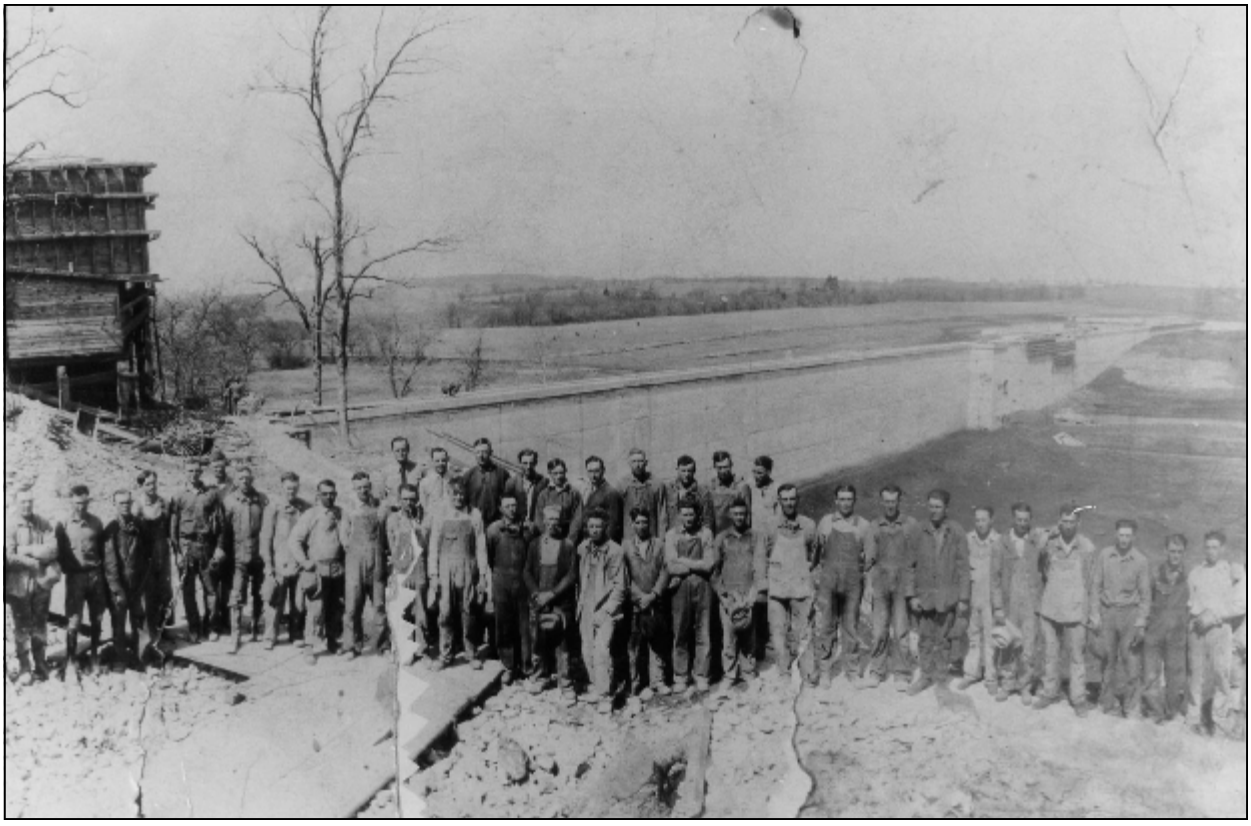
Source to Tap:

A History of Missouri's Public Water Supplies

By: Loring Bullard



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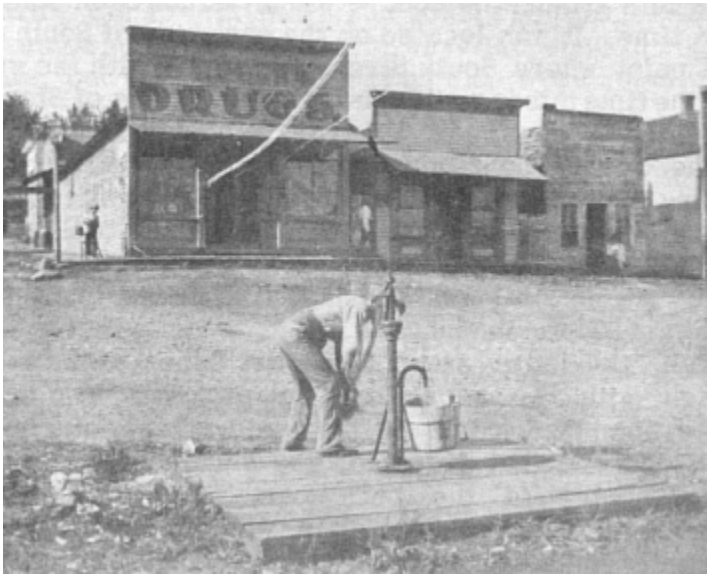
Introduction

To their great benefit, most Missourians have access to adequate supplies of clean, safe drinking water. Nearly nine out of ten people in the state are served by public water systems. Missouri's four largest cities—St. Louis, Kansas City, Springfield and Independence—have provided drinking water to their citizens for well over a hundred years, and most of the state's cities have enjoyed public water for over three-quarters of a century. Like the communities that fostered them, these water systems have grown and evolved over the years, reflecting technological advancements and the changing expectations of customers. Today it easy for Missourians, like other Americans, to take their safe, readily available water supplies for granted.



A Public Well (Courtesy Cedar County Historical Society)

At some point in time, citizens in almost every city realized that public water would be essential to their community's continuing growth and prosperity. Adequate water supplies were especially good for business. Merchants and manufacturers pushed for public water supplies because they saw the positive effects, such as the expansion of industry, on cities that had obtained them. In 1875, when Springfield's civic leaders solicited proposals for a *waterworks* (a term used to describe all the built components of a water system—pipes, pumps, reservoirs, tanks, filter plants, etc.), a newspaper editorial noted the "universal experience" that cities which had established waterworks moved ahead, "while their sisters, with other advantages equal, were rapidly going to decay."[1]

Naturally, people were concerned about the purity of their city's water source, especially since the early water-works employed little in the way of water treatment as we know it today. For murky sources, like many of Missouri's rivers and streams, basins were built to allow settling time for the water. But the clarified water was then pumped directly into mains and to customer hydrants without further treatment.

Introduction

Although some early waterworks employed crude filters, the quality of water delivered to customers was controlled primarily through the selection of sources, the timing of pumping from sources, and the settling time provided in ponds prior to distribution. Until the second decade of the 1900s, very few of Missouri's water supplies used filtration and none used disinfection.

Source water quality and the cleanliness of water delivered to customers became contentious issues for some of Missouri's early public water supplies. But for most communities, concerns about health and disease did not necessarily drive the first procurement of public water. Rather, fire protection became a leading argument for water to be delivered in pipes under pressure.[2] After disastrous fires in Chicago and New York, the number of waterworks in the country jumped from 244 in 1870 to 598 in 1880, and almost 1,900 by 1890.[3] Businesses found that insurance rates dropped significantly with the installation of pressure mains and large capacity fire hydrants.

Many of Missouri's communities followed a national trend in the conversion from private to public ownership of the waterworks, often accompanied by a great deal of debate about which was better. Some citizens felt that profit-motivated water companies should not be entrusted with something as vital as the community's water supply. Others argued that private companies could marshal greater technical and financial resources, and would be less subject to political maneuvering and bureaucratic interference.

