REPORT
-UPON-
SYSTEM OF SEWERAGE FOR THE CITY OF PORTLAND, OREGON,
To the Mayor and Common Council, December, 1883.

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"The great purpose of modern water sewerage is, to remove immediately,
entirely beyond the occupied portions of a town, all manner of domestic waste
and filth, before it has time to enter into decomposition; and, with a well regulated,
even if slight fall, every particle of the sewage of the town may be delivered at the outlet,
far away from the built up districts, long before any decomposition of the refuse matter has set in."—Waltin.

Hon. J. A. Chapman, Mayor of the City of Portland and
Gentlemen of the Common Council:
I beg to submit herewith the following report on a system
of sewerage for this city.

I.

In preparing the plans and estimates for the methods rec-
ommended in this paper, with the reasons that have led to
them, I am oppressed by the fact, that what is now presented
is radically different from the system heretofore submitted
to the judgment of our tax-payers, and must, on this account,
be so elucidated that every citizen of fair intelligence may
understand it, to appreciate its advantages over what has
gone before.

The last quarter of a century is distinguished by such a
revolutionary movement in hygienic theories and practices
that the average duration of human life in the cities of
Europe and America has advanced somewhat over two
years. It is beyond doubt that we owe this fact to the
genius and researches of the medical profession, who,
especially in the countries mentioned, have directed their
studies with singular success to the cause and prevention of
disease and the conservation of health.
Discoveries, touching the frequent causes of enteric diseases; pollution of wells and other sources of water supply, impure air and sewer gases, and insufficient heat, have led to new household and municipal regulations, so that we have now a profession of educated sanitary engineers, by whom the science of that most interesting body of men, the physicians, has been developed into the practical arts of hygienic plumbing, drainage and ventilation.

The last decade of this quarter century has been especially marked by the popular diffusion of sanitary knowledge and the creation of devices by which human life can be kept clean; for this is all it amounts to; the immediate separation and removal of all the wastes and filth of life from our habitations; from the air we breathe, the water we drink and bathe in.

Such progress in the art of sewerage has taken place in this time, that we may congratulate ourselves on not being so deeply committed to an expensive and defective system like that of the great city of London, that, in the language of the distinguished engineer of the government board we are obliged to say; "the eloquence of an arch-angel would not avail to effect an improvement."

It would be strange, indeed, if the little city of Portland, situated on the western edge of the continent, and until now, isolated from eastern civilization were entirely prepared for the highest sanitary conditions. when an old and great commercial port, like Baltimore, which has enjoyed the dignity of paved streets for a century, is only in the infancy of a sewerage system; having but last year determined on its execution, though its population has reached 350,000.

Mr. C. H. Latrobe submitted a report on the subject in August, 1881, with estimates of cost to the amount of $3,200,000 and made his report a complete treatise on the theory and practice of municipal sewerage and the necessity for sanitary reform, so essential was it deemed, that citizens should be educated, not only in the method but also the importance, of a safe disposition of the general filth.
When all the facts are considered, the average citizen of Portland would be ashamed to acknowledge such a condition as is stated of Baltimore by Mr. Latrobe, who declares there are 80,000 privies in that city many of which are from only six to eight feet deep.

By at least one factor, my task is greatly reduced when compared with the labor of many city engineers, who have gone before me.

I am not required to instruct the citizens of Portland by a treatise on sanitary engineering. No one, who has spent the last year in this city will have failed to hear enough about "malaria," "sewer-gas" and a "bad system of drainage" as causes of disease and requirements of a better sanitary condition. It seems thoroughly well understood here that unventilated pipes from a sewer to the house or from a cess-pool, are dangerous conveniences leading disease and death in their train.

It is further understood that our present custom of leading sewers into the Willamette river on the city front is a radical error, believed to create typhoid along the banks of that stream.

Everybody appreciates this menace of the presence of filth to such an extent, that it is made the excuse for much illness, which is due to entirely distinct causes.

