

Water Qualities and Usage in the Zanjias of Los Angeles, 1781–1904

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From the colonial era until the beginning of the twentieth century, most water used in Los Angeles was distributed through channels called *zanjas*, conduits supplying water for irrigation, power, and household use. Anglo-Americans sought an alternative to this network, and protomodern water mains began domestic deliveries in 1864. Mains did not at first displace *zanjas*; the two systems evolved together, competing to provide water for the conflicting usages of the era—household use, industrial use, and sewage removal. Angelenos managed the conflicts between usages and supply systems with a complex sociotechnical system of distributed agency and distributed competency: they filed nuisance suits, drafted regulation, and made public and private modifications to the infrastructure, tailoring the network for their particular needs. When the mains supplanted the *zanjas*, the Los Angeles water supply system lost a significant share of its flexibility and Angelenos much of their control over water.

Zanjias—the Spanish word for “ditches”—distributed water for domestic as well as agricultural use in the Spanish colonial pueblo of Los Angeles from its foundation in 1781, through Mexican independence and then after 1848 under US administration (fig. 1). It wasn’t until 1864, when the population of the town was five thousand, that the first customers received domestic water through pressurized water mains.¹ The

Electronically Published on May 26, 2022.

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Figure 1. Zanja 8-R along Figueroa Street, ca. 1890. Credit: C. C. Pierce Collection, Huntington Library, San Marino, CA.

descendant of this “protosystem,” to use Martin Melosi’s term, eventually replaced the *zanjas*, but historians who jump ahead to that development miss the complexity of water history in Los Angeles. The *zanja* network grew in mileage and capacity between 1864 and the mid-1880s and then operated for another twenty years until 1904, when the population reached nearly 200,000. During that time, Angelenos used and expanded the *zanjas* within the service area of the mains, as well as beyond them. *Zanjas* served new territory and new kinds of users, while continuing to provide domestic water to many households.² Then William Mulholland, in charge of both networks, shut down the *zanjas* in June 1904 for reasons of quantity—not quality—to shift all the water into the mains.³ When the city government shut the *zanjas* down, much of the flexibility of the older system disappeared as well.

The water history of Los Angeles has been studied as extensively as any city in the United States. This historiography emphasizes the giant environmental manipulations that enabled Los Angeles’s metropolitan growth, from the 1913 Los Angeles Aqueduct that diverted the Owens River to the 1941 Colorado River Aqueduct and beyond.⁴ Like much of western US water history, it focuses on big infrastructure at

the municipal and federal level and on the twentieth century. Nineteenth-century events usually serve as preamble, told primarily as a long campaign for the city's legal dominion over the Los Angeles River, the 1868 privatization of the water mains protosystem, and its remunicipalization in 1902 in time to build the aqueduct.⁵ These are essential stories, for Los Angeles and for the environmental shaping of the US West. What they have in common is a supply-side perspective, an emphasis on the sources and distribution of water from the perspective of those who would control it to fashion a hydraulic society, in the term that Donald Worster adapted from Karl Wittfogel.⁶ This is a modern perspective of commoditized water, in which the demand side is mainly quantitative: how much, where, and to whom. But before big infrastructure there was little infrastructure. This article examines water infrastructure before the mains gained predominance and water usage in Los Angeles before the advent of modern commoditized water. Analyzing water usage requires a demand-side perspective, with attention to water quality as well as quantity, considering the diverse uses of water and the agency of diverse users, whose choices drove evolution of both systems.⁷ This is a history of technology-in-use.⁸

Water histories mostly treat premodern systems as agricultural and traditional; Worster's term is "local subsistence."⁹ But Los Angeles's zanjas were urban, in a city emphatically oriented toward the larger market economy, especially toward its own urban growth. These circumstances were not unique; ditches and canals flowed through Denver, Phoenix, Salt Lake City, and every other aspiring metropolis of the arid West. Historians have noted these networks but seldom have explored their centrality to urban development, and as with Los Angeles the perfunctory attention paid them usually lapses once modern water mains appear.¹⁰ Only the rare historian, such as David Torres-Rouff, questions the techno-positive account that zanja water was bad and mains water good. This is characteristic of histories of technology, which foreground episodes of innovation rather than the long coevolution of new systems with legacy networks.¹¹ Modern, commoditized water did not appear suddenly in Los Angeles in 1864 or in 1904 but emerged from the four intervening decades of coevolving water systems.

Los Angeles newcomers arrived mainly from places without irrigation cultures, where surface channels often were made or appropriated for waste flows. Zanjas did not look like the urban water supplies of

their previous homes, and by 1853 Anglos began proposing mains. Retrospective accounts attribute the motive to water quality and health, citing for example Harris Newmark's twentieth-century recollections of smallpox sufferers bathing in *zanjas* in 1863. But Los Angeles saw no particular prevalence of waterborne diseases, and Newmark himself attributed the system's inception to "the inconvenience and expense of obtaining water for the home."¹² During the four decades when parallel systems coexisted, water quality in the *zanjas* no doubt worsened in general as the city grew and more sources of pollution found their way into the open ditches. But "in general" was not how people experienced water. The city reduced these pollution sources by disposing of wastes systematically, enclosing *zanjas* through dense districts, and bringing water from more remote parts of the river through new supply canals. The actions of water users suggest that water quality improved at least in some places and some times. At any rate, it is difficult to prove with existing historical sources that *zanja* water was dirtier than mains water.

One indisputable difference between *zanja* water and mains water, however, was the greater levels of agency granted to users of *zanjas*. Perceptions mattered for a resource whose use was subject to individual agency. The range of agency here was broad—not only the freedom to choose from *zanjas*, mains, wells, and vendors but also the freedom to choose how to use the water from each source, for a variety of purposes. Water could be filtered or stored to settle impurities; it could be recycled through multiple uses as gray water. Angelenos perceived waters, plural, a rough taxonomy that guided action (including substitution, as in choosing beverages, or in suppressing street dust with oil rather than water). Waters required choices, and they offered choices. When the *zanja* network existed, urban users could make decisions that managed water quality and helped drive the coevolution of multiple systems of water infrastructure.

The dynamic urban setting that produced new categories of users also produced new categories of pollution, and *zanjas* provided possibilities for responding to it. Public actions dominate most historical accounts but reflect few coherent policies as to water quality, as we will see below.¹³ Water users' role is harder to document and thus receives less attention, but it was essential, often anticipating or driving the actions of suppliers. This article will describe four sets of water quality conflicts—first, traditional pre-urban ones, then oil pollution,

manufactured gas wastes, and sewage—demonstrating that zanjias increased the agency of water users and discussing how they employed this agency.

Traditional Uses, Traditional Conflicts

The original eighteenth-century zanjias were rebuilt after an 1815 flood; the network grew gradually from the 1830s and then faster in the 1850s and 1860s. Under Mexican and US governance, labor came mainly from prisoners, most of them Indians. The network as a whole was always administered by the municipality, although some parts were privately controlled. By 1870, eight numbered zanjias spread in a fan shape through the flatter parts of town, with additional branches between them (fig. 2). The Canal and Reservoir Ditch, a new private canal, took water from higher upstream, winding among the hills to a storage reservoir (now Echo Park Lake), and powering a mill. In the late 1870s the city reengineered its main canals, on the west side acquiring and enlarging the Canal and Reservoir Ditch as a high-service trunk capable of gravity feeding additional territories, and on the east side of the river creating a new high-service supply.