Fire on the Springfield Square, 1913 (Courtesy History Museum for Springfield and Greene County)

These debates are not entirely settled. Today, public water supplies are highly regulated, but controversy over privatization, rates, quality of service and the procurement of new sources goes on. The costs of providing safe water continue to rise as systems struggle to pay for infrastructure improvements, ongoing maintenance and meeting increasingly stringent standards. At the same time, customers still expect their water to be inexpensive. For rapidly growing communities, obtaining large new sources of water is particularly difficult. And for some of Missouri's public water supplies, the pollution and loss of existing sources have created expensive problems and public relations headaches.

In many cases, Missouri's public water systems have long histories intertwined with their host communities, marked by civic progress and technological achievement, but also fraught with turmoil and controversy. Citizens remain very sensitive to drinking water issues and expect to be involved in decisions affecting their

Bored Wooden Water Pipe, Seattle (Photo by Author)

water supply future. But public discussion and debate on these matters, to some extent, will merely be echoes from the past. That is why the lessons to be gleaned from Missouri's long water supply history are of value to us today.

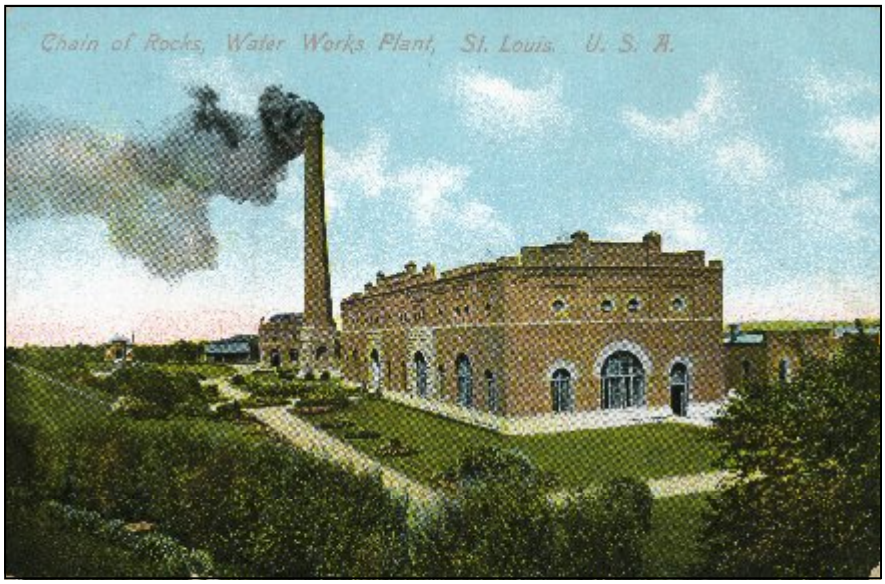
Moving Ahead

*E*ngineer and historian Nelson Blake wrote that urban life was "peculiarly dependent on water." After 1860, he suggested, most cities had "learned a great lesson. No longer could they depend upon internal sources of supply."[4] In other words, individual wells or cisterns or springs couldn't sustain a city. A growing city needed more water, and had to look further to get it. Public water, in fact, became the first municipal service that underscored a community's stability and its commitment to growth.[5] In demonstration of that fact, by the 1880s two-thirds of American cities with populations exceeding 2,500 had obtained a public water supply.[6]

Missouri's largest city, St. Louis, acquired the state's first waterworks, constructed in 1831 when the city reached a population of about 6,000. Pumps drew water from the nearby Mississippi River. Some of the sediment in the murky water settled out in a small basin, with a capacity of only 230,000 gallons, before the water was pumped into town.[7] John Wilson and Abram Fox received the contract to build this system in 1829, but work proceeded very slowly. The city had to borrow money to assist in the construction and within four years of the beginning of operation had purchased the waterworks.[8]

Forty years went by before other Missouri cities obtained their first waterworks. In the 1870s, only two major cities in the state got them—Sedalia and Kansas City. Sedalia, a thriving railroad town on the central Missouri prairie, established a waterworks in 1872. Oddly, in the absence of a Board of Trade, the matter of building the city a waterworks originally came before the local Library Association. In October 1871 an ordinance passed to issue $100,000 in bonds for the construction of the waterworks.[9] The water would be pulled from the West Fork of the Lamine River, also called Flat Creek. But the supply from this small stream proved deficient during droughts, so the city turned to a new reservoir in 1882 and eventually to deep wells and a larger reservoir.[10]

Kansas City, which grew rapidly after the Civil War, made it first presentation of $300,000 in bonds in 1870 to construct a municipal waterworks. But the effort was derailed by a "technical violation of suffrage laws" when it came to light that many "ex-Rebels" had illegally voted.[11] The state legislature amended the city charter in 1873, allowing Kansas City to either build its own waterworks or grant a twenty year franchise to a private company.[12] Two elections on franchise ordinances failed in1873, with many

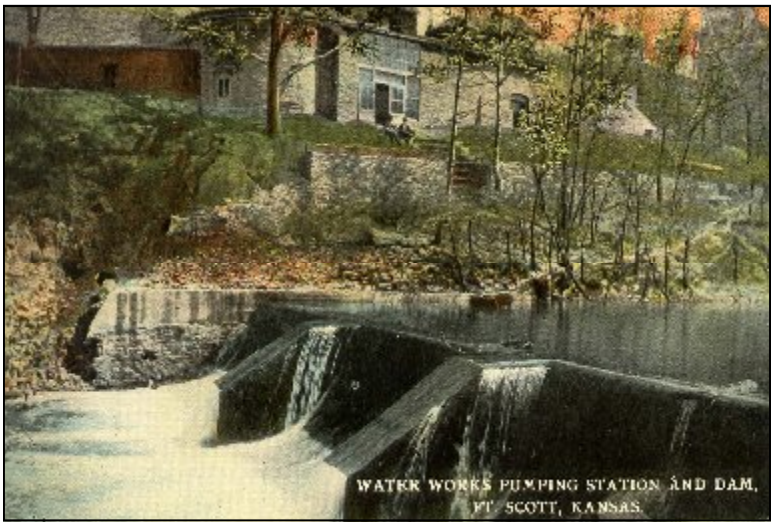


Chain of Rocks Water Works Plant, St. Louis, MO (Courtesy State Historical Society of Missouri, Columbia)

residents expressing concern about cost. A newspaper quoted one citizen as saying "it would be better by far for half the city to burn up, than that her taxes should be doubled."[13] Finally, in October 1873, through a lopsided vote of 2,433 in favor to 64 against, citizens endorsed a proposition from the National Waterworks Company of New York to build the city a waterworks, using water from the Kansas River pumped to large settling basins.

In the 1880s, one man—Paul B. Perkins of Geneseo, Illinois—constructed waterworks for the cities of Springfield, Boonville, Jefferson City, Nevada and Joplin. This businessman sold all of these cities on variations of his "Perkins System," consisting of a carefully engineered apparatus to pump water from a source to a settling reservoir and then to an elevated tank, which provided pressure to mains. Perkins specialized in waterworks construction, so his propositions embodied the engineered certainty and technical detail that locally devised schemes usually lacked. He also carried with him a waterworks ordinance template, ready to be adopted. Thus, in the cities mentioned above, the original waterworks ordinances are strikingly similar.

