Historic Context

Denver's Brick Sewers

Denver, Colorado

Colorado Department of Transportation, Region 6
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City and County of Denver, Colorado

Prepared by

Gail Keeley
Hermsen Consultants

Prepared for the
Colorado Department of Transportation, Region 6

and the
Office of Archaeology and Historic Preservation
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Executive Summary

Period of Significance: 1880-1937

Denver built its first sewers in 1880 to serve the needs of its growing population. The process involved with the development of sewers for Denver is summarized in the Timeline on the next page. The population has continued to grow and so has its sewer system. When first built in 1880, the sewers were designed to deal with the most serious problems - - the removal of human waste. Within a decade, sewers were also removing storm water. Some sewers were specifically designed for storm water removal and some were designed for combined use of storm and sanitary needs.

Brick was selected as the appropriate material for building Denver's sewer mains because of its durability and moderate costs. Bricks were also easy to work with because of their small size and uniform shape. They could be easily handled by the brick masons and worked well in building sewers in a variety of shapes. When installed properly with even surfaces and thin joints, they provided a true and fairly smooth interior surface which resisted corrosion. However, over time, concrete became more advantageous to use than brick.

Concrete Sewers

In 1909, the first concrete sewer lines were installed in Denver. They were lines greater than 18" in diameter in the North Denver Storm District. After the first installation in 1909, concrete gradually started being used for Denver sewers, and by 1924 it was the main choice. A few sewer mains were built of brick in 1937, but they were an exception and the last ones. Use of concrete had many advantages over use of brick for sewer lines, with the overriding advantage being its lower cost. Installation of concrete was more economical from a material and labor standpoint. Because concrete starts out as a viscous material, it can fit exactly to any irregularities in a sewer line excavation, providing better foundations. Concrete can be molded into any desired shape and size of sewer pipe. Concrete sewer lines have no joints like brick and are a solid structure less prone to uneven settlement. Lastly, concrete work can be done by relatively unskilled workmen, versus the skilled brick masons need for brick sewer lines.

Sewers mains were built of brick in Denver for over a half-century. Construction of brick sewers continued at a strong pace for about three decades before the first concrete lines were used. Brick sewer line construction continued at a moderate pace for another decade after the introduction of concrete lines. There was a decreased construction of brick sewer lines after 1923, but there were still a few lines built of brick through 1937. By 1938, brick was no longer used for construction of new sewer lines.

Timeline – Brick Sewers in Denver

Date	Event
1858	Denver's first settlers arrive.
1865	Water is brought to Denver.
1874	Discussion on health concerns from contamination of water by human wastes begins.
1877	Ordinance prohibiting cesspool construction except under certain circumstances passed.
1879 - August	Health concerns escalate
1879 - October	Public vote is held on whether or not to build a sewer system in Denver – approved by a wide margin.
1879 - November	Plans are prepared by City Engineer Lowrie.
1880 - March	Bids of sewer construction are let and awarded to Hugh Pritchard.
1880 - June	Construction begins on first sewer lines – sanitary lines in Lower Downtown. Brick is used for large lines and vitrified clay is used for the small lateral lines and collectors that connect to the sewer mains. Sewers discharge directly to the South Platte River.
1889	First brick storm sewer is built
1892	First large sewer - - Delgany Street Sewer is built
1895	Delgany Street Sewer Extension is built bringing discharge point further away from Downtown. Discharge point is now directly into the South Platte River at about 46th St.
1909	First concrete sewer is built - - a storm sewer in North Denver
1910	Large West and South Side interceptor sewer is built.
1912	Sanitary sewer system has grown to include a total of 362 miles of sewer lines. 10 miles were built of brick.
1912	Storm sewer system has grown to include 116 miles of sewer lines of which 24 miles are built of brick.
1937	Primary sewage treatment plant opens which removes the solids from the sewage. Liquids are still discharged into South Platte River. Last brick sewer is built.
1967	Secondary treatment plant opens and treats all sewage prior to discharge.
2012	69 miles of brick sewer lines remain in operation in Denver

Denver Brick Sewer Segments – What Remains Today

There are 46 miles of brick storm sewers, 16 miles of brick sanitary sewers and 7 miles of brick sanitary interceptor sewers for a total of 69 miles of sewer lines built of brick that remain in use in Denver today. The diameter of these lines range from a few very narrow ones with an 8" diameter to many extremely large lines with a diameter of 120" (10 ft.). Databases have been developed that show the location of all remaining brick sewer lines. Information included in the databases, which are developed and maintained by the City and County of Denver Wastewater Division and the Metro Wastewater Reclamation District, includes the diameter of the sewer segment, its length, slope and specific location. Information is also included on the specific sewer district that the sewer is located in and the year it was built.

Remaining Brick Sewers:

- 46 miles brick storm sewers
- 16 miles brick sanitary sewers
- 7 miles brick sanitary interceptor sewers

Continued Operation of Sewer System

The framework of the original brick sewer system in Denver is largely still intact. With more than a century of continuous use, there have been many changes over time. These changes have been in the areas of repair and replacement. The City of Denver has had no systematic plan to replace the existing brick sewer lines with concrete. When a city project, such as a street widening or replacement, affects a sewer line, it may be replaced with new materials.

At the end of 1911, there were 24.2 miles of brick storm sewers out of a total of 116 miles of storm sewers in the city. Brick lines accounted for 21% of the total storm sewer lines, vitrified clay pipe was 68% and concrete was used in 11% of the storm sewer lines. In that same year, brick sewers accounted for about 3% of the sanitary sewer systems and clay pipe made up 97% of the sanitary sewer lines. The main reason for that lower percentage is because so many of the lines in a sanitary sewer system are small laterals and collector lines that are less than 36" diameter and the smaller lines were mainly all built of vitrified clay.

Currently there are 1484 miles of sanitary sewer lines in Denver and 781 miles of storm sewers. The 23 miles of brick sanitary sewer comprise 1.5% of the total mileage of sanitary sewer. The 46 miles of brick storm sewers comprise 5.9% of the total mileage of storm sewer. Overall, brick sewers comprise 3% of the total mileage of sewers in Denver.

Integrity of Denver's Brick Sewers

The historic integrity of all the remaining brick sewer lines is good. The setting, location, feeling, association, design, materials and workmanship exhibited in the lines is basically the same as when constructed. That has changed is the integrity of the entire brick sewer system. New sewer lines have been built of concrete and portions of the brick lines have been replaced with concrete. All portions of the brick lines connect to other concrete lines at numerous points.

The importance of the brick sewer lines is mainly in their workmanship. The brick sewers exhibit high levels of workmanship with hand-laid bricks in a variety of sewer cross-sections from a single row of bricks in a circular pattern to oval-shaped and egg-shaped lines and circular lines with up to 4 rows of concentric bricks providing support for the overlying loads. Their importance is also in their ability to provide information about some of the first engineered elements of Denver as a newly established city. The brick sewers themselves can teach us much about early engineering by demonstrating sewer system design and construction techniques. And notably for Denver, their importance lies in that fact that more than 130 years since the first line was constructed, they are still in use providing waste and storm water conveyance for the city's needs.

The sewers themselves provide the important information about the sewer line design and construction techniques and will be useful in answering further research questions. Possible research questions that might be answered are: what supports were used for the sewer lines; what is the relationship of the thickness of cement lining on the exterior of the line to the number of rings of brick used to build the line; what conditions necessiated the use of 3-rings in the arch and one ring in the invert vs. 3-rings in both the arch and invert.

The brick sewer lines are associated with the early development of Denver and demonstrate the techniques the city used during the period of significance from 1880 - 1937 for dealing with the removal and conveyance of sewage and storm water. For these reasons, they have been assessed as eligible for inclusion to the NRHP under Criterion D.

Historic Context

Denver's Brick Sewers

Introduction

The purpose of this study is to present the history of brick sewers in Denver. In Denver, as in most developed cities, there are two types of sewers - sanitary and storm. Sanitary sewers are used to remove human waste and wastewater from individual buildings, and storm sewers are used to move runoff, mainly rainwater and snowmelt, from streets. In the late 19th century and early 20th century, many miles of brick sanitary and storm sewer lines were built in Denver. Eventually, sewers made of concrete became the accepted practice for sewer construction. As time went on, and sewer lines needed replacement or repair, they were replaced with concrete sewers. Today, 69 miles of brick sewer lines remain in service in Denver. This study provides the broad historic context for the development of brick sewers in the Denver area.

Early Sewers

The need for removal of human waste became a pressing issue long before the need to remove excess runoff from streets. Consequently, the history of the sanitary sewer goes back a lot earlier than that of the storm sewer. So the story of the development of the sewer starts centuries ago in widespread reaches of the world.

Earliest Sewers around the World

In today's society, we take sanitary sewage disposal for granted. We rarely think of all the health problems that are avoided by a fully developed sewage collection and treatment system. Today, all we do is depress a lever on our toilet. It is a part of everyday life. And yet, even as recently as 100 years ago, many people in America did not have bathrooms in their home.

Archaeologists have spent much time and energy trying to find out about early living patterns and the initial development of infrastructure. During an excavation in Skara Brae on the Orkney Islands off the north coast of Scotland, archaeologists uncovered a group of huts built of large slabs of stone. Along the perimeter walls of the huts, they found hollowed out places with a crude drain that let out of the hut to a type of underground sewer system.[1] These huts date back about 5000 years, making this site the first evidence of a technique to carry human waste away from a structure.

Skara Brae ruins

In the ruins of the ancient city of Mohenjo-Daro, situated along the Indus River in Pakistan, archaeologists found brick-lined sewers running along the side of wide straight streets. The sewers along the streets, built about 2000 B.C., connected to each house by an open, brick-lined gutter. The bathroom and kitchen wastes traveled through drains to the brick-lined gutters outside. The sewers along the streets brought the wastes to a large cesspool that was apparently cleaned out on a regular basis.[2]

The Minoan civilization is credited with the first toilet that actually flushed. This was the Queen's toilet, circa 1700 B.C., in the Palace of Minos at Knossos on the island of Crete. It had a seat and an earthenware pan with a system of pipes and drains where the water from flushing was connected to sewers.[3] The water pipes bringing water into the palace were made out of terra-cotta cones. The tapered end of one cone fit into the wide end of the adjacent cone. Strung together in a series, these cones formed a pipe. Water channels and drains in the palace emptied into a large sewer under the palace.

In Tel el Amarna, Egypt, a type of early bathroom dating to about 1370 B.C. was also discovered by archaeologists. These bathrooms were in private houses. They had a limestone slab in a corner of the house. The slab was surrounded by a low wall made of mud brick that was covered by stone. This area was for bathing. A person would stand on the slab and pour water over themselves which would drain into a large jar or through a channel that led through the wall and emptied outside the house. Archaeologists also found evidence of a limestone toilet seat. The limestone was smoothed and had a hole in the middle. Sand was placed under the seat and servants cleaned and changed the sand similar to the way people today clean and change kitty litter for their pet cats.[4]

One of the earliest evidences of using sewers to remove storm runoff was dated to about 500 B.C. - 4500 years after the first evidence of a primitive sewer for sanitary waste removal. It was in Rome where archaeologists found ruins of a 16 ft. wide tunnel, built around 500 B.C. of fitted stone blocks. It was called the Cloaca Maxima and was built to keep the streets from flooding.

Cloaca Maxima – Rome

A system of sewer pipes carried rainwater into the Cloaca Maxima. The sewer pipes also transported wastewater from kitchen drains and toilets.[5] Rome also had public toilets aligned in a row over an open trench filled with running water that collected and moved the human waste.

Earlier cultures had different perspectives on cleanliness than many of the more modern cultures. In a fair number of early cultures, bathing was rarely undertaken. In the 1400s, Queen Isabella of Spain, who funded Christopher Columbus and his crew on explorations, bragged that she had taken only two baths in her life.[6]

In Europe, in the 1500s, people relieved themselves in buildings wherever and whenever the urge came. This became such a commonplace occurrence that in 1589, the British royal court posted a public notice in the palace that read: "Let no one, whoever he may be, before, at, or after meals, foul the staircase, corridors, or closets with urine or other filth."[7]

For centuries, residents of a great many European cities, particularly in France, England and Germany, lived without a system for disposal of human waste. Large cities like Paris and London developed without latrines, baths or sewers. Surface ditches were built to carry away rainwater, but many citizens threw their human waste and trash in the ditches or out onto the streets causing the streets to reek. Parisians in the 1700s just had to put up with the filth. By the mid-1800s, Paris had wide sewers and Parisians were able to take tours through the wide sewers in tour boats equipped with wing-like devices that cleaned the sides of the sewer as the boat passed through. These boat tours continued for over a century, ending in 1970.[8]

It took a cholera epidemic to change things in London. In 1832, London was hard hit by the epidemic and thousands of people lost their lives. Cholera came back several times. Dr. John Snow, an English doctor, finally was able to prove that drinking water that had been polluted by sewage was the source of the cholera.[9] The English government then addressed the deadly problem by building a safe sewer system.

> "There is no truer sign of civilization in culture than good sanitation. A good drain implies as much as a beautiful statue."
>
> - J. C. Stobart, British writer on archaeology

Early Sewer Development in America

Early colonial towns and cities in America were built without sewers. People threw their human waste and garbage in the streets. This accumulation in the streets attracted pigs. Visitors to New York City in the 1840s saw thousands of pigs roaming the streets eating the garbage.

By the middle of the 1800s, people's attitudes about dealing with waste changed. Americans had heard of the devastating cholera epidemics in Europe and realized that good sanitation was imperative for good health. Boston was the first city in the United States to build a system to bring drinking water to its citizens and to build a hotel with indoor plumbing. Philadelphia was first to use cast-iron pipes for water delivery and Chicago is credited with being the first to build an advanced sewer system.

Large-scale production of toilets, sinks and bathtubs started occurring in American factories after the end of World War I. Public facilities where large numbers of people gathered, such as schools, factories, hotels and hospitals, all had indoor bathrooms.[10] By 1920, the plumbing industry had undertaken a strong sanitation promotional campaign. *Domestic Engineering Magazine* published a booklet that was widely distributed and helped gain widespread appreciation for the importance of bathing and sanitation in the home.

Denver became established about a century after many of the east coast cities in America. Consequently, there were many examples of sewer systems for Denver leaders to review in order to develop a course of action for Denver. Sewers need water to convey wastewater through the sewer lines, so it was critical for Denver decision-makers to determine how best to bring water to the city.

Water to Denver

Settlers first began arriving in the area that eventually became Denver in 1858. It was the lure of potential riches from gold that originally brought the earliest settlers. As the word spread, the number of adventurers moving into this area increased and so did the attendant challenges and problems. Settlers brought with them the need for land, food and water. Once settled, they created the need for disposal of human waste and trash.

The need for water is the most basic of all human needs. Shortly after the first settlers arrived in Denver, a company was formed to bring water by ditch to what was then Auraria. Nothing much happened in terms of additional water provision for the next 6 years. In 1865, the Whittier Ditch was constructed from the South Platte River near Littleton to the Capitol Hill area in central Denver. The ditch, which was used for irrigation, was eventually extended to City Park and was renamed the City Ditch.[11]

By 1868, community leaders were working hard to address the increased needs for water. Early residents needed the water for drinking and irrigation. As the number of residents increased, water was also necessary for fighting fires in the growing city as most of the early structures were built almost entirely of wood. It was proposed to build a reservoir south of town and then lay pipes through all the principal streets. The logic was that not only would this help with the threat of fire, but it would also help with the sanitation of the city. Having pipes running through all the principal streets and installing plugs at every corner would ensure that the gutters could be purified daily which would improve the overall health of the city, particularly during the warm months.[12]

The discussion of the need for a water system continued in 1868, with related discussion of the past season's outbreak of cholera and the expected continued large immigration that would undoubtedly bring more disease. Concern arose that if cholera and other such contagious diseases find Denver "without any means of purifying the streets and lanes, and mudholes of the city, no man can estimate the damage that will arise from its ravages." Cholera outbreaks in the United States occurred in 1849 and 1866.[13] While people were not sure at that time what caused cholera, they knew its effects. At first, victims just felt sick. Then it rapidly accelerated into vomiting, diarrhea, chills and dehydration. Their faces would turn blue and their feet and hands would be freezing. They could die within a few days or even a few hours of the onset. This is what made it so terrifying to the American people.

It was felt that the best solution to preventing widespread disease would be to introduce a water system. Newspaper editorials recommended that development of a system for water provision should be undertaken not only by Denver, but by other town and county organizations throughout the territory because disease could easily be spread to the surrounding areas as well.

After two more years of debate on the issue, the Denver City Water Company was organized in October 1870, for the purposes of bringing domestic water to Denver. By 1872, the water company had begun pumping from the South Platte River near Cherry Creek and delivering the city's first piped water. By 1878, the Denver City Irrigation and Water Company was incorporated as an auxiliary to the Denver City Water Company with a goal of providing even more water for Denver's growing population. The president of the water company was James Archer, and Colorado leaders David Moffat and Walter Cheesman were trustees. The company built a canal two miles in length that terminated in a reservoir they named Lake Archer, which was located on the east side of the river on what is now the site of Denver Water(1600 W. 12th Ave.) Up to 5 million gallons of water per day could be pumped from the supply in Lake Archer for use by Denver's residents.

A rival, the Citizen's Water Company, was organized in 1889 and brought some stiff competition to the water provision business. Neither company made a great deal of profits during those competitive times. In 1894, the two rival companies merged into the Denver Union Water Company. Not all Denver residents purchased the piped water. Many chose to purchase water from delivery wagons.

Horse-drawn water truck. Circa 1910-1915
Photo Courtesy of Denver Public Library, Western History Collection, Reference CHS – L1812

No matter how the water came into the household, there was no denying the fact that the growing population of Denver needed and demanded increased amounts of water. The piped water helped everyday life continue more smoothly for city residents. All seemed to be going well until October 1879**,** when a near epidemic of typhoid and other waterborne diseases brought the focus back to the waste side of the new water system. The cause of the epidemic was fiercely debated in the newspapers. Community leaders understood that threats of widespread disease were related to the sanitation conditions of the growing city and that action was needed to deal with these issues. [14]

Health Concerns / Politics of Planning a Sewer System

Denver, the new city on the plains was not such a healthy place to live in the early years of its settlement. During the summer of 1865, the fledgling newspaper reported that Denver citizens suffered much sickness and death due to illness from "cholera morbus, dysentery, flux and other diseases."[15] In March of 1866, a summer cholera epidemic became a very real fear for the Denver area. The city center was described as an area where: "Pens of hogs and litters of pigs wallow in the mud and mire of their filth...Carcasses of dogs, cats and chickens lie undisturbed...while the larger animals, such as horses, mules and cattle" are slightly more honored in death. After "being dragged through the principal streets," they find a resting place along swampy river beds or even in Cherry Creek itself.[16]

Cherry Creek, Circa 1900
Photo Courtesy of Denver Public Library, Western History Collection, Reference X - 18261

The appalling conditions described in this news article would have made Denver a perfect location for an outbreak of disease and the editors of the Rocky Mountain News appealed to the citizens of Denver to clean up their filth in order to better control diseases once they descended upon the city. The newspaper article declared citizens "indifferent" and the authorities "criminally negligent" for allowing the city to enter such a state of filth and implored all residents to keep their premises clean "before the time shall have come when efforts will be in vain." [17] While the article did not directly call for a system of city-wide sewers, it did make a plea for "strict sanitary ordinances" and "special officers... whose duty it shall be to see to it that these health regulations are enforced." [18]

Public Debate on the Need for a Sanitary Sewer System

The need for developing a sanitary sewer system in the city of Denver was discussed informally among residents and city leaders for a long period before it became a public issue. Jerome Smiley, in his 1901 *History of Denver*, noted that the public need for a general sewer system was obvious by 1873 and the subject of much discussion.

In February of 1874, City Engineer, Wm. Lloyd Peacocke, publicly raised concerns on the ideas for a system of sewerage in Denver. Peacocke feared that if "immediate attention" was not paid to the issues of sewerage in Denver, the results could have some very negative effects. He felt that developing a system of sewage disposal was "a matter of the greatest importance for the health of the city and suburbs" and one that should be undertaken immediately.[19] Another city engineer, Fred J. Stanton, said that the dirty wells and cesspools that dotted Denver were breeding grounds for "typhus and miasmatic fevers, cholera and their attendant minor and subordinate complaints" and the ceasing of their use would "save hundreds of valuable lives." The newspaper coverage of the concerns of these engineers initiated an extended period of debate and discussion on the pros and cons of a sewage system for the city.

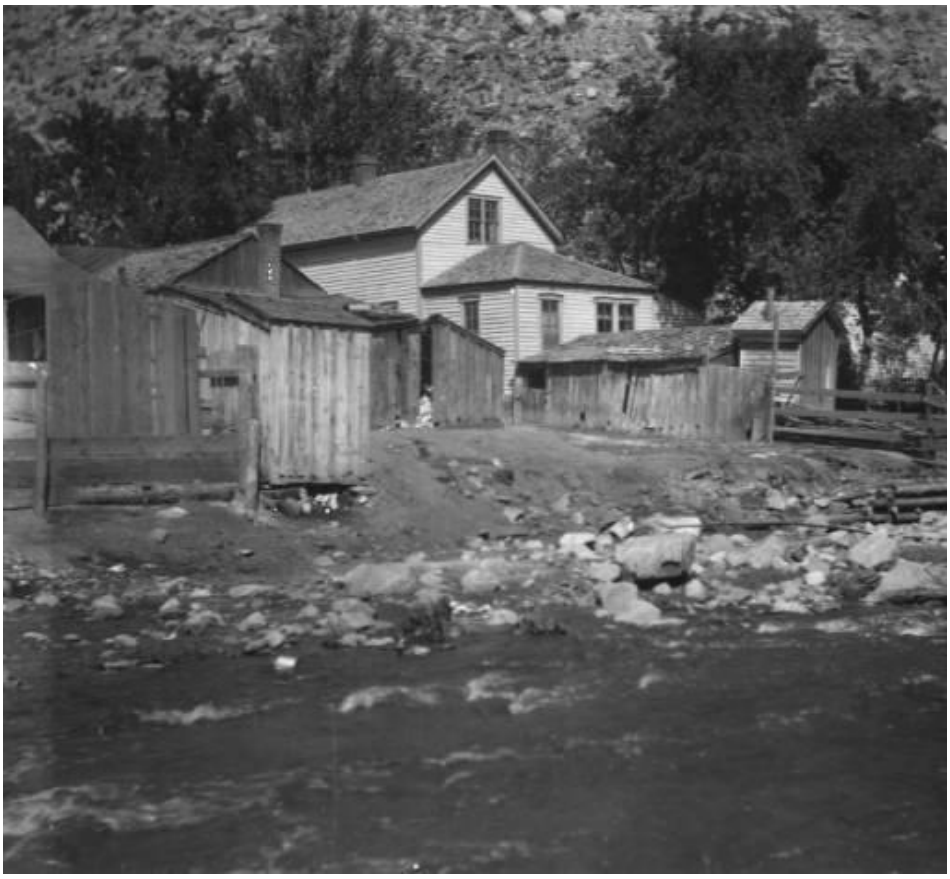
One of the health issues in Denver was the porous nature of the soil. People worried that if privies were placed in close proximity to wells used for drinking water, that "poisonous matter will filter through the gravelly strata" where it would mix with drinking water.[20] Citizens and some decision-makers felt that no well water could avoid being infiltrated by the increasing volumes of sewage, especially as the city of Denver and its suburbs continued to grow. This situation could only lead to "sickness and epidemic."