In the mid-1880s, Los Angeles experienced its first great boom, doubling in population from 1885 to 1888 as the new Santa Fe railroad set off a fare war from the East, launching Southern California's rise as a region independent from the Bay Area. Many of the city's vineyards, orchards, crops, and gardens were staked into house lots. Agriculture, increasingly consisting of market gardens aimed at feeding the growing city, moved a couple of miles south, out of town. The zanja network stretched farther to water this periphery while diverted underground through the city center. This is the system that continued in operation for another fifteen years, with a few abandonments and a gradual diminution, but by no means disappearance, of irrigators.¹⁴

Irrigation canals have served multiple uses, in settlements and in fields, for millennia, and multiple uses brought inherent conflicts, in continual need of mediation.¹⁵ The day-to-day mediator in Los Angeles was the Zanjero, a public official in the Spanish and Mexican pueblo, whose service continued in the US municipality under the same name.¹⁶ The Zanjero had to balance a wide array of different interests. Most zanja water was used for irrigation, first for farming and later for urban landscapes such as parks. The nineteenth-century urban fabric featured

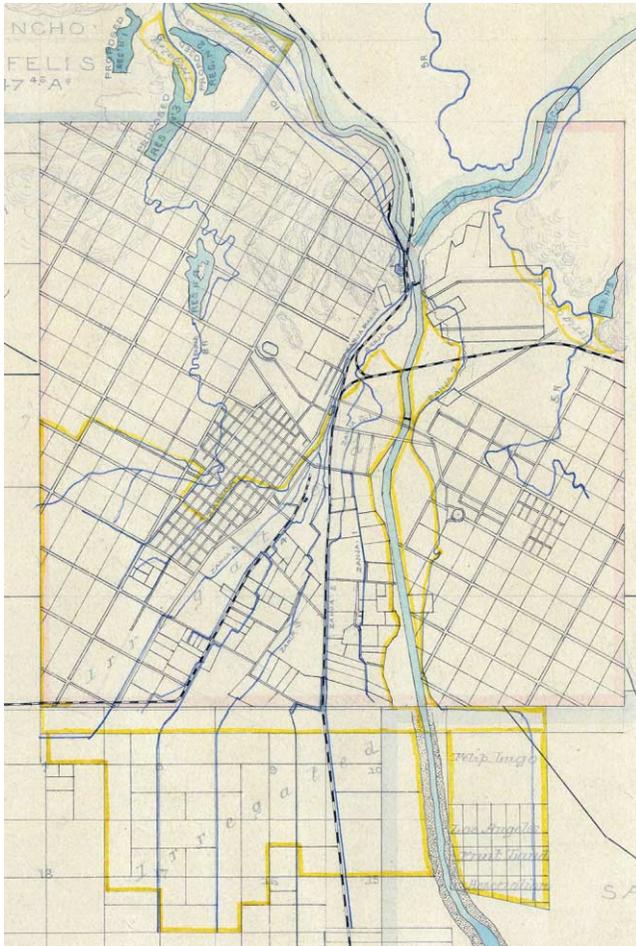


Figure 2. Los Angeles irrigation survey 1880 (detail), state engineer's office. Reservoir No. 4 is the site of today's Echo Park Lake, proposed Reservoir No. 3 the site of Silver Lake. Credit: William Hammond Hall Papers, California State Archives.

diverse agricultural forms, including household gardens, vineyards, and orchards. Livestock in the ditches were considered a problem, mainly for mechanical damage to the channel but also for water quality.¹⁷ Animal waste was a normal part of the environment but when concentrated (as in corrals, stables, or manure piles) was treated as a contaminant to be managed and kept from the *zanjas*.¹⁸ But in addition to irrigation, people took water from the *zanjas* for many uses. Users followed an implicitly riparian ethic: water should be passed down the *zanja* undiminished in quantity or in quality.¹⁹

The Zanjero also had to consider one of the oldest traditional uses, laundry. Laundering clothes properly involved directing gray water from laundry to the fields, a process that was often omitted. In 1852, the city council member Ygnacio Coronel authored an ordinance codifying these expectations: “The plank or wash-board must be placed outside of the edge of the ditch, so that, although water may be taken therefrom, care must be had that none of the dirty water coming from the clothes which are being washed can in any manner whatsoever contaminate the drinking water.”²⁰ The best solution would involve building a *lavanderia*, a structure to contain the washing and control its waste flow. The city council in 1853 contemplated one, but there is no report of any *lavanderia* in early Los Angeles.²¹

Washing also meant washing people. The city prohibited bathing or swimming in the zanjas, thus mandating the purchase of a tub and the effort to carry water to it. This ordinance was widely ignored and selectively enforced. A bathhouse built in the 1850s used zanja water, but another one proposed in 1886 was turned down to protect water quality in the zanjas. Washing even meant zanja-supplied facilities for bathing horses and cleaning carriages, ancestors of the ubiquitous Los Angeles car wash.²²

As David Torres-Rouff observes in *Before L.A.*, these traditional frictions came to be expressed as conflicts over modernity and ethnicity, with water mains signaling the Anglo future. But this binary coding glossed over actual experience. The same complaints made against zanjas were made also against the mains water: its source a “resort of wash-women” and “stamping ground of cattle”; its reservoir a swimming hole, where geese were “surrounding it with a plateau of guano.”²³

Zanjas were not made for drainage but from their beginnings they received runoff. Good ditch design then as now sought to avoid wash-outs and sediment (the city built traps to remove sand from zanjas). But drainage was not entirely unwelcome. In arid areas rainwater and seepage were good; more water was better. And in the multifunctional spirit of the zanjas, water supply and water disposal did not seem incompatible. If there was too much water in one place, well, here was a handy channel for moving it. So as the city’s landscape grew increasingly impervious, the drainage role of zanjas became explicit, in an ad hoc fashion. In 1869, for example, the city council instructed that one street be graded “in a proper manner, so as to drain itself into said Zanja No. 5.” Engineer Frank Lecouvreur, who prepared the city’s first

comprehensive drainage plan in 1870, thought storm drains impracticable for Los Angeles's infrequent but powerful storms, instead recommending "street gutters of a somewhat unusually large size, . . . amply sufficient to take charge of all such extraordinary currents, until the nearest irrigation ditch receives and finally disposes of them."²⁴

Urbanization intensified drainage from both rainwater and human water uses. Covering *zanjas* mainly served purposes of urban land use convenience, or conserving water quantity, but water quality—preventing drainage that introduced impurities—did occasionally figure in the arguments. Piping for whatever reason eliminated inadvertent drainage, leaving only intentional drains (not all authorized). Intentional drainage conduits were sometimes called "sewers" but in a pre-modern meaning of the word unfamiliar to our ears today. "A 'sewer' in this early period," writes Martin Melosi, "was intended to carry off stormwater or to drain stagnant pools rather than to handle wastewater."²⁵ For example, with chronic standing water near the new railroad station, the city council in 1869 authorized "a sewer, that will always keep the streets . . . free of water." Some of this excess water likely came from *zanjas*, as irrigation or leakage, before being returned to them. Twenty years later, the beginnings of a separate stormwater system used two of the *zanjas* as its main conduits for street drainage.²⁶ Urbanization brought new, or newly concentrated additions to all kinds of drainage water. How water users understood and responded to these new flows shaped the *zanjas*' water quality in their final decades and the evolution of both *zanjas* and mains.

Oil Pollution

Petroleum in *zanja* water was not a traditional problem, but by the last quarter of the nineteenth century it had emerged as an urban challenge. In 1870, the city council sent the marshal to prevent "tar or *brea*" from draining into a *zanja* from an industrial site.²⁷ Oil drilling in the Los Angeles basin began in subsequent decades. Its first great productive field, and its first high-profile environmentalist opposition, came after Edward Doheny drilled successfully within city limits in 1892.²⁸ The Los Angeles City Oil field developed quickly just uphill of the city center. Oil leaked and found its way into the *zanjas*. *Zanja* users protested loudly.

One homeowner complained that on her *zanja*-irrigated half-acre yard, "the water has been so foully impregnated with petroleum that

the lawn is no longer an attraction to herself or to visitors. . . . The petroleum was so thick on the last irrigation . . . that it was taken off the next day by shovels full, thick and heavy like mud.” Irrigators farther down the ditch described “very offensive matter from the oil region” that was “very injurious to our crops of hay, berries and vegetable crops.” One farmer claimed \$300 of damages in a single night.²⁹

Oil fields brought numerous environmental problems beyond water pollution: smells, smoke, and noise from steam-powered pumps; heavy traffic and encroachments onto streets; fierce and hard-to-control fires; a landscape cluttered with derricks and the detritus of abandoned works (fig. 3). The oil district had been projected as a fashionable neighborhood, an extension of the affluent areas such as Figueroa Street just downhill. Oil field runoff reached Zanja 8-R on Figueroa at Eighteenth Street and ran past its finest mansions; it spread east on Washington Street, “one of Los Angeles’ choicest residential districts,” according to one resident, where “children track the oil into houses and ruin carpets and floors; ladies and gentlemen get it on their clothes.” “My husband,” said another, “has had to take his buggy to a repair shop twice to get the oil scraped off and most of the paint came with it.”³⁰