Perkins built a waterworks for the city of Joplin in 1881. Prior to this time, people relied on cisterns or wagons hauling water from springs outside the city.[14] A proposal to build the waterworks was submitted in December 1880 and in January voters overwhelmingly approved the measure, 1229 to 31.[15] Perkins selected as the source nearby Shoal Creek, a swift, clear Ozark stream. The opening of the waterworks in the summer of 1881 turned the "overgrown mining camp" of Joplin into an up-to-date city, with the construction of "business houses and factories of the permanent kind" and houses sporting "nice blue-grass lawns."[16]



Waterworks at Ft. Scott, Kansas, Constructed by Paul Perkins
(Courtesy History Museum for Springfield and Greene County)

In 1883, Perkins built a waterworks for the city of Boonville, taking the supply from the nearby Missouri River. Before that time, city residents got their water from the city spring, cisterns or the river. In March 1883, Boonville's City Council approved Perkins' plans for the waterworks, including two basins of 150 by 250 feet and a tank thirty feet in diameter sitting atop a sixty foot tower.[17] Citizens were invited to witness a test of the new waterworks in October 1883, when Perkins had firemen attach hoses to hydrants and "throw water eighty feet above the pavements." A newspaper described the occasion as "an epoch of note in the history of Boonville."[18]

Perkins arrived in Springfield in the summer of 1882, carrying waterworks plans and his standard ordinance. Several proposals generated by local mechanics had already been defeated by voters. A former mayor introduced Perkins at a meeting of city council and he presented his detailed plans for a waterworks in an "able and satisfactory manner."[19] Council eagerly fashioned an ordinance from his proposition, which voters subsequently ratified, 733 to 187.[20] Perkins located the waterworks at Fulbright Spring, the site of a grist-mill from the 1830's and a favorite local picnic spot. Schools were

Moving Ahead

dismissed a half hour early to witness a test of the new system in November 1883, when firemen sprayed water onto the tallest buildings downtown.[21]

In St. Joseph, the City Council passed an ordinance to establish a waterworks in December 1879. The system was completed in 1881, using water pumped from a station on the bank of the Missouri River to a reservoir, 300 feet above the river level. It is interesting to note that local businessmen had already tried a scheme in 1874 to pump "pure water" from a caisson sunk "a considerable distance below the level of the river," but their "cherished hope" for a sufficient supply using this means was not realized.[22]

At least twenty other waterworks were established in Missouri towns during the 1880's. Supplies for Hannibal and Louisiana were pumped from the Mississippi River, while Independence, Lexington, St. Charles and Washington all drew water from the Missouri River. Carrollton, Clinton, Fulton and Marshall utilized wells, While Bonne Terre, Holden, Maryville, Carthage and Rich Hill used rivers or impounded creeks. Chillicothe, Mexico, Moberly and Trenton used some combination of streams, wells and impoundments.[23] In the 1890's, at least thirty-four cities in Missouri established waterworks. Warrensburg, Palmyra, Webb City, Bolivar, Mt. Vernon, Aurora, and Neosho all used springs as sources of supply. Osceola, Macon, Poplar Bluff and Verona used rivers and Monett, Princeton, Richmond and Tarkio used wells.[24] By the end of the 1930's, waterworks had been constructed in most of the rest of Missouri's larger cities. According to DNR Census of Missouri Public Water Systems, the peak of creation of new public water systems actually occurred in the twenty years following WWII, from 1950 to 1970, when 246 systems were established.[25] However, almost all of these supplies serve small communities and the vast majority used drilled wells.

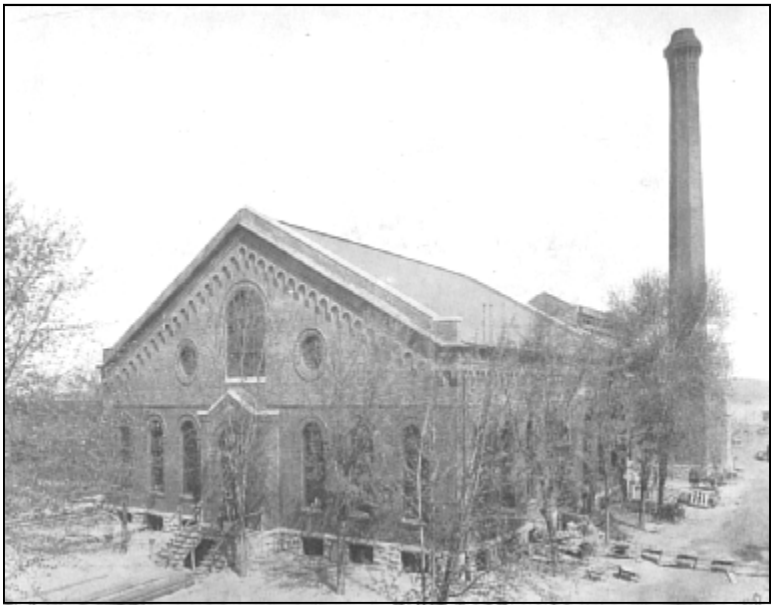
Water Main Construction in St. Joseph, ca. 1894 (Courtesy State Historical Society of Missouri, Columbia)

Running the Works

*P*rivate water companies built the first waterworks in most of Missouri's cities. Usually included in the contract was an option for the city to buy the waterworks at the end of the franchise period. As that horizon approached, citizens often argued about whether the city should secure the financing to buy the works or renew the contract with the private company. Many citizens thought that private water companies could operate more efficiently. Others felt that owning and operating the waterworks would help the city control its own destiny, by allowing it to direct growth and extend service to new areas as desired. Further, they argued, the waterworks could be operated at a profit and the surplus used to reduce bonded indebtedness.[26]

In 1835, St. Louis became the first Missouri city to acquire its waterworks after the private water company faltered. Fifty years later, Kansas City began a movement to obtain its privately owned waterworks in response to citizen concerns about source contamination, insufficient pressure and exorbitant rates. Urgent calls for municipal ownership began to appear in city newspapers. One disgruntled citizen referred to the National Waterworks Company as the "leeches that have festered and grown fat upon the blood they have drawn from this unsuspecting city."[27]

While negotiations with the water company in Kansas City crawled along, the city initiated steps to build its own waterworks, even advertising for bids in 1891.[28] In response, National Waterworks printed pamphlets pointing out that the city, based on a cost projection from one engineer, had placed $2 million in bonds for a new plant on the market, while another engineer had estimated that a new plant would cost at least twice that amount. The pamphlet blamed one particular council member and the *Globe* newspaper for initiating the unhelpful "agitation" for municipal ownership.[29] "Dark rumors" circulated in January 1892 that the water company planned to shut off the water because of the conflict, but it didn't happen. The city made an offer to purchase the plant in 1893, but the deal couldn't be struck because the company refused the terms. Finally, backed by a federal directive, the city purchased the existing waterworks in 1895 for 3.1 million.[30]



Quindaro Water Plant, Kansas City (Courtesy State Historical Society of Missouri, Columbia)

In 1889, Springfield's private water company was bought by a utility holding company headquartered in Portland, Maine. The city made an attempt to buy the waterworks in 1901, but Missouri's legislature had set limits on the bonds that a city could issue to a maximum of 5% of the city's assessed valuation. The $400,000 asking price for Springfield's waterworks was just too steep, and the opportunity slipped away.[31] During another purchase drive in 1905, the water company priced the waterworks at $700,000, which the president considered "fair and equitable" but

firm, providing "no occasion for any dickering."[32] Even though the state's bond limitations had been removed by then, the city council could not muster enough votes to call for an election and the issue died once more.