City leaders argued that if Denver was going to be the metropolis that it appeared to be, there needed to be sewers on every street with a main leg that extended into the South Platte River. The Rocky Mountain News declared that the best use of city funds was for a system of sewers through the city. The article asserted that while the cost could potentially be high to the city, the benefits outweighed the expenses and there was little doubt that property owners wanted to see their premises improved with sewers. [21]

Stemming from escalating debate on the need for sewers, Dr. Whitehead, Chairman of the Committee on Health and a member of the Denver City Council as Alderman from the Sixth Ward, was requested by the rest of the City Council to write a report on "some of the most essential requirements of Denver in reference to public health." In his report, published in the October 28th,1875 edition of the Rocky Mountain News, Dr. Whitehead did not seem to believe that a system of sewers and all the "evils, and inconveniences which accompany it" was necessarily the answer to all of Denver's problems. The doctor touted Denver as a healthy city with an extremely low death rate, but acknowledged that deaths due to preventable causes need "earnest attention" especially since many ill people came to Denver for a sanitary haven.

Essentially, Dr. Whitehead believed that for Denver to be a cleaner city, its inhabitants needed to be cleaner people, regardless of whether there were sewers or not. Dr. Whitehead opined that,

> ...if man, like the cat, were naturally a hygienic animal and disposed each time of his excretions in the same careful and inoffensive manner that so peculiarly distinguishes this feline, cities would not be decimated from time to time by low fevers, and there would not be so much to say about the ill effects of privy vaults or sewer gas.[22]



House with privy. 1896
Photo Courtesy of Denver Public Library, Western History Collection, Reference X – 11152

Dr. Whitehead claimed to view the subject "as a physician and solely with reference to its bearing on public health." As such, Whitehead believed that sewers were not necessarily the solution and were, in his opinion, a waste of money. The doctor then referred to another doctor, Dr. C.C. Cox who served as the President of the Board of Health for the District of Columbia, who said, in 1873, that sewers themselves were becoming "a prolific source of disease and death, instead of means of their prevention." Dr. Cox maintained that sewers were also not a good idea "because they waste an immense amount of excrementation material, which should be used for agricultural purposes." [23] The language of Dr. Whitehead's report became almost ominous when he wrote that, "carelessness, ignorance or culpable negligence in the construction or use of soil pipes, drains or waste pipes, which connect with a sewer, may endanger the health of a whole family; and the entire district." [24]

Dr. Whitehead furthered his recommendation against a sewer system by referring to problems with other existing sewer systems in cities in the eastern United States. He brought up a situation in Massachusetts, a state he contended had "contributed more largely than any other

state to the generous diffusion of sanitary knowledge in this country." Whitehead said that imperfections in a sewage system created by the State Board of Health for Massachusetts caused a typhoid fever epidemic when a blockage in the sewer lines resulted in cellars filling with sewage. A prolific sanitary engineer, General Viele, was quoted in the report stating that disasters involving sewerage systems were not "an exceptional case."

Two days later, Dr. Whitehead published a "second paper" in the Rocky Mountain News under the heading *Sewerage in Its Relation to Health, and Its Adaptability to Denver*.[25] In the article, Dr. Whitehead explained that even though the Romans had an incredibly advanced system of underground canals for the purpose of removing waste and water, the porosity of the canals allowed for the "liquid filth of excretes, and other soluble impurities to permeate freely its massive walls." Any excrement that made it through the ancient sewage system ended up in a subterranean vault where the feces would then seep into the soil, "much in the same manner that such liquid filth now seeps from the privy vaults of Denver into wells at a convenient distance from them." [26] He persisted that if Denver were to create a sewerage system of "very porous brick" beneath some of the busiest sections of town, the speed of the sewers would have to be "very rapid" to ensure that the sewerage continued to its holding place or into the river rather than being absorbed into the soil surrounding the sewage pipes.

Cesspool Ordinance

It seems as though Dr. Whitehead's papers on the non-necessity of a sewerage system in Denver in regard to the public's health were taken seriously enough to dispel any future questioning on a sewer system until 1877 when the issue of contamination from cesspools was presented to the public. Many people in Denver used cesspools as a waste collection system for their homes. Cesspools are the holes in the ground under an outdoor privy or indoor toilet that hold the accumulated waste. The contamination of nearby soil from leaking cesspools became a big enough problem that on May 18, 1877, the Denver City Council agreed to prohibit "the construction of any cesspools within the more thickly settled portions of the city, except under certain conditions." [27] Those conditions were basically to ensure that the cesspools constructed to be water-tight, which was something that was hard to achieve. The ordinance the City Council passed was intended to "secure the safety and health of the public both from the danger of cesspools caving in, through faulty construction, and from the evils of such a thorough contamination of the soil beneath." The new ordinance was fully supported by the Rocky Mountain News.[28]

While the public may have been the driving factor in creating the new cesspool mandate, there was some doubt that the law would be viable as the Rocky Mountain News said that cesspool ordinances had "never been enforced for any length of time." Residents believed that soil in highly populated areas was "already so polluted that no further drainage" would impact the area and that those existing cesspools should be left alone.

The ordinance prohibiting the construction of cesspools created an immediate problem for new incoming residents. What were they to do with their waste if they couldn't collect it in a cesspool? This spurred an intensified round of debate and in-depth study on the benefits and the problems associated with developing a public sewer system. On November 4, 1878, the City Council called a special meeting to discuss the subject of a sanitary sewer system. They appointed a committee with Mayor Sopris acting as Chairman, and instructed them to visit St. Louis to study their sewer system and method of financing it. A few weeks later, on December 8, 1878, the committee reported back to City Council.[29]

Mayor Richard Sopris. 1891
Photo Courtesy of Denver Public Library, Western History Collection, Reference Z - 4980

Colorado Law Allows for the Establishment of Districts by Ordinance

One of the necessary steps to position the city for establishing a system of sewers was to amend the state law incorporating the city of Denver to allow the establishment of districts by ordinance. This was completed by passing an Act on February 19, 1879, which gave the City Council of Denver the right to establish and maintain a sewer system and required that:

- City Council establish sewer districts by ordinance.
- Sewers would be constructed whenever the majority of property owners in a district petitioned for one or if the Board of Health recommended it for sanitary reasons and it was approved by City Council.
- No public sewers would be constructed until an election on the issue was held and the majority of taxpayers voted approval.[30]

Delays in Coming to a Decision on a Sewer System

No decision on moving forward with a sewer system in Denver had been made by the following summer and residents were getting irritated and impatient. The August 6th, 1879 edition of the Rocky Mountain News turned to sensationalism to spike the fear that one day Denver would "suddenly wake up to the fact that the ground beneath us is so thoroughly impregnated with decomposing filth" that the city would be inhabitable. The newspaper wanted to explain to the public that while externally things may look clean, nothing but a good sewer system could "avert the ruin of our city's health and prosperity." The article claimed that every privy in Denver was "dug into a porous soil which rapidly absorbs filth" causing the sewage to seep in every direction "like a poisonous tree planted upon each lot." [31]

This delay in creating a system of sewerage alarmed one correspondent to the extent that he wrote an editorial stating that he felt the prolonged absence of a sewerage system was in the financial interest of Denver's water company. Cesspools were allowed by the government to be excavated to the level of the "purest and best" water vein, which in turn would contaminate "the purity of water in the wells for an unknown distance all round." He surmised that the tainted water supply of nearby wells would drive people to "abandon their wells and take water from the company." [32]

Public Vote on a Sewer System

Finally, in September of 1879, "as a reluctant concession to indignant public opinion" the City Council agreed to hold a public vote as to whether the city should spend $15,000 on building a system of sewers in 1880. Even though the Council had decided on a price parameter for the project, the general public was left unclear as to how the Council decided upon the $15,000 sum or as to what construction would take place with said money.[33] In an editorial published on September 18th, 1879, the Rocky Mountain News claims that with few details of the project, the people of Denver were left questioning what exactly they were voting on. The editorial proposed that the money could "be used in building a main sewer from the Platte bridge up Sixteenth Street or in extending a sewer along Wazee, emptying into Cherry Creek," but that no one was able to say what the exact intention was.

The local press editorial coverage surmised that a main sewer would "not cost less than five dollars a foot," so the proposed $15,000 amount would only allow for construction of at most 3,000 linear ft. [34] This short distance of sewer would "hardly bring it from the Platte into the central part of the city." The editorial made the assumption that if the proposed amount of $15,000 was not enough money to create a functioning sewer line, the whole plan would be "arrested."

Even with the Rocky Mountain News urging citizens to vote 'No' on the Denver Sewerage measure, a resounding 'Yes' was declared by the citizens of Denver. On October 7, 1879, out of 1498 responses, 1158 were in favor of sewers, while 340 stood firm in their opposition.[35]

A few days after the election, the City of Denver agreed to devote $20,000 to the building of a new sewer system instead of the previous amount of $15,000 which had been allocated. The people of the city felt that "all facts bearing on the subject should be brought out" as "it is highly important that there be a full and intelligent discussion of the plan to be adopted" in order to put the allotted money to the best possible use. Although the funding for the project was not as extensive as hoped, it also meant that people involved in the creation of the system needed to make sure that it was not wasted "upon a system that will have to give way to something better as the city grows." "Every citizen is now anxious that the start we now take shall not be a wrong one," as the sewer project would be an extensive endeavor with the city estimating that "the work of sewerage thus commenced will be an elaborate engineering achievement that will extend through years and cost from half a million to a million of dollars." [36]

In the Mayor's address published in the Rocky Mountain News on October 15, 1879, Mayor Sopris encouraged City Council to move on with "immediate and effective action" due to the "ample endorsement" from the public. Mayor Sopris suggested that they "do not permit the grass to grow or snows to fall before excavated trenches shall show the earnestness of your purpose to fulfill the wishes of your constituents." The Mayor recommended that City Council create a committee on sewers, to include Aldermen Morris, George Anstee and Flavius N. Davis

(who comprised the Drains and Sewers Standing Committee) and "two unimpeachable citizens and practical men" to help make decisions and ensure a proper construction.[37]

George Anstee, was born in England and came to Denver in late 1870 after emigrating to the United States in 1869. He first settled in Chicago, and then went south working at his trade as a contractor and brick mason. When Anstee came to Denver, he supported his family by making bricks, laying bricks and working as a building contractor. He was elected Alderman from Denver's Sixth Ward on the Democratic ticket in1875 and served one term from 4/1/1875 through 10/9/1877. He was re-elected to a second term which ran from 10/8/1878 through 11/4/1880. [38]

Flavius N. Davis was elected to the Denver City Council in 1878 as Alderman from the Fourth Ward. He also had a background as a brick mason starting out in 1853 in Michigan as an apprentice brick mason at the age of 16. He served in the apprenticeship for three years and then traveled working as a journeyman bricklayer. He married in July 1860 and worked in Sturgis, Michigan as a contractor. After the Chicago fire, he moved to Chicago working as a foreman on large construction contracts to rebuild the city. In 1872, he moved from Chicago to Denver, because of his wife's health, where he continued his contracting work which involved many of Denver's finest buildings including the Tabor Block and the Tabor Grand Opera House which opened in September 1881. [39] In 1878, he formed a partnership with E.E. Eaton (Davis & Eaton) for manufacturing brick.

Now that it was known how important the sewage project was to the citizens of the great city of Denver, city engineers wasted no time and started working intensely on detailed plans for a sewer system for Denver.

Planning for Denver's First Sewers

Issues related to the planning and construction of a system of sewers were complex and under much public scrutiny. Of utmost concern from the public's perspective, was where to dispose of the collected sewage. Citizens were also concerned about the health threats from build-up of sewer gas. From the perspectives of city's officials and engineers, whether the sewers should be for sanitary waste only, for storm water only or for combined use was a critical decision that would affect the design and implementation of the system.

Where to Dispose of the Collected Wastes

One of the biggest topics of discussion for the plans of the new system of sewerage was what was to be done with the sewage once it was collected in the sewers. The options seemed to be to let the waste empty into the South Platte River or to have the sewage collected, treated and then sold as fertilizer to the local farmers. City Engineer Wm. Lloyd Peacocke supported the use of the waste as a fertilizer for soil enhancement. He claimed that the waste would be "the best that can be procured for agricultural purposes" and that the scheme would "prosper if properly carried out." Peacocke also suggested that by adopting the method of spreading the wastes on farm fields rather than discharging it into nearby watercourses, "the waters of the Platte River will be protected."

Bridge over South Platte River. 1900
Photo Courtesy of Denver Public Library, Western History Collection, Reference X- 20830

The critics of the plan to sell human excrement as fertilizer claimed that it would not be cost efficient and that the farmers would not "pay to purchase sewerage from the City of Denver and haul it to the country farm," as they were farming on the "finest virgin soil in the world." It was also argued that the use of sewage as a fertilizer would not be successful in Colorado like it was in Europe, as land prices in Colorado were much cheaper and the soil quality was much better. Critics of the plan stated that manure was readily available in large quantities, but still farmers were not using it to better their crops.

Fred J. Stanton, another engineer for the City of Denver, disagreed with Peacocke. Stanton felt that the best choice for disposal of the collected waste material was to dump it in the South Platte River as that option was the most cost effective. He pointed out that no additional pump would be needed to push the sewage along as there was a "steep fall from every point in the city to the Platte River." Mr. Stanton declared that the "reckless extravagance" practiced by engineers needs to change and they need to "put the gauge of the most severe, rigid, practical economy to every scheme." His ire at the high cost estimates that were being provided to the city leaders for some of the options dealing with sewerage made him quip that they had "better charter the United States Treasury to run the machine." If the engineers were going to keep claiming such steep costs, they better be "brought down to business or engineers had better go to a lower order of employment." [40]

After much consideration, it was determined that the sewer system would eventually empty into the South Platte River. [41] The price of the bringing the sewage all the way to the South Platte River was a major factor in figuring out where to empty the sewage.

The decision to empty the sewage into the South Platte River received significant backlash from the public. As stated in the Rocky Mountain News,

> ...the deleterious effects of depositing the refuse of the city in the shallow Platte near the center of a populous and growing district, and among shops, offices, warehouses, and depots of wholesale merchants and the northern pooled lines, is a matter of sufficient

magnitude, in its relations to health and property, to demand the most careful attention at the hands of the council and engineer.[42]

The Rocky Mountain News put their trust "that the engineer's report will open a feasible, economical and desirable escape" from the evils presented by dumping sewage into the South Platte River in the middle of the city. A little more than a decade later, historian Jerome Smiley noted that “between the demand upon it for irrigation and the burdens imposed by the city sewers, the Platte is destined soon to become a most disreputable water-way.” [43]

“Rank smell of a thousand rotting eggs”

Sewer Gas

Blockages of sewer lines and the resultant build-up of sewer gas was presented to the public in an article published in the October 28, 1875 issue of the Rocky Mountain News by Dr. Whitehead of the City Council, as an issue that could potentially impact peoples’ health and cause dire consequences. Each sewer configuration, whether circular or arched or elliptical, led to issues of slow moving water or blockage. The best shape for continuous water movement was the “egg shaped” sewer, however the uneven sides created issues of blockage in the pipe which could cause the build-up of sewer gas.[44]

Dr. Whitehead wrote that “an obstructed sewer is worse than none” and could “produce the most repellant and nauseous odors during warm weather.” These gases were not just pungent, but potentially lethal. According to a sanitary engineer by the name of Latham, unventilated sewer systems throughout districts could lead to the spread of disease “from house to house by sewers and drains.” Dr. Whitehead described the “injurious gases” as “highly explosive” and having the “rank smell of a thousand rotting eggs, and very poisonous.” He continued that other gases emitted the “odor of a rank manure pile” and that some gas was “a fatal subtle, fetid and organic vapor that assiduously poisons the blood with typhoid, and other low forms of fever which kill, and the cause of the disease is unsuspected frequently, even by the medical attendant.” These gases were so problematic “that all sewers as well as all privy vaults should be ventilated, as it is better that sewer gases should escape into the air above the house tops, but not near chimneys or windows, than into the sleeping apartments of our people.” [45]

Sanitary, Storm or Combined Sewer Systems

A prominent consideration in the sewer debate was whether the sewers should contain both human waste and storm run-off or whether the first sewer lines should be for human waste only. With fecal matter in the sewers, the question then was whether it was a sound decision to dump the sewage into the South Platte River “when it is known that the people of the future towns along this river will depend on it for their water supply.” [46]

Storm sewers need to be larger than sanitary sewers because of the large flows after storms. Because the funding for a sewer system was limited, it was felt that the first construction should be of sanitary-only sewers. This would deal with the health problem and threat of disease caused by poor sanitation conditions in the city. The money allotted to the sewers would also

go further in building more lines, since the size of the lines would be smaller for sanitary-only sewers and less costly to build than the larger lines.

Sewer Line Materials and Design Considerations

Once the decision was made that sanitary sewers would be built first, the next key decision was to determine what material should be used to build the sewer lines. From that point, engineering decisions could be made on the size, shape and placement of the sewer lines.

Brick and Other Building Materials for Sewers

Part of the planning for the proposed sewer system was an important discussion of what materials to use to build the sewers. City staff looked at what type of materials had been used to convey water and sewerage in other cities. As with many towns built in the era, the primary building materials were wood and brick. Wood had been used extensively in water pipes and occasionally for sewers in other cities. Stone was used in some locations and iron or steel pipe was another option, although both of these options were seldom used by other municipalities. The availability of materials, costs and the size of the project were all factors affecting the decision on the type of materials to use for the sewer line construction.

Early sewers had been made of vitrified (glass-like) clay pipe or wood stave. The wood was durable and did not corrode. The staves, curved pieces of wood, were bound together by steel or iron bands. The material used also depended on the size of the sewer line. Clay pipes worked well for small lines, those generally less than 36 inches. In most cases those were the laterals. In fact, vitrified clay was used most of the time for pipes 24" or less and was often used for pipes from 24"-36" in diameter. Large sewer mains greater than 36" were generally built of brick which would not crack as easily as clay pipes.

Sewer crew laying clay line in trench. 1923
Photo Courtesy of Denver Public Library, Western History Collection, Reference X - 29451

Brick provided many advantages as a material for sewer line construction. Bricks were a very durable commodity and their costs were moderate. Bricks were also easy to work with because

of their small size and uniform shape. They could be easily handled by the brick masons and worked well in building sewers in a variety of shapes. [47] When installed properly with even surfaces and thin joints, they provided a true and fairly smooth interior surface which resisted corrosion.

Brick used in sewer construction, commonly called sewer brick, were burned harder than ordinary building brick. The harder burning in the kiln enabled them to hold up longer against breakdown from the continual flow of sewage over them. The enhanced burning process helped close up the pores in the brick and make them more impervious to leakage. Sometimes, vitrified paving brick is used for the inner ring of the sewer. This helps prevent damage to the inside of the sewer from high velocity flows and abrasive material carried in the sewage. The typical size for a sewer brick was 8½" long by 4" wide by 2½" deep.[48]

The City Council Committee on Drains and Sewers conducted research on the costs associated with construction of sewer lines. They found that the cost of excavation for a sewer pipe trench 8 to 12 ft. deep would be 75 cents per foot and the cost of laying and cementing the pipe would be 10 cents per foot. [49] Individual property owners would have to pay for the cost of the cross-pipes that connected their property to the sewer main.

Based on research by the Committee on Drains and Sewers and the city engineers, Denver eventually decided to use clay pipes for most all of the smaller lines in the city, but most of the lines 27" in diameter and larger were made of brick because of its strength and durability.

Competition for Contracts to Supply Bricks

There were several firms competing for the contract to provide brick for Denver's planned sewer construction. One of these firms was the Cambria Fire Brick Works in Golden, Colorado who produced brick from material mined from clay deposits about three miles south of Golden. Their main operation building was constructed in Golden over the summer of 1879 and ready for use by October 1, 1879. The company had stone quarries, silica beds, clay seams and lime kilns on a 160 acre site served by the Golden and South Platte Railway, which then connected with the Colorado Central to bring the materials into Golden. In November 1879, the company set up an office in Denver.

Cambria Fire Brick Works ran an ad for its products in the Rocky Mountain News that appeared in the November 11th, 1879 and January 1st, 1880 issues of the paper. The ad read:

FIRE BRICK. Fire Tile for furnaces, variegated 8 or 9 inches square, and octagon for the side walk purposes, Sewerage Pipe, Fire Clay and silica, also a superior quality of Lime."

Hodges, Pritchard & Co. as Proprietors
P.O. Box 51, Golden, Colorado
branch office at 423 Larimer St., Denver

Another company in competition for the contract to furnish brick for Denver's planned sewers was the Colorado Pressed Brick Company, also from Golden. They provided a sample of brick to the mayor's office for his close scrutiny and for examination by any others interested in the material. The company, managed by Mr. W. J Shiek, had a brick making factory in Golden that provided pressed brick made of superior clay that was of a higher quality than that used for ordinary bricks, but less than that of fire clay. The brick is processed in steel molds with a "pressure of 350 tons to each brick, by Anderson's patent machine." [50] This huge pressure forced all the air out of the brick and closed all the pores which made them especially well-suited to use for sewers. Ordinary brick, made without the benefit of such huge pressure, remained full of pores and would be too porous for sewer use as the sewerage would seep through the bricks. The National Board of Health discussed the use of bricks for sewers, condemning the regular brick and recommending the pressed brick.