Nevertheless, with all the intelligence existing in this city; and intelligence in the direction of sanitary reforms, there are many blocks where a well furnishes water for the occupants and is surrounded by several privy vaults; and these cess-pools are often connected with the houses by what are called "modern improvements" in such a manner that no other ventilation is afforded than such as goes through the family apartments.

It cannot be necessary to instruct citizens concerning the evils of such a system and yet it is a condition existing in the houses of some of the wealthy men of Portland; an evil aggravated by the free use of water by which the surrounding soil is saturated. Neither should it be necessary to say
that a cistern, though an improvement on a well, is by no means a complete security against water pollution, when near a cesspool, as are several in this city.

II.

It has been declared on the one hand that Portland is without a drainage system, and on the other, that the existing system is a bad one.

It would be an error to give an unqualified assent to either the one or the other proposition.

In 1872, Mr. Wm. E. Morris, C. E. of Philadelphia, by invitation of a committee of the common council and of citizens, made an examination of our territory and devised a system of drainage quite abreast of the times; and in 1874 Mr. Robt. A. Habershon was called on to report concerning such a system and improved on the plans of Mr. Morris by several very intelligent suggestions in accordance with the later discoveries in the art.

Up to this time all plans have been designed to convey our sewage into the Willamette river, although Mr. Morris foresees that Portland may sometime in the future contain such a population as shall make it inexpedient to pollute the river with the city’s filth and suggests that in such an event an intercepting sewer may be built along the city front to conduct the sewage to a point below the town.

It is plain, from this report, that in 1872 no liberal view had been generally taken of the possible future of this city. It is gravely set forth by Mr. Morris that sewers may have to be provided as far back as Eleventh street!

III.

The present custom in Portland is to place sewers in streets on the petition of property holders. These sewers consist of terra cotta pipes of which the dimensions appear to be arbitrary, and they are laid without inspection; that being impossible under the present economical organization of the street department.

All lines of pipe are on streets perpendicular to the course of the river into which they discharge their contents.
In the month of June when the floods of the Columbia river back up the Willamette, the mouth of every sewer is closed by the high water.

In the winter, during the rainy season, all this filth is carried safely away from the town, because, in those months there is a strong outward current; the river water is then of excellent quality. Already, the drainage of more than twenty streets with the wastes of 300 blocks or 500 acres finds its way to our river. So near as I can estimate, this sewage contains the wastes of about 12,000 lives.

The citizen who has taken the trouble to observe the Willamette in the season of the summer rise from the Columbia, will have found the direction of the current to set up stream past this city.

This phenomenon is not exceptional; it occurs every year and is made apparent to the most casual observation by the long lines of sawdust swept away from the mills to a point three miles above the city. Water works passing directly over the pumps that give us our supply of potable water and imparting the nauseating reflection that we are consuming in various ways the diluted excreta of 12,000 human beings besides the filth of all the domestic animals kept in the drained district with the added filth of the slops, offal and garbage of our kitchens.

The movement of this water in passing up stream under the summer sun is so sluggish, that if no extraneous filth entered the river, the organic matter contained in suspension is subjected to putrefying influence that can not but have a disastrous effect on the public health. So that, when this already bad condition is aggravated by the addition of every nastiness on 500 acres of city surface, and served up to us in our tea and soup; and drank with gusto in its unadorned purity is there any wonder at the phenomenal prevalence of diarrheal diseases during the summer months? Is it strange that our people complain of languor and headaches? Is it necessary to call up the bugbear of malaria, when we are charging our systems during three of the most trying months
of the year, with the insidious poison of a city’s filth, the depressing and enervating effects of which, it is nearly impossible to shake off in the remaining nine months?

Is it strange that when the season of colds and congestions arrives so many debilitated systems surrender to typhoid?

While the evil thus stated is an important—may I not say a horrible—one, it is not the only danger. When the water on the city front, during the summer remains in this quiet condition, certain gross particles of filth not dissolved but held in suspension as well as the tainted liquid itself, assists to poison the earth of the shore and create an infecting, stinking sludge to be thrown open to the seething influence of the sun when the floods retire, producing a second source of disease.