Another push for ownership developed in Springfield after the Depression. A Board of Water Commissioners was appointed in 1937 to oversee the anticipated municipal system and forces for and against public ownership squared off in an election in 1940. The negotiated price ended up at about $6 million. Opponents of municipal ownership pointed to the political corruption in Kansas City and its effects on public utility operations like waterworks. At the time, the Pendergast political machine was being dismantled, but the leader of Springfield's opposition argued that the lesson to be learned from that kind of political manipulation was clear—"extravagant and inefficient management."[33] The election failed, and the city did not purchase its waterworks until 1957, nearly three quarters of a century after its initial construction. By then, the price tag had soared to almost $20 million.

Cash flow was a continuing problem for many water companies, which frequently struggled to pay for new equipment and main extensions. Many companies had small customer bases when they first opened for business, causing operating revenue to accumulate slowly. Springfield's water company, serving a community of about 15,000, opened for business with only 31 subscribers, and when the National Waterworks Company began service in Kansas City, only

Springfield's First Board of Water Commissioners, 1937 (Courtesy City Utilities of Springfield Archives)

300 customers initially signed up.[34] Many people, especially those who had access to a good spring, well or cistern, simply refused to hook up. The Health Officer of St. Louis observed in 1873 that "well water, being cool, clear and palatable to those who have long used it, has its influence in determining people to continue its use, instead of the hydrant water." The Health Officer made a "correct registration" of the wells and cisterns still in use within the city of St. Louis, discovering 5,999 wells and 9,553 cisterns.[35]

At the time of the first waterworks, most homes had no indoor plumbing. The homeowner was responsible for connecting from the main to a single or a few hydrants in the yard or house. There were no meters. Water companies typically set license fees for specific appliances or uses, such as the number of tubs or water closets, or for livestock watering, lawn watering or street sprinkling. Complicated billing systems and the lack of meters made it difficult to police uses. In 1884, Springfield's water company issued a terse statement in a local newspaper: "Persons having license for sprinkling either lawn or street must confine themselves to the space paid for. A license for lawn sprinkling does not include the street."[36]

Sharing of hydrants between neighbors was common and, in the absence of meters, represented significant revenue loss for water companies. A notice in a Springfield newspaper warned that water licenses were "granted only

for occupants of premises where service is furnished" and "if they permit others to use the water of their service it will be withdrawn."[37] In 1890, stockholders of Jefferson City's water company, worried about unauthorized and unpaid uses, ordered the superintendent to "enforce the printed rules and regulations strictly" in order to obtain the "full value of earnings" of the waterworks. They called for the rules to be "enforced against everyone alike."[38]

Metering solved many of the problems of prescriptive billing, but there was at first resistance to the use of meters as well. Some public health advocates felt that metering would discourage bathing and cleanliness and therefore constitute an "obstacle to social progress."[39] Low water pressure, another common problem, was especially troublesome on hilltops or the upper stories of taller buildings. Customers complained so frequently about low water pressure that it typically became another reason for suggesting a municipality buy or take over the operation of a privately owned waterworks.

Early 1900's Yard Hydrant (Photo by Author)

Choosing the Source

The choice of where to obtain water depended largely on a city's geographic setting in the state. Large rivers were obvious choices for cities located near them, but in other parts of Missouri, water suppliers had to consider alternatives such as springs, streams, impoundments or deep wells. Each of the source types presented unique challenges in terms of pumping, clarifying, treating, storing and delivering water to customers.

At first, most cities depended on individual shallow wells, cisterns or springs, and sometimes, in the public interest, cities owned or managed these sources. In Kansas City, municipal cisterns were maintained at "strategic points" for fire fighting.[40] The city of St. Joseph established cisterns of 1,200 barrels capacity each throughout the city for fire protection.[41] In 1872, the city of Springfield passed an ordinance protecting the public well and providing fines or imprisonment for those who might "carelessly or maliciously" handle the pump.[42] Many cities quickly outgrew these minor sources or they became polluted or unusable as development surrounded them. A Kansas City history stated that "many fines springs" once flowed at the original town site, but in grading streets and excavating for building the springs were "covered over and their veins laid bare and dried up."[43]

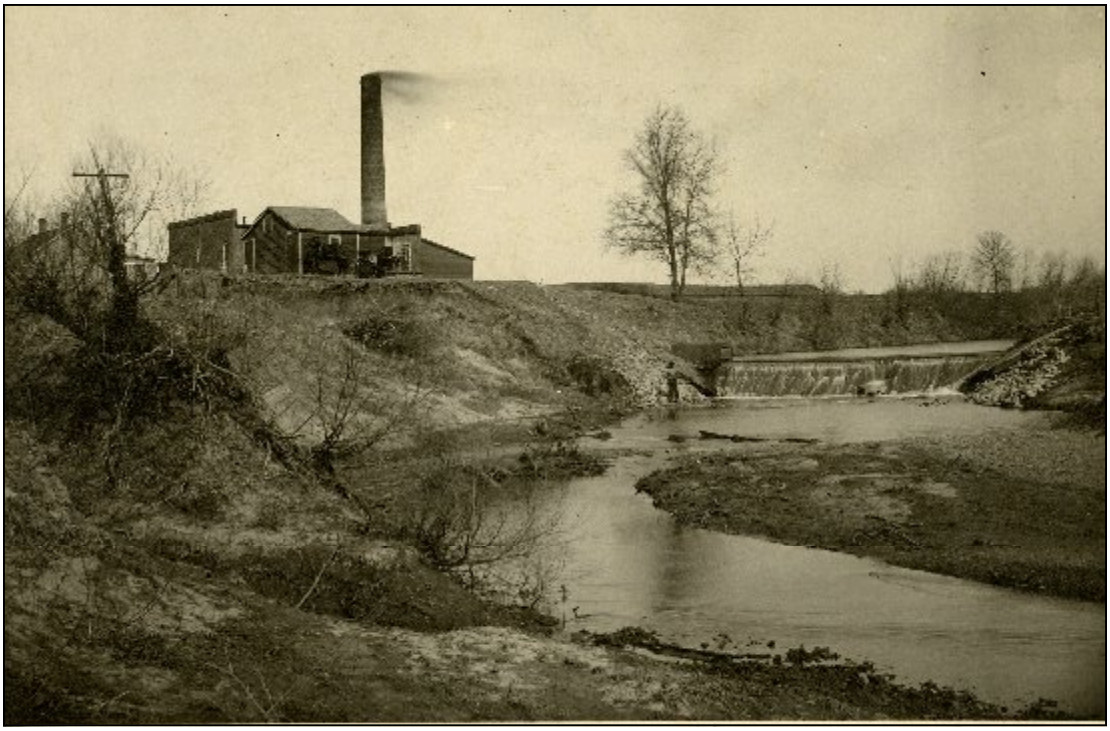
Many Ozark towns used springs for their early waterworks, although almost all of them eventually turned to deep wells. In the nineteenth and early twentieth centuries, geologists, doctors

and engineers all recommended springs as drinking water sources because of their "everlasting flows" and assumed "purity." In 1910, a University of Missouri publication repeated a commonly held notion about springs: "As a rule their waters are palatable, wholesome and free from organic impurities" owing to "natural filtration" in the "subterranean strata."[44] Only later were scientists able to show that most springs were, in fact, easily contaminated.