The bricks offered by the Colorado Pressed Brick Company had 11 cone-shaped holes on the surface designed to hold the mortar which helps keep the brick in its place, "as though it were part of solid stone." The cost for these bricks was $35 per thousand. [51]

One option that was discussed was to glaze ordinary bricks to use in the sewers. Mr. Shiek said that would not work for sewers. Because the ordinary bricks are full of pores, expansion and contraction of the brick under varied temperature conditions will crack the surface of the glazing and the solid material in the sewage passing through will break up the interior of the sewer. While he indicated that his bricks would hold glazing permanently, he was certain that if his bricks were used, glazing would not be necessary.[52]

The Mayor, City Council and city engineers carefully evaluated the use of clay pipes for segments with a diameter of 18" or less. They actually had some of the clay from the Cambria Fire Brick Works company in Golden shipped to St. Louis to be made into pipe there, then shipped back to Denver. The clay pipe was vitrified,(thoroughly glazed) to make the surface glass-like and impervious. The plan was to make the pipe at Cambria Fire Brick Works in Golden from the same type of clay which had been used for the test pipe made in St. Louis. That way the city could have a high quality pipe manufactured locally at a moderate price.[53]

It was estimated that about 3200 ft. of 18" pipe would be needed for the sewer lines that would connect into the main interceptor sewer. The main interceptor sewer would be built of brick because of its larger 30" size. The smaller laterals would be built of 9" clay pipe.[54]

On December 14, 1879, a representative of the Colorado Pressed Brick Company wrote a letter to the editor of the Rocky Mountain News stating to the public,

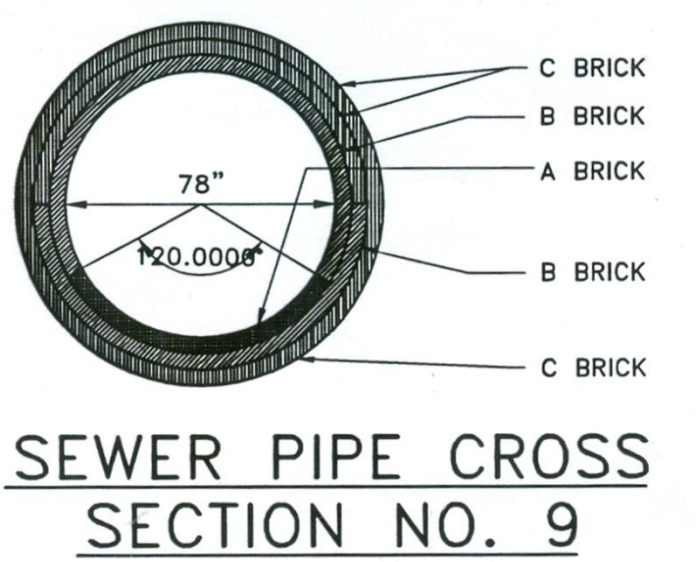
> ...that it is well known by all conversant with brick-making that here are no clays whatever within reach of Denver that will make a suitable sewer brick by any of the old processes. We have, however, secured a new and valuable patented process by which we are able to manufacture a brick which is admitted by all to have the required qualifications. The only objection, it seems, is the price, $35.00 per thousand.[55]

In spite of this plea to the public, the contract was awarded to Cambria Fire Brick Works. In May of 1880, the Rocky Mountain News reported that 50,000 bricks of the best clay had been burned at the Golden Fire Brick Works for use in the main sewer along Wynkoop St. Excavation for the line was underway between 21st and 22nd Streets.[56]

Size, Shape and Placement of Sewer Lines

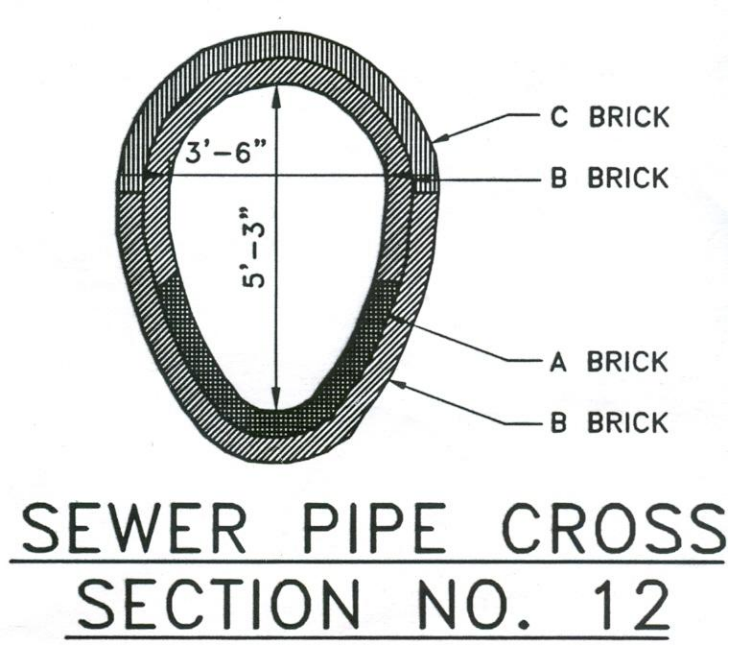
The size of the sewer line, its shape and its placement in the street were important factors in the planning and design of a sewer system. Sewer lines of a variety of sizes would be needed for the system. Small lateral lines ran from individual buildings to sub-main lines under the streets which collected their discharge and transported it to the main sewer line. The large main or trunk sewer line then collected the discharge from the sub-main lines and carried the sewage to its disposal outlet, which was usually a stream, river or other body of water. The last segment of the sewer, before the point of discharge was the outlet sewer line. This line had to be large enough to carry off the sewage from all of the mains, sub-mains and laterals that eventually fed into it.

In a sewer line, the top of the pipe is called the arch, and the bottom where the liquids will be the deepest is called the invert. The typical shape for a sewer line is a circle. However, a variety of other forms, such as oval-shaped, egg-shaped, a shape with a flat bottom and an arched top and other irregular shapes are used depending on the specific situation. Oval-shaped sewers are often used for large sewers where there is low clearance from the ground to the top of the sewer.



Delgany Interceptor Sewer Plan and Profile
Metro Wastewater Reclamation District

Combined sewers that convey both sanitary discharge and storm water have unique design needs. During times of dry weather, the flow of the sewage is small in relation to the size of the sewer which needs to be large enough to enable it to handle high volume flows during and after intense storm events. During the times of low flow, there is only a shallow, trickling, low-velocity stream of waste in the bottom of the sewer. This low flow keeps the sewer from being self-cleansing. Use of an egg-shaped design can overcome this problem. The egg-shaped design has a circular invert that has a radius only half the size of that of the arch. Because the invert has a narrower shape, it allows the depth and velocity of the waste flow to be the same as in a circular sewer with this smaller radius. Yet, the capacity during a big storm is still that of a larger circle because of the large arch.



Delgany Interceptor Sewer Plan and Profile
Metro Wastewater Reclamation District

The shape of the sewers was an important design consideration. Regardless of the shape of sewers there were issues. Each sewer configuration, be it circular or arched or elliptical, led to problems of slow moving water or blockage. The best shape for continuous water movement was the egg-shaped sewer, even though the uneven sides created some issues of blockage in the pipe. The shape of the sewer pipe and slope could help avoid obstructions which caused a variety of problems. The October 30, 1875 edition of the Rocky Mountain News carried an article about sewer obstructions and said that "an obstructed sewer is worse than none" and could "produce the most repellant and nauseous odors during warm weather." [57] The depth to which the sewers were buried was another important factor in the sewer design. Early engineers felt that sewers should be buried beneath cellar levels.

The placement of sewer lines under the street is different for sanitary sewers than storm sewers. Sanitary sewer lines are often located on the center lines of the streets so that there is an equal grade (fall) from the houses on both sides of the street. Sanitary lines are generally buried about 10 ft. deep. Storm sewer lines are generally located along the sides of the streets close to the curbs where the storm water enters the system. In Denver, the storm sewer lines are buried an average of 4 feet below the ground surface. In terms of installation and maintenance, it is better to have them shallow to avoid excessive costs of digging. However, there must be enough cover above the sewer to support the road surface above.

Adoption of Plans for a Sewer System

In November of 1879, a month after the affirmative vote for a sewer system, plans for the system had been prepared. A comprehensive report on a proposed sewer system between Larimer and Champa Streets from 13th to 19th Streets was presented to the Denver City Council by City Engineer, Harvey C. Lowrie, who is credited with planning most of the first sewer system

for Denver and overseeing much of its construction.[58] Lowrie was the City Surveyor for Denver from April 1875 until he was appointed as the City Engineer in October 1879. He continued as City Engineer through1889, overseeing many public improvement projects for the city. City Council was called upon to examine the details of the presented plan for the sewer system and provide comments. The Council's input on the plans would "bring to this important task clean hands, clear heads and a determined resolution to observe the interest of the silent many rather than heed the clamor of the noisy few, no matter who they may be or from what locality they hail." [59]

On November 15th, 1879, the Rocky Mountain News ran an article declaring that the City Engineer's plan for Denver's new sewer system did not adhere to boundaries previously set by agreement between the City Council, Colorado's General Assembly and the city engineers. Originally, the area between 15th and 17th Streets had been put into one district. However, the city engineer proposed to "make a larger district reaching from Cherry Creek to Twenty-first Street and containing three distinct sewers, one up Fifteenth, one up Seventeenth, and the other up Nineteenth street - all running back as far as Broadway and emptying into the public sewer on Wewatta Street, which is to flow into the Platte." [60]

With the changes that the city engineer wanted to make, the plan would "require a new district to be formed and a new petition of the property owners" which would require significant time. The Rocky Mountain News questioned "why the engineer's report was not submitted before any steps were taken" to assign districts, but came to the conclusion, in the non-politically correct vernacular of the day that the "city administration is hopelessly stupid and is compelled by nature to do everything backwards and in a halting, hesitating and blundering manner." [61]

The Rocky Mountain News further complained that it would be a "calamity" to spend the allotted $20,000 "upon a false start on this great work" and that the "Council is wholly incompetent to deal with the problem except from the standpoint of picayune objections of every kind to anything proposed." [62] The News felt that the main responsibility for the sewers rested with the city engineers with "brains, experience and honesty," since the citizens were "no more fit than alderman to pass upon technical questions." If the City Engineer was competent, he would prove to be "a blessing to the city." But if the engineer were to be "a botch," then he would "turn out to be the greatest curse that ever afflicted us" since the sewers would "cost immensely." [63] The News stressed the importance of an open public process and felt that in order for the sewer system to be a success, every step must be taken with the "utmost publicity" and "rigid accountability exacted."

In late November of 1879, the sewer system planned by City Engineer Lowrie was adopted by the City Council. The plans were solely for sanitary sewers and were adopted under the condition that there be no provisions for surface drainage, except for rainfall from roofs of houses. If surface drainage removal was necessary in the future, a new system of storm sewers would be developed.

The Council also recommended that the district sewers be "modified and changed as to place mains on Fourteenth, Sixteenth, Eighteenth, and Twentieth streets" rather than on "Fifteenth, Seventeenth and Nineteenth, as recommended in the engineers report" as it would "enable parties on Eighteenth and Nineteenth streets to secure sewerage" early rather than waiting until the sewers are needed on 20th Street.[64] City Engineer Lowrie's plan was voted in by sections and the report was "adopted as a whole with little discussion and no noticeable opposition" by a vote of seven to five as long as the requested changes were made. The city engineers then returned back to work and prepared more detailed plans which were returned to the Committee on Sewers on December 23, 1879, less than three months after the public voted "yes" for a sewer system.

By February 1880, the plans that the Council had agreed upon were presented for public viewing at the office of the City Clerk to be "examined by contractors and other interested parties" so that appropriate and timely bids could be obtained.[65]

Within one month, vocal public criticisms of the proposed sewer system were making news. Some members of the City Council, members of the Committee on Sewers and varied citizens disagreed on specifics of the sewer plans. Everything from pipe size to the layering of bricks to the slopes and pitches of the street had at least two sides to be discussed.

Frustration about the implementation of the sewer system began to escalate by May 1880 as evidenced by the following in the Rocky Mountain News. "At last the dodging, quibbling, whining Council, after feeding the community on false promises for a year, has definitely decided to substantially build no sewers." [66] As of May 1880, only "one little stump of a sewer up Eighteenth only, to Lawrence, and another up Sixteenth only to Curtis" were intended to be built within the year. The residences will not be able to connect to sewers and only a few stores will be able to be drained, "but it is precisely the residences, and not the stores, that are crying for a need of sewerage." These oversights in planning and implementation were enough for "every intelligent republican who voted for this Council to begin to feel mean enough to think about suicide." [67]

Definition of Sewer Districts

In what was considered by The Rocky Mountain News as a "dull and uninteresting session" in May of 1880, the City Council passed ordinances defining the boundaries of sewer districts. The Board of Health had recommended that the "Sixteenth and Eighteenth Street sewers be built up to Broadway." The Sixteenth St. Sewer District ran from the beginning of:

> "the intersection of Wewatta with the northeast bank of Cherry Creek, thence along said northeast bank of Cherry Creek to the center of Fourteenth Street; thence up Fourteenth Street to Colfax Avenue; thence along said Colfax Avenue to Broadway to Seventeenth

Street, thence down Seventeenth Street to Wewatta Street; thence along Wewatta to place of beginning." [68]

The Eighteenth Street Sewer district was then defined as the "portion of the city of Denver lying between Wewatta Street and Seventeenth Street, Broadway and Nineteenth Street." [69]

The City Council further clarified that if any of the new sewer district boundaries conflicted with older district alignments, the new ones were to be correct and the old boundaries were repealed. In a final move of business for the Council, the City Clerk was instructed to "advertise anew for bids for the laying of the main sewer pipes" in hopes to get a quick start on the project.

Construction

Bids for Construction

Hopes were high for those citizens who had been waiting for sanitary sewer service in Denver. Residents had voted approval of the concept, agreements had been made and plans had been drawn up and approved. The next step in the process of developing a sewer system for Denver was to obtain bids for construction of the sewer lines.

The city clerk was finally instructed to advertise for thirty days for bids to build the new sewers in Denver in January of 1880. These bids were to include all costs for the sewers based on "plans and specifications adopted by the City Council." Bids were received from six firms with the range of bids coming in between $15,515 to $30, 817. In early March 1880, the Committee on Sewers reviewed the bids and recommended that the contract be awarded to the lowest bidder which was that put forth by Hugh Pritchard. Hugh Pritchard was also the superintendent of the Cambria Fire Brick Works in Golden who was supplying the brick to be used in the sewers. In mid-April, the contractor indicated that he hoped to "have his contract completed in less than two months." [70]

Construction Underway

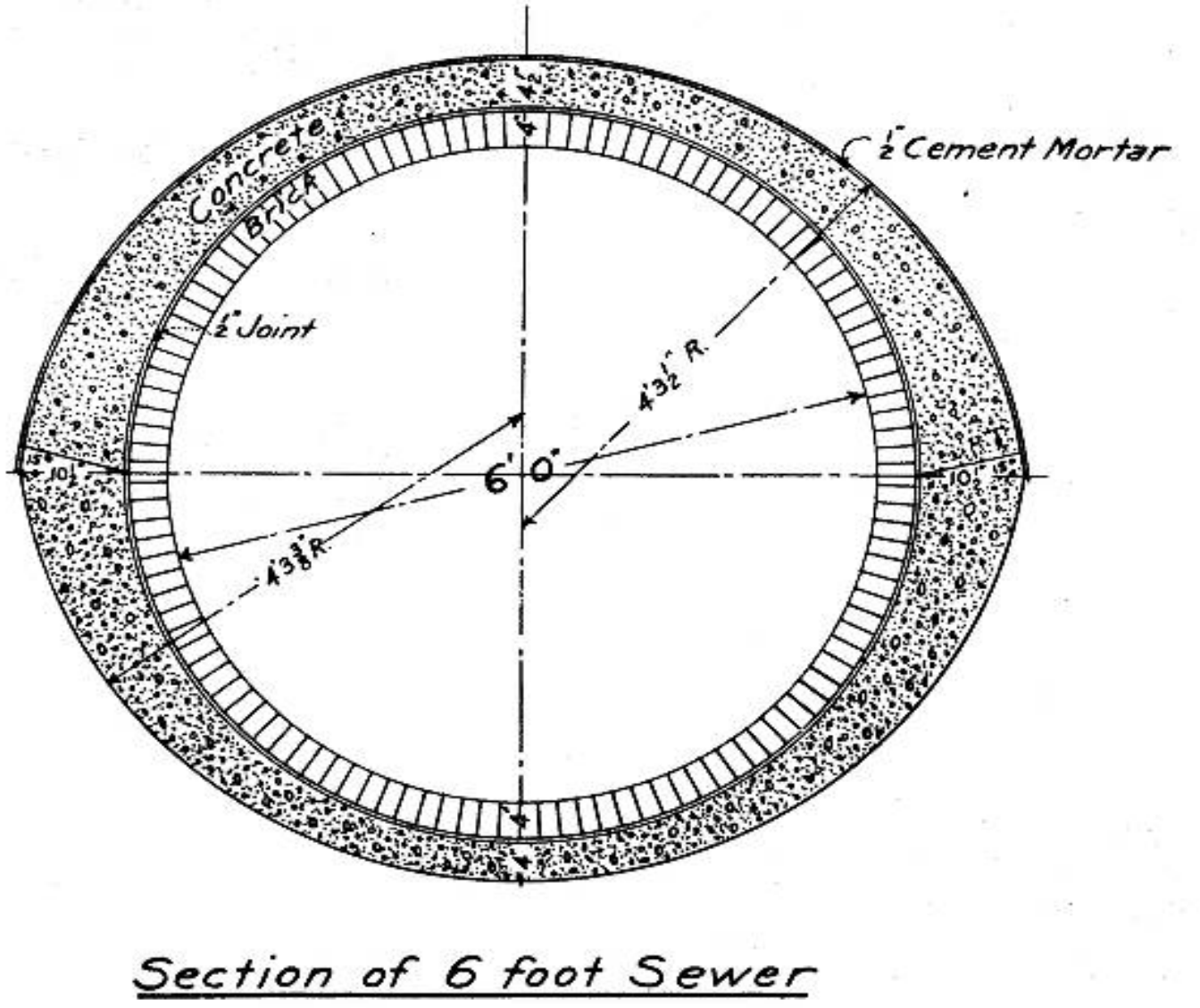
The first sewer built in Denver was a main brick sanitary sewer line along Wynkoop and Wewatta Streets, followed by clay pipe sewers on 16th and 18th Streets. Construction on the main sewer was underway in June of 1880.[71] Described as "brick, laid in cement mortar," the sewer was being covered as fast as it was being laid. The construction was presumed to be of good quality, even though the contractor was "burdened with a good deal of expense on account of caving." The length of this sewer segment was 4620 ft. and the cost was $24,192.[72]

Aldermen Anstee, Morris, Davis, Linton, Force, Bandhauser and Needham inspected the sewer, while "the three Alderman who compose the Sewer Committee were conspicuous by their absence." The men who inspected the sewers "expressed themselves satisfied that the work was done according to contract." [73] These first brick lines on Wewatta and Wynkoop Streets have since been replaced with modern sewer lines.

Constructing Sewers from Brick

Brick sewer lines built in Denver contained from one to four rows of concentric brick. The smaller lines between 15" and 60" diameter were built of one layer of brick as shown in the

diagram below for a typical layout for a sewer built of a single layer of brick with a layer of concrete around the outside of the brick.



A typical layout for a sewer built of a single layer of brick
with a layer of concrete around the outside of the brick.

Larger sewer lines, generally over 60" in diameter, needed extra rows of concentric brick to support the larger diameters of the line. Two rings of concentric brick were sometimes used for building sewers from 60-72" diameter and in Denver sewers with a diameter of over 72" were largely built of three or four rings of concentric brick.

Building a 2-ring brick sewer line of the North Denver Sanitary Sewer. Circa 1910-1920.
Photo Courtesy of Denver Public Library, Western History Collection, Reference X-29448

In a sewer line, the top of the pipe is called the arch and the bottom, where the liquids will be deepest, is called the invert. When building a brick sewer line, construction of the invert is guided by a wood profile that has the same dimensions as the brickwork. The wood profile is set up at the forward end of the segment to be constructed. The arch of the sewer line is built on strong ribs or centers which support the lagging which are boards joined together side by side to line the excavation.

When building a sewer line of bricks, the brick mason would thoroughly wet the bricks immediately before laying them. He would then lay the brick in rings with the 4" dimension forming the circle shape of the sewer line and the 8½" dimension extending the length of the sewer. The brick was laid in a mortar of Portland cement with one part of cement to three (1:3) parts sand. Bricks in sewers were laid by line with each course perfectly straight and parallel to the axis of the sewer. The joints between the bricks had to be less than ¼" and needed to be filled full of mortar in order to ensure a nearly water-tight surface that would prevent leakage of the sewage into the surrounding soil.[74] The outside ring of the invert was laid in a 1:2 ratio of

Portland cement and when the outside ring of the arch was completed, that too was plastered over by a 3/8" to 1/2" layer of 1:2 Portland cement. This provided a sealed surface to keep any groundwater from filtering in and any sewage from leaking out.

3-ring brick sewer line near South Platte River in Globeville. Circa 1930.
Photo Courtesy of Denver Public Library, Western History Collection, Reference X-27588

When constructing brick sewers, careful workmanship was very important or there may have been deformations in the pipe which could result in large amounts of leakage. The brick masons working on the project had to provide careful bedding of the bricks in the mortar and they had to place mortar between the separate rings of brick in the larger sewer lines. There are several methods of construction for brick sewers. In one technique for building concentric ring sewers, the bricks are all laid as stretchers - with the edges of the bricks parallel to the sewer axis. In another technique, part of the bricks are laid as stretchers and part as headers, as is done in ordinary brick wall construction. The joints are all radial with the extra width at the outer edges filled with mortar. The mortar joints in both the arch and the invert needed to be less than ½" in the outside ring.[75]

Men work with sections of sewer pipe and wooden forms. Circa 1909
Photo Courtesy of Denver Public Library, Western History Collection, Reference CHS-L1307

Brick Glazing Problems

The early feeling of success on the sewer construction was short lived, and in June of 1880, City Engineer H.C. Lowrie submitted a letter to the City Council with concerns about the brick being used in Denver's public sewer. The Council had agreed that the bottom half of the brick pipe would be made out of glazed brick, but they would allow the use of "unglazed but very durable" brick in the upper part of the sewer pipe, as it would not be as greatly impacted by water.[76]

According to the specifications in Section 10 of the contract, the brick was also required to be uniform in size, "hard-burned entirely through," be free of lime and other impurities that could affect them in water, have straight edges and uniform angles, and be "salt glazed or vitrified on the inner or concave surface to the satisfaction of the engineer and equal to samples on exhibition at his office." [77] Even though these requirements for the brick had been laid out, the bricks being delivered from Golden were not glazed. Lowrie had to allow the construction teams to put those unglazed bricks in or stop the work and he needed the Council's opinion as to how to continue.