But, during these months of flood, when, as previously stated no rain is falling and the ends of the sewers are closed, there is only the intermitting, ordinary, domestic water supply to keep them clean. I have lately had occasion to learn the insignificance of this amount for the ordinary purposes of cleansing. In the last month of November, after twenty-four hours of continuous though light rains, the greatest depth of flow in any sewer has been less than three inches and this was regarded as extraordinary; the truth being, that it was rare to find more than one inch and generally only a film of liquid running along the pipes.

In the summer, therefore, when the sewers must rely solely on the domestic water supply, they become elongated cesspools and throw their poisonous gases on our atmosphere or into our houses.

The catch-basins, that are filled by the last rainy season with a rich deposit of rotting wood, street filth, dead cats and all unnameable things that reek, are dispensing the gases of putrefaction along the sewers for distribution in our houses or at the street corners.

This is a condition of things existing at the present time, while the district under consideration is, as compared with other cities, sparsely settled.
The time will come—and the child is already at school who will see it—when these 300 blocks will be closely built in small lots of twenty-five feet fronts and will shelter a population of 120,000 souls in place of the 12,000 now living there and the dangers of to-day will be multiplied ten-fold.

IV.

It is not due to the ignorance of our people, that the faulty system we have described is in existence and being continued.

The daily press of the city has continually called attention to its evils and private citizens have contributed innumerable communications on the subject.

A notable editorial leader appeared in the Morning Standard of September 26, showing much more familiarity with the late improvements in sewerage than is common with any but a professional sanitary.

The difficulty in the way of a perfect system of sewers for Portland is of another character. It cannot be had without paying the cost; and the limited capacity of the public treasury considered with the apparent magnitude of an undertaking to construct a complete work has deterred the city government from the enterprise.

Now, however, the necessity has become crying and every interest unites in a clamor for immediate protection against the dangers to which the public health is exposed.

If, therefore, it were possible to command the means it seems desirable to begin the construction of a properly designed work.

V.

There are two well tried systems of sewerage before the world. To advocate either one, for adoption under all circumstances, would be as injudicious as the conduct of those who insist on one gauge of railroad for all regions and all classes of traffic.

The two systems are known respectively as the combined and the separate.
By the combined is meant a system of conduits, through which is conveyed all the refuse of a town of whatever kind, that can be moved by a current of water. Such refuse includes the wastes of life removed by the agency of water-closets; the slops of the kitchen; the rain water from roofs; the drainage of city garden irrigation surplus; the slops from the wash of porches and pavements; the liquid refuse of stables; the storm water, that falls upon the town with its varied cargo of whatever class; in short, everything that the population permits the water supply to carry off for domestic convenience and everything swept by the rainfall.

To do this work accurately has not yet been found possible. It has been attempted ever since sewers were first thought of and has invariably resulted in failure.

There is one universal difficulty, that of estimating the sewer capacity for discharging storm water. It would seem that men, who have made a constant study of such a subject should be out of the reach of failure. But the truth is, that when the engineer dares to state the dimensions necessary to conduct the exceptional floods of vehement thunder storms and what are known in this region as "cloud-bursts," his judgment is overruled by the fear of extravagance on the part of the authorities, who collect and disburse the taxes. And so failure has everywhere followed the attempt to carry away the water falling from the clouds in the same conduits that convey the sewage. Col. Geo. E. Waring, the distinguished American sanitary engineer read a paper before the American Public Health Association of New Orleans, in 1881, which has been quoted by Mr. Latrobe in his Baltimore report, in which he said of "London, the theater of the proudest achievements of the drainage engineer, a city whose intercepting sewers are a model for the world," that "many of the lower parishes are crying aloud for relief from the stinking floods with which the new sewerage system is deluging the poor inhabitants. The storm water has been gotten rid of with a vengeance; it has been robbed from the surface of the streets, where it would have done good service in flushing the gutters, and has been delivered into sewers of
great velocity, to accumulate, at the lower levels, far beyond the capacity of the pumps to remove it.”