Cities in the north part of the state, without the benefit of springs or large streams, often built dams on small creeks for water supply impoundments. But droughts were a real problem for these sources. A state water plan in 1938 noted that the cities of Cameron, Bethany and Marceline found their water storage facilities woefully inadequate during the droughts of 1930, 1934, and 1936.[45] Another problem for north Missouri reservoirs was the heavy silt loads of inflowing streams, causing an accumulation of sediment and loss of storage capacity.

For cities such as St. Joseph, Kansas City, Jefferson City, St. Louis and Hannibal, the big rivers flowing at their doorsteps were obvious choices for water supplies, but using these rivers presented certain problems. The Missouri and Mississippi Rivers carried huge loads of sediment resulting from the erosion of a large portion of the continent's interior. They also contained organic and industrial wastes discharged from cities upstream. Cities served by these rivers were therefore forced to build large and expensive settling basins in efforts to clarify the water before pumping it into mains.

In St. Louis, water from the Mississippi River at first received only a modest amount of settling in a drastically undersized basin. By 1849, however, the small basin had been abandoned and a new waterworks of seven million gallons per day capacity constructed. Another reservoir, of forty million gallons capacity, was added in 1854, and the "magnificent works" at Bissell's Point built in 1871 could produce nearly sixty million gallons per



Dam and Waterworks for Maryville, Missouri (Courtesy State Historical Society of Missouri, Columbia)

day. From an oval-shaped inlet tower in the in the river water was pulled through a pipe over five feet in diameter and pumped into four basins, each eighteen feet deep. These large basins allowed water to settle long enough to be "tolerably well freed from sediment" before it was pumped again to a standpipe a mile distant at Grand and 14th Street.[46]

In spite of these improvements, some citizens complained about the frequently murky drinking water in St. Louis. Mark Twain once joked about the city's water that "every tumblerful of it contains nearly an acre of land in solution."[47] Many residents, however, simply got use to it. Twain suggested that this made it easy to spot strangers in St. Louis. They let the sediment settle in their glasses before drinking, while natives, who considered the mud healthful, "do not take them separately, but together, as nature mixed them," stirring their water and then taking the draught "as they would gruel."[48]

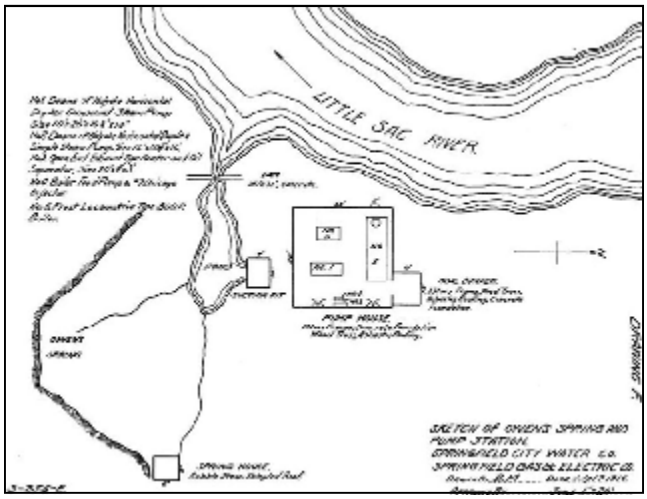
Most of Missouri's communities, of course, did not have big rivers flowing nearby. For the majority of them, the water supply future would be found in groundwater obtained through wells. Hydraulic rotary drilling, developed in Louisiana's oil fields in the early 1890s, greatly advanced the technology and had become commonplace by 1910.[49] Drillers could now reach deep into the hard bedrock underlying much of Missouri, where usable, clean and often prodigious amounts of groundwater could be obtained. Exceptions were the St Francis Mountains region, where dense volcanic rocks produced very little water, and the alluvial boot heel of southeastern Missouri, where shallow wells or well points driven into saturated gravels and sands just below the surface produced huge volumes of water.

Deep wells could not always be counted upon to produce high quality water. This was especially true outside the Ozarks, in the western and northern parts of the state. In Appleton City in St. Clair County, a well was used for a few years but eventually "discarded" because it was so mineralized, corroding the pipes and casing and "killing the neighboring vegetation."[50] A water supply well was sunk in Fayette to 860 feet, where "so strong a flow of salt water was encountered that the original idea was abandoned."[51] In Clinton, an 800-foot well drilled in 1887 produced disappointingly saline water but a second well, drilled only a few hundred yards away, turned out to be "fresh," so was used instead for the city water supply.[52]

In 1907, Edward Shepard, a geology professor at Drury College in Springfield working under contract with the United States Geological Survey, published a survey of Missouri's public water supplies. He noted that of the 103 public water systems in the state at the time, thirty-four were using wells as their source of water. Twelve systems depended on springs, thirty-nine used rivers or streams, and eighteen used some combination of streams and wells.[53]This diversity of water

Clinton Artesian Well *(from Shepard: Report on Mineral Waters, Mo Geological Survey, 1892)*

supply sources reflects, to a great extent, the varied geologic and hydrologic settings of the state.

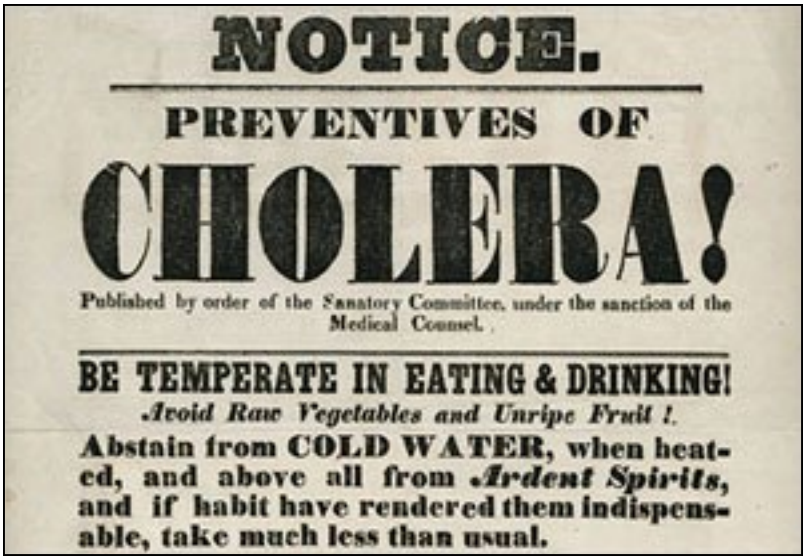


A Spring Water Supply, 1914 (Courtesy City Utilities of Springfield Archives)

The Promise of Purity

*I*n the last two decades of the 19th century, Americans began to learn how polluted drinking water could spread disease through the transmission of unseen bacteria, or germs. The germ theory of disease had first been advanced in the 1870s (a story about it appeared in the first issue of *Popular Science* in 1872) and in 1880, scientists isolated and identified the bacteria causing typhoid fever. By 1900, few water experts considered chemical analyses alone to be sufficient in determining the safety of drinking water.[54] Microbiological quality had to be considered. A.J. Detweiler, Missouri's State Bacteriologist, reported in 1902 that the "systematic examination" of the state's water supplies had begun, using both chemical and microbiological analyses, in a laboratory facility provided by the State University.[55]

Citizens were generally aware of the hazards of source contamination and demanded "pure" drinking water even before the major advances in microbiology. But between 1870 and the 1920s, when most of Missouri's larger communities obtained public water supplies, no drinking water standards were in place to determine what "purity" actually meant. In spite of this, Missouri's Public Service Commission, established in 1913, required public water systems in the state to issue "at regular intervals a certificate of purity."[56]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Published by order of the Sanatory Committee, under the sanction of the Medical Counsel.