The brickmakers explained how it was impractical to glaze the bricks on the inner surface only and so the bricks either had to be glazed completely or not at all. Mr. Lowrie stated that he felt the completely glazed brick were "detrimental" "because the mortar will not take hold of them properly." [78] If used, they would also prevent the drainage of the adjacent subsoil. Samples of the glazed bricks that were used initially were shown to the Council followed by samples of the unglazed bricks that Lowrie was proposing to continue utilizing. Samples of red brick were also presented to the Council for consideration for future use in sewers. Lowrie said that he felt the red brick was suitable for use in the arch (top portion) of the sewers.

Along with potential changes to the brick, City Engineer Lowrie had a few other requests. He suggested that more manholes were necessary than were being installed. He proposed to have "one put in the middle of each block, making them 240 feet apart." [79] He also proposed that an inspector be assigned to the project who would be on-site for the construction to be sure everything was being done right. Additionally, Lowrie flexed his power by subtly threatening the contractor, Mr. Pritchard, with removing his control over his contract if it was not finished by the agreed upon date of July 19, 1880.

Council members argued back and forth about whether glazed or unglazed brick should be used. The Council agreed to appoint, at the Council's choosing, "an inspector at one hundred dollars a month to help the engineer keep constant watch." [80] Lowrie requested that he be able to choose the inspector so that he could "trust" the man. However, the Council wanted to choose the inspector as they wanted someone "who would not, as the engineer appeared to have done, permit the contractor to go on violating the contract." [81]

Brick Size Issues

After strides in the right direction, construction was still halted on the sewers. This led writers at the Rocky Mountain News reporting on the construction halt to question whether "their children or their children's children" would be the ones to enjoy the sewer system.[82] The next hold up on the sewer construction was due to incongruities in the size of the brick as specified in the contract and what was actually being used. The contract stated that the bricks should be 4 ½" wide, where the ones being used were between 4 1/8" and 4 ¼". The molds for the bricks were of the correct size; however due to shrinkage of the materials, the bricks themselves were slightly smaller than anticipated. This new announcement differed from the information given by the City Engineer and Council who had assured the public that everything was being built to the correct standards.

"Another Blunder"

Groundwater Issues

With newspaper headlines such as "Another Blunder," and "A Worthless and Imperfect Work That Will Be Useless," it was obvious that some citizens were less than pleased with the construction on the main sewer as of August 1880.[83] The Rocky Mountain News sent a reporter to investigate "some curious rumors and serious complaints" that were made about the construction of the main sewer down on Wewatta Street. The sewer started at 15th St. on Wynkoop St. following Wynkoop St. in a northeast direction. It turned down to Wewatta St.,

following under that street to about 23rd St. where its course turned towards its outfall into the South Platte River. [84] There were issues with building the sewer along this alignment due to the water rising in the ditch excavated for the sewer. At the time of the reporter's investigation, a depth of about nine inches of water was found in the excavation. The reported surmised that the problem was that the water "accumulates faster than it can be pumped out, and so prevents the proper laying of the bricks." [85]

Due to this water issue, there were significant delays in construction with one worker claiming, "that it was utterly impossible with the conditions the sewer was in to proceed with the work" and that "the lower part of the sewer cannot be cemented." If the sewer was not cemented, the consequences described were adverse: "the sewer will be half full of water all of the time and when the water comes down from the cross sewers it will be choked up and driven back into the cellars above, and worse still, it will probably bust this sewer." [86] The worker alleged that they were told by the City Engineer to continue building the sewers using dry bricks, rather than cement which the contract called for. However, cement could not be used on account of the standing water in the ditches. The worker felt that the construction was shoddy and that the sewer should not have been buried so deeply. As a final blow to the design, the worker vented that "it will cost the city $20,000, and when completed it will not be worth $20." [87]

Headlines of "Further Blunders" helped fuel citizens' fears that the new sewer would be "practically useless" if they continued on the present plan.[88] Work had resumed on the flooded ditches that were to hold the new sewers on Wewatta St. The sewers continued to be laid without cement adhesive, per orders given by the City Engineer. As construction continued, news coverage expressed concerns that "the sewer, when completed, would rest on a very insecure foundation" due to the lack of cement and the excess water under the newly constructed pipes.

Mr. W.J. Fay, Superintendent of the Gas Works, was called upon to analyze the current sewer situation. He was not directly or indirectly associated with the construction, but was knowledgeable as "he had supervised extensive works in the largest cities of Europe." [89] From his position of being distanced from the project, many felt that he was able to give an unbiased opinion of the sewer systems. Mr. Fay felt that a competent paid sewer commissioner should be appointed to supervise the remainder of the sewer planning and construction. He also felt that the sewer size of 30" was not large enough for the anticipated flows. Alderman Anstee agreed with the opinion that the sewer was not of a large enough size to properly serve the city and claimed that he originally recommended that the sewer be "four by six feet, egg shaped." As the sewer was currently being built, Mr. Anstee felt that it would not be worth "twenty cents in a few months;" where if the sewer had been enlarged slightly and had a double row of bricks, a change that would cost "not more than four to five thousand dollar (sic)" the sewer would have lasted for years. [90]

The main sewers on Wewatta St. were not the only ones impacted by poor planning. The plans for the 15th and 16th Street sewers were also "another great mistake" according to an article in the August 4th, 1880 issue of the Rocky Mountain News. The pipe for these sewers was to be brought in from St. Louis at a transportation price of "a cent and a half per pound" when the sewers could have easily been built from brick, which would have allowed for the money spent to be kept in the city of Denver and to not have incurred transportation costs for the product.

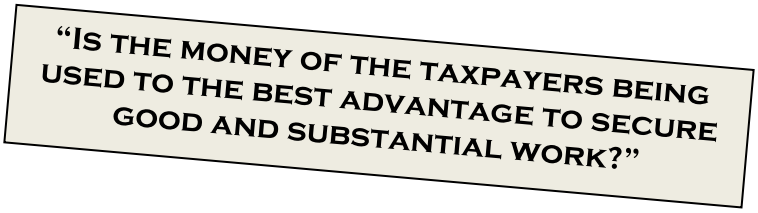
Alderman Anstee was very critical of the management of the project. He was irritated that the City Engineer was given sole responsibility for inspection of the construction and the determination of whether or not the work had been properly completed instead of the City

Council Sewer Committee of which he was a member. Mr. Anstee suggested that the "whole thing be torn up and a new sewer commenced." [91] Mr. Pritchard, who had been awarded the sewer contracts, agreed with the concerns made by Alderman Anstee, as Anstee was considered "an expert, being a practical brick layer and having been engaged during his life in construction of some of the largest sewers in the world." [92]

Sixty-inch circular sewer, two rows of bricks
North Denver Storm Sewer
Photo from Denver Municipal Facts, Volume 4 #6, 6/1/1921, pg. 13,
downloaded from http://history.denverlibrary.org Denver Public Library, Western History Collection

The construction of the sewers on Wewatta St. attracted considerable attention and was the subject of much comment among the property owners and businessmen of the city. They wanted to be certain that the sewers were built in an efficient manner and that the end product was a durable long-lasting sewer line. There was concern that Mr. Pritchard went against the original contract at the demands of the City Engineer by utilizing dry brick for the main sewers. Experts had explicitly said not to use dry brick since it would leave sewers "inoperative" and "worthless" due to accumulation of water in and around the pipes. The Rocky Mountain News interrogated Mr. Lowrie, the City Engineer, who denied giving the order "to lay dry brick in the sewer, and furthermore stated that no dry brick had been laid" which was a complete contradiction to the statement Mr. Pritchard gave.[93]

In response to all the concerns, reporters from the News and other gentlemen were invited by the city engineers to inspect the work done thus far. When they arrived at the construction area, they found several inches of water in the sewer and evidence that the most recently laid section of line had been cemented. Contractor Pritchard stated that the "last twenty feet of sewer had been cemented but that there was one hundred and fifty feet behind that, that was not." Upon further inspection of the pipe that lay within the previous 150 ft., the bottom area of the pipe "appeared to be covered in mortar." Mr. Jordan, an architect who was developing "extensive buildings in the city," assessed the sewer situation and deemed it "a very complete and effective piece of work." He claimed that "hundreds of miles of sewers in Chicago" were "not built half as well" as the Denver sewers.[94]



Mr. Keyes, the superintendent for the project, stated that he had watched the construction of the sewer (as the representative of the city), day by day and hour by hour, since its commencement, and that there had been no dry brick laid. While the city was able to prove that the sewers were in working order for the time being, there was still a question of veracity between Mr. Lowrie and his inspector on the one side who said there was no dry brick laid, and Mr. Pritchard and Alderman Anstee on the other side who completely contradicted Lowrie and his inspector. The disparities in what was said to be the construction technique between the two sides can only be solved by "a proper examination of the work done by competent persons." At least one side had to be doing some "tall lying" in the situation and regardless, fears were still present post-examination, as the Sewer Committee after visiting the sites "made an order that the work be stopped at once." All that the citizens wanted to know was, "is the money of the taxpayers being used to the best advantage to secure good and substantial work?"[95]

Mr. Lowrie stated that he never authorized any defective work on the sewers, that the sewer inspector did not see any issues with the construction, and that the sewers were working. Lowrie believed that the work completed thus far was "fairly good work in all respects" and that it does not mean that "under a pressure of water there will be no places found where it will come through," as "even when on watch of masonry, he cannot see every joint and an unscrupulous contractor might here and there successfully evade him in some small particulars." [96] Mr. Lowrie cited the fact that even if there are issues in the sewer, according to pre-set specifications "the contractor upon being so directed by the Engineer, shall remove, or rebuild, or make good at his own cost, any work which the latter shall decide to be defectively executed" prior to the final payment being made.[97]

It was suggested, at the end of Lowrie's address, that Mr. Pritchard should be required to "tear up and rebuild the work that he alleged to have been defectively executed." The Committee on Sewers concurred with Mr. Lowrie's choice to have the defective areas reconstructed due to significant imperfections in the foundations. They had called for an immediate suspension of the work in progress in order to evaluate where the defective areas were and how they were to be handled.

The concern about adequate construction of the sewers in Denver stemmed from the hopes to "largely enhance the health and comfort" of the city and its citizens and also "to afford an example of successful engineering for all cities in the state to follow." [98] In response to these claims of defective workmanship and the recommendation that Pritchard tear up and rebuild the defective areas of sewer, the Council created a citizens committee to investigate.

The members of this new citizen sewer committee, some Council members and a few citizens went out to inspect the Wewatta St. main sewer. In their report back to Mayor Sopris, the committee claimed that "from 100 to 150 feet of the west end of the sewer [they] found that water was boiling up in the sewer through the bricks in several places and that for that distance the work is not well done." [99] The committee did believe that the work was done as well as the circumstances would permit and that the lack of cement in that portion of sewer supposedly had been caused by upward flow of spring water. They did not think it "desirable to tear out or remove any portion of the work, as in replacing it the same difficulty from the flow of the water will be experienced." Additionally, they recommended that the grades of the sewers would be adjusted from here on out to make sure that they were above the groundwater and that further issues of this nature did not occur.

In the end, the decision for fixing the leaking sewers was to continue patching the defective work, as needed and to "begin at the point where the work has been stopped, at a higher grade, in order to avoid the water." [100] The sewer committee members, Aldermen Anstee, Morris and Davis, disagreed with the decision to patch the Wewatta St. sewer as needed and felt that it would be necessary to remove the defective portion of the sewer line and replace it at the expense of the contractor even though the fault lay with the City Engineer.

Engineer Lowrie said that when he noticed the groundwater problems, "he ordered the contractor to put in board cradles and lay bricks upon them." The contractor, however, "spent all of one day in trying to lay twenty-four feet, and then gave it up as impossible." [101] During this period, the Rocky Mountain News ran a story charging that the sewer construction was being poorly done which in turn led the City Council to stop construction, unbeknownst to Mr. Lowrie, who was absent at the time. Lowrie contended that this issue was merely a ploy on the contractor's part to get the grade raised and lessen the work that was originally contracted. When Lowrie was finally notified of the issue, he was at the sewer site within ten minutes when he noticed a few small holes in the last 150 feet of sewers through which water was "bubbling up." The engineer conceded that the work done was not a "first class job," but that it was due to the fact that the brick was not as superior as the brick used on the first job. Lowrie also felt that the committee injured the job more than any other causes, but did not deny that another contractor "might have done a better job." [102]

It seemed as though Lowrie had an excuse for any hiccup in the construction, but Alderman Davis told Lowrie that in spite of his excuses, he was to blame.[103] Since there were obvious issues with the construction, the Council moved to adopt an amendment that placed the blame and the subsequent costs on the contractor, however any defects which were approved by the city engineer at the time would not be liable to Mr. Pritchard, the contractor for the project. The city attorney advised the Council that evidence would need to be gathered in order to officially determine who was at fault and responsible for the imperfections.

Morris wanted to have the contractor take up the defective work on the Wewatta St. sewers and replace it correctly, but Alderman Myers objected as he did not want Mr. Pritchard to have anything more to do with the work. Anstee acknowledged that Mr. Keyes, the inspector, was "ordered to lay five courses of dry brick" and the workers would back him on this allegation.[104]

City Engineer Lowrie categorically denied concealing defects

Lowrie, when directly asked, categorically denied concealing defects in the sewers and laying dry brick, claiming that the excess cement found during inspection was there as it was "thrown over the bottom of the work as a sort of finishing touch" and that the brick had been grouted then laid over with "finishing touch." [105] After Anstee acknowledged that he knew Lowrie could "not make a proper joint with four or five inches of water to work in," Lowrie "admitted that he did the best he could." In the end, the Council, with a vote of 4 "ayes" to 7 "nays", denied Alderman Morris' request to make Mr. Pritchard rip up the faulty work and replace it." [106]

Squabbling and delays due to concerns about workmanship were not the only reasons for delays in the sewer construction. Serious rain and a flash flood in August 1880 caused extensive damage to bricks being made for use in the sewer construction. The "young son of Alderman Davis observed a tremendous body of water descending with great force from the bluffs to the southlands" and the water "swept over the brick yards, filling the clay pits and carrying away all the green brick that had been laid out." [107] Delays in construction were expected city-wide due to the shortage of brick resulting from the flood damage.

With construction on the Wewatta St. sewer started again, crews were making good progress and there was an expectation that by mid-September it would be completed up to 16th St. As the "bickering between committee, engineer and contractor" ended, work rapidly progressed on the main sewer on Wewatta St. and it was believed that the job would "be a good one." [108] It was estimated that nearly 75 feet of sewers were being laid on a daily basis, even though they were still experiencing issues of water in the ditches.

Hopes were that the 16th St. and 18th St. sewers would be completed by April 1881. Both of those sewers were clay pipe sewers 15" to 18" in diameter, buried 10 ft. deep that extended from their connection with the main brick sewer on Wynkoop St. to Broadway. Houses were connected to this line by a clay pipe 9" lateral line.

Sadly, during the construction of the 16th St. sewer, Mr. Nelson N. Strand incurred life-threatening injuries. Strand, a 22-year-old Norwegian man who had "not a friend nor relative in the United States," was excavating a narrow trench when a large slab of hardened dirt fell onto his back. It took three men to lift the slab from Strand's back and it was evident the man was in great pain as "every twitch of the muscles served to contort his body with pain, and he could rest easy in no position." The physician who attended to Mr. Strand "examined the wounded man's injuries and pronounced them fatal, stating that the back was either completely broken or badly fractured, and that his recovery could not be hoped for." [109]

By late September 1880, the main public sewer was nearing completion and an extension would be used to extend the sewer outlet directly to the South Platte River to "avoid carrying the discharge through an open ditch for any part of the way." The sewage would meet up with the "mill ditch," a stream with "considerable daily overflow" to carry the waste away from the city.[110]

Trench digging machine. Circa 1910 - 1920
Photo Courtesy of Denver Public Library, Western History Collection, Reference X - 29446

In addition to the construction issues from the sewer itself, sewer construction also caused some damages to adjacent private property. The collapse of a building on 15th St. in 1881 was attributed to the recent sewer excavations in that area. Mrs. Amelia Fischer, who owned the property, claimed that the only reason for the collapse was because of the sewer that was being placed in her alleyway. She claimed that "the house was well and substantially built" and enforced her claims by drawing attention to the wall that remained standing on the opposite side from construction.[111]

Thoroughly inspecting the completed sewers was highly important to make sure that no future issues would be encountered after the city had paid the contractor for his work. The method used to inspect the sewers was "accomplished by placing a large iron ball, nearly the same circumference as the sewer, and by flushing the latter causing the ball to roll through slowly." The progress was to be "watched at every manhole, and if it goes through all right, the committee is satisfied that the sewer is perfect." [112] In the March 6th, 1883 issue of the Rocky Mountain News, it was reported that in the section of the 13th St. sewer tested thus far "the ball has rolled along evenly enough without any stops."

Between 1880 and 1885 many district sewers were constructed, and a significant portion of the city was served by the sewer system. On account of the extensive construction of new sewers in Denver, fears of the deadly disease cholera that was expected to infect America over the summer of 1885, were dulled. "The sweltering heat, imperfect sewerage, and other favorable conditions" that allow for cholera to blossom in "sea-board states" would be halted in Denver because of "its elevation, the purity of its atmosphere and the perfect sewerage system of the city, which is far in advance of that of any other metropolis." [113]

Corruption

Concerns of corruption were present from the beginning of the decision to create sewer systems in Denver, as a large amount of money would be able to be made through the sewer contracts. The responsibility for proper construction of the sewers would mainly be up to the City Engineer and the City Council and fears that the city government will "get their fingers into the pockets of the people while this vast amount of money is being spent will be closely watched." The Rocky Mountain News declared, that "the politicians who control this community will never have such an opportunity for wholesale stealing," and the citizens should "look for a cat in every meal tub" during this highly public dealing.[114]

Sewer Contract Award Controversy

In June of 1880, the contract for construction of the 16th and 18th Streets sewers was awarded to Mr. Hugh Pritchard, the original contractor for the main sewer system. Immediately, there were accusations of corruption. There was a fear that the corruption present in the beginning of the sewer construction would "grow up and fasten itself as a 'knawing' canker upon a young and rising city," as reported in the June 20th, 1880 issue of the Rocky Mountain News. The uproar from citizens was because they felt a strong need "to deal severely with the first symptoms of jobbery, in order to beget a healthy public sentiment" that would help to "protect against municipal ruin." [115]

The parties charged with corruption were Mr. Clements, a contractor who came all the way from Cleveland to bid on the 16th and 18th Streets sewer project, and the current contractor, Mr. Pritchard. Mr. Clements was alleged to have been lobbying for the contract; a claim that he denied as not even possible since he only arrived in Denver a day prior to the bids.[116] Mr. Pritchard was accused of giving work to Alderman F. N. Davis, a brick maker, who was accused of burning bricks for the sewer project. That would have been a major conflict of interest since Alderman Davis had a vote in awarding the contract to Mr. Pritchard.

The Council had been hesitating on the decision as to who to award the contract to as there was a close bid between Mr. Pritchard and Mr. Clements. Pritchard was the low bidder; however, when Mr. Clements was not awarded the contract, some Council members felt a delay in the contract award and an investigation into the situation was warranted.[117]

The investigation found that some members of the Council favored one contractor over the other and were working to assign the contract to their specific candidate. Clements was accused of lobbying with the Councilmen to gain their favor in hopes of garnering the sewer contract. Mr. Clements said that he was not in the city to lobby for contracts, but he "had left his interests in the hands of a young attorney whose zeal has spoiled the whole thing." [118] This youngster "had influential gentlemen of both political parties running after Councilmen soliciting them to vote to give Clements the contract" and Clements' requested to not be held responsible for "the indiscreet zeal of his attorney." [119]

During a Council debate, Alderman Davis, was again implicated of being in league with Mr. Pritchard, who was accused of building the sewers "to establish big brick reputation." [120] It was then made known to the Council that Davis was creating brick "unquestionably designed for the main sewer" as they were molded to shape into an arch.[121] Pritchard adamantly rebuffed this claim stating "Alderman Davis [was] not burning bricks for the main sewers, but [was] burning them for the manholes." [122]

Even after all the effort exerted by both Mr. Clements and his youthful attorney, the contract was awarded to Mr. Pritchard, who bid $87 less than Clements on the $24,000 contract. And while Clements caused some commotion with the allegations of corruption, the City Council believed the competition between the two bidders led to "considerable saving" on the City's behalf. [123]

Party Politics

The process for awarding sewer construction contracts had become very political. The Republicans were accused of throwing "cold water on the discussion" prior to news of the possible involvement of two Democrats. After that proclamation, "the subject has become very interesting to the Times" who ran an editorial in "attempts to connect the Democratic Party with the irregularities investigated." [124] The accusations that The Times focused on were that "Alderman Anstee, a Democrat and Chairman of the Sewer Committee, was to receive a bribe of a thousand dollars if the contract was awarded to a certain party." [125] The News felt that this was a very serious accusation and "either The Times is reckless in its assertions or Alderman Anstee is in a bad way." [126]

The News, a Democratic paper, commented that they felt the Council was Republican and it was "most extraordinary that Alderman Anstee, a Democrat, should be picked out for the chairmanship of the Sewer Committee." They raised the question that possibly Mr. Anstee was chosen by the Council as a scapegoat "for the purpose of saving the Republican party from the odium to which it would be fairly entitled." [127] Rumors also circulated that Aldermen Anstee and Davis were "furnishing brick for the sewer" and together "had a sort of an understanding about the business that looked very much like a ring and that they have fallen out and have begun to expose one another." [128] If any of these claims rang true, the public would be thankful for the exposé, as Aldermen Davis and Anstee made up two of the three men who have had "nearly

everything to say" on "making the contracts and seeing that the city gets a good bargain." According to The News, "if Aldermen Anstee and Davis are sub-contractors for brick for the purpose, it is easy to see that a gross outrage is being perpetrated." [129] If the accused Aldermen were actually monetarily benefiting from the sewer contract, there could be serious consequences because in some states at that time it was a "penitentiary offense for an Alderman to be directly or indirectly interested in City contracts." [130] Alderman Anstee had yet to come clean to the claims, however Alderman Davis admitted to his involvement in supplying bricks to the contractor and was "ready for sentence" on the matter.[131]

The News believed that Alderman Davis should have been asked to resign at the first sign that he "violated that clause in the city charter which prohibits an Alderman to be interested directly or indirectly in any contract with the City." [132] However, instead the Council decided to focus on the allegations of Anstee lobbying rather than "the manufacture of sewer brick by a Republican Alderman, the delivering on the ground of a portion of the material, and a dozen other acts that might be cited in proof of a violation of the law." [133] Regardless of whether he "violated the law either knowingly or ignorantly," The News felt that Davis was hardly fit to be involved in the Council and that the Council should ask for his removal. [134] Two weeks previous, Davis had admitted to his involvement in supplying bricks.