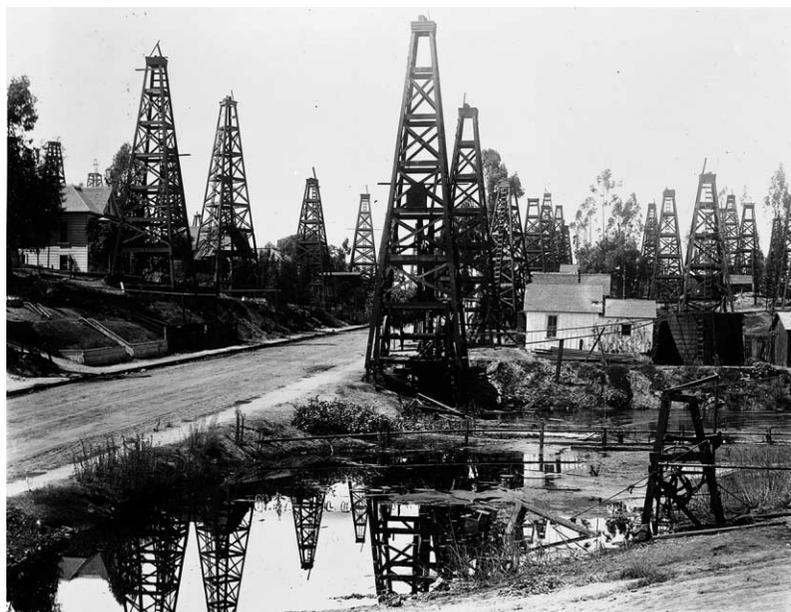


Figure 3. Los Angeles City Oil Field, Toluca and Court Streets, 1895. Credit: C. C. Pierce Collection, Huntington Library, San Marino, CA.

With so many problems, and elite constituencies complaining, government responded swiftly, regulating drilling operations and locations, including a no-drill radius around West Lake (now MacArthur) Park, and constructing alternate drainage paths bypassing the zanjas.³¹ But as these initial efforts proved only partial successes, and as the oil industry grew more important to the city's economy, lawmakers concluded that a certain amount of environmental degradation was inevitable and tolerable.³² Each egregious episode was found to have a specific cause—accident or negligence—that could be remedied. “Been attended to,” the Zanjero wrote on one complaint. The social construction of pollution adjusted to tolerate background levels of oil: a few months after working to remedy the well-field wastes on Washington Street, the city began controlling dust in that neighborhood by sprinkling streets with oil.³³ Oil producers made the city around them, including its zanjas, an inadvertent sink. Another industrial pollutant fit a different pattern.

Manufactured Gas Pollution

Before electric lights, and before natural gas, cities were lighted by manufactured gas, usually extracted from coal, although sometimes from local feedstocks such as petroleum tar. Gas manufacture produces nasty, stinky by-products including phenol compounds.³⁴ The Los Angeles Gas Company began manufacturing and delivering gas in 1867. The first streetlamps were installed at the central Plaza, and the company located its gasworks nearby, a block uphill from the Zanja Madre (fig. 4).

Gasworks waste was not an inadvertent by-product like oil spillage but an integral output in search of a sink. As the company explained: “A large amount of water is required . . . for the purifying, keeping and manufacturing of gas”; the water “soon becomes unfitted” for further use “and must be . . . conducted away.” The company could operate only with “the continuous receipt of pure water” and “means for getting rid of the refuse and drainage.”³⁵ The gasworks drained its refuse to one of the city's protosewers, where it percolated indirectly to a zanja.

Gasworks waste brought the fiercest of all pollution protests. “The stench is unendurable,” one neighbor complained. “Every day I can smell it at the house and at night I cannot sleep on account of it,” wrote

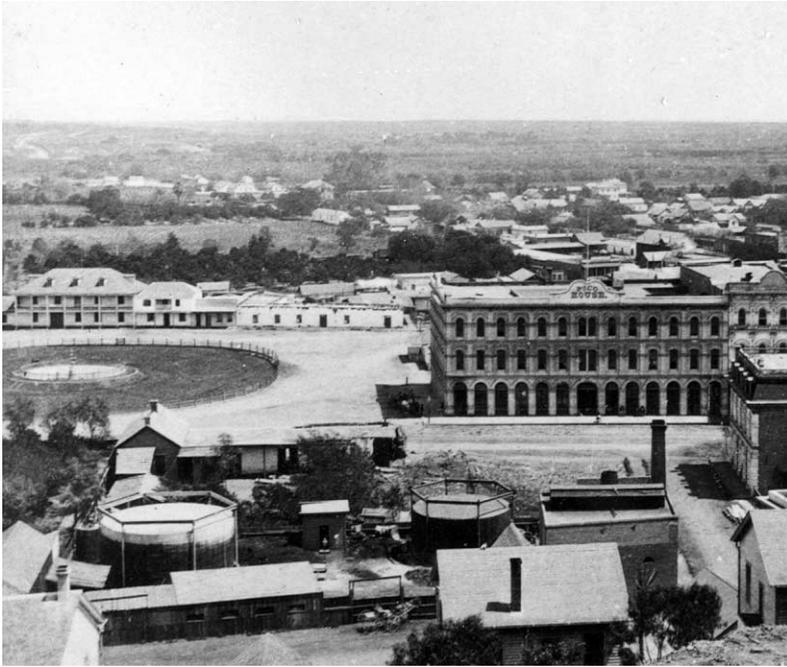


Figure 4. Gasworks (*foreground*) with Plaza (*middle ground left*) and Pico House (*middle ground right*), ca. 1875. In background, tree lines show zanjias. Credit: Security Pacific National Bank Collection, Los Angeles Public Library.

another. Businesspeople were driven from their premises.³⁶ “Horses will not drink the water,” nor would other animals.³⁷ The zanja water became “very injurious to vine and brandy interests, also to vegetation, . . . even trees will die.” Where trees survived, their fruit tasted of gas waste. A city council member who used the zanja called its water “unfit” for any purpose.³⁸

Landowners near the gasworks sued, as did several along the path of its drainage, all but one without success in the courts. These suits relied on the common law concept of nuisance—the property of one used in ways that harm the property of another. Christine Meisner Rosen has examined mid-nineteenth-century nuisance-law decisions as responses to industrial pollution and finds that courts were selectively reluctant to apply nuisance doctrine to new industries. This was partly because those industries represented growth and progress such as street lights, and partly because the problems they caused were unfamiliar. They did not fit what she calls “traditional” nuisance categories such as slaughterhouses and tanneries. Gas manufacture was a partial

exception, writes Rosen, because it “generated such awful smells, smokes, and water pollution that a consensus developed . . . that the pollution was a per se nuisance, just like the stenches emitted by traditional nuisance businesses.”³⁹ This consensus reached Los Angeles courts only unevenly.

The city council in 1869 ordered the gas company to keep its wastes out of *zanjas*, but the problem arrived through the city’s haphazard drains. Council members balked at the costs of Lecouvreux’s comprehensive drainage plan and instead addressed urgent problems piecemeal. Topography dictated that drainage needed to flow south, and what flowed south were *zanjas*. As gasworks wastes began flowing, the city was solving one local flooding problem by connecting a street drain directly to *Zanja 3*. This was the drain that served the gasworks.⁴⁰

Henry Kohler sued to prevent this *zanja* connection, the only *zanja* water quality suit that succeeded, eventually, in the courts. Kohler’s home and vineyard lay a mile and a half south on *Zanja 3*, and he used it for irrigation, for making wine and brandy, and for his household’s domestic water. So did seventeen other households. The city’s defense argued, against the facts, that *zanja* water never had been delivered for domestic purposes, only for irrigation, and that gasworks waste was compatible with irrigation. City lawyers showed less concern for water quality than for the long-standing Los Angeles impulse to assert dominion over water, and the state supreme court rewarded them by writing that “the city has the entire control of the *zanja* and the waters flowing therein.” That decision refused a preliminary injunction, and the *zanja* connection was completed. The suit proceeded to trial, which found the gasworks waste now flowing to Kohler’s property was indeed a nuisance and ordered the street drain disconnected from the *zanja*.⁴¹

As the environmental historian Joel Tarr points out, policy decisions could redirect pollution from one place to another and from one medium—water, air, or land—to another. The city made such a decision in 1871, building what they called a “sink”—a supersized cesspit—to deliver all the downtown drainage to the groundwater instead of *zanjas*. It soon overflowed, clogged by gummy gasworks residue. The overflow spread through the vineyard of former mayor Manuel Requeña, he sued, and the city began constructing yet a further extension of its drains, beyond Requeña’s land. Meanwhile the city got more serious about gas wastes, in 1872 finally ordering the city marshal to sever the gasworks sewer connection.⁴²