BE TEMPERATE IN EATING & DRINKING!

Avoid Raw Vegetables and Unripe Fruit !.

Abstain from COLD WATER, when heated, and above all from *Ardent Spirits*, and if habit have rendered them indispensable, take much less than usual.

National Public Health Service bacteriological standards were in place by 1914 (governing only interstate carriers), but it wasn't until the 1920s that bacteria were routinely tested for in most public water supplies.[57] This sometimes placed Missouri's early water companies in awkward situations. They had only rudimentary scientific tests to back up their claims of delivering "pure" water to their customers. And while they did their best to deliver high quality water, that quality sometimes varied. In the absence of credible scientific information, their water sometimes became the subject of widespread suspicion and fear, especially when disease outbreaks occurred in the community.

The Promise of Purity

Even prior to the introduction of filtration and disinfection, however, public water supplies had already reduced the incidence of disease and saved lives. During a terrible cholera epidemic in the eastern United States in 1832, Philadelphia, which had a public water supply, suffered much less of the disease than New York, which had none.[58] Statistics compiled by the Massachusetts Board of Health showed that in the twenty years from 1865 to 1885, during which all of the larger towns in the state obtained public water supplies, typhoid death rates fell from thirteen to three per 10,000 people, a decrease of 70%.[59]

Much of the improvement was due to a general awareness that using sources tainted with sewage or other wastes constituted an unhealthy practice. Many waterworks ordinances from the 1880s, such as those that Perkins brought to Missouri, contained language forbidding the use of sources contaminated with "excreta" or "sewerage." The distance separating a waste discharge from a source of drinking water seemed to be a major consideration, however. Many scientists and engineers ascribed to the views of the president of the New York Board of Health, who in 1873 stated that while big rivers served as the nation's "great sewers," the "natural process of purification, in most cases, destroys the offensive bodies derived from sewage, and renders them harmless."[60]

Vibrio cholerae

The problem of fouled drinking water sources in urban areas was well recognized by the 1880's. Dr. Albert Merrell, a medical doctor serving on the Missouri State Board of Health, described in an 1885 report how shallow wells could easily be contaminated by the "percolation of filth through the soil." He noted that the more "closely settled" the country, the greater the potential for contamination of "rain and well water." Like many scientists, he believed that oxidation and sedimentation of organic impurities would naturally purify the water in big rivers like the Mississippi and Missouri, but at the same time he regarded this an "unsafe assumption for smaller streams."[61] In 1891, Missouri's State Bacteriologist decried the "defiling" of the state's water supply streams with sewage and disease germs that were "not necessarily destroyed" in flowing waters.[62] The State Bacteriologist noted in 1901, however, that flowing streams were still preferable to most wells. He sampled one city's artesian well and found high numbers of bacillus coli, while Shoal Creek, providing water to Joplin, produced "very good water."[63]

An early solution to the problem of fouled river sources was to move the intake upstream of a city, above immediate sources of contamination. This was the first thing that St. Louis tried. In a paper written in 1860, William Carr Lane, a medical doctor twice mayor of St. Louis, pointed out that the city's water supply suffered "great deterioration from nuisances of every conceivable description and unavoidably cast into the river above the waterworks." He lamented the fact that water drawn at this point was at one time clean and unpolluted and would "remain sweet for more than a fortnight, in an earthen jar or barrel."[64] Lane argued for

The intake to be moved above the city. The St. Louis Board of Water Commissioners, reporting in 1865 on the location of a new waterworks, echoed Lane's logic. There was definitely a need to look further upriver for an intake, to "satisfy the reasonable prejudice of the community against the use of impure water." Chain of Rocks, the commissioners reasoned, was far enough above "contaminating influences" to furnish "pure, living water."[65]

Kansas City faced similar circumstances. Within a few years of the establishment of the waterworks on the Kansas (Kaw) River, questions arose as to whether this had been the best choice for an intake. The wastes of Kansas City were mostly discharged downstream of the intake, but when the Missouri River flooded, as it often did, floodwaters backed into the mouth of the Kansas, stagnating its flow and contaminating the intake area with slaughterhouse wastes and sewage. The National Waterworks Company moved the intake to the larger and more powerfully flowing Missouri River in 1887, even though several large cities upstream discharged sewage into it. At the same time, the company built a new waterworks at that location, near Quindaro Kansas, just over the state line and about five miles upstream of Kansas City.[66]

Not surprisingly, bottled water vendors capitalized on the public's fear of contaminated public water supplies. An advertisement for a bottled mineral water in the *Kansas City Star* in 1892 proclaimed that "statistics show that bad water causes more deaths than war, whiskey or famine."[67] The ad purported to show two drops of water, magnified 800 times.

A River Intake (Courtesy City Utilities of Springfield Archives)

The first was Hygeia Mineral Spring Water, which was clear; the second was a drop of city water, filled with particles, presumably sediment or microbes. The ad blared, "Which would you drink?"

Typhoid was the primary waterborne disease of concern in the early part of the twentieth century, but in the first half of the previous century, it had been the much dreaded cholera. With increases in steamboat travel after the 1820s, big rivers served as conduits for the rapid spread of disease. Cholera, most likely originating from New Orleans, visited St. Louis in 1849 with devastating results. At the height of the epidemic that summer, over 700 people died in one week.[68] Further, some people blamed public water supplies for the spread of the epidemic, since St. Louis University, which had its own wells, did not report a single case of cholera.[69] By 1900, cholera had been drastically reduced in American cities by quarantines and sanitary measures.

Typhoid, however, remained endemic in Missouri as elsewhere in the country. In 1900, 40 people per 100,000 died of typhoid fever in Kansas City and 29 per 100,000 in St. Louis.[70] Typhoid remained a serious problem in 1912, when 76 people died of the disease in St. Louis, 33 in Kansas City and 25 in Springfield.[71] And in 1918, the State Bacteriologist reported over 200 cases of typhoid in one north central Missouri town, where the city

water intake was located "approximately 250 yards below a sewer outfall" and the water furnished to patrons was "filthy beyond imagination."[72]

Typhoid Treatment ca. 1900

Ironically, St. Louis had by 1900 already investigated, but elected not to use, a method that might have improved the city's drinking water quality and reduced disease. In 1865, the St. Louis Water Commissioners sent James Kirkwood, a prominent Scottish engineer living in Brooklyn, to study the methods that European cities used to cleanse their murky river sources. Kirkwood visited nineteen cities, including Berlin, Liverpool, Edinburgh, Dublin and Marseilles. He was recalled before completing his study, but never-the-less brought back to St. Louis plans for a sand filtration system—plans that weren't adopted because in his absence all of the commissioners had been replaced with people opposed to filtration.[73]

The issue of polluted source water flared up in St. Louis in 1900, when the state of Missouri sued Illinois and the Sanitary District of Chicago over the alleged pollution of the Mississippi River, the source of drinking water for St. Louis. Chicago had for years been plagued by sewage contamination in Lake Michigan, that city's drinking water source. A significant rise in typhoid cases had been noted to "follow the freshets whereby the waters of the open sewer known as the Chicago River have been carried into the lake and thence into the city water pipes."[74] Engineers tried piping the sewage over four miles out into the lake, but it was not enough. Beginning in 1892, workers began dredging the Chicago River, diverting its flow into the Des Plaines River, a tributary of the of Mississippi, and thus directing sewage away from Chicago and toward St. Louis.[75] The Health Commissioner of St. Louis complained about this situation in 1897, when he wrote that "soon all the filthy sewage of Chicago will probably be sent to us by the Drainage Canal, through the Illinois River."[76] The Commissioner went on to point out that "the best method of rendering a polluted supply pure is by filtration on a large scale through sand," an ironic statement given the fact that his city had rejected the idea of sand filtration thirty-two years earlier.