At a meeting of the Sanitary Institute of Great Britain held on the 23rd of September, 1880, a discussion was participated in by twelve members, during which, the distinguished chairman, Mr. Robert Rawlinson C. B., C. E., said: “Belgravia—the most fashionable part of London—notwithstanding the great expenditures on it, was subject to flooding in the basements from the sewers, and was the foulest part of all London. The sewers contained deposits and sewer gas.” He also said that, “in the government buildings in Whitehall, the sewage was perceptible in the passages and that no beggar’s lodging house was fouler than the basement of Somerset House.”

Mr. Latrobe was commissioned by the municipality of Baltimore to visit various cities and learn from personal inspection, the character and condition of their drainage. He selected Brooklyn, N. Y., and Providence, R. I., because they presented the most elaborate and perfect illustrations, in the United States, of the “combined system of sewerage,” the merits of which we are now examining.

I shall present the result of his investigation as briefly as the importance of the case will permit.

Brooklyn contains almost exactly 300 miles of sewers of which about 55 miles are of brick varying from 12 inches to 10 feet in diameter. The system cost nearly $8,000,000 and notwithstanding the provisions made for a complete disposition of the storm water in the construction of these immense works, “not only in the lower parts of the city, but at points as high as seventy feet above tide, the sewage bursts out at the man-holes and floods cellars and basements, which have to be pumped out by the fire department.”

The city engineer, Col. Julius W. Adams, said in a report on the 23rd December, 1870: “Your engineer has been aware for several years of the importance of improving the sewerage system. * * * * * The flooding of basements and cellars depreciates the value of property and endangers the lives of those occupying the flooded dwellings.” Col.
Adams further said: "The lower portions of many districts are frequently inundated, and what is proposed is a system of interception of the sewage and storm water of the upper portion of such districts."

Mr. Latrobe found that the "catch basins admit large amounts of building refuse, and the condition of many of the mains is very bad. Cleaning by hand seems to be the principal method available and the solid matter is lifted from the man-holes in buckets and carted away for manure." Cleansing and repairing are difficult and expensive, costing about $133 per mile per annum; and yet the sewers are not clean and sewer gas is much complained of in the houses." In view, therefore, of what he found in Brooklyn, Mr. Latrobe declares the combined system as there exhibited to be "overtaxed and unsatisfactory, notwithstanding its great cost and careful construction." Providence, R. I., has a population of 104,000. Its sewers designed by Mr. Herbert Shedd, civil engineer, are believed to be among the most perfectly planned and executed works in the country.

They consist of 28 miles of pipe and 15 miles of brick culverts, with 16 outlets into the harbor and rivers on which the town is located and had cost up to the end of 1880 the sum of $1,500,000. The smallest sewer used is 12 inches diameter; the largest 5 feet 6 inches diameter.

The streets of Providence are kept exceptionally clean so that the catch basins are not choked by the street litter.

But, "the defects of the sewers of Providence are the same as those of Brooklyn, viz: an incapacity to carry off the storm water, even at elevations of one hundred feet above tide and consequent gorging resulting in deluged cellars, basements and streets, and the driving of sewer gases into the houses," so that with this elaborate system, which was to take care of both storm water and sewage in a single set of conduits, it has been found necessary "to throw a portion of the rainfall in violent storms over the surface of the streets; but while this relieves the sewers, it does what the sewers were built to prevent and as the surface gutters of
Providence are very shallow, and evidently not intended for surface drainage, the effect must be a flow over the greater part of the streets in violent storms.”

In Providence as in Brooklyn, “additional storm sewers have been constructed and more are in contemplation, whilst ultimately a complete system of main intercepting sewers will have to be built, to gather up the sewage from the sixteen outlets now in existence and transport it to some points below the city, where it will not befoul and silt up the rivers and harbor.”

VI.