The gas company countersued, boldly claiming entitlement to push its externalities into the commons. Its city-approved location, said its lawyers, gave it a right to dump into the sewer. The city reversed its earlier arguments in *Kohler*, offering much evidence that gas wastes in the drains disrupted its whole irrigation system. The company answered in effect with a shrug: if you need to create a second zanja system because we spoiled the first one, they implied, that is not our problem, there is more water in the river.⁴³ The judge at first thought the evidence “clearly” showed gas refuse to be a nuisance.⁴⁴ But then an expert testifying by deposition from San Francisco, his nose far from Los Angeles, described as inoffensive the wastes of a hypothetical well-run gasworks. The court awarded the company a permanent right to put its wastes in the sewer, “in common with other citizens and persons along the line of the same.” It was not like those other users, but “in some cases,” writes Rosen, “judges responded to the new industrial pollution suits in a way that appears, to the modern mind at least, to suggest they were in a state of psychological denial about the severity of the pollution problems associated with the new industries.”⁴⁵

Gasworks pollution was not so much solved as successfully ignored. Gas wastes probably declined for a while, as the largest customer, the city, let its expensive street-lighting contract lapse for five years. These were years of growth, and other flows likely increased relative to gasworks effluent. As the sewerage system expanded, wastes traveled farther through the city in enclosed sewers rather than zanjias. Street lighting restarted in 1876 when Los Angeles Gas relocated next to the Los Angeles River, away from zanjias.⁴⁶ Until then gas wastes, if less conspicuous, were by no means eliminated from the zanjias, and irrigators managed around them.

Sewers, Zanjias, and Sewage Farming

If gas waste was unambiguously a problem, Angelenos’ relationship with their biological wastes was more ambivalent. Swill—liquid food wastes—was gathered as livestock feed but also regulated as a nuisance. Animal excrement was collected and used as fertilizer, but it was also dumped unused outside the city. Human excrement too, deposited in privy vaults and cesspools, was gathered as fertilizer, as in many US and European cities, but also treated and disposed of with repugnance.⁴⁷

As in other cities, the advent of water mains fostered the adoption of flush toilets by the well-to-do (by 1880, only one in five Los Angeles houses had them). Households connected these new devices to cesspools. They overflowed. Angelenos first understood this as a private failure of construction or maintenance. If sewers collected the overflow, it was in their original role of keeping streets “free of water,” more as a convenient backup not a fundamental infrastructure need.⁴⁸ The council at one point reconsidered whether it really needed public sewers at all, as one member put it, “for the benefit of a few rich men who were quite able to take care of their own sewerage.” A proposal to abandon public sewers lost by a single vote.⁴⁹

To our sensibilities, it may not seem rational to build sewers that ended after a block or two, or to close sewers altogether, or to run one into a *zanja*. All the *zanjas*, Mayor Joel H. Turner testified in 1869, “are now and have been for many years past used for sewerage purposes, to a greater or less extent.” This may have been true in that earlier sense of generic drainage but not the later meaning of a conduit for concentrated human wastes. As Tarr points out, infrastructure decisions were greatly complicated “by adding ‘black’ water to ‘grey.’”⁵⁰

Unlike gasworks wastes, some irrigators saw human waste as fertilizer—a feature, not a bug. One witness, André Briswalter, testified about gas wastes’ toxicity but offered to pay to route the rest of the sewage to his vegetable farm at the city’s southern boundary.⁵¹ Others made similar proposals, in this area where the *zanjas* were most likely to run dry and perhaps most likely already to carry contaminants.⁵² Chinese farmers increasingly worked the market gardens here. In the era’s racially poisonous atmosphere, they were called unclean for using human waste as fertilizer (although traditionally they composted it first). Prevented from owning land, they rented fields in Los Angeles, where they used fresh sewage. Their landlords tolerated it well enough that many lived on these properties, and growers of other national origins likewise irrigated with sewage. As the *Herald* wrote in 1875, “experience teaches that what we call filthy matter is the best fertilizer, no matter whether used by a Mongolian or American.”⁵³ The city extended sewer outlets successively farther south, bringing their fertilizing bounty to growers, sometimes through parts of *zanjas*. For several years the main terminus of this continuous flow was Briswalter’s land, where the state engineer’s staff said that “the sewage had become a crying nuisance from the lack of system of disposing of it in irrigation.”⁵⁴

In 1883, Briswalter and landowners south of the city incorporated the South Side Irrigation Company, “to distribute and sell” the sewage more systematically.⁵⁵ The city extended its main sewer to the city boundary and granted South Side an eighteen-year franchise to take it from there. Within a year the company was delivering sewage through its own pipes and ditches, eventually serving more than two thousand acres up to six miles away.⁵⁶ Land values in the sewer-irrigated district of Vernon rose six- to ten-fold. The state engineer’s staff in 1886 reported that this organized system avoided most of the disagreeable side effects of earlier ad hoc sewage irrigation. Such “broad irrigation” was the first form of sewage treatment in the United States, and early bacteriological studies showed it to be effective in reducing typhoid-producing water pollution.⁵⁷

“Sewage farming”—deliberate irrigation with human wastes, as practiced by South Side’s customers—would seem to be a story separate from the story of zanja water. These were separate networks (fig. 5). Yet they were adjacent both spatially and functionally. South Side’s service area overlapped the outside extensions of several city zanjās, and at times they competed for customers.⁵⁸ And zanja water was used for flushing the sewage lines, which thus carried by an alternate path a mix something like what previously came through parts of some zanjās.

The boom of 1885–88 increased sewage flows at the same time that it fallowed agricultural lands, leaving extra water in the zanjās. Subdivisions began expanding south of the city, and new neighbors, finding unpleasant smells, sued South Side and some of its customers.⁵⁹ They won injunctions to shut off irrigation of various tracts, and South Side passed the flow farther, for a time dumping much of it to the empty bed of the Los Angeles River.⁶⁰ The city constructed an “Outfall Sewer” running twelve miles to the Pacific—not in order to dump the sewage unused but to bypass squeamish suburbanites while reaching new irrigators who could pay the city directly for some of the flow on its way to the ocean. When the outfall opened in 1894, the ends of several zanjās were attached for flushing it.⁶¹ A state supreme court decision the following year affirmed the city’s right to all the water in the Los Angeles River but only for its own needs, not for sale outside city limits.⁶² Sewer flushing “used” water in the city, allowing its sale to outside irrigators.

Sewage irrigation moved farther from neighbors, but it increasingly offended produce consumers. Its opponents sought to run oil field wastes to the sewers, hoping to make their contents unusable on crops

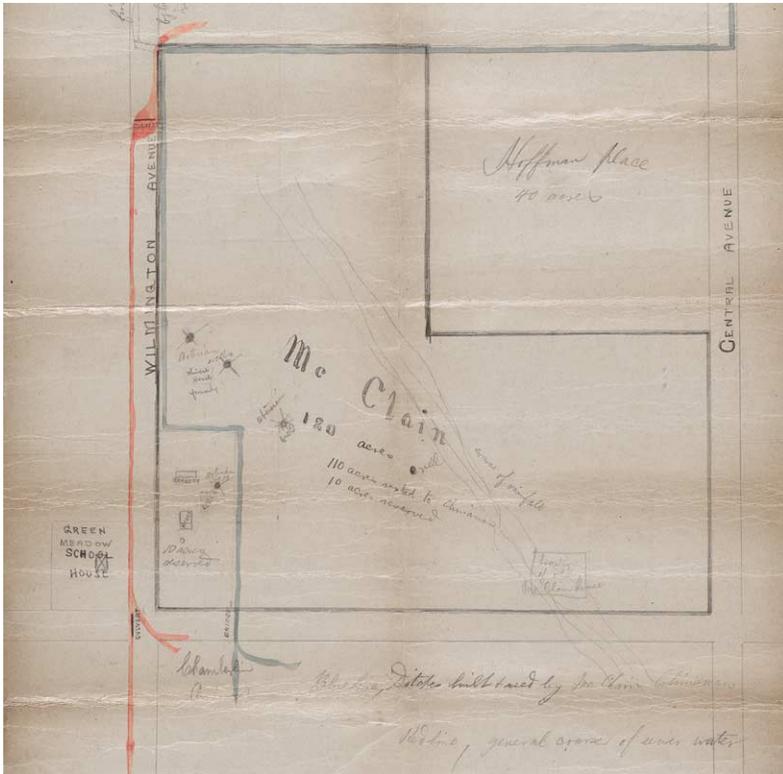


Figure 5. Zanjias (blue) and sewage ditches (red), 1889, then south of Los Angeles city limits (present Avalon Blvd. and Firestone Ave.). Credit: Huntington Library, San Marino, CA.