Filter Gallery, Fulbright Plant, Springfield (Courtesy City Utilities of Springfield Archives)

By this time, practical applications of sand filters backed

up the Health Commissioner's conclusions. Studies beginning in 1892 showed that Hamburg, Germany, which used sand filtration, enjoyed a markedly lower incidence of cholera than the city of Altona, which did not. Even more telling, Hamburg drew its water from the river downstream of Altona and its sewage discharges.[77] Similar results were seen with sand filters and typhoid fever in Lawrence, Massachusetts, where filtration experiments began in the late 1880s.[78] In spite of these encouraging results, it took some time for the technology to spread. Less than two percent of the urban population of the United States drank filtered water by 1890, and very few water systems in Missouri used sand filtration prior to 1910 (Hannibal used a small gravel and sand filter beginning in 1882, Rich Hill used a Hyatt sand filter in 1886, and sand filters were constructed for the city of Louisiana, Missouri in 1899).[79]

Studies on the transmission of waterborne diseases also began to cast doubt on the theory of river self purification. Missouri's attorney in the lawsuit against the Chicago Drainage District pointed out "it is but natural to believe that with a stream velocity of from eight to eighteen days from Chicago to St. Louis, considerable infectious material finds its way to St. Louis."[80] A St. Louis medical doctor, Gustavious Heinrichs, put it in blunter terms, observing of Chicago's officials that "instead of disposing of their sewage in the manner of civilized people, they act toward St. Louis like the criminal who throws his slops into the cistern of his neighbor."[81] In spite of pleas to force Chicago to send its sewage elsewhere, the federal judge eventually dismissed the case, ruling that the sewage had become adequately diluted and its harmful ingredients diminished by the time it reached St. Louis.[82]

Meanwhile, St. Louis faced other kinds of water problems at the dawn of the twentieth century. The Louisiana Purchase Exposition and World's Fair was coming, and local civic leaders worried that an episode of cloudy public water might embarrass the host city.

Louisiana Purchase Exposition and World's Fair, 1904 (Courtesy State Historical Society of Missouri, Columbia)

When considering the possibility that "muddy Mississippi water" might flow to them through city mains, fair organizers "raised their voices in protest."[83] They were particularly concerned that murky water would spoil the visual effects of the "Cascades" and the other elaborate waterfalls and fountains at the fair.

St. Louis had begun planning for new and larger settling basins in the late 1880s, and had directed James A. Seddons to study the "natural laws" governing sedimentation rates.[84] His findings, along with the later work of a St. Louis waterworks chemist, John Wixford, indicated that the sedimentation process would be greatly accelerated and improved with the addition of a proper coagulant.[85] Thus, in early 1904 St. Louis became the first large city in the country to use ferrous sulfate and lime to improve water clarity.[86] There would be no complaints about murky water during the Fair.

In spite of the city Health Commissioner's observations about sand filtration in 1897, St. Louis would not adopt this technology until 1915, fifty years after Kirkwood returned from Europe with that recommendation (although, to be fair, the rapid sand filters actually constructed were much advanced over Kirkwood's earlier slow sand filter design, which most likely would have performed poorly in St. Louis).[87] The plant built in 1915 was at the time the largest rapid sand filtration system yet constructed in the U.S., capable of producing 120 million gallons per day at the Chain of Rocks, upstream of the old pumping station.[88]

Kansas City faced similar problems with sediment, which at the Quindaro plant would accumulate in the basins to four feet thick over a typical season. The city also suffered from typhoid outbreaks in 1903 and 1910. Suspected sources of typhoid germs were the sewers of Leavenworth, Omaha and St. Joseph, upstream. The city began chlorinating its water to kill germs in 1911, and typhoid deaths dropped after that from 35.6 per 100,000 to 13.8.[89] But cloudy water remained an occasional problem, and customers were advised to boil their water at times. Kansas City finally passed an $11 million bond issue in 1922 to construct a new rapid sand filtration plant, which went into service in 1928.[90]

Springfield built its first filtration plant in 1910, after a vexing year for the private water company. In the summer of 1909, a flood washed out a reservoir dam and muddied the city water for several days.[91] This added fuel to the fire, already burning brightly, for public ownership of the waterworks, and the water company knew that if it wanted to stay in business in Springfield, it would need to make improvements. In late 1909, the water company president brought R. E. Milligan to town, representing the New York Continental Jewel Filtration Company, which at the time had constructed over 90% of the filtration plants in the country.[92] Milligan designed and built a 6 million gallon per day rapid sand filtration plant for Springfield. At a ceremony on Thanksgiving Day, 1910, the mayor pulled the lever to start the new plant in operation, giving thanks and proclaiming, "I feel sure that muddy water is a thing of the past."[93]

Modern Filtration Plant, Blackman Plant, Springfield (Courtesy City Utilities of Springfield Archives)

The Promise of Purity

Other cities that used surface water eventually either switched to other sources or installed water treatment plants. Voters in Carthage passed a $220,000 bond issue in 1907 for a new filtration plant and upgrades to the distribution system, which were completed in 1910. However, when Carthage's waterworks were first built, in 1881, a crude rock and gravel "filter" had been included in the design.[94] In Jefferson City in the early 1920s, the water company argued for a rate increase before the Missouri Public Service Commission in order to finance a new filtration plant.[95] This commission of four people appointed by the governor was created in 1913, and ruled on issues of rates and service provided by the state's investor-owned public utilities, including water supplies.[96] Jefferson City's new filtration plant was completed in 1926.

Elevated Water Tank Under Construction (Courtesy City Utilities of Springfield Archives)

Few proven cases of disease connected with public drinking water came to light after the widespread adoption of filtration and chlorination and routine testing of water supplies. By the end of the 1930s, Missourians enjoyed low rates of waterborne disease and, for the most part, safe public drinking water. Prominent engineers became confident by the 1940s and 1950s that sophisticated water treatment technologies could remove any and all pollutants. To some of them, the quality of the source water was no longer a major consideration. It was a dangerous illusion—one that would vanish in the ensuing decades when new facts about drinking water pollution and the limitations of water treatment technologies, including filtration and disinfection, came to light.