As drainage systems for towns have been built before the general introduction of water supplies acting under considerable pressures and were first intended to simply relieve the streets from the rush of storm water and carry away only the surface filth, it was but natural that they should consist of great culverts for the ready conduct of floods.

They were a luxury confined to large cities with plethoric treasuries, and even in such cases were generally open on the surface and not conveyed under it.

The potable water of the town coming in aqueducts under a low head along lines of arches and in open ditches for the domestic necessities of the town was confined to the ordinary purposes of cooking and cleanliness; such as bathing, the work of the laundry, washing the dishes, the house and the pavements, and, the irrigation of the gardens of the rich. Then, convenient sinks were made to receive this waste and convey it to the street gutters, whence it reached the culverts that led it to some natural outfall.

Modern civilization has introduced the house water closet as the sequence of the use of potable water possessing sufficient head to exercise a scouring force.

Nothing could be more natural than to lead the new class of wastes of the house into channels already existing. But the result has been an unforeseen complication, arising from the deposit of dangerously putrefying filth in great culverts that could be cleansed only by storms.
The odors and diseases resulting from the passage of gases out of the sewers into the houses led to innumerable devices, prominent among which, are, "traps," which have caught a great many innocent house-holders and oftentimes nothing else, while the sewers have remained, a menace to the people.

In 1842, Mr. Edwin Chadwick, who had instigated many sanitary improvements in ventilation, cleanliness and drainage, and who is thought by Col. Waring entitled to rank as the 'father of sanitation' in England, suggested, and supported the idea with "strong arguments, that household waste and matters of like character should be provided for, by a separate and distinct system of pipes." He has long been supported in his opinions by Mr. Robert Rawlinson, the Engineer of the Local Government Board of London, and beyond question the foremost man in his profession in England.

The result has been the development of the separate system of sewerage.

VII.

In the separate system, the wastes of the household—just so much as it is moved by the water supply—is conveyed to the outfall by a system of pipes into which none of the rainfall, not even that upon the roof is permitted to enter.

This system has been built in England under the advice of the distinguished men named above, in the towns of Ponsance, Carlisle, Dover, Chelmsford, Ely, Rugby, Reading, Oxford, and Halstead with most satisfactory results. In some of these towns the old systems already existed; where this was the case they have been devoted to conveying only the storm water and the new pipes have been retained for domestic sewage.

Where old drains did not exist, the storm water has been distributed by systems of gutters along the surface of the streets, except that in some cases the roof water has been used to flush the sewers.

In the United States the separate system has been adopted
in Lenox, Massachusetts, where the roof water has been introduced for flushing purposes with good results in a region where rain falls every month in the year.

Later, the separate system has been applied in the town of Cumberland Mills, Maine, where it has been improved by the addition of automatic flushing tanks.

Its use has been extended to several considerable towns in the United States, among which may be named as either possessing or constructing it. Keene, N. H., Wilkesbarre, Penn., Pittsfield; Mass., Pullman, Ill., Kalamazoo, Mich., Omaha, Neb., Little Rock, Ark., Birmingham, Ala., Norfolk, Va., and notably at Memphis, Tenn.

The latest and most important application of the separate system is now in course of construction in the city of Baltimore.

VIII.

As the separate system was first carried to complete perfection in Memphis, Tenn., its defects patiently studied and remedied; and it has, after such corrections proven so thorough a success that not only is it being extensively adopted in our own country, but several European cities, Rome, Trieste, Naples, St. Petersburg and Paris are inaugurating experimental introductions to practically test the character of a system radically distinct from the ancient methods. I have been in communication with the authorities of Memphis and am indebted to Mr. Anthony Ross, Superintendent of Sewers, for very complete information, with plans and maps in detail; and the municipal regulations for house connections with the sewers besides a general description of the work and statement of results.

Mr. Latrobe, from whose report I have already freely quoted, made a personal inspection of the Memphis works and has given the result of his investigation with great fullness and clearness: I shall, therefore, here present verbatim what he has written on the subject.