so all would be dumped in the ocean. When the outfall needed to be rebuilt, it opened in 1907 with no more sewage irrigation.⁶³

Zanjias and sewers coevolved over decades. In the 1860s to early 1870s, some zanjias served as premodern “sewers”—carrying cesspool overflows, household drainage, and some sanitary waste from early water closets. As sanitary sewers expanded, they flowed to specific zanjias at points ever farther south, putting more sewage into progressively less of the zanja network. From the mid-1880s, purpose-built sanitary sewers flowed largely independent of zanjias, while sewage farmers used South Side’s separate network. Active zanja users were attentive to these changes, but other Angelenos may have had only the general impression that there were ditches, and some of what ran in them was sewage. The zanjias closed in 1904, and by 1907 the city of Los Angeles no longer supplied irrigators, inside or outside the city, zanja water or sewage.

Variable Waters and User Agency

Los Angeles residents had agency regarding water sources—they had alternatives and they made choices. These included: agency as to source, including which zanja and when; agency in ways they could modify water quality after acquiring their water; and agency as to use, which waters they applied to which purposes. Agency depended on competency, awareness of changing water sources, and qualities and their fitness to purpose. Such competency and agency were found among households as well as irrigators and other urban users of bulk water. Thus they managed the quality of waters used in Los Angeles.

The variability of water qualities, and the choices made by water users, could hardly be starker than in choosing between sewage from one ditch or river water from another. These choices were conditioned by availability, reliability, and cost, each of which varied over time. Growers deeply disagreed over sewage irrigation and fought to achieve or prevent access to it; immediate neighbors took opposing sides and met in court. Some irrigators with access to free artesian well water nonetheless paid for sewage, showing that it was genuinely valued as fertilizer.⁶⁴

Irrigators paid attention to variable water quality in the zanjás themselves and took it as the basis for choices when they could. A day-to-day example was the variable sediment content of zanjás, depending on storms. During the gasworks controversies, one grower described “carefully watching the time to irrigate when . . . gas sewerage matter has not been permitted to flow.” Some users watered a single plot from more than one zanja.⁶⁵ Residential irrigators too could make choices on the basis of water quality. On Figueroa Street, wealthy homeowners paid to install an ornamental zanja and the gates for each garden to use it (fig. 1) but then found its water impregnated with oil wastes and switched instead to hoses sprinkling mains water.⁶⁶

Industrial users of the zanjás often used water for power or cooling; these processes were not highly reliant on water quality. Some users, such as mechanized laundries, were more sensitive. The Troy Laundry Company in 1901 proposed to tap the Zanja Madre through its own filter, at a time before the water company filtered its supply (fig. 6).⁶⁷ The city sometimes paid attention to water quality in industrial settings; a woolen mill’s water power contract required that it return water to the zanja “free from adulteration by chemical mixtures injurious

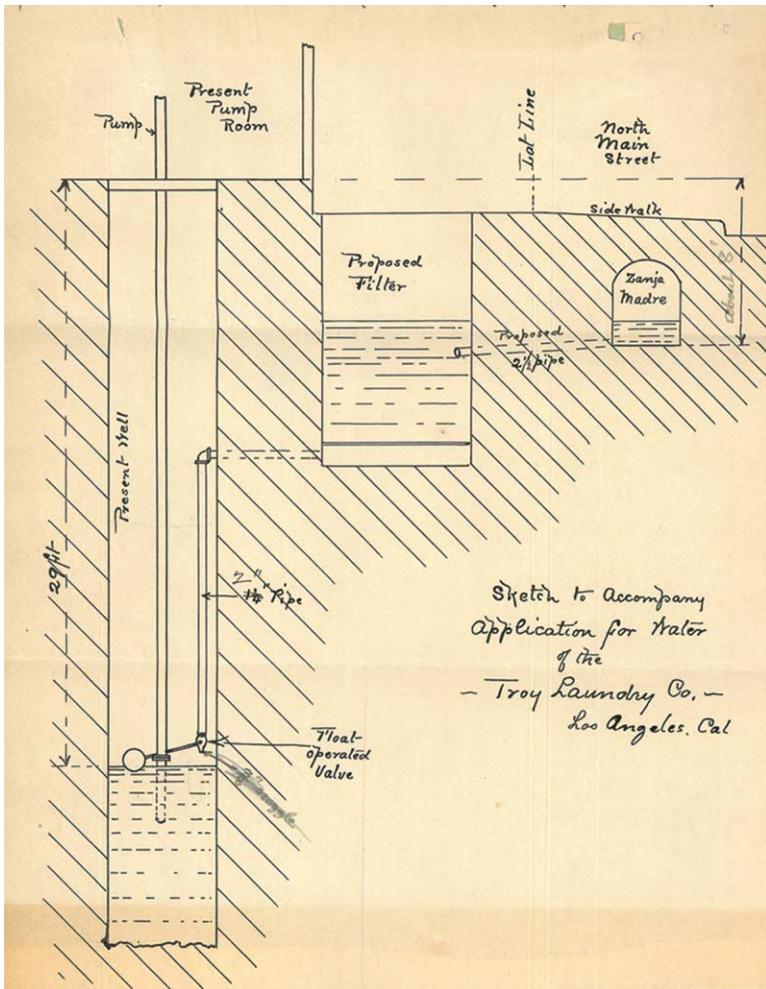


Figure 6. Troy Laundry Company proposed zanja water filter, 1901. Credit: Los Angeles City Clerk Archive.

for irrigation.”⁶⁸ Users of cooling water addressed these concerns: one promised that it would flow “through clean pipes” and “return undefiled”; another asked the city’s preference whether cooling water should be returned to the zanja or used instead to flush sewers.⁶⁹

The most sensitive question of user agency was water for household use. Domestic water represented an agglomeration of uses: drinking water; “culinary water”; wash water, for dishes, for laundry, for bodies. Each brought its own requirements and preferences for quality.⁷⁰ In every period there were multiple sources for domestic water, usually

including water mains and zanzas. Water carriers and water wagons were common in early years—the carrier who took his water from a zanja seems to have been better regarded than the one who brought river water, which was often murky. Water carts continued delivering through at least the 1890s.⁷¹ Many households used wells and reported good water, although by 1887 the city health officer thought most were polluted.⁷² Meanwhile, at all times many Angelenos continued to take their household water from zanzas. The mains network took years to reach many parts of the city (twenty-three miles of pipe in 1880, compared to fifty-four miles of zanzas within the city).⁷³ Within the water company's service area, many households could not afford its rates, which in 1870 started at two dollars per month for a single-family home without a tub or outdoor hose, plus a twelve-dollar tap fee. Some blocks, frequently Mexican or Chinese occupied, did not get mains for many years even while others nearby were served.⁷⁴

Officials made contradictory statements on domestic use of zanzas. In the *Kohler* case, Mayor Turner testified that zanja water never had been sold for domestic use, but three years later when city lawyers argued to disconnect the gasworks drains, they said that zanja water was indeed sold for domestic use, and the zanja made for that purpose.⁷⁵ Turner also testified that the water in Zanja 3, even before adding gas wastes or sewage, was “unfit for domestic purposes, and . . . any person with a due regard for himself and family” would not use it. But just two weeks later, residents along Zanzas 1 and 2 asked, and the council agreed, “to let always the water run in the above mentioned zanzas, in sufficient quantity for all domestic purposes.”⁷⁶ The mayor's assessment of zanja water was echoed by two medical doctors, one of whom called its household use “dangerous to health.”⁷⁷ But that was John S. Griffin, one of the owners of the water company, so his advice no matter how sincere cannot be called disinterested. While rhetoric generally ran against zanja water and toward the normative triumph of the new piped water, domestic users of zanzas were often accommodated when they asserted their interests.