City Council Investigation

The City Council of Denver launched an investigation by a special committee into its sewer contracts in July 1880, focusing on the allegations of impropriety for Councilmen Davis and Anstee. Contractor Pritchard was called as the first participant in the guaranteed lengthy inquiry. Pritchard explained his background in brick burning and brick laying and construction in general. He confirmed that he and Davis had come to an agreement on Davis making bricks for the manholes for the sewers, "but nothing beyond this." [135]

Alderman Anstee had been contacted in hopes of securing a contract for Mr. Clements. Anstee held firm that the contract would go to the lowest bidder and none other. Anstee "stated emphatically and unequivocally that he had no interest whatever, in any way, shape or form, in letting of the sewer contracts, except so far as the good of the City was concerned." He also proclaimed "he never sold any brick for sewer purposes, and had no promise, no hope, nor expectation of being interested in the sewer contracts." [136]

The investigation found that the bricks that were made by Alderman Davis and sold to Mr. Pritchard for use in the main sewer were approved by the City Engineer since he felt "if such brick as that can be made in Denver, I don't see the use of going to Golden for them." [137] Davis did benefit monetarily from the brick sold to Mr. Pritchard and was going against City law by gaining a profit. Alderman Morris testified on behalf of the Council members accused of corruption claiming that he had "no information that Alderman Davis or Anstee had favored a particular bidder" and that "the contract was simply let to the lowest bidder." [138] Morris also

expressed his concerns as to whether the city engineer "with his other duties" could give the amount of time necessary to inspect "the details of a work like the building of the sewers." [139]

In 1880, the Council's discussion moved from corruption in the sewer contracts to corruption in the police departments, then back to the investigation into the sewers. There was little doubt cast on the charge that Davis was interested in who the contract was let to, owing to the fact that he had accepted a contract from the contractor, Mr. Hugh Pritchard, to furnish bricks for the manholes and was additionally accused of burning 35,000 - 40,000 bricks for the contractor. However, the investigation found no proof that any of the 35,000 - 40,000 bricks had been or were to be used in the sewers. [140] The news coverage felt that Davis's transgressions were even "more flagrant from the fact that he was a member of the committee in charge of the works" and was charged with being "above suspicion" and "doing justice" rather than benefiting from his position of power.[141] The special committee concluded that accepting the brick contract was "practically the same as a bribe" and should allow for the removal of Mr. Davis from the Council.[142]

On the accusations that Alderman Anstee had a personal motive in selecting the contractor, the special committee could "find no evidence which would warrant a report in favor of his expulsion, as in the case of Alderman Davis." [143]

Alderman Davis, who the special committee recommended be removed from the Council, was outraged that he was to be "convicted without trial" and "wanted to be heard at once through his attorney." The Council questioned whether Davis should be able to speak his piece and it was decided that the Council meeting "was neither the time nor the place for such a showing as Mr. Davis proposed to make." [144]

Davis was frustrated with what he characterized as "false Information" and wrote a letter to the Daily News to tell his side of the story. It was published on July 18, 1880. In that letter he stated that he did make "some bricks for Pritchard of peculiar shape, to be used in the manholes of the sewer, and some other brick suitable to be used in constructing sewers, manholes or walling wells and cisterns." [145] He wrote that these bricks were all sold to Mr. Pritchard at regular prices and "the payment for these is in no way dependent upon, nor connected with his contract with the city." They "were sold to him as I would sell him a horse or anything else he might want." He said that if selling bricks to a contractor made him have a specific interest in who receives the contract, then he had been "doing business all my life in ignorance of my rights and liabilities".[146]

After a vote of Council members, Mr. Davis was allowed by City Council to have his counsel, Judge Marsh, speak on his behalf. Marsh acknowledged "Davis had sold a few brick to a contractor, who happened to have a contract with the city" but there was not "one scintilla of evidence that Davis was guilty of the charges" of corruption. [147]

"Corrupt and Rotten Council"

As is often the case with the political process, there was a lot of talk and very little action. Apparently the whole controversy fizzled out after it lay dormant for a few months. In October 1880, the Rocky Mountain News reported that contractor Hugh Pritchard continued to use Alderman Davis' bricks for construction of the sewers.[148] Alderman Davis remained on Council until 11/4/1880. Two years later, he was elected to another term serving again as the Alderman from the 4th Ward from November 1882 – April 1885.

Large Interceptor Sewer – Delgany Street Sewer

In 1892, about a decade after brick sewer construction started, the Delgany Street sewer was built. As Denver grew, more flow was going through the downstream end of the sewer lines closest to the South Platte River discharge point. To accommodate the flow from the ever expanding city, a larger sewer that had the capacity to collect the increasing amounts of waste from outlying areas was needed. The Delgany Street sewer was a very large interceptor sewer (92" to 94" in diameter) and was a major public works project for Denver at the time it was built.

Starting at Stout St., it followed 11th St. to its intersection with Delgany St. From that point, it followed Delgany St. to the point where 26th St. intercepted the South Platte River. [149] At that point, a four ft. square temporary wooden culvert carried the flow to the intersection of 31st St. and the South Platte River where it dumped into the river. The Delgany Street sewer carried both sanitary and storm water flow and was the first major sewer line to do so. The flow was about 30 cubic feet per second (cfs) of sewage and large amounts of storm water during short periods during and after storms.[150]

The contract to start work on this line was awarded on June 30, 1892 to Murphy & Nelles Contractors at a cost of $159,325. The job was completed within three months finishing on October 1, 1892. The arch of the sewer was built of three concentric rows of bricks. Clay pipes for future connections (stub-outs) were found at 100 ft. intervals along the line.

Delgany Street Sewer Extension

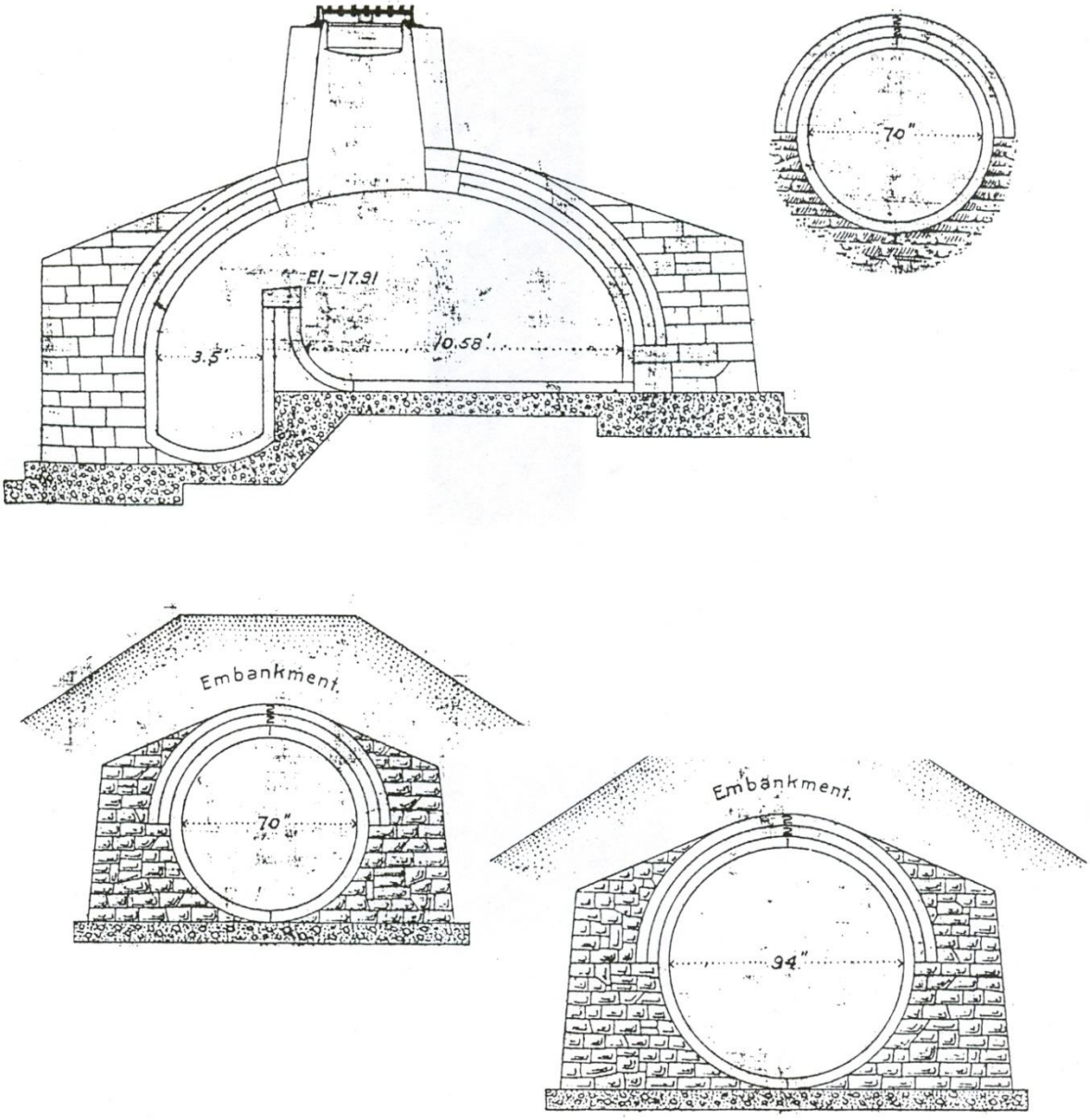
By the mid-1890s, the population of Denver was about 130,000. The strategy for the disposal of the collected sewage was to move the point where the sewage was dumped into the river farther out from the growing city. It was this mindset which spawned the extension of the Delgany Street sewer. The Delgany Street sewer extension was designed to carry the flow further downstream from its current outlet at 31st St. and dump the waste into the river at about 46th St.

There had been multiple instances of health implications from disposal of the sewage at a site closer in to the city. In the summer, almost the whole flow of the river was diverted into irrigation ditches above Denver meaning that the river channel would be nearly dry in September. This left sewage collecting on sand bars and created a significant health menace. The Board of

Health declared the sewage a nuisance and local physicians claimed that diphtheria and typhoid had been engendered on account of its unsanitary condition.[151]

The Delgany Street sewer extension was designed as a combined sanitary and storm water sewer. Besides receiving almost all of the sewage from Denver, it also received the storm runoff from the central business district of the city.[152]

Cross Sections of Various Segments of the Delgany Street Sewer Extension



In May of 1894, the Board of Public Works determined that they would build about 8300 ft. of the Delgany Street sewer extension which was a much as they could build with the funds at their disposal at the time. The Delgany Street sewer extension was designed shortly thereafter by E. P. Martin, Chief Engineer of the Board of Public Works for the City of Denver. It was designed to serve as a main intercepting sewer carrying all sewage down the river to the outskirts of the city. It would reach the ground three miles below 26th Street and at that point would be available for irrigation use. [153] Using the storm and sewage flow for irrigation was a decision that solved the health problems created by dumping the sewage in the river and then having sewage collecting on sand bars when there was low flow in the river in the late summer.

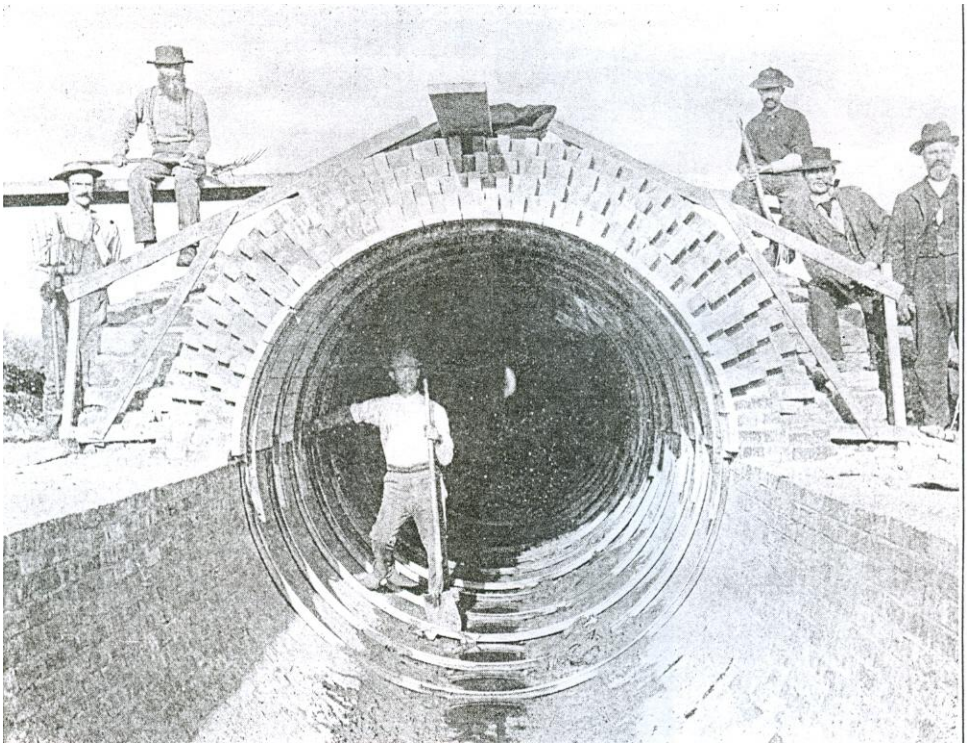
Actual construction of the Delgany Street sewer extension began on August 20, 1894 under the direct charge of Mr. A. M. Gibson. He remained in charge of the work until December 7, 1894 when he was replaced by Mr. W. W. Follett. Construction continued through the winter of 1894/1895 when the weather was not too inclement. This added to the costs of some portions of the work, but helped out the laboring men of Denver at a time when that help was badly needed.[154] The length of the finished line was 8290 ft. and construction was completed by June 13, 1895 at a total cost of $148,628.

The Delgany Street sewer extension was built of three concentric rings of brick set in a cradle of rubble which rested on a concrete base. The wooden culvert between 26th and 31st Streets was replaced by a 94" diameter brick sewer. The total length of that segment was about 2300 ft. Between 31st St. and 46th Ave., the line varied in size from 70" to 77" in diameter. Manholes were built about every 400 ft. for the length of the extension. In some sections of the sewer, the invert (bottom) of the sewer was a single layer of bricks and the arch (top) was built of three concentric rings of brick. In other sections, the sewer was built of a full three concentric rings of brick on both the top and bottom.

Construction materials for the Delgany Street sewer extension included Portland cement mortar, (mixed 3 parts sand to 1 part cement) for laying the inner ring of brick, and Louisville cement mortar (mixed 2 parts sand to 1 part cement) for the rest of the brickwork.[155] All concrete was mixed by hand and then put in place with wheelbarrows and shovels. The mortar and brick were lowered into the sewer trenches by hand ropes.

There was a significant amount of controversy over the selection of the type of labor to be used for the project. The issue was whether it would be better to use day labor where individual independent workers were used or contract labor where the workers were part of a construction business work-force. The issue became even more controversial when the Governor insisted that the workers would be selected by their political affiliations.[156] This caused the Denver Republican, a political foe of the Governor at the time, to characterize the project as "illegally constructed for political purposes." A compromise was eventually worked out which permitted the Board of Public Works to do the construction by day labor rather than contract labor. The only preference in hiring men was to select those who had families.[157]

An assessment of costs showed that the work was done cheaper by day labor than if it had been done by contract labor. Daily wages for an eight hour day ranged from $1.00 for water boys, to $5.00 for the foreman. The laborers were paid $1.75 to $2.00 per day and the brick masons earned $4.00 per day.[158] The wages paid to all classes of labor were about 40% above the average rates. The engineer in charge of this project had exclusive power to employ and discharge men and local reports indicated that this was the reason there were no "incompetent mechanics and shiftless workmen" on the job.[159] The result was a project of excellent workmanship with quality materials.



Delgany Street Sewer Extension. 1895
Photo Courtesy of Denver Public Library, Western History Collection, , Follett, Am. Soc. Civil Engineers Vol. XXXV, No. 773 Plate II

The Board of Public Works had been correct in saying that day labor could do the job cheaper than contract labor. The Delgany Street sewer extension included 8290 ft. of sewer built at a cost of $148,628.18 for a cost per foot of $17.93. [160] The cost per foot of the initial construction of the Delgany Street sewer done by contract labor three years before was $26.82.[161]

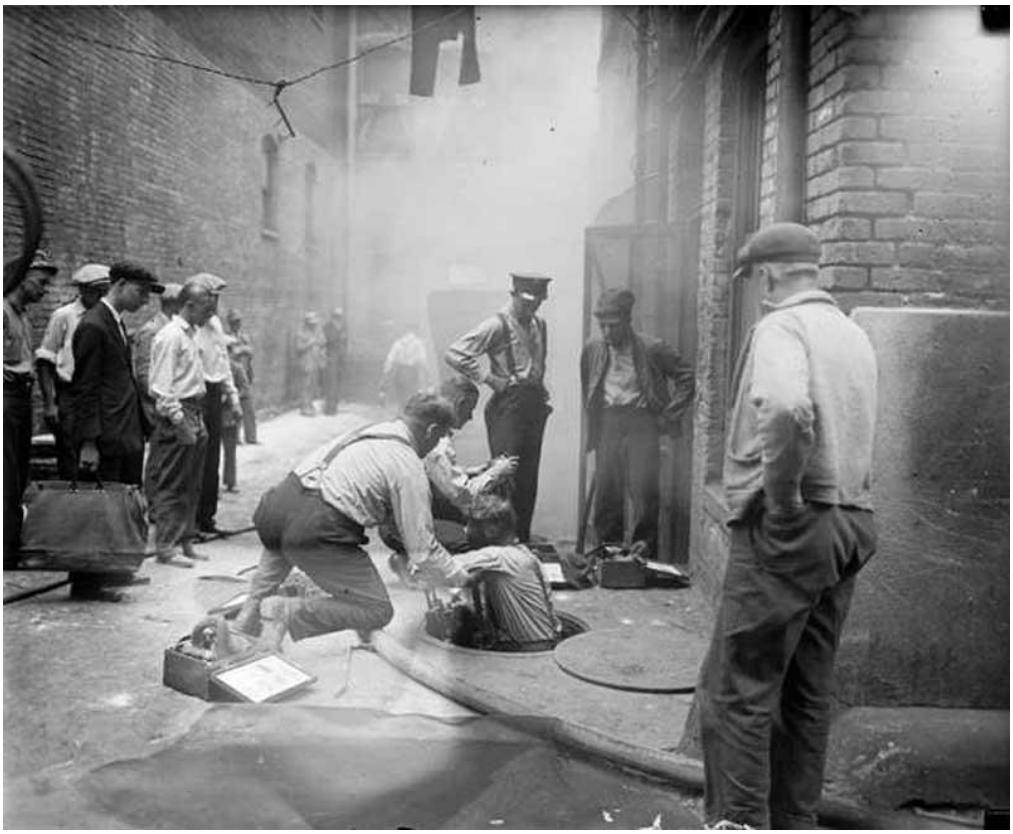
Maintenance and Operations

Once Denver had some sewer lines in operation, the need for regular maintenance of the lines became evident. The City Engineer brought "the necessity of a systematic and regular cleansing" of the sewers to the City Council's attention in December of 1881. He proposed the use of "a small car with which to flush the entire system" or the use of "a machine for the same purpose, which had been constructed by Windy Clark." The reason for this new equipment was that "the sewers in the lower part of the city [were] getting foul and needed immediate attention."[162] The Denver Water Company offered to give a discounted rate of 15 cents per gallon water for the purpose flushing the sewers and the matter was turned over to the Council committee on streets. Within the week, Windy Clark's "flushing machine" was tested by the City Engineer for potential use in the sewers.[163]

Several years later, the "Council committee on sewers, the faculty of the Denver Medical college, the mayor, several prominent physicians and representatives of the daily press" were invited to inspect the condition of the sewer systems, "especially in the 16th and 18th St. districts." [164] During the inspection, "the system was tested in a number of ways by the experts present" and was pronounced to be of sound working order. In fact, Denver's new sewer

system, touted as “one of the best in existence” and “quite a feather in the professional cap of City Engineer Lowrie,” required “less than five hundred dollars” for flushing and repairs for the entire year of 1883.[165]

General sewer maintenance activities included flushing, cleaning, repairing and overall maintenance. In the early 1900s, the flushing operations were completed by a working force of three flushing tank wagons each pulled by a two-horse team with a driver. The flushers and cleaners not only conducted daily flushing work, but also responded to issues such as blocked sewers. For those jobs, the maintenance team brushed the sides of the lines, used rods to probe and prod to find the blockages, and dragged chains through the sewers to relieve the blockage. Accumulations also had to be removed from catch basins in storm sewers. In addition to the flushing teams, there were 397 automatic flushers in the city as of May 1911.[166]



Sewer crew coming out of a manhole in Denver. Circa 1920 - 1940
Photo Courtesy of Denver Public Library, Western History Collection, Reference Rh-1462

In July 1911, the Denver Municipal Facts reported that a bill was referred to committee that would allow the city to sell sewage to the Denver Fertilizer and Irrigation Company. The company wanted to use the water from the sewage for irrigation and to spread the sewage itself as fertilizer. The company offered Denver $5000 per year for the sewage up through the time when the city population reaches 250,000. The 1910 census count for Denver was about 213,000 and the city was consistently growing. They offered to pay an additional $1250 per year for every 50,000 gain in population and requested a perpetual franchise from the city. Their request was defeated by the City Council. Several Council members felt that the offer was just a way for the company to get some irrigation water. The company brought the offer to the City again in October 1911 and it was referred to committee. After much discussion,

passage of time, and modification to the agreement, it passed. The agreement that went into effect in January 1913 called for an annual payment of $7500 with an increase of $2500 annually for every increase of 50,000 in population.

By the 1930s, Denver had a sewer flushing department. It was part of Denver's Public Works agency, and was associated at times with the city's paving department, its highway department and other groups associated with streets. The sewer flushing department cleaned debris from storm sewer catch basins, repaired sewer lines, flushed the sewer system, installed manholes and unclogged plugged sewer lines.