Growth and Prosperity in the 1950's (Courtesy City Utilities of Springfield Archives)

Back to the Source

*P*roblems encountered with using big rivers for drinking water first suggested a reconsideration of the importance of source water quality. After World War II, the production and use of synthetic organic chemicals rose steeply in the United States. Most large cities at the time still employed only primary sewage treatment. As a result, millions of gallons of poorly treated wastewater along with huge volumes of industrial waste poured into the nation's waterways. Studies conducted in the 1960s at New Orleans, on the receiving end of much of the sewage and industrial wastewater of the entire mid-continent, revealed that some organic chemicals had managed to penetrate water treatment plants. These troublesome compounds showed up, albeit at low levels, at the city's drinking water taps.[97]

Decades earlier, some scientists, doctors and engineers had seen this problem coming, at least in a general way. By the late 1800s, a growing number of astute individuals realized that the unabated pollution of the nation's air and water would eventually result in major problems for public water supplies. Recognizing the pollution threats from industrial emissions and the widespread burning of coal, Dr. Albert Merrell of the State Board of Health observed in 1885 that water sources could be kept clean only in "sparsely settled regions where the atmosphere is free from gaseous impurities."[98] In 1907, geologist Edward Shepard noted of Missouri's surface waters that "these are so generally becoming polluted with sewage, manufacturing wastes and in other ways, that the problem of pure water is yearly more and more serious."[99] But three decades later, the same kinds of problems persisted. In 1938, in Missouri's first water plan, the writer suggested that "pollution of the streams, lakes and springs in the state is assuming increasing importance, and there is a growing demand for knowledge as to its extent and intensity.[100]

Water Supply Protection Area Road Sign

For the most part, Missouri's prominent point sources of pollution, such as sewage treatment plants and industrial discharges, did not get cleaned up until basic water pollution laws were in place after World War II. But really significant improvements to the quality of the nation's waters, including those in Missouri, came about only after the passage of the Clean Water Act in the early 1970s. The first federal Safe Drinking Water Act, setting enforceable new standards for drinking water quality, became law in 1974. Suppliers now had to carefully examine their raw and finished water for a host of potential pollutants, both chemical and microbiological.

In an effort to protect sources, some of Missouri's water suppliers purchased or retained buffer lands around reservoirs, springs or streams. Typically, these buffers were narrow and offered only limited protection. Water providers sometimes undertook sanitary surveys of their watersheds, locating and mapping potential pollution source. For example, Drury College students in 1934 surveyed the McDaniel Lake Watershed, a water source for the city of Springfield, driving around on gasoline provided by the water company.[101] The students noted large

numbers of unsanitary dairy barns, hog wallows and outhouses. But neither the water company nor state or local governments had the authority or political will to deal with these "non-point" sources of pollution.

Population growth and urbanization also threatened some of Missouri's public water supplies. As development spilled into formerly farmed or forested watersheds, water supplies became increasingly subject to pollution from septic tanks, urban runoff, transportation accidents, pipeline breaks and fuel spills. In agricultural areas, water supply sources faced problems from animal waste, pesticides, nutrients and soil erosion. A myriad of potential sources existed in many of the state's water supply watersheds. Problems eventually began to show up in a few of Missouri's drinking water supplies, even in the rural areas of the state.

For example, atrazine, an herbicide used on corn, was found at levels above drinking water standards in some of north Missouri's water supply reservoirs. A deep public well in southwest Missouri became contaminated after a nearby electronics plant burned. When the ruins of the old plant were demolished, solvents flowed into an abandoned well in the basement of the razed building and a plume of contamination traveled toward the city's pumping well. A sinkhole-induced sewage lagoon collapse in south central Missouri allowed wastewater to travel many miles underground, possibly contaminating some wells along the way. And a water main

in one city may have allowed contaminated soil drainage to seep into the distribution system, resulting in an outbreak of toxic *E. coli*.

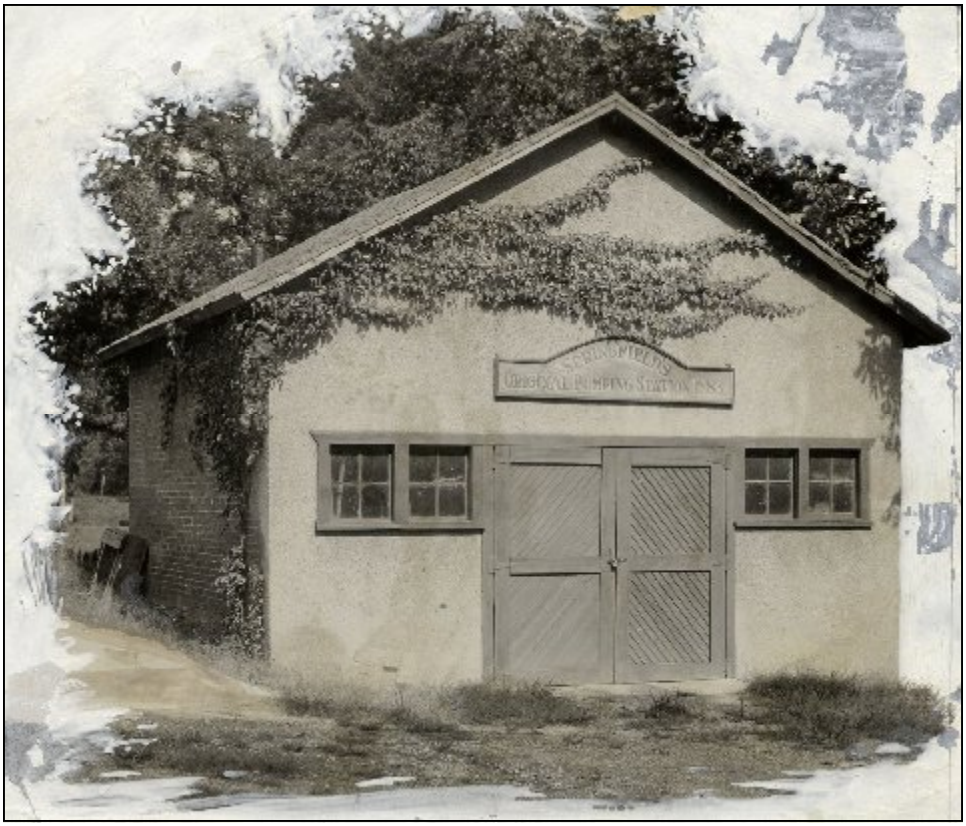
Other problems, although arising at least partly from natural causes, have been equally difficult to resolve. In western Missouri, an algae bloom on a small drinking water impoundment may have led to a few cases of illness. Some blue-green algae produce toxins that can pass untreated through water treatment plants. In this case, algal growth in the city's drinking water reservoir was probably stimulated by excessive nutrients from abundant waterfowl or runoff from the surrounding farmed lands, or both. In several of Missouri's communities, excessive growths of algae or

Algae

other organisms in water supply reservoirs have led to troublesome taste and odor problems, particularly when the lake water mixes (or, the lake "turns over") in the fall or winter.

Nowhere, it seemed, were our precious water supplies, whether surface or groundwater, perfectly insulated from problems. Eventually, with encouragement from EPA and the Public Drinking Water Program of the Missouri Department of Natural Resources, the state's communities began to take a closer look at protecting their source waters. This time, it wasn't just a matter of switching sources or moving intakes, because any source can be compromised if potentially polluting activities occur in the watershed. With pollution prevention as a re-awakened strategy, the emphasis began to shift once more toward keeping pollutants out of sources in the first place, rather than just focusing on their removal in the treatment process. Not only would this strategy help to protect public health, it could also save on cleanup costs and the avoidance of more sophisticated and expensive water treatment methods in the future.

Water supplies, it seems, had come full circle—from an absolute dependence on source water quality, through a period of perceived lessened reliance on that quality, to the realization that source protection should be a major component of the overall water supply management portfolio. In the twenty-first century, Missouri's water supplies remain vulnerable to the threats of drought and rampant development and pollution and overuse. We simply cannot afford to lose to pollution or wasteful practices the supplies that we use and depend upon today. At some point, there may be no new sources for Missouri's water suppliers to turn to, or enough high quality source capacity to meet all of the state's growing demands.



Original Fulbright Station, built 1883

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