Domestic users, such as those along Zanzas 1 and 2, or individuals seeking permission for household connections, did continue showing up before the council. This written record must be understood as just the documentary tip of a great submerged iceberg of undocumented domestic zanja use. Recurring accounts allude to this unrecorded practice: “Hundreds of families that take the water used for cooking and

drinking purposes” from zanjas in 1874, according to the *Herald*; “the water in all zanjas was extensively used for domestic purposes” in 1886, according to the *Zanjero*. Evidence also comes through numerous accounts of unauthorized use.⁷⁸ These reports often described problematic outcomes—leaks, overflows—implying that other unauthorized users, taking better care not to cause trouble, likely avoided attention. Small-scale uses of the zanjas remained widespread but mostly unauthorized, thus outside most policy discourse on water quality. Stanley Crawford, writing in *Mayordomo* about rural northern New Mexico, describes “water for the chickens” as a polite proxy for discussing domestic water from ditches; in Los Angeles “garden” use may have served a similar euphemistic purpose.⁷⁹

Individual agency, like public policy, was based on prevailing theories of public health. In the mid-nineteenth century those theories saw the causes of illness in “miasmas,” or foul-smelling air. This was perhaps one factor in the near-universal revulsion at gas wastes while reception varied for more familiar sewage flows. A miasma corollary held that running water purifies itself. Reflecting that belief, the city’s future postmaster, I. R. Dunkelberger, said in 1872 that “I use water from a sanja [*sic*] into which sewerage empties for domestic purposes and find it pure when it gets to my place.”⁸⁰ By the end of the century, public health adopted the germ theory of disease transmission, and the city health department hired a bacteriologist.⁸¹

Some individuals acted to modify the quality of their water. In the late 1870s, the city surveyor John Goldsworthy used zanja water that he ran through a filter; during a dysentery epidemic the city health officer recommended his installation as a model. Contemporary marketing of home water filters suggests that others took similar action.⁸² A Montgomery Ward catalog lists Jewett Water Filters in four- to fourteen-gallon sizes for purifying “rain, river and hydrant” water; “hydrants” here mean not fireplugs but supply taps for either irrigation or mains water. In Los Angeles it would be the late 1880s before any water company began to experiment with filtering, and not until the twentieth century would water generally be filtered on its way to the consumer.⁸³

Water companies as well as zanjas faced questions of quality, and user agency included decisions to reject their product. Various mains systems served different areas of the city, and they earned various reputations for odor, taste, and biological contaminants, such as live “fat

leeches.”⁸⁴ Leeches were a problem emerging from the tap in a way that leeches in the ditch were not: tap water was conceived as a reliably standardized commodity, while zanja waters could be inspected and selected. Inspection showed different waters in different places, even along a single zanja. On the same canal that received most of the oil drainage, people upstream from the oil field were taking their domestic water even at the turn of the twentieth century. And in 1891, the fashionable Bellevue Terrace Hotel and one of its neighbors switched back to zanja water rather than the “impure” product of water mains.⁸⁵

Some parts of the zanja system came to be readapted for domestic use, through user agency and then through policy. User choices were the driver along Zanja 9-E (5-R in fig. 2), one of the last to be constructed, the high-line distribution service east of the river. Its water came from far upstream, ran through countryside where it would pick up little pollution, and supplied growing parts of the city not well served by water companies. Many residents in new suburban areas, assessing their options, asked and received permission to tap it for domestic use. By 1888, the city surveyor recognized that this “water system had changed from an irrigation to a domestic system, and not enough water was rented for irrigation purposes to pay the interest on the zanjias, but nearly every family wanted to connect . . . for domestic purposes.” The city accommodated them by approving \$111,000 to rebuild part of Zanja 9-E to better serve domestic customers.⁸⁶ The city approved new domestic connections to the zanjias up until a year before shutting off the whole system.⁸⁷ Some zanja water, these householders knew, was at least as good as what they would get through water company pipes.

William Mulholland knew it too. Before closing the zanjias, he diverted much of their water into mains. After shutting them he cannibalized parts of the zanja network itself: the Main Supply Canal—from the same clean upstream diversion that supplied Zanja 9-E—was rebuilt as the water department’s Main Supply Conduit, filling what are now Silver Lake and Ivanhoe Reservoirs.⁸⁸

As 1902 began, Los Angeles operated just one of its two water networks, the zanjias, while the mains were private. Over three years the city became a water monopoly operating both networks and then finally delivered a single product through a single network, with just one quality for all purposes—commoditized water. By most accounts the city did a good job for its consumers. The end of the zanjias may

have soon brought a higher quality of water; what it brought first was fewer water choices. Most city residents probably did not notice. The municipal Board of Water Commissioners commenced an era of professionalized management, and for ordinary Angelenos one dividend of modernity and commoditization was relief from needing to think about water, except for an occasional bond election. Water became an abstraction, as much political and economic as tangible.⁸⁹

This modern, centralized regime displaced an earlier sociotechnical system for managing water and water quality. The story was more complicated than dirty old zanjas and clean new mains. Conditions were varied and changeable in both networks. The earlier water culture recognized such variations and distributed both agency and competency for responding to them. Angelenos were accustomed to having water choice and knew how to use it; it was not in their interest to be passive consumers. If the results were not as pristine or healthful as the modern twentieth-century system would eventually deliver, that came from limitations in knowledge and capacity that were common to public and corporate actors as well as individuals. Nor was this merely the vestigial water culture of a pre-urban, agricultural settlement. It was an evolving, adaptive system of both physical and cultural infrastructure, by which Angelenos jointly managed waters during their city's rapid urbanization.

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Notes

This article is part of a larger study-in-progress including San Antonio, Salt Lake City, Denver, and Phoenix, supported by the James Marston Fitch Charitable Foundation, the Charles Redd Center at Brigham Young University, and the University of Texas at Austin. Many archives and many archivists have made it possible. Special thanks to the Huntington Library, the California State Archives, Mike Holland and Todd Gaydowski at the Los Angeles City Clerk Archive, and Angela Tatum and Paul Soifer at the Los Angeles Department of Water and Power Records Center. Thanks to two anonymous reviewers and to Joel Tarr for helpful feedback.

1. A small private system was aborted in the late 1850s. I have adopted the term "mains" (more common in Britain) to refer to the pressurized water delivery

network. “Underground” and “piped” do not disambiguate since these terms describe much of the zanja network during its final two decades.

2. Martin Melosi, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore: Johns Hopkins University Press, 2000), chap. 1; Blake Gumprecht, *The Los Angeles River: Its Life, Death, and Possible Rebirth* (Baltimore: Johns Hopkins University Press, 1999); Robert M. Fogelson, *The Fragmented Metropolis: Los Angeles, 1850–1930* (Berkeley: University of California Press, 1993).
3. In 1868 the city granted a thirty-year franchise to the Los Angeles City Water Company, which later took over smaller companies that supplied remote districts. J. Gregg Layne, *Water and Power for a Great City* (Los Angeles: Department of Water and Power, 1957); Fogelson, *Fragmented Metropolis*, 95–97; Gumprecht, *Los Angeles River*, 86–89; Los Angeles Board of Water Commissioners, *Annual Report 3* (Los Angeles: Board of Water Commissioners, 1904), 22–23.
4. Norris Hundley Jr., *The Great Thirst: Californians and Water; A History*, rev. ed. (Berkeley: University of California Press, 2001); Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Oxford, 1985); Abraham Hoffman, *Vision or Villainy: Origins of the Owens Valley-Los Angeles Water Controversy* (College Station: Texas A&M University Press, 1981); William L. Kahrl, *Water and Power: The Conflict over Los Angeles’ Water Supply in the Owens Valley* (Berkeley: University of California Press, 1982); William Deverell and Tom Sitton, *Water and Los Angeles: A Tale of Three Rivers, 1900–1941* (Berkeley: University of California Press, 2017).
5. Fogelson, *Fragmented Metropolis*; Hundley, *The Great Thirst*; Vincent Ostrom, *Water and Politics: A Study of Water Policies and Administration in the Development of Los Angeles* (Los Angeles: Haynes Foundation, 1953).
6. Worster, *Rivers of Empire*, 7, 22–23.
7. Two histories do look at Los Angeles’s premodern water. David Samuel Torres-Rouff, *Before L.A.: Race, Space, and Municipal Power in Los Angeles, 1781–1894* (New Haven, CT: Yale University Press, 2013) is indispensable but asks a different question: how resources and space reflected and shaped racial identities. As such his story substantially concludes in the 1870s, before the Los Angeles of relentless urban growth regime. The other is Gumprecht’s *Los Angeles River*. He treats human-river interactions comprehensively but does not examine the quality of water once it leaves the river.
8. David Edgerton, “From Innovation to Use: Ten Eclectic Theses on the Historiography of Technology,” *History and Technology* 16 (1999): 111–36.
9. Worster does acknowledge the many ways these systems evolved on their way to the “Agrarian State.” Worster, *Rivers of Empire*; José A. Rivera, *Acequia Culture: Water, Land, and Community in the Southwest* (Albuquerque: University of New Mexico Press, 1998); Michael C. Meyer, *Water in the Hispanic Southwest: A Social and Legal History, 1550–1850* (1984; repr., Tucson: University of Arizona Press, 1996); Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 2000); Eric P.