Sewer Flushing Department of the Denver Highway Department. Circa 1930 - 1940
Photo Courtesy of Denver Public Library, Western History Collection, Reference X - 20715

By the 1950s, Denver was ready to try a new technique for sewer inspections and maintenance. The City of Denver purchased a 10-foot collapsible rubber boat for use in a 'down-under' survey of Denver's West and South Side Sanitary Interceptor Sewer, which runs "from Overland Park in southwest Denver to the City's main sewage treatment plant at E. 51st Ave. and Franklin St." The city engineer, Dewy Wright, insisted that "the only way we can determine the condition of the sewer is to go down into it and find out." He acknowledged that they "will experiment with the best and hope for success" as the "sewer carries a tremendous load and the current might be too swift." [167]

The sewer to be inspected was “built in 1910 of bricks” and “serves approximately 75 percent of the city” while it “follows the Platte River on its meandering route under the entire city to the plant.” The size of the sewer ranges from 48 to 72 inches and typically is not more than “half-full at peak periods.” [168] The investigation of these pipes “is one of four major projects that the city has undertaken with the $1.3 million obtained for sanitary sewers” during the election in May of 1955. Of the money granted, “approximately $250,000 will be spent for construction of three new digestors.” These digestors were “huge bacteria-filled tanks which reduce the solids in sewage;” this had become an issue “because of Denver’s rapid expansion plus the increased use of garbage disposal units which increase the solids in sewage.” [169]

Teams of people were tracking “stream flow, peak periods and other necessary data” to make the trip into the sewers as safe and efficient as possible. Furthermore, “every possible safety precaution” would be taken prior to the journey, including the “opening of man-holes to clear the main of sewer gas, adequate lighting and breathing apparatus,” as well as “crews on top of the ground” who would “control the boat by ropes.” [170]

More Sanitary Sewers

As the years passed, the City of Denver expanded to the west side of the South Platte River and to the south of Capitol Hill. With all this additional population growth, it became clear that in addition to the Delgany Interceptor, another large sanitary interceptor sewer was needed. The West and South Side Sanitary District was created to meet this need.

Formation of Sewer Districts throughout Denver

The general way that sewers were constructed in Denver was through the formation of an improvement district. The improvement districts were usually formed after petitions were filed by property owners in the area who wanted specific improvements, such as sewers or paving. The Bureau of Engineering and Survey of the Denver Board of Public Works would prepare maps, plans and specifications for the sewers. To prepare these documents, they had to find out information on the topography of the land in the district. For storm sewer districts, they also had to locate the natural drainage points. The city staff would then provide a notice about the specific plans to all the property owners in the district. If there were no objections to the formation of the district, a bill for an ordinance was prepared and recommended for passage by City Council.[171]

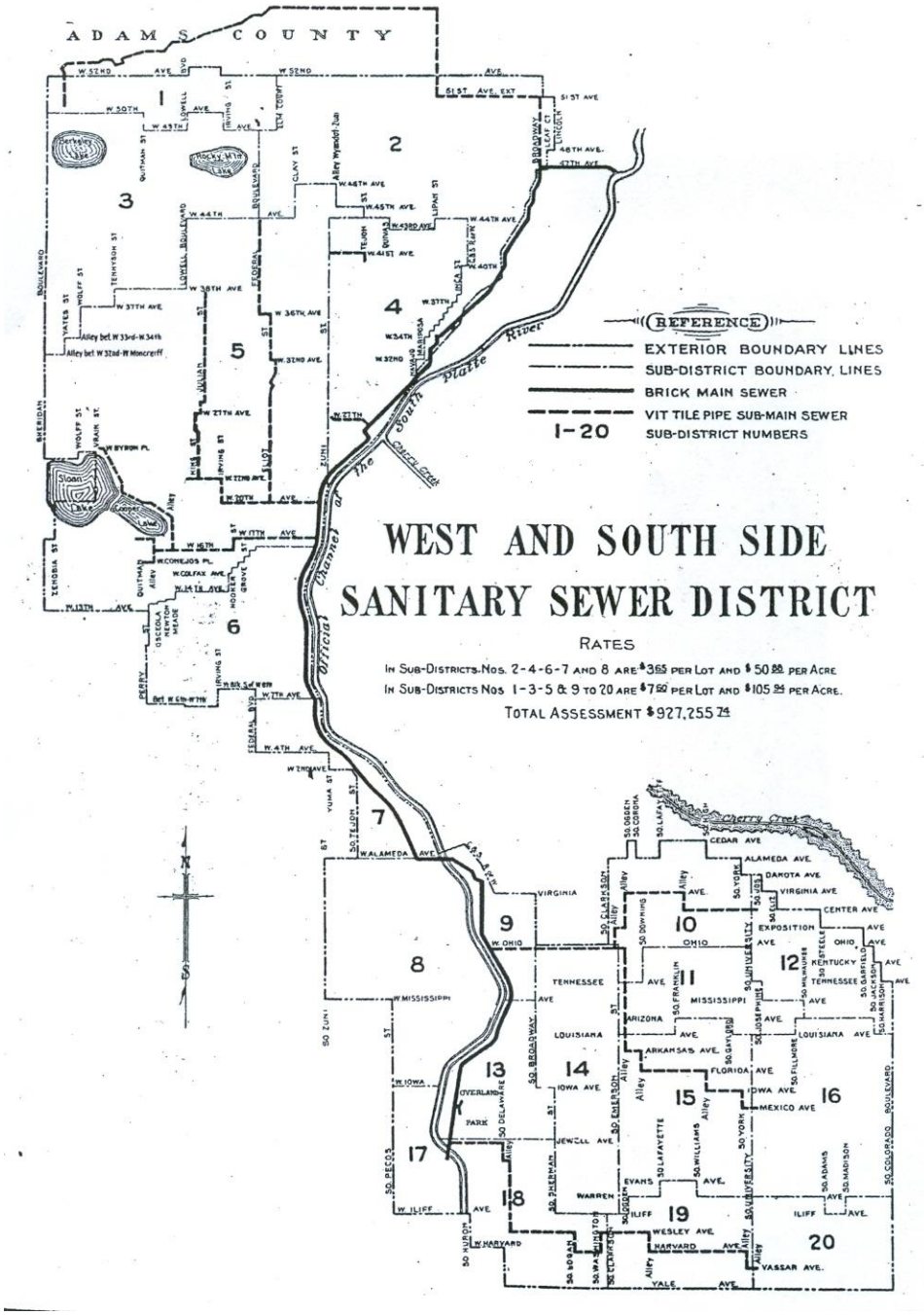
The construction of the sewer lines in a district was funded by assessments on individual properties in the area. Property owners had to go to the office of the Auditor in Denver City Hall with their property deed. The Auditor’s office would prepare a statement of the amount of the assessment for their specific property. The owners would then make their payments at the Treasurer’s Office.

People in Denver wanted sanitary sewers and forming districts was the first step in accomplishing that goal. Many of the residents were impatient for the improvements to be installed. The residents were willing to bear the expense of the sewers and they wanted the work done as soon as possible as proven by the many petitions that the City of Denver received asking for new sewer installations in early 1910.

North Denver Sanitary Sewer, Circa 1910-1920.
Photo Courtesy of Denver Public Library, Western History Collection, Reference X-29447

West and South Side Sanitary Sewer District

The West and South Side Sanitary Sewer District was established in 1909 for the purpose of providing sanitary sewer service to newly developed areas in the northwest and southeast portions of Denver. At that time, this district was nearly half of Denver. An area of 12,920 acres was included within its boundaries which encompassed the northwest quadrant of Denver immediately west of the South Platte River to the western city boundaries at Sheridan Blvd. between approximately 6th Ave. on the south and 52nd Ave. on the north. It also included the city's southeast quadrant immediately east of the South Platte River to Colorado Blvd. on the east between approximately Alameda Ave. on the north and Yale Ave. on the south. The entire district included enough land for 144,833 ordinary lots with dimensions of 25 ft. x 125 ft. Since this was such a large district it was divided into 20 sub-districts.



Map from Denver Municipal Facts, Volume 2 #2, 11/22/1913, pg. 11,
Denver Public Library, Western History Collection

The cost to the property owner for the assessment varied with the location of the area receiving the sewers. Properties in most of the sub-districts on the northwest side of the West and South Side Sanitary Sewer District had assessment rates of $3.65 per lot, whereas properties in southeast Denver, on the east side of the South Platte River, had assessments of $7.60 per lot. The reason for the wide variation in assessments was that the northwest part of Denver was only receiving a main sewer line, whereas the southeast portion of Denver was receiving a main sewer and large branch lines. The northwest part of Denver in the district was largely undivided, unimproved farmland. After the farmland was divided and improved, it would be

necessary to also construct large branch sewers through these sub-districts. When that happened, the property owners in those districts would be assessed again.[172]

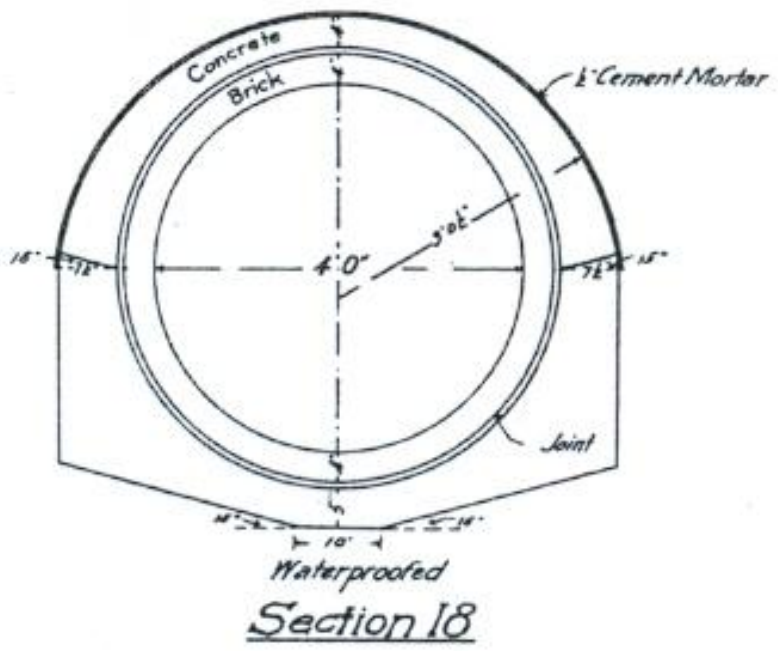
Sewer improvements costing $589,660 and handled by contractor Dennis Gibbons were underway for the West and South Side Sanitary Sewer District by February 1910. This project was the largest public project in assessment improvements as yet undertaken by the city.[173] Construction of the West and South Side Sanitary Sewer was completed by May 1912, and required the following work:

- 631 ft. of 72" brick and concrete sewer
- 6,996 ft. of 70" brick and concrete sewer
- 1,489 ft. of 62" brick and concrete sewer
- 5,002 ft. of 60" brick and concrete sewer
- 1,466 ft. of 56" brick and concrete sewer
- 3,733 ft. of 52" brick and concrete sewer
- 6,190 ft. of 48" brick and concrete sewer
- 3,746 ft. of 46" brick and concrete sewer
- 5,706 ft. of 44" brick and concrete sewer
- 2,156 ft. of 34" brick and concrete sewer
- 990 ft. of 32" brick and concrete sewer
- 339 ft. of 30" brick and concrete sewer
- 633 ft. of 26" brick and concrete sewer
- 285 ft. of 16" brick and concrete sewer

The total amounted to 39,362 linear ft. of brick sewer lines for this project. It also included 89,731 linear ft. of pipe sewer, about half being 18" and half being 24" pipe.[174]

The large main sewer built for the West and South Side Sanitary Sewer District basically followed the course of the South Platte River northward from Jewell Ave. to 47th Ave. where it discharged into the river. In May 1910, one crew of workers was laying the brick for the main trunk of the sewer which had a 62" diameter near 47th Ave. and Broadway, while two other crews were working on the southeast Denver portion of the sewer line. The main sewer was completed by the end of March 1912. It had about 30 miles of sewer mains in it extending from Rocky Mountain Lake in the Berkeley neighborhood to the South Platte River and from University Park in southeast Denver, under the South Platte River at Alameda Ave. and along the river's edge. In 1912, there were about 60,000 inhabitants within this service area and it was estimated that the planned West and South Side Sanitary Sewer District would have sufficient capacity to serve 308,000 inhabitants.[175]

Portions of this sanitary sewer were laid below the elevation of groundwater, necessitating that the sewers be made waterproof even though that raised the cost of construction of the sewers. The sewers were made waterproof by covering the layer of brick with a shell of waterproofed concrete that utilized a chemical preparation known as toxement, which was mixed in with the cement concrete at a rate of 3 lbs. of toxement for every 100 lbs. of cement concrete.[176]



Waterproofed Sewer Plan, Map of Full Details for the West and South Side Sanitary Sewer District, June 15, 1909, Sketch Courtesy Metro Wastewater Reclamation District

There were many Denver City Council actions and bills associated with this sanitation district. The contract to construct the sewers in Sub-district No. 3 was awarded in June 1911 to Commonwealth Construction Co. for a bid of $99,662. In that same month, the contract for work in Part A of Sub-district No. 1 was awarded to the Denver and Pueblo Construction Company for their low bid of $11,785. In November 1911, the contract to construct the sewers in Sub-district No. 10 was awarded. Also in 1911, construction of sewers in Part A of Sub-district No. 14 and in all of Sub-district No. 11 was approved. In February 1912, City Council gave authorization for the construction of laterals in Part A of Sub-district No. 15 and the contract for construction of sewers in Sub-district No. 11 was awarded. In that same month, estimates came out for the cost of connection to a sewer for a standard lot in Sub-districts No. 16 and No. 20. That cost of connecting to a sewer was estimated to be $15 per lot.[177] In September 1912, a bill providing for the construction of branch sewers in Part B of Sub-district No. 20 was passed.

By January 1913, Supervisor's Bill No. 154 authorizing the construction of laterals in Part A of Sub-district No. 5 was passed. A similar bill approving the funding for the laterals in Sub-district No. 3 was passed by July 1913. By September 1913, laterals were fully provided to 11 of the 20 sub-districts in the West and South Side Sanitary Sewer District. A February 1912 notice that payments for the sewer assessment were due, stated that property owners would receive a 10.5% discount if they paid by an early given date.[178] Construction within this large district continued for well over 15 years. In the fall of 1924, the Denver City Council was still establishing new sub-districts and authorizing construction of new sewer lines. A large amount of the brick sewer lines of the West and South Side Interceptor are still in operation today.

Other Sanitary Sewer Districts in Denver

In addition to the district for the large West and South Side Interceptor Sewer, there were a variety of smaller districts established for providing sanitary sewer service to city blocks and neighborhoods. One of the larger of those districts was the East Side Sanitary Sewer District.

East Side Sanitary Sewer District

In 1908, a sanitary sewer in Sub-district No. 8 of the East Side Sanitary Sewer District was completed at a cost of $117,619. All the lines in this sub-district were constructed of vitrified pipe as the sizes were small ranging from 8" to 12" pipe.[179] In March 1909, construction of sanitary sewers in Sub-district No. 2, which is west of Steele St., was approved. In August of that year, the payment for construction of sewers in Sub-district No. 5 was approved. Sub-district No. 5 generally included the area between Steele and High Streets and 26th and 37th Avenues. In 1910, sewers were approved for Sub-districts No. 10 and No. 11 of the East Side Sanitary Sewer District No. 1. The sewers were actually built in Sub-district No. 10 by the Dillon Stone Company during 1911.[180] The estimated assessment for that sub-district was $16.50 per lot. That sub-district included the area between Monaco Parkway and Holly St. on the east and west and 6th to 22nd Avenues on the north and south. Sub-district No. 11 is directly east and included the area between Monaco Parkway and Roslyn St. and 6th Ave. to Montview Ave.

By September of 1909, approval had been provided for payment of construction of sewers in Sub-district No. 2. Also, a bill authorizing the study of sewer construction for Sub-district No. 6, which is in the general area south of 29th Ave., had been referred to the Committee on Drains and Sewers for their consideration. Approval for the cost of construction for all the sewer improvements in that sub-district came in January 1912.[181] During 1911, over $21,000 was spent putting sanitary sewers in a part of Sub-district No. 6.

By the end of 1911, the largest sanitary sewer was a 77inch diameter brick sewer line.

The smallest sanitary sewer was only 8" in diameter, but there were about 1.5 million ft. of sewer line that size.

In early 1912, the Burlington Ditch and Reservoir Company made an offer to the City of Denver to purchase the complete output of sewage from the East Denver Sanitary Sewer. The output from the sewer opened into the Burlington Ditch. The ditch company agreed to convey the sewage to a location beyond the city limits where they would install a measuring device that would measure the flow of water from the sewer. The Burlington Ditch and Reservoir Company proposal said they would pay the city a sum equal to 5% of $3000 multiplied by the average annual discharge in cubic feet/second. The company's offer was to start on January 1, 1913. In its proposal, the company pointed out that the discharge of the sewage into the South Platte River would only result in a danger to the health of Denver citizens and that their proposal could help relieve the pollution in the river. The proposal was referred to the City's Health Commissioner for consideration in April 1912. Within a week, Health Commissioner Sharpley had signed a contract with the ditch company accepting their proposal for implementation in

January of 1913.[182] That arrangement lasted until August 1939 when the sewage was instead sent to the new sewage disposal plant and the Burlington Ditch was allowed to take an equal volume of water from the South Platte River.

> In 1912, there were 10 miles of brick sanitary sewers in Denver out of a total of 362 miles of sanitary sewer lines.

The City and County of Denver Department of Public Works Wastewater Operations maintains a database that provides information on all the sewer lines within the city. That database showed that remaining brick sewers in the East Side Sanitary Sewer District are found at the following locations: York St., E 40th Ave., under the alley east of High St. between 28th to 35th Avenues, E 27th Ave., Josephine St. and City Park.

Storm Sewers

Construction of storm sewers started in 1889 after the sanitary system had been functioning for nearly a decade. The first area to receive storm sewers extended from 8th Ave. north to the South Platte River and from Elizabeth St. on the east to Market St. on the west.[183] The contract for construction of the storm sewers was awarded to O'Rourke Construction Company. Billed as "one of the largest pieces of public improvement work that has ever been attempted in Denver," the sewer pipe was laid 21 feet below ground and was done at "a large scale than ever before attempted." [184]

Storm sewers are larger in size than sanitary sewers and more costly to build. In contrast to sanitary sewers, storm sewers have more options for locations to discharge the storm water. The storm water drains follow the slope of the land and are directed to outlets that are located at the closest convenient location on the South Platte River or Cherry Creek. The distances to discharge points can be shorter since there are multiple discharge points. An evaluation of Denver's sewer system by the Chicago sanitary engineering firm of Alvord, Burdick & Howson in 1924, showed that the natural topography of Denver provided an advantage in that there are many opportunities for storm drainage discharge.[185]

Storm sewers or a combined storm and sanitary sewer, have street-inlets or catch-basins that must be built for admitting the storm water to the sewers. These are covered by grates at the ground surface and are usually placed near curb corners at street intersections.

Development of Storm Sewer Districts

Similar to the sanitary sewers districts, the general way that storm sewers were constructed in Denver was through the formation of an improvement district. The improvement districts were usually formed after petitions were filed by property owners in an area who wanted specific improvements, such as sewers or paving. The Bureau of Engineering and Survey of the Denver Board of Public Works would prepare maps, plans and specifications for the sewers. To prepare these documents, they had to find out information on the topography of the land in the district. For storm sewer districts, they also had to locate the natural drainage points. The city staff would then provide a notice about the specific plans to all the property owners in the

district. If there were no objections to the formation of the district, a bill for an ordinance was prepared and recommended for passage by City Council.[186]

The construction of the storm sewer lines was funded by assessments on individual properties in the area. Property owners had to go to the office of the Auditor in Denver City Hall with their property deed. The Auditor's office would prepare a statement of the amount of the assessment for their specific property. The owners would then make their payments at the Treasurer's office.

Financing was the principal problem in storm sewer construction. The City had the authority to order construction of both storm and sanitary sewers, regardless of the desires of the property owners involved. However, the City did not have the same sense of urgency to create storm sewers as they had to create sanitary sewers. City officials were swayed by public protest to not create storm sewers as they were not deemed as necessary as sanitary ones and some residents did not want the extra assessment on their property.[187] Property owners in lower areas definitely understood the need for storm sewers as their property was subject to flooding from runoff from the higher areas. The runoff problem in the early to mid-20th century progressively got worse due to Denver's rapid growth and building boom since more paved streets, sidewalks, alleys, and homes means increased runoff due to less absorption of water into the ground.

In 1909, there was some frustration with the timing of the construction of storm sewers. Apparently, the streets had recently been paved and then workers had to rip up the paved street to lay the storm sewer line. This prompted the Board of Public Works to advise that the storm sewer first be laid in districts before the streets were paved.[188]

There had also been problems in the summer of 1909 with the runoff from intense summer storms washing out the newly installed street paving in the Park Hill District where storm sewers had not yet been installed. The rain formed lakes and undermined both the paved and unpaved streets in the area.[189]

Even though a property owner was in an area where a district had been formed, and also had everything lined up for improvements, sometimes there was a long wait. In early 1910, there was a two-year construction back-up in Denver because of all the requests the City had for improvements. In August 1913, the fee for a storm sewer connection was $2.00 for each house.

