the Interior, Bureau of Reclamation, 2000.

Robinson, Michael C. *Water for the West : the Bureau of Reclamation, 1902-1977*. Chicago: Public Works Historical Society, 1979.

Rosenberg, Charles E. *The cholera years*. Chicago: University of Chicago Press, 1962.

Strasser, Susan. *Waste and want : a social history of trash*. 1st ed. New York : Metropolitan Books, 1999.

Tarr, Joel A. *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective*. Akron: University of Akron Press, 1996.

Taylor, Ray W. *Hetch Hetchy; the story of San Francisco's struggle to provide a water supply for her future needs.* San Francisco: R.J. Orozco, 1926.

Troesken, Werner. *Why regulate utilities? : the new institutional economics and the Chicago gas industry, 1849-1924.* Ann Arbor : University of Michigan Press, 1996.

Troesken, Werner. "The Sources of Public Ownership: Historical Evidence from the Gas Industry." *Journal of Law, Economics, and Organization* 13 (1) (1997): 1-27.

Troesken, Werner. "Race, Disease, and the Provision of Water in American Cities, 1889-1921." *Journal of Economic History 6*1 (3) (2001): 750-776.

Waterman, Earle Lytton. *Elements of water supply engineering*. New York, J. Wiley & Sons, 1938.

Weidner, Charles H. *Water for a city; a history of New York City's problem from the beginning to the Delaware River system.* New Brunswick, N.J., Rutgers University Press, 1974.

Williamson, Oliver. *The Economic Institutions of Capitalism*. New York: Free Press, 1985.

Utilities Table List

<TW.J.1> Indexes of output and productivity in electric and gas utilities: 1899-1942 {Carter}
<TW.J.2> Gross domestic product originating in the electric, gas, and sanitary services industries: 1947-2000 {Carter}
<TW.J.3> Index of industrial production -- all utilities: 1939-2001 {Carter}
<TW.G.3> Employees of utility firms, by industry division: 1947-1999 {Carter}
<TW.M.2> City waterworks, by type of ownership: 1800-1924 {Carter}
<TW.M.3> Waterworks at the close of 1800 -- year built and year changed to public ownership: 1652-1891 {Carter}
<TW.M.4> Los Angeles water supply and consumption, by source and use: 1920-1950 {Carter}
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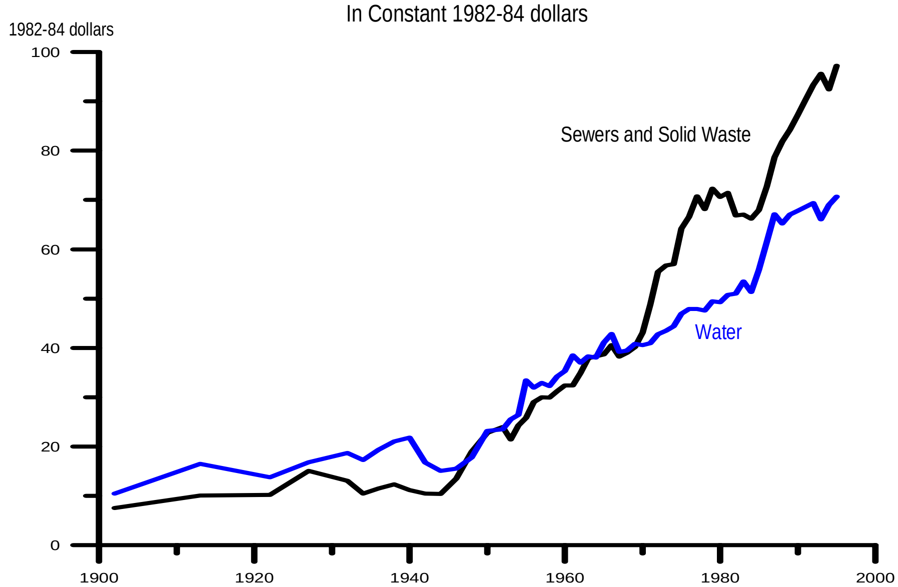
<TW.M.9> Dams and hydroelectric power plants owned by the Federal government and the Tennessee Valley Authority -- number and capacity: 1904-1999 {Carter Chambers}
<TW.K.1> Rural Electrification Administration and Rural Utilities Service -- electric program, summary of operations: 1935-2000 {Chambers}
<TW.F.1> Average operating and capital costs for sanitation works in selected cities: 1899-1929 {Weiss Cain}
<TW.F.2> Solid waste generation and disposal per capita: 1960-1996 {Weiss Cain}

<Utilities.fig.1>

Per Capita Government Expenditure on Water and Sanitation

In Constant 1982-84 dollars

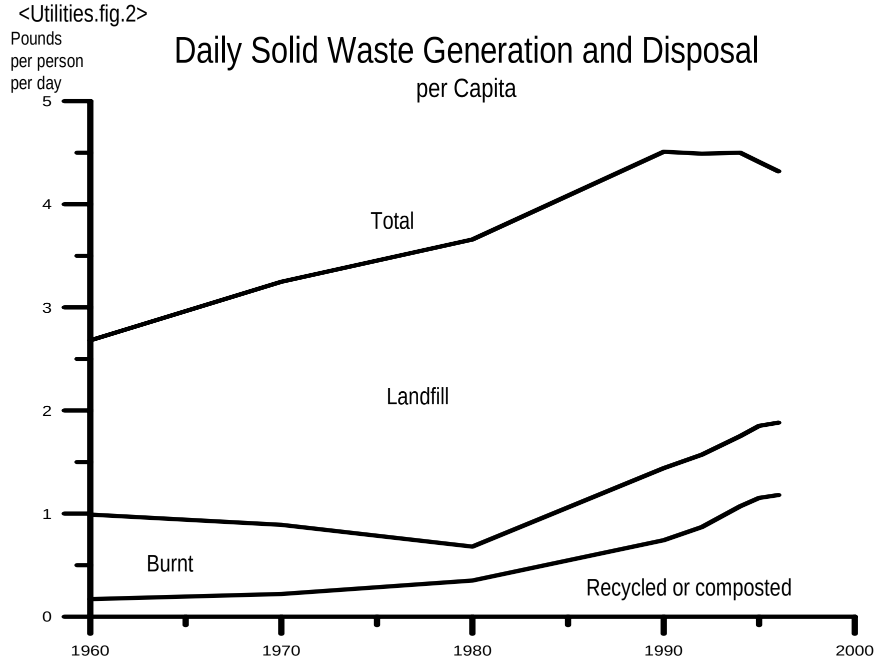


Sources: jw.a.14.38, jw.a.14.52, mrh.a.2.1, and phl.b.2.1.

<Utilities.fig.2>

Daily Solid Waste Generation and Disposal

per Capita



Source: <tw.f.2>.