- Perramond, *Unsettled Waters: Rights, Law, and Identity in the American West* (Berkeley: University of California Press, 2019).
10. Patricia Nelson Limerick, *A Ditch in Time: The City, the West, and Water* (Golden, CO: Fulcrum, 2012); I. Wayne Cox, *The Spanish Acequias of San Antonio* (San Antonio: Maverick, 2005); Charles R. Porter Jr., *Spanish Water, Anglo Water: Early Development in San Antonio* (College Station: Texas A&M University Press, 2009). Two who pay attention to modern ditches are Robert R. Crifasi, *A Land Made from Water: Appropriation and the Evolution of Colorado's Landscape, Ditches, and Water Institutions* (Boulder: University Press of Colorado, 2016); and Douglas E. Kupel, *Fuel for Growth: Water and Arizona's Urban Environment* (Tucson: University of Arizona Press, 2006).
 11. Svante Lindqvist, "Changes in the Technological Landscape: The Temporal Dimension in the Growth and Decline of Large Technological Systems" (1994), in *Changes in the Technological Landscape: Essays in the History of Science and Technology* (Sagamore Beach, MA: Science History Publications, 2010).
 12. Harris Newmark, *Sixty Years in Southern California, 1853–1913* (New York: Knickerbocker, 1916), 210 (quote), 322.
 13. City government flip-flopped between denying or trying to prevent domestic use of zanjas and then accommodating it; the city sided with and then against gas company waste dumping.
 14. Layne, *Water and Power*.
 15. Meyer, *Water in the Hispanic Southwest*; Thomas F. Glick, *Irrigation and Society in Medieval Valencia* (Cambridge, MA: Harvard University Press, 1970).
 16. Sometimes officially called the "Water Overseer."
 17. Los Angeles Common Council minutes [hereafter, CC, including City Council after 1889], September 13, 1873, 464 (all CC minutes available at <http://clkrep.lacity.org/oldcfdocs> [accessed February 13, 2022]); CC, May 21, 1874, 713; *Los Angeles Times*, July 4, 1882; Rachel Surls and Judith Gerber, *From Cows to Concrete: The Rise and Fall of Farming in Los Angeles* (Santa Monica, CA: Angel City, 2016).
 18. CC, March 11, 1875, 407; *People v. Ah Hey* (1893), in Early Los Angeles Court Transcript Collection, 1885–1904, SC/LACT box 19, folder 8, Special Collections, California State University at Northridge.
 19. Melosi, *Sanitary City*, 4.
 20. CC, March 6, 1852, 214 ("The plank or wash-board"); Torres-Rouff, *Before L.A.*, 78–79; Meyer, *Water in the Hispanic Southwest*, 69; Gumprecht, *Los Angeles River*, 62.
 21. CC, November 23, 1853, 357.
 22. CC, February 26, 1856, 116; *Los Angeles Herald*, June 8, 1886; CC, May 30, 1859, 89.
 23. *Los Angeles Herald*, October 18, 1874 (all quotes), June 3, 1891; Torres-Rouff, *Before L.A.*, 163–64, 176–77; CC, July 8, 1882, 469.
 24. CC, October 28, 1869, 19; report of consulting engineer on a system of sewage for Los Angeles City, April 20, 1870, Los Angeles City Clerk Archives [hereafter, LACA] vol. 11, pp. 126–60; CC, August 29, 1872, 50.

25. Melosi, *Sanitary City*, 41; Joel A. Tarr, *The Search for the Ultimate Sink: Urban Pollution in Historical Perspective* (Akron, OH: University of Akron Press, 1996), 181; CC, February 4, 1875, 329–30.
26. CC, August 19, 1869, 369; *Map Showing Stormdrains in Los Angeles, Dec. 1, 1889*, city engineers map collection, microfiche HS 499, Los Angeles Public Library.
27. CC, March 17, 1870, 78.
28. Daniel Johnson, “Pollution and Public Policy at the Turn of the Twentieth Century,” in *Land of Sunshine: An Environmental History of Metropolitan Los Angeles*, ed. William Deverell and Greg Hise (Pittsburgh: University of Pittsburgh Press, 2005), 81–83.
29. 1894 City Council petition 936 (“fouly impregnated”); 1899 City Council petition 496 (“offensive matter”); 1898 City Council petition 751 (\$300), all in LACA.
30. *Los Angeles Herald*, May 15, 1901.
31. 1894 Ordinance 2467, Ordinance regulating the depositing of oil in streets, zanjias and other public places; 1897 Ordinance 4117, Ordinance prohibiting oil wells in certain districts; 1897 Ordinance 4062 [per CC index, LACA] or 4061 [per CC, February 8, 1897]; *Los Angeles Herald*, September 12, 1899, April 30, 1901.
32. Compare the inaugural messages of Mayor Frank Rader (*Los Angeles Herald*, January 8, 1895): “While we foster [oil] industries, we must also so restrict them as to properly protect the property of others”; and Mayor Meredith Snyder (*Los Angeles Herald*, January 5, 1897): “This is one of the leading industries of the city, and all legislation bearing on it should be liberal.”
33. 1898 City Council petition 751 (“attended to”); CC, October 7, 1901, 649.
34. Joel A. Tarr, “Toxic Legacy: The Environmental Impact of the Manufactured Gas Industry in the United States,” *Technology and Culture* 55 (2014): 107–47; Leslie Tomory, “The Environmental History of the Early British Gas Industry, 1812–1830,” *Environmental History* 17 (2012): 29–54; Tarr, *Ultimate Sink*, chaps. 14 and 15.
35. *Los Angeles Gas Company v. Los Angeles*, complaint, California 17th District Court case 2033, Los Angeles Area Court Records 1850–1910, Huntington Library, San Marino, CA [hereafter LAACR-Huntington].
36. Petition of F. Signoret [indexed as “Ligmonet”], May 10, 1870, LACA box 1367, vol. 7, p. 150 (“stench”); *Requeña v. Los Angeles*, engrossed statement, California 17th District Court case 2101, LAACR-Huntington (“every day”); *Los Angeles Gas Company*, affidavit of Jacob Metzger.
37. *Los Angeles Gas Company*, affidavits of H. J. Crow, André Briswalter.
38. CC, October 6, 1870, 167 (“very injurious”); *Los Angeles Gas Company*, affidavit of André Briswalter; CC, February 11, 1871, 261 (“unfit”).
39. Christine Meisner Rosen, “‘Knowing’ Industrial Pollution: Nuisance Law and the Power of Tradition in a Time of Rapid Economic Change, 1840–1864,” *Environmental History* 8 (2003): 585; Melosi, *Sanitary City*, 21–22; *Kohler v. Los Angeles*, California 17th District Court case 1523; *Signoret v. Los Angeles Gas Co.*, California 17th District Court case 1911; *Requeña*; *Pico v. Los Angeles Gas Co.*, Los Angeles County Court case 441, all LAACR-Huntington. Former governor Pio Pico,