North Denver Storm Sewers

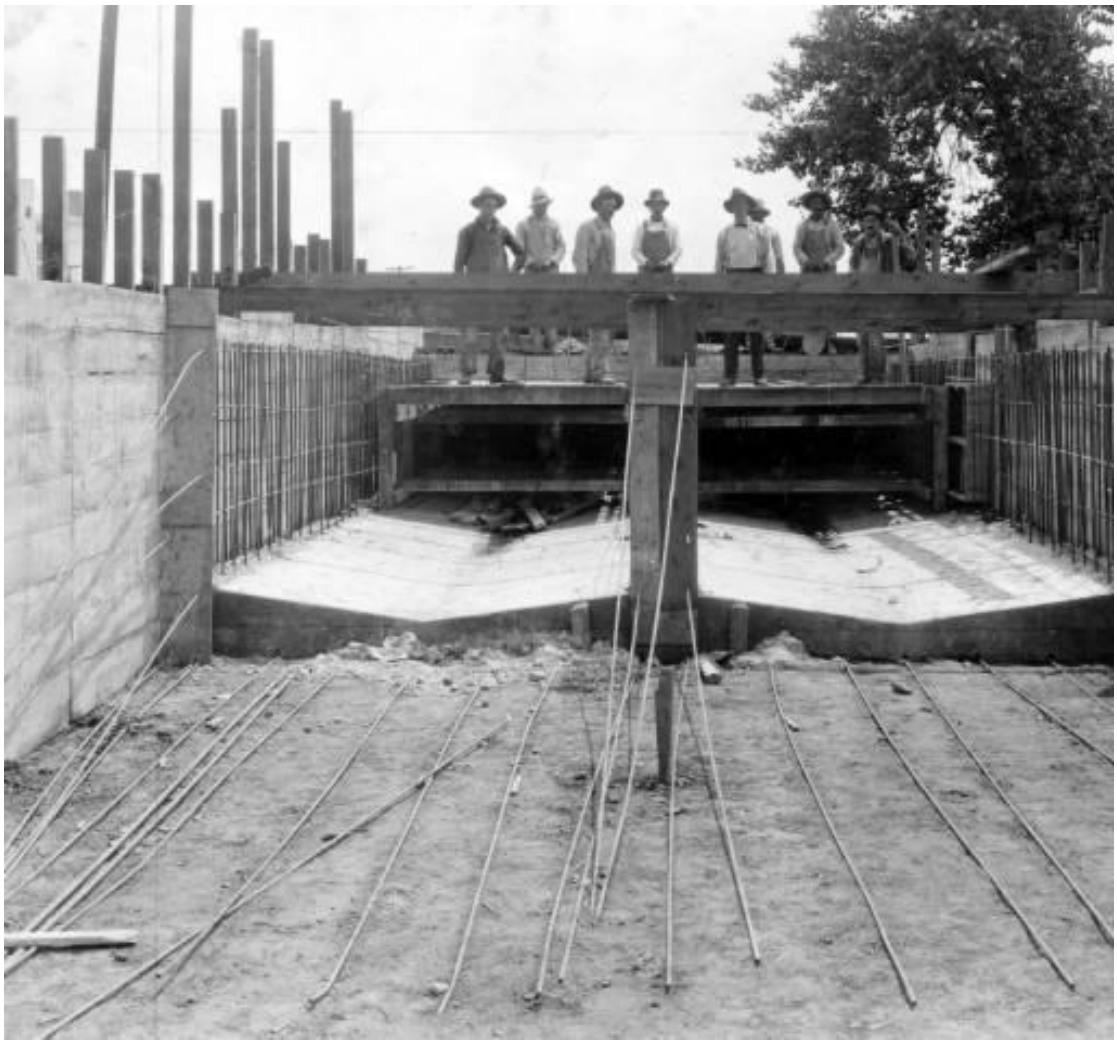
North Denver Storm Sewer District No. 1

The North Denver Storm Sewer District No. 1 covers a large portion of northwest Denver. It was established prior to 1906 and generally included the area bounded by Colfax Ave. on the south, the South Platte River on the east, 34th Ave. on the north and Lowell Blvd. on the west. The main district was divided into several smaller sub-districts.

The sewers in this district were built in stages. By the end of 1908, a total of $246,686 had been spent on storm sewers in North Denver Storm Sewer District No. 1.[190] In autumn of 1909, Aldermanic Bill No. 92 (introduced by Alderman Conlon) was passed. It approved funding for the total cost of improvements that had been made in the entire North Denver Storm Sewer District No. 1.

The North Denver Sewer District No. 1 has the distinction of having the first contracts for storm sewer construction awarded by the City where concrete was used as the building material. These contracts were awarded in April 1909 for construction of storm sewers larger than 18" in diameter. The use of concrete reduced the overall construction costs for the sewers. Prior to April 1909, storms sewers had been built of brick. The firms that had the lowest bids, and thus won the contracts for the first installation of concrete storm sewers, were the Denver & Pueblo Construction Company for Sub-districts No. 2 and No. 6, and W. M. Porter for Sub-districts No. 3 and No. 4.[191] Even though the sewers greater than 18" were built of concrete in this storm sewer district, other storm sewer lines in the city continued to be built of brick for about 25 more years.

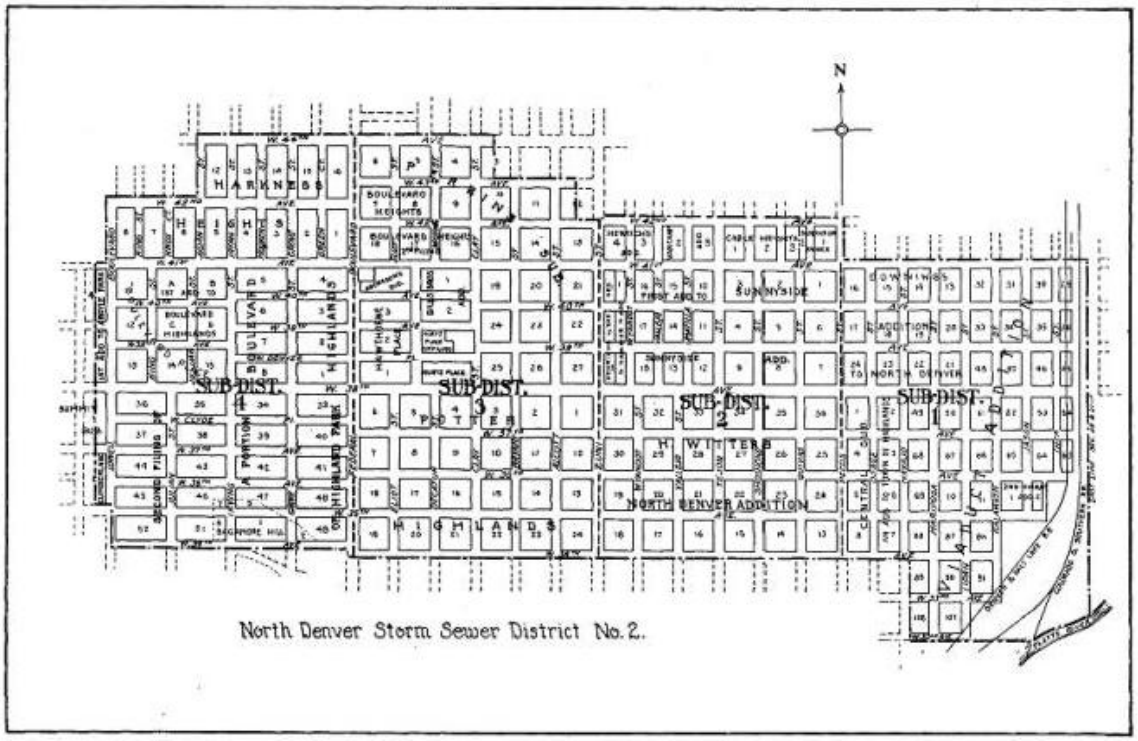
Remaining brick storm sewers in the North Denver Sewer District No. 1 are found under Confluence Park, Elitch Gardens, Gates Crescent Park and under portions of the following streets: Federal Blvd., Hooker St., Zuni St., Byron Pl., Water St., Speer Blvd., Colfax Ave. and W. 16th, W. 20th, W. 23rd, W. 24th, W. 29th and W. 32nd Avenues, as well as under portions of Interstate-25.



Outlet of the North Denver Storm Sewer, Circa 1910-1920.
Photo Courtesy of Denver Public Library, Western History Collection, Reference X-29449

North Denver Storm Sewer District No. 2

The North Denver Storm Sewer District No. 2 covers the area of the far north portion of northwest Denver. It included the area bounded by 34th Ave. on the south, railroad tracks on the east, 44th Ave. on the north and Lowell Blvd. on the west. This district is directly north of the North Denver Storm Sewer District No. 1. The sewers in District No. 2 were constructed in 1921, about a decade after those in North Denver Storm Sewer District No. 1. The construction costs for the storm sewers in this district were over $500,000. The cost per lot for complete storm drainage was about $65. The District No. 2 storm sewer project included sewer pipes ranging in size from 10“ to 78” in diameter. A total of 20 miles of sewer lines were built, with approximately 250 manholes and 650 catch basins.[192] The sewers in District No. 2 drained an area of 1200 acres, making this the second largest storm sewer district in Denver at the time (the Capitol Hill Storm Sewer District was larger).



Map from Denver Municipal Facts, Volume 3 #10, October 1920, pg. 16,
downloaded from http://history.denverlibrary.org Denver Public Library, Western History Collection

One of the construction challenges for this sewer line was an area where the land was very low on the east side of the district near the railroad tracks. Because the land was so low, a typical circular sewer would not have been able to be fully buried, and part of it would have been exposed at the ground surface. To deal with this issue, the engineers built a flat-shaped twin concrete conduit which crossed under the railroad tracks. The twin conduits then emptied into a 78“ brick sewer built of three concentric rings of brick. This 78” line carried 420 cubic ft. of water per second and discharged into the South Platte River.

View of a ditch leading to the South Platte River during construction of the twin conduits for the North Denver Storm Sewer #2, Circa 1910-1920.
Photo Courtesy of Denver Public Library, Western History Collection, Reference X-29453

Remaining brick storm sewers in the North Denver Sewer District No. 2 are found under portions of the following streets: Clay St., Lipan St., Quivas St., Shoshone St., Zuni St., Federal Blvd. and W. 36th, W. 37th, W. 38th , W. 39th , W. 40th and W. 41st Avenues.

West Denver Storm Sewers

On August 10, 1909, Aldermanic Bill No. 84, entitled "Creating and Establishing West Denver Storm Sewer District No. 1", which had been introduced by Alderman McLachlan, passed. In another two years, a bill was introduced to City Council to approve the funding for all the storm drainage improvements that had been made in the district.[193]

Remaining brick storm sewers in the West Denver Storm Sewer District No. 1 are found under portions of the Denver Health complex at 8th Ave. and Bannock St., Sunken Gardens Park and under portions of the following streets: Bannock St., Osage St., Kalamath St., Lipan St., Stout St., Walnut St., Speer Blvd., Colfax Ave. and W. 14th Ave.

Capitol Hill Storm Sewers

Capitol Hill Storm Sewer District No. 1

In May 1911, bills to authorize the construction of laterals in Sub-district No. 4 and Sub-district No. 7 of the Capitol Hill Storm Sewer District No. 1 were introduced and referred to the Committee on Sewers and Drains. By mid-July, the city had awarded contracts for the work in both of these sub-districts. Sub-district No. 4 was bounded by Walnut, Downing, and 31st and 34th Streets. The successful bidder was the Gaffey and Keefe Company who won the contract with the lowest bid of $8140.[194] Sub-district No. 7 was bounded by Walnut, Champa, and 26th and 31st Streets. Nine different firms bid on the construction in this sub-district; the Denver & Pueblo Construction Company provided the lowest bid at $13,181 and was awarded the contract.[195]

Bids were let by the City for construction in Sub-district No. 1 and four contractors responded. In late June, 1911, the City awarded the contract to the lowest bidder which was Westcott-Doan Investment Co. Work was completed on the sewer lines in 1912 in Part A of Sub-district No. 1 which included the area roughly bounded by Downing Ave., Blake St., and 34th and 38th Streets.

Brick sewers in the Capitol Hill Storm Sewer District No. 1 that still remain today are found under portions of the following streets: Grant St., Champa St., Downing St., Ogden St., Franklin St., Park Ave., Humboldt St., Clarkson St., Washington St., Gaylord St., Vine St., Race St., High St., Lafayette St., Tremont Pl., Walnut St. and 9th, 10th, 13th, 14th, 16th, 17th, 20th, 21st, 23rd, 24th, 28th, 29th, 33rd, 36th and 37th Avenues.

South Capitol Hill Storm Sewer District

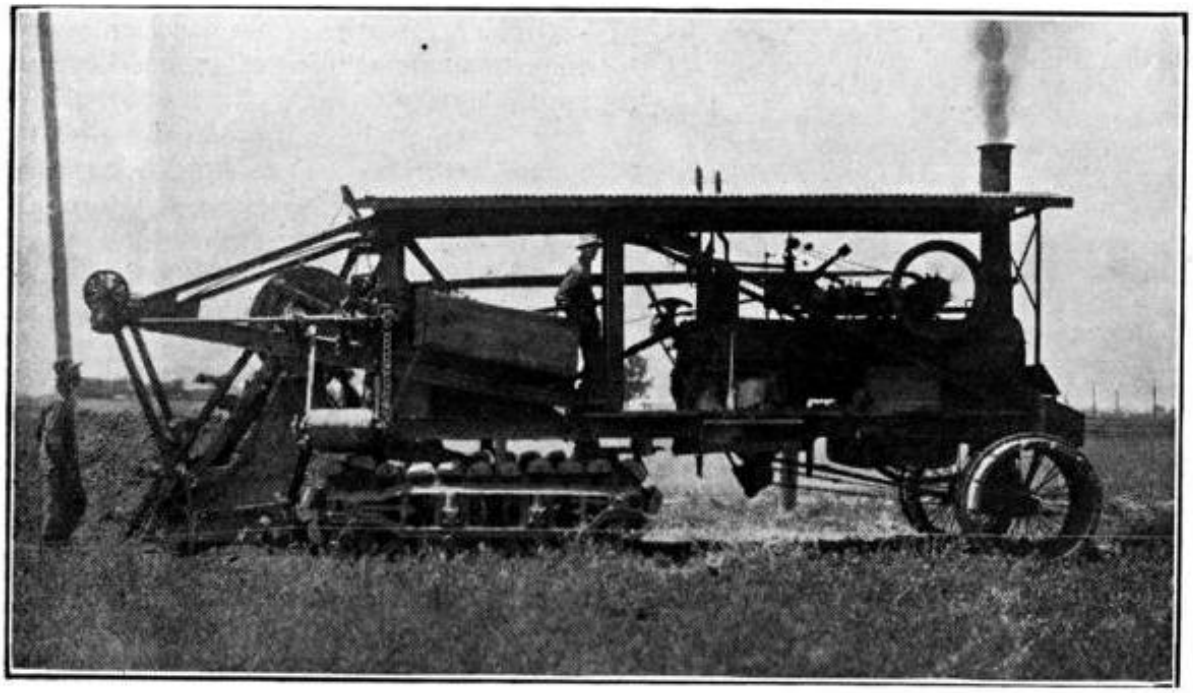
As its name implies, this district is south of the Capitol Hill Storm Sewer District and encompassed an area between 1st and 7th Avenues. Some of the storm sewers were built in this district prior to 1909. There were a fair amount of sewers built through at least 1913. When payments for the sewer assessment were due, property owners were provided with a 5% discount if they paid by an early given date.[196] Brick sewers in the South Capitol Hill Storm Sewer District that still remain today are found under portions of the following streets: Race St., Fillmore St., Josephine St., Clayton St., E. 1st Ave., and E. 3rd through E. 7th Avenues.

The~~se~~ above two Capitol Hill Storm Sewer districts had approximately $35,000 of storm sewer improvements constructed in 1911.[197]

Park Hill Storm Sewers

The Park Hill storm sewer was discussed for many years before it finally received initial approval for construction from the Board of Public Works in 1912. Years of evidence defined clearly the need for this sewer. The Park Hill Storm Sewer District encompassed an area of about 9.5 sq. miles between Fairmount Cemetery (Alameda Ave.) on the southeast and the South Platte River and the stockyards on the northwest (Interstate-70 and Washington St.). This district included the neighborhoods of Park Hill, Montclair, City Park and Clayton's Addition.[198]

In 1923, more construction of storm sewers in this district was discussed as a high priority. By 1924, the Chicago sanitary engineering firm of Alvord, Burdick & Howson was hired to prepare the engineering report on design and cost of storm sewers for this district. This project was described in the January-February 1923 edition of the Denver Municipal Facts as "the largest sewer ever planned in the city of Denver" to date. The estimated cost in early 1923 was $1,213,000.[199] By September 1924, the Park Hill storm sewer had a $2,000,000 price tag.[200] Actual construction of most of the sewer lines did not occur until 1933.



Trench machine digging a sanitary sewer line in Park Hill
Photo from Denver Municipal Facts, Volume 2, #34, October 1920, pg. 4,
downloaded from http://history.denverlibrary.org Denver Public Library, Western History Collection

The City and County of Denver Department of Public Works Wastewater Operations maintains a database that provides information on all the sewer lines within the city. That database showed that remaining brick storm sewers in the Park Hill Storm Sewer District are found under portions of Denver City Park and under portions of the following streets: Jersey St., E. Colfax Ave., E. Batavia Pl., Jackson St., Colorado Blvd., Gaylord St., High St., 23rd St., 40th St., and 14th and 16th Avenues.

Most all of the remaining brick sewer segments in Denver are built of a single row of bricks laid in mortar. However, for larger lines, some 2-ring, 3-ring and 4-ring sewers were built. There are a total of 34 segments of 3-ring brick storm sewers remaining within the city. Thirty-three of those segments are part of the City Park to E. 40th Ave. and Brighton Blvd. storm sewer segment. Those sewer segments were installed on August 1, 1933 as part of the Park Hill storm sewer project.

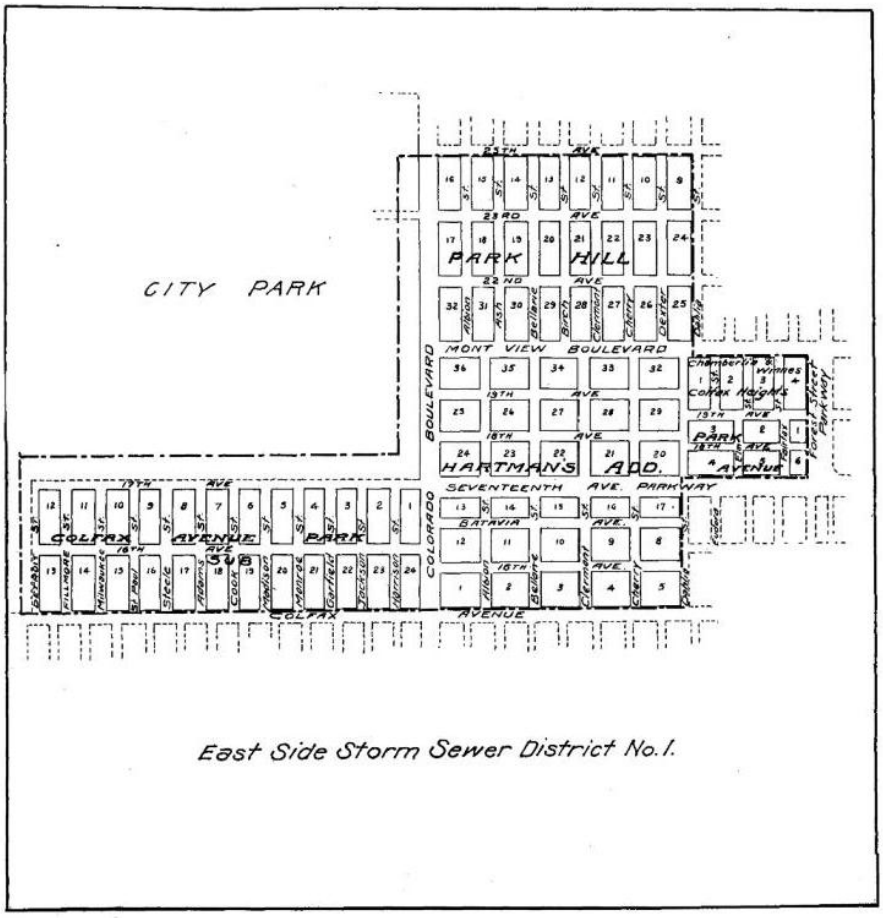
The size of the sewer segments in this project are very large ranging from 102" to 120" in diameter, with the great majority being 114" or 120". This sewer follows an alignment from 23rd Ave. through the City Park Golf Course in a 102" line in a northwest direction intersecting E. 26th Ave. at York St. It then continues west under 26th Avenue in a 114" line turning north and

following under Gaylord St. to East 29th Ave., which it follows for three blocks until its alignment turns north under High St. By 35th St., the sewer is in a 120" line. The 120" size remains the same for the rest of the alignment on High St. to 39th Ave., then along 39th Ave. until the intersection with 40th St. and on to the end of the segment just northwest of its crossing with Brighton Blvd. The remaining 3-ring brick segment is just east of City Park. It is a very short (14 ft.) segment of 84" diameter line on Jackson St. just north of 16th Ave.

There are three segments of 4-ring sewer remaining. They are also part of the City Park to E. 40th Ave. and Brighton Blvd. storm sewer segment described above for the 3-ring brick sewers. These large-diameter sewer segments were also installed on August 1, 1933 as part of the Park Hill Storm Sewer Project. The remaining 4-ring segments are all 120" in diameter and are located under 40th St. between Blake St. and Wynkoop St.

East Side Storm Sewer District No. 1

This storm sewer district is located to the east of City Park between Colfax Ave. and 23rd Ave., an area of about 400 acres. The district was created in 1920, under Ordinance No. 41, Series of 1920 which was approved June 18, 1920. Within a month, a contract was awarded to Gibbons & Lawrence for construction of the sewer system.



Map from Denver Municipal Facts, Volume 3 #10, October 1920, pg. 16,
downloaded from http://history.denverlibrary.org Denver Public Library, Western History Collection

The construction of this storm sewer was critical in relieving flood conditions that occurred to the south and east of City Park after every storm. The storm sewer system in this district included about 8 miles of sewer ranging in size from 10 to 48 inches. It also included 223 catch basins and 100 manholes. The cost to property owners was $39 per lot. When first built, this sewer connected temporarily to the brick sanitary sewer that crossed City Park before later connecting to a new storm sewer main.[201]

Remaining brick storm sewers in the East Side Storm Sewer District No. 1 are found under portions of the Denver Zoo, City Park and the Denver Museum of Nature and Science. In addition there are segments under portions of the following streets: E. Colfax Ave., E. Batavia Pl., Jackson St., Colorado Blvd., and E. 17th Ave.

Washington Park Storm Sewers

Storm sewers were built in this district from at least 1910 through 1924, as reported in the Denver Municipal Facts. In August 1910, the contract for construction of sewers in the Washington Park Storm Sewer District was awarded to Dennis Gibbons who provided the lowest bid.[202] Gibbons had other crews out in 1910 working on construction of the West and South Side Sanitary sewer.

A summary of construction projects in 1911 shows $175,389 spent on storm sewer line construction in the Washington Park Storm Sewer District. The maximum cost assessed against each 25' x 125' residential lot for the sewer line was $28 in Sub-district No. 3, which basically extended from Logan St. on the west to Downing St. on the east and from Virginia Ave. on the north to Mississippi Ave on the south. In the spring of 1924, a contract for over $285,000 was awarded for storm sewer construction in this district.[203]

In 1912, there were 24 miles of brick storm sewers in Denver out of a total of 116 miles of storm sewer lines.

There are many brick storm sewers that still remain today in the Washington Park Storm Sewer District. They are found under portions of the following streets: S. Broadway, S. Cherokee St., S. Bannock St., S. Pennsylvania St., S. Corona St., S. Emerson St., S. Franklin St., S. Williams St., S. University Blvd., S. Downing St., Speer Blvd., Marion St., Bayaud Ave., Center Ave., Dakota Ave., Exposition Ave., Kentucky Ave., Ohio Ave. Virginia Ave., W. Alameda Ave., Arizona Ave., Arkansas Ave, Florida Ave., Tennessee Ave., Louisiana Ave., and Mississippi Ave.