"The city of Memphis is situated immediately on the Mississippi river and contains a population of 35,000. The
fatal epidemics of 1878 and 1879 made it necessary to take decided measures for draining and sewerizing the city and abolishing the 7000 cesspools, which had contaminated and poisoned the soil."

Ten years before, Mr. Charles Hermony had presented several plans for such a work, varying in cost from $800,000 to over $2,225,000, depending upon the amount of storm water to be accommodated. This excessive cost, so far ahead of the capacity of the treasury in the impoverished condition of the city after 1879, led to the necessity of some more economical system.

"In this crisis Col. Waring was consulted and advised the adoption of the separate system for the disposal of the house sewerage alone, through impermeable pipes; common tile drains to be laid in the same trench for the drainage of the sub-soil; the storm water to be permitted to flow on the surface into the nearest water course."

After considerable opposition this plan was adopted, and on the 21st of January, 1880, the work was actually begun. The system is based upon a flow of about forty gallons of sewerage per head per diem."

"The main outlet sewer is twenty inches in diameter and built of brick; all the other sewers of burnt and glazed clay pipes, ranging from 15 inches to 6 inches in diameter; the latter being the size adopted for nearly all branch sewers."

"At the dead end of every branch sewer is placed an automatic flushing tank with a capacity of 112 gallons. Each tank is filled from the city water supply through a pipe and spigot so arranged as to flow continuously with a sufficient stream to fill this tank once in twenty-four hours, or oftener if desired."

"As soon as this tank is filled to the proper height, a syphon comes into play; the tank is suddenly emptied into the head of the sewer and thus prepares itself for another charge of water."

"There are, at this date, over twenty miles of sewer and one hundred and twenty-five flush tanks at work in Mem-
phis—the total cost of which, including expenditures of all kinds, has been about $137,000 or $6850 per mile.”

“The system is now being extended so as to take in the entire area of the city.”

“Of the 7000 cess-pools 5000 have, at this date, been emptied and filled with clay, while the others are being filled as rapidly as possible.”

“In my examination of the Memphis sewerage, I was accompanied by Major Humphries, the engineer in charge, who is thoroughly acquainted with every part of the work.”

“I first examined the flush tanks placed at the extreme ends of the branch lines. They fill and discharge with the most perfect regularity; there are literally no moving parts, and their extreme simplicity is manifest.”

“They consist of a brick chamber built on a concrete bottom of any size designed (those in Memphis being forty inches in diameter) set below the level of the street and covered like an ordinary man-hole with a perforated cover; in their center stands an annular syphon four inches in diameter.

“A three-quarter inch pipe near the top admits the city-water, the flow being governed by a spigot.”

“When the the tank is filled to the bottom of the syphon the discharge takes place with a rush, the entire body of water (one hundred and twelve gallons) being discharged in from forty to fifty seconds.

“It first runs into a box under the syphon and from thence into the sewer head. As soon as the tank is emptied by the main syphon, its lower end is unsealed by a small syphon and the process of refilling the tank begins.”

“The only drawback to the perfect action of these tanks has arisen from the muddy character of the city water, which may be appreciated from the fact that a half-gallon pitcher will deposit during the night one half-inch of solid mud. This muddy deposit sometimes clogs the action of the subsidiary syphon which has a bore of only one inch. This difficulty has been obviated at Memphis by washing out the small syphon, say once a week, with a small hose about three feet long, put on the supply pipe of the tank—a
process which takes about ten minutes. One man attends to and keeps in order the entire lot of flush tanks, one hundred and forty-five in number, without difficulty."

"The grade of the branch sewers, which are connected directly with the flush tanks, varies from six inches to three inches in the hundred feet; and the rush of water from the tanks is distinctly felt at a distance varying from four hundred to nine hundred feet, keeping the pipes perfectly clean."

"No tendency to freeze has been noticed in the tanks, although the temperature has been as low as 4° the past winter."

"These tanks are a patented article, and the city of Memphis paid ten dollars per tank for the privilege of building and using them. The total cost of building a tank, exclusive of royalty, has been forty-five dollars. I should say from observation they admirably fulfill their purpose, are thoroughly automatic in their action, and require very little attention."