- who had just built the luxurious Pico House hotel on the Plaza and would lose his fortune on it, argued that it was being killed by the gasworks' smoke and smells.
40. CC, March 15, 1869, 316; *Los Angeles Gas Company*, plaintiff's affidavit on motion, October 7, 1872.
 41. *Kohler*, 38 Cal. 510 ("entire control"); *Kohler*, answer, stipulation, LAACR-Huntington.
 42. Tarr, *Ultimate Sink*, chap. 1; CC, November 5, 1870, 183; *Requeña*, engrossed statement on motion for new trial, statement of Jasper Babcock, street commissioner; *Requeña*, findings.
 43. *Los Angeles Gas Company*.
 44. *Los Angeles Gas Company*, opinion of court, October 15, 1872.
 45. *Los Angeles Gas Company*, judgment, December 28, 1872, plaintiff's exhibit B; Rosen, "Knowing Industrial Pollution," 588.
 46. CC, January 26, 1871, 253; CC, November 15, 1877, 19.
 47. *Los Angeles Herald*, January 6, 1886, November 12, 1883; CC, May 6, 1869, 332; US Department of the Interior, Census Office, Tenth Census 1880, *Report of the Social Statistics of Cities*, comp. George E. Waring Jr., 2 vols. (Washington, DC: US Government Printing Office, 1887), 2:782; Tarr, *Ultimate Sink*, chap. 10.
 48. CC, August 19, 1869, 369; US Department of the Interior, *Report*, 2:782; Tarr, *Ultimate Sink*, chaps. 4 and 7.
 49. CC, March 16, 1871, 291 ("rich men"); CC, February 16, 1871, 274; Tarr, *Ultimate Sink*, 113. See Melosi, *Sanitary City*, 12: even after developing early water distribution systems, cities "continued to regard waste disposal as an individual responsibility."
 50. *Kohler*, transcript on appeal, 12, Supreme Court Records, California State Archives; Tarr, *Ultimate Sink*, 10. City attorneys expressed the confused meanings of the word "sewer" when denying that one "sewer was used exclusively for the purpose of a public sewer"; *Los Angeles Gas Company*, answer.
 51. *Los Angeles Gas Company*, affidavit of André Briswalter; CC, September 14, 1871, 370.
 52. CC, February 23, 1871, 278; CC, August 12, 1871, 354; CC, August 22, 1871, 362–63; CC, August 31, 1871, 366; more in subsequent years.
 53. *Los Angeles Herald*, May 7, 1875; Sucheng Chan, *This Bittersweet Soil: The Chinese in California Agriculture, 1860–1910* (Berkeley: University of California Press, 1986), 90, 99–100.
 54. William Hammond Hall Papers, misc. working papers, folder 64, California State Archives; CC, May 1, 1873, 286.
 55. Los Angeles County Incorporation Records GC 1145–333, Seaver Center, Los Angeles.
 56. M. N. Baker, *Sewage Purification in America* (New York: Engineering News, 1893), 107–9, quotes City Engineer Dockweiler with the commonly reported figure of 1,700 acres. The 1888 City Council petition 453 reports about four square miles (LACA). Looking at locations of reported deliveries, it appears that considerably more area received sewage irrigation at one time or another.
 57. Baker, *Sewage Purification*, 107; Tarr, *Ultimate Sink*, 162–63.

58. 1887 City Council petition 478; 1888 City Council petition 453, both LACA; *Los Angeles Herald*, June 12, 1888.
59. Young v. McKinley, Los Angeles County Superior Court case 7861; Cartwright v. Entwistle, Los Angeles County Superior Court case 7862; Williams v. Hanna, Los Angeles County Superior Court case 7873; Marlatt v. McKinley, Los Angeles County Superior Court case 7875, all LAACR-Huntington.
60. Stump v. South Side, Los Angeles County Superior Court case 9363, LAACR-Huntington; *Los Angeles Herald*, October 23 and October 25, 1889; Baker, *Sewage Purification*, 108.
61. Baker, *Sewage Purification*, 108; Anna Sklar, *Brown Acres: An Intimate History of the Los Angeles Sewers* (Santa Monica, CA: Angel City, 2008); *Los Angeles Herald*, April 28, 1894.
62. Vernon Irrigation Co. v. Los Angeles, 106 Cal. 237. Hundley, *The Great Thirst*, 135: “Perhaps the most important decision in the history of Los Angeles.”
63. Milan Nikolitch, “Sewerage System of Los Angeles and Sewage Irrigation in Southern California” (MS thesis, University of California, 1906), 21; *Los Angeles Herald*, April 22, 1901; 1901 City Council petition 571; 1901 City Council petition 1093; Sklar, *Brown Acres*, 42–43.
64. McClain v. South Side Irrigation Co., Los Angeles County Superior Court case 9384, LAACR-Huntington.
65. *Los Angeles Gas Company*, original affidavit of H. J. Crow; CC, August 13, 1874, 34.
66. Historical Society of Southern California subject photos, Huntington Library, CL400 vol. 1, no. 84.
67. 1892 City Council petition 249; 1897 City Council petition 275; 1901 City Council petition 349 (Troy), all LACA.
68. CC, August 24, 1872, 50.
69. 1900 City Council petition 141, by the American Oil and Asphalt Company—evidently aware that its name and business might raise concerns (both quotes); 1895 City Council petition 1017, both LACA.
70. Carl Smith, *City Water, City Life: Water and the Infrastructure of Ideas in Urbanizing Philadelphia, Boston, and Chicago* (Chicago: University of Chicago Press, 2013).
71. Gumprecht, *Los Angeles River*, 63–64; Layne, *Water and Power*, 34, citing Newmark, *Sixty Years*, 116–17; 1891 City Council petition 33, LACA.
72. Annual report of health officer, 1894, LACA; Kohler, transcript on appeal, 18–19; *Los Angeles Herald*, December 29, 1887.
73. US Department of the Interior, *Report*, 2:780; William Hamilton Hall, *Irrigation in California (Southern)* (Sacramento: State of California, 1888), 547.
74. CC, April 14, 1870, 92–94; *Los Angeles Herald*, August 7 and October 11, 1874, June 5, 1887; *Sanborn Fire Insurance Map from Los Angeles*, 3 vols. (New York: Sanborn Map Co., 1894).
75. Kohler, transcript on appeal, 11; *Los Angeles Gas Company*, answer.
76. Kohler, transcript on appeal, 12; CC, September 30, 1869, 10.
77. Kohler, transcript on appeal, 15–16.

78. *Los Angeles Herald*, October 11, 1874, June 8, 1886; annual police dept. reports, 1879 and 1881, LACA.
79. Stanley Crawford, *Mayordomo: Chronicle of an Acequia in Northern New Mexico* (Albuquerque: University of New Mexico Press, 1988), 88; CC, March 13, 1854, 394; CC, February 1, 1864, 303; CC, June 9, 1864, 340; CC, May 23, 1867, 145 (mayor's message).
80. *Requeña*, engrossed statement on motion for new trial; Melosi, *Sanitary City*, 12. On consumer knowledge and agency, see Nancy Tomes, "The Private Side of Public Health: Sanitary Science, Domestic Hygiene, and the Germ Theory, 1870–1900," *Bulletin of the History of Medicine* 64 (1990): 509–39.
81. The bacteriologist, Ethel L. Leonard, started in October 1903. Testing of a zanja is reported only in 1905. It was the highest bacteria count in a list of city water sources, but this was after the zanjas were shut so it is not clear what was tested. Health dept. annual report, 1905, LACA.
82. *Los Angeles Herald*, August 7, 1879, March 13, 1879, June 19, 1884, and April 23, May 13, and October 17, 1886. See also Newmark, *Sixty Years*, 117.
83. *Montgomery Ward Catalog of 1895* (New York: Dover Pictorial Archive, 1969), 438; *Los Angeles Herald*, December 21, 1887; health dept. annual report, 1906, LACA.
84. *Los Angeles Herald*, October 22, 1874, August 28, 1884 ("leeches"); 1891 City Council petition 33, LACA.
85. 1891 City Council petitions 439 and 459 ("impure"), LACA. The hotel completed its connection: *Sanborn Fire Insurance Map*, 3:113.
86. *Los Angeles Herald*, February 5, 1888. In 1888, about half the zanjas showed "pipeline" income, fees for continuous users rather than bulk deliveries for irrigation (which still dominated revenues for the system as a whole); Zanjero's annual report, 1888, City Archives vol. 43, p. 9, LACA. By 1895, domestic permits accounted for half the zanja receipts in some months: journal, Office of Water Overseer, WP05–88, Los Angeles Department of Water and Power Archives.
87. 1903 City Council petition 65, LACA.
88. Los Angeles Board of Water Commissioners Minutes Book, vol. 1, July 12, 1902, 5, Los Angeles Department of Water and Power Archives; Los Angeles Board of Water Commissioners, *Annual Report 9* (Los Angeles: Board of Water Commissioners, 1910), 13.
89. Much like the abstraction of grain, lumber, and beef in Chicago: William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: Norton, 1992).