Sewage Treatment

The solution to pollution is dilution - or so it was thought for many decades. After the primitive sanitary conditions experienced by the early settlers in Denver, the construction of a sewer system to remove human waste seemed like the long-term solution to a pesky problem. Where were the wastes removed to? Initially, the waste was dumped into the South Platte River where, it was thought, the dilution from the river flow would take care of everything. However, it was only a little more than a decade before the discharge point for the sewage into the South

Platte River at 31st St. was already too close to a quickly growing city. The logical solution was to move the sewage outlet further from the city and consequently, further downstream on the South Platte River. The Delgany Street sewer extension project, completed in 1895, again solved the problems temporarily by moving the discharge outlet more than a mile downstream from its first location at 31st St. to a site on the South Platte River near 46th St. This again, temporarily took care of the immediate concern for a few more decades.

In 1902, local press reports cited residents of Globeville and Elyria protesting that the sewers were emptying into the South Platte River upstream of them.[204] That concern was valid as Globeville is located on the west side of the river and Elyria on the east side in the general area between 40th and 62nd Avenues, so the outlet was upstream of them and the South Platte River carried the sewage discharge as it flowed through those areas.[205]

By the 1930s, attention was again focused on the health issues from having sources of drinking water contaminated by sewage disposal. The Delgany Street sewer extension kept on dumping the city's collected sewage and storm run-off into the South Platte River at 46th St. By 1930, it had already been dumping sewage into the river for 35 years.

A 1932 report by the Colorado Department of Health linked the pollution of the river to cases of typhoid fever and dysentery in locations downstream of the sewage outlet. That report recommended that a sewage treatment plant be built.[206] In early January 1934, Dr. Henry F. Vaughan, one of the nation's leading experts on pediatric health and the health commissioner for the city of Detroit, gave a lecture in Denver on the importance of proper sewage disposal and treatment. Dr. Vaughan said, "lack of proper sewage disposal means typhoid fever and dysentery. I am sure Denver would rather bear the expense of a disposal plant than plot its self-destruction." [207]

On January 11, 1934, the Denver Post reported the city was notified that the federal public works board had approved a $2 million loan and grant for a Denver sewage disposal plant, contingent on a vote of Denver citizens authorizing a general obligation bond for $1.6 million.[208] The vote was held a few weeks later on January 23rd and it was defeated. The issue escalated in October when the State Board of Health ordered Denver to discontinue its present system of dumping sewage into the South Platte River.[209]

Within a year, Denver was moving forward with the planned treatment plant. Business leaders, parent-teacher associations and service clubs rallied behind the cause and the city's bonds were approved at an election in May 1935. Denver again received notice of federal government financial assistance for the construction of a treatment plant. Mayor Ben F. Stapleton received a telegram notifying him that the federal government would provide 45% of the cost of construction of the treatment plant. The grant was personally approved by President Franklin Delano Roosevelt after considerable lobbying by Representative Lawrence Lewis.[210] The engineering firm of Black & Veatch was awarded the contract to prepare the plans and specifications for the sewage plant. By October 1935, a 30-acre site on the west side of the South Platte River at 51st Ave. and Franklin St. was selected for the location of the sewage disposal plant. Construction of the plant started in July 1936 with an average of 150 men employed by the project.[211]

The direct pollution of the South Platte River from the dumping of Denver's sewage stopped on November 29, 1937 when the first sewage treatment plant began operation. The new North Side Treatment Plant provided primary treatment of Denver's sewage. Primary treatment is a mechanical treatment that uses screens, skimmers and settling to remove the solids from the

sewage. The treatment plant, built at a cost of over $ 1.1 million was thought by many to be one of the most modern sewage treatment plants in operation at that time.[212] Capturing the excitement of the opening, the Rocky Mountain News reported that the treatment plant would be responsible "for transforming germ-bearing refuse into soil-vitalizing fertilizers for use of local farmers." [213]

Chemical Building at the Metropolitan Denver Sewage Disposal District Sewage Disposal Plant, 1937.
Photo Courtesy of Denver Public Library, Western History Collection, Reference Z-10068

The plant was sized to process 50-60 million gallons of sewage daily. Thomas T. Brunton, an inspector in the city engineering department who served as the chief inspector for construction of the new plant, was named the first superintendent of the plant.[214] By July 1938, the plant was processing about 38 million gallons of sewage per day. The monthly plant operations cost was about $6000, which was about half of what had been appropriated.

The treatment plant provided a chance for staff to evaluate the contents of Denver sewage. Newspaper articles were written occasionally on the strange items found in the sewage. An article written on the contents of Denver sewage in 1966 revealed, bizarrely enough, that false teeth happened to be one of the most common "foreign" objects sewer workers found in sewage.[215] The sets of dentures that were found were "cleaned, sterilized and stored" at the off chance their owners came to claim them. Bob Madden, chief chemist at the treatment plant in 1966, was the "keeper of the teeth" and said that "lots of people call inquiring about lost teeth and other items… but generally change their minds about claiming them" once they enter the building due to the odor. This scent, however, does not prevent "Larimer St. Winos" from saying they lost their teeth and setting "about busily pulling teeth from the box and trying them on for size until they find a set that feels pretty comfortable." [216] Diamond rings and other lost items were typically "too small to be screened out and end up as fertilizer." Paper money was also frequently found in the sewage and one worker claimed to have found "$390 in the past three years." The treatment plant workers denied the claim that "sewage levels suddenly jump during

TV commercials," but admitted that there is a noticeable slump during the evening rush-hour, followed by a rise after dinner time.[217]

After less than ten years of operation, it was already evident that the primary treatment which removed the solids from the sewage was not adequate treatment and the discharge was still a menace to public health. Headlines in the September 25th, 1945 edition of the Rocky Mountain News blared, "Typhoid Germs Found in Denver's Sewage." The article went on to describe how the discharges from the sewage treatment plant contained several types of typhoid and dysentery germs. This was the same concern that Denver citizens had over 70 years earlier before the sewage collection or disposal plant was ever built. Only by now, the population of the metro area was nearing 400,000.

It took another decade before Denver again hired the engineering firm of Black & Veatch to conduct a comprehensive study to address additional treatment needs. They recommended the construction of secondary treatment facilities. Secondary treatment is biological processing through the use of microorganisms. The Denver metro areas population was exploding. It was about 400,000 in 1950 and had doubled by 1960. Many of the suburban communities in the Denver area had primary treatment plants in operation. They were also discharging their effluent into the South Platte River. It would make little sense for Denver to invest in secondary treatment when the rest of the suburban cities continued to pollute the South Platte River with their discharge from only primary treatment facilities. What was needed was a consolidated approach to the issue. This eventually led to the formation of a new special district for sewage treatment. Enabling legislation was passed in 1959 and representatives from Denver and the surrounding suburbs met at the Colorado Department of Health to work out the details. The Metropolitan Denver Sewage Disposal District No. 1 was officially created on May 15, 1961.[218]

It took a couple of years to plan and engineer the design of the advanced wastewater treatment plant. Construction of the plant started in 1964, and the completed $20 million wastewater treatment plant was in full operation by 1967. Finally, a century after Denver was first settled, a comprehensive approach to the treatment and disposal of sanitary waste was in effect and only treated water was being discharged into the South Platte River.

Denver Brick Sewer Segments – What Remains Today

There are 46 miles of brick storm sewers, 16 miles of brick sanitary sewers and 7 miles of brick sanitary interceptor sewers for a total of 69 miles of sewer lines built of brick that remain in use in Denver today. The diameter of these lines ranges from a few very narrow ones with an 8" diameter to many extremely large lines with a diameter of 120" (10 ft.). Databases have been developed that show the location of all remaining brick sewer lines. Information included in the databases, which are developed and maintained by the City and County of Denver Wastewater Division and the Metro Wastewater Reclamation District, includes the diameter of the sewer segment, its length, slope and specific location. Information is also included on the specific sewer district that the sewer is located in and the year it was built.

Remaining Brick Sewers:

- 46 miles brick storm sewers
- 16 miles brick sanitary sewers
- 7 miles brick sanitary interceptor sewers

Currently there are 1484 miles of sanitary sewer lines in Denver and 781 miles of storm sewers. The 23 miles of brick sanitary sewer comprises 1.5% of the total mileage of sanitary sewer. The 46 miles of brick storm sewers comprise 5.9% of the total mileage of storm sewer. Overall, brick sewers comprise 3% of the total mileage of sewers in Denver.

Brick Storm Sewers

1901 was a year that saw great strides in the building of brick storm sewer lines. Of the remaining brick storm sewers, by far the largest numbers of sewer segments were built in the year 1901. There are also many brick sewers that remain that were built in 1906, 1907, 1911, 1912, 1920, 1922, and 1923. The last year that saw a substantial amount of building of brick sewers was 1933, although two lines built in 1936 also remain today. Concrete storm sewer pipes were first installed in Denver in 1909. By 1937, virtually all of Denver's sewer lines were being built of concrete.

The most common sizes of remaining brick storm sewer line are 30", 33" or 36" in diameter. These lines were built of one row of bricks laid in a longitudinal pattern. Other common sized remaining brick storm sewer lines include 27", 39" and 54" diameter lines.

Workman in sewer outfall near South Platte River. Note the longitudinal pattern of the bricks in the sewer line. 1909.
Photo Courtesy of Denver Public Library, Western History Collection, Reference CHS-L2696

Most all of the brick sewer lines remaining in Denver are built of one layer of brick. However, there are several areas with sewers built of 3 or 4 concentric rows of brick. These 3 and 4-ring sewers are the larger sewers that needed the extra rows of brick to support such a large diameter sewer line.

3-Ring Brick Sewers

There are a total of 34 segments of 3-ring brick storm sewers remaining. 33 of those segments are part of the City Park to E 40th and Brighton Blvd storm sewer segment. These sewer segments were installed on August 1, 1933 as part of the Park Hill Storm Sewer Project. The size of the sewer segments in this project are very large ranging from 102" to 120", with the great majority being 114" or 120". This sewer follows an alignment from 23rd Ave. through the City Park Golf Course in a 102" line in a northwest direction intersecting E. 26th Ave. at York. It then continues west under 26th Avenue in a 114" line turning north and following under Gaylord St. to East 29th Ave. which it follows for three blocks until its alignment turns north under High St. By 35th St., the sewer is in a 120" line. The 120" size remains the same for the rest of the alignment on High to 39th Ave, then along 39th until the intersection with 40th St. and on to the end of the segment just northwest of its crossing with Brighton Blvd.

The remaining 3-ring brick segment is just east of City Park. It is a very short (14 ft.) segment of 84" diameter line on Jackson St. just north of 16th Ave.

4-Ring Brick Sewers

There are 3 segments of 4-ring brick storm sewer remaining. They are also part of the part of the City Park to E 40th and Brighton Blvd storm sewer segment described above for the 3-ring brick sewers. These large-diameter sewer segments were also installed on August 1, 1933 as part of the Park Hill Storm Sewer Project. The remaining 4-ring segments are all 120"in diameter and are located under 40th St. between Blake St. and Wynkoop St.

Brick Sanitary Sewers

The majority of the brick sanitary sewer segments remaining in Denver were built between 1889 and 1892. The most common sizes of remaining brick sanitary sewer lines are 36" - 45" in diameter. Other common sized remaining brick sanitary sewer lines include 31.5" and 32" diameter lines. These lines are mainly found in northeast Denver and near the corridor of the South Platte River.

Brick Sanitary Interceptor Sewers

The interceptor sewers are the large lines that collect sewage from the many mains and laterals and transport the sewage to the sewage treatment facility. These lines are owned and maintained by the Metro Wastewater Reclamation District. There are two remaining interceptor sewer lines that are built of brick - -one is the Delgany Common interceptor and the other is the West and South Side Interceptor. Both of these sewers were described previously in this report. The Delgany Common Interceptor is comprised of the 76" – 78" diameter Delgany Street Sewer built in 1892, the 70" diameter Delgany Street Sewer Extension built in 1895 and other portions of the Delgany Common interceptor built in 1937. Some of the segments built in 1892 include egg-shaped sewer lines that are 63" in height and 42" in width.

The brick sewers lines of the West and South Side Interceptor were built in 1910 and range in size from 24" to 72" with about half of the line having diameters of less than 50" and half of the lines having diameters larger than 50". The Delgany Common Interceptor is built of 3-ring brick in a variety of cross-sections.

Summary

Denver built its first sewers in 1880 to serve the needs of its growing population. The population has continued to grow and so has its sewer system. When first built in 1880, the sewers were designed to deal with the most serious problems - - the removal of human waste. Within a decade, sewers were also removing storm water. Some sewers were specifically designed for storm water removal and some were designed for combined use of storm and sanitary needs.

Brick was selected as the appropriate material for building Denver's sewer mains because of its durability and moderate costs. Bricks were also easy to work with because of their small size and uniform shape. They could be easily handled by the brick masons and worked well in building sewers in a variety of shapes. When installed properly with even surfaces and thin joints, they provided a true and fairly smooth interior surface which resisted corrosion. However, over time, concrete became more advantageous to use than brick.

Concrete Sewers

In 1909, the first concrete sewer lines were installed in Denver. They were lines greater than 18" in diameter in the North Denver Storm District. After the first installation in 1909, concrete gradually started being used for Denver sewers, and by 1924 it was the main choice. A few sewer mains were built of brick in 1936, but they were an exception and the last ones. Use of concrete had many advantages over use of brick for sewer lines, with the overriding advantage being its lower cost. Installation of concrete was more economical from a material and labor standpoint. Because concrete starts out as a viscous material, it can fit exactly to any irregularities in a sewer line excavation, providing better foundations. The concrete can be molded into any desired shape and size of sewer pipe. Concrete sewer lines have no joints like brick and are a solid structure less prone to uneven settlement. And lastly, concrete work can be done by relatively unskilled workmen, versus the skilled brick masons need for construction of brick sewer lines.

Sewers mains were built of brick in Denver for over a half-century. Construction of brick sewers continued at a strong pace for about three decades before the first concrete lines were used. Brick sewer line construction continued at a moderate pace for another decade after the introduction of concrete lines. There was a decreased construction of brick sewer lines after 1923, but there were still a few lines built of brick through 1937. By 1938, brick was no longer used for construction of new sewer lines.

Continued Operation of Sewer System

The framework of the original brick sewer system in Denver is largely still intact. With more than a century of continuous use, there have been many changes over time. These changes have been in the areas of repair and replacement. The City of Denver has had no systematic plan to replace the existing brick sewer lines with concrete. When a city project, such as a street widening or replacement, affects a sewer line, it may be replaced with new materials.

One of the reasons that many of the brick lines have still been able to function effectively is because of advances in maintenance and upkeep processes. Many of the brick lines in Denver have been able to continue operations because of Cured in Place Pipe (CIPP) line enhancement. This is a process where a polyester impregnated felt liner with a thermal-setting resin coats the interior of the line. This coating increases its strength and resistance to corrosion. The thickness of the lining ranges from a few millimeters to approximately 1 inch. The CIPP process is also used on clay lines. An 8" clay lateral would generally have a CIPP liner of about ¼ ".

At the end of 1911, there were 24.2 miles of brick storm sewers out of a total of 116 miles of storm sewers in the city. Brick lines accounted for 21% of the total storm sewer lines, vitrified clay pipe was 68% and concrete was used in 11% of the storm sewer lines. In that same year, brick sewers accounted for about 3% of the sanitary sewer systems and clay pipe made up 97% of the sanitary sewer lines. The main reason for that lower percentage is because so many of the lines in a sewer system are small laterals and collector lines that are less than 36" diameter and the smaller lines were mainly all built of vitrified clay.

Currently there are 1484 miles of sanitary sewer lines in Denver and 781 miles of storm sewers. The 23 miles of brick sanitary sewer comprise 1.5% of the total mileage of sanitary sewer. The 46 miles of brick storm sewers comprise 5.9% of the total mileage of storm sewer. Overall, brick sewers comprise 3% of the total mileage of sewers in Denver.

Integrity of Denver's Brick Sewers

The historic integrity of all the remaining brick sewer lines is good. The setting, location, feeling, association, design, materials and workmanship exhibited in the lines is basically the same as when constructed. That has changed is the integrity of the entire brick sewer system. New sewer lines have been built of concrete and portions of the brick lines have been replaced with concrete. All portions of the brick lines connect to other concrete lines at numerous points.

The importance of the brick sewer lines is mainly in their workmanship. The brick sewers exhibit high levels of workmanship with hand-laid bricks in a variety of sewer cross-sections from a single row of bricks in a circular pattern to oval-shaped and egg-shaped lines and circular lines with up to 4 rows of concentric bricks providing support for the overlying loads. Their importance is also in their ability to provide information about some of the first engineered elements of Denver as a newly established city. The brick sewers themselves can teach us much about early engineering by demonstrating sewer system design and construction techniques. And notably for Denver, their importance lies in that fact that more than 130 years since the first line was constructed, they are still in use providing waste and storm water conveyance for the city's needs.

Brick Sewer Lines in Other Cities in Colorado

A query of the larger cities on the Western Slope and Front Range was conducted to find out if there were any brick sewer lines in any of those cities. A total of six cities were contacted including Grand Junction and Durango on the Western Slope and Pueblo, Colorado Springs, Fort Collins and Boulder on the Front Range. Only one of those cities, Pueblo, had a brick sewer line. Pueblo's line is a 66" diameter line built of 3-rings of concentric brick that extends for a length of one mile. In most cases, the sanitary waste and stormwater flows generated by the other cities in their early years was not large enough to require anything larger than what

could be handled by a vitrified clay pipe. By the time these cities had grown to the size where they had flows requiring larger pipes, concrete was the material that was generally being used for the lines.

Surveys of Brick Sewer Lines

A few sewer lines within Denver had been surveyed prior to the preparation of this context. As part of the effort to document and gain a better understanding of Denver's brick sewers, surveys were prepared for 15 additional sewer lines. Those lines include storm and sanitary sewers in a variety of sizes, and shapes representing multiple construction types. The following table lists all the sewers lines in Denver that have been surveyed (the asterisked lines were surveyed for this project). The location of the 15 surveys prepared for this project is shown on the map that precedes the table.

All the sewer lines surveyed for this project were field assessed as eligible for inclusion on the National Register of Historic Places under Criterion D. The brick sewers of Denver make up an historic district and these lines support the eligibility of that district. These brick sewer lines are representative of the contruction techniques used for sewer line construction during the period of significance.

The sewers themselves provide the important information about the sewer line design and construction techniques and will be useful in answering further research questions. Possible research questions that might be answered are: what supports were used for the sewer lines; what is the relationship of the thickness of cement lining on the exterior of the line to the number of rings of brick used to build the line; what conditions necessiated the use of 3-rings in the arch and one ring in the invert vs. 3-rings in both the arch and invert.

The brick sewer lines are associated with the early development of Denver and demonstrate the techniques the city used during the period of significance from 1880 - 1937 for dealing with the removal and conveyance of sewage and storm water. For these reasons, they have been assessed as eligible for inclusion to the NRHP under Criterion D.

Denver's Surveyed Brick Sewers

Site #	Name / Location	Sewer Type	Status
5DV.4725.1	Delgany Street Sanitary Sewer	Sanitary	ONE
5DV.4725.3	Delgany Street Sanitary Sewer under Wewatta At.	Sanitary	OE
5DV.4725.4*	Delgany Common Interceptor Sewer (31st St. and Arkins Ct. to South Platte River at 48th Ave.) Brick Sanitary Sewer	Sanitary	E
5DV.4725.5*	Delgany Street Sewer (Speer Blvd to 16th St.) Brick Sanitary Sewer	Sanitary	E
5DV.9953.1	Broadway Brick Sewer Line	Storm	OE
5DV.9953.2	Broadway Brick Sewer Line	Storm	ONE
5DV.9953.4	Broadway Brick Sewer Line	Storm	NS
5DV.9954.1	Mississippi Ave. Clay Sewer Line	Storm	ONE
5DV.10635.1	West and South Side Interceptor	Sanitary	OE, S
5DV.10635.3*	West and South Side Interceptor (I-25 and I-70 Interchange) Brick Sanitary Sewer	Sanitary	E
5DV.10635.4*	West and South Side Interceptor (34th to 44th Ave.) Brick Sanitary Sewer	Sanitary	E
5DV.10635.5*	West and South Side Interceptor (11th to 16th Ave.) Brick Sanitary Sewer	Sanitary	E
5DV.10635.6*	West and South Side Interceptor (3rd to 6th Ave.) Brick Sanitary Sewer	Sanitary	E
5DV.10982	Glenarm – Colfax Storm Sewer	Storm	ONE
5DV.10983.1	West Colfax Storm Sewer	Storm	OE, S
5DV.11023.1	Center Ave. Brick Storm Sewer	Storm	NS
5DV.11279*	Byron Pl. / W. 25th Ave. / N. Federal Blvd. Brick Storm Sewer	Storm	E
5DV.11280*	City Park to E. 40th St. and Brighton Blvd. Brick Storm Sewer	Storm	E
5DV.11281*	Colorado Blvd. (4th to 7th Ave.) Brick Storm Sewer	Storm	E
5DV.11282*	Colfax Ave. (Colorado Blvd. to Jackson St.) Brick Storm Sewer	Storm	E
5DV.11283*	York St. / E. 40th Ave. Brick Sanitary Sewer	Sanitary	E
5DV.11284*	Grant St. (Colfax Ave. to 17th Ave.) Brick Storm Sewer	Storm	E
5DV.11285*	20th Ave. (I-25 to Grove St.) Brick Storm Sewer	Storm	E
5DV.11286*	Bayaud Ave. (S. Broadway to I-25) Brick Storm Sewer	Storm	E
5DV.11287*	S. Santa Fe. (W. Louisiana Ave. to W. Iowa Ave.) Brick Storm Sewer	Storm	E

* Surveys prepared for this project.
ONE = Officially Not Eligible for the National Register of Historic Places (NRHP)
OE = Officially Eligible for the NRHP
E = Eligible field assessment
S = Segment supports eligibility
NS = Segment does not support eligibility

Glossary

Arch - the top half of the sewer pipe

Catch basins - used to catch large debris under manholes for easy cleaning.

Cesspool - a hole in the ground under a toilet/latrine that holds sewage.

Invert - that portion of the interior of a drain or sewer pipe where the liquid is deepest.

Lagging - a number of boards or the like joined together side by side to line an excavation.

Primary treatment - mechanical treatment that uses screens, skimmers and settling to remove solids from the sewage.

Sanitary sewers - used to remove human waste and wastewater from individual buildings.

Secondary treatment – biological processing through the use of microorganisms

Staves - curved pieces of wood

Storm sewers - used to move run-off, mainly rainwater and snowmelt, from streets.

Stub out - a connection device or line which is connected to the water or sewer main line and which is intended to facilitate the connection of a service line to the water or sewer system, either directly to the main line or indirectly through a private main.

Vitrify - to convert or be converted into glass

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