"Whenever it is practicable, the branch sewers of Memphis are located on alleys in the rear of the houses, so as to avoid the cutting of trenches in the streets. With the small sewers of the separate system, this is perfectly practicable, and prevents the necessity of carrying the house soil pipe to the front of the house."

"I next gave close inspection to the condition of the main and outlet sewers, both to the fifteen inch pipe and twenty inch brick sewer."

"This was readily done, as it had been found expedient to break into the crown of the main at several points for the purpose of constructing manholes. At the time of my inspection (11 A. M.) the sewers were running, three-fourths full, with a swift current. Nothing solid of any sort was to be detected in the flow even by dredging; an occasional piece of paper constituting the only undivided matter; everything was in solution, and the sewage was about the color and consistence of the Mississippi river water."

"Although in several places the entire crown of the sewer had been removed, it was difficult to detect any odor until
you were within two or three feet of the flow. Major Humphries stated that this was the uniform condition of the mains and that the ventilation seemed perfect."

"I would state in this connection that the main house pipe is required by law to be four inches in diameter, and to connect with the sewer without a trap, its upper end is then carried above the roof of the house, full size and left open; every water closet, kitchen-sink, bath-tub and waste-sink connects with this four inch pipe by a trapped connection of its own."

"The varying height of the four inch house mains, together with the constant flow of the sewage, stimulated by the intermittent discharge of the flush tanks, keeps the whole system well ventilated and in perfect order."

"The main and outlet sewers have an inclination of from one in 400 to one in 600 feet and the sewage is finally discharged into Wolf river, near its confluence with the Mississippi."

"To assist the ventilation and afford means for inspection, it was originally intended to place a fresh air inlet at every junction of a lateral sewer with the main; this is so arranged as to let in air and keep out dirt, and is covered with a grating. I found that out of forty provided only nine had been used from the belief that they were unnecessary. The only deposit which has ever been noticed in the mains is a fine silt of moderate tenacity, supposed to be a mixture of the mud held in solution by the river water, combined with the pulp of dissolved paper. This is readily washed out by passing a ball from man-hole to man-hole. A hollow ball of galvanized iron having one inlet and stopper, and about three inches less in diameter than the sewer, is charged with water sufficient to keep it in contact with the roof along which it rolls; it is then dropped into the sewer at the man-hole, the current instantly gorges, rushes under the ball with great velocity, and seours the bottom of the sewer, the ball, in the meantime, rolls along the roof of the sewer, and is stopped, if desired, at the next man-hole, and taken out. Balls of different sizes are used
as desirable. The above mentioned deposit of silt in the mains has never been more than from one inch to one and a half inches in depth. The only obstructions which have occurred (thirteen in number) in the branch pipes during the twelve months in which the system has been in use, have invariably been occasioned by sticks about six inches long getting across the six inch pipe. The obstruction is immediately located by the rising of the sewage in the yard-waste-sink of the house just above it. The sewer is then uncovered at the proper place, cut open on the top, and the obstructions pulled out with a hook of twisted telegraph wire. This would seem to indicate beyond a doubt that any slender article, not over six inches long, might pass through a four inch trap; this is further proven by the fact that a number of two-feet carpenters rules, which fold to six inches, have been taken out of the sewers. This being so, the remedy would seem to be either to use no pipe less than seven inches in diameter, or to arrange the traps so as not to pass six inch sticks. No obstruction has ever taken place in the eight inch or ten inch pipes, or in the twelve inch, fifteen inch or twenty inch mains.”

“I understand, from Major Humphries, that not a single case has occurred of the breaking of a pipe. The drainage of the sub-soil by common agricultural drain pipes, from one to three inches in diameter, is excellent. They are laid along side of the sewer-pipe in the same trench, and at the proper points are carried off to empty into the nearest water course.”

“Now, as to the house arrangements, the regulations are stringent, no plumbing is allowed on any plan but that adopted by the authorities and carried out under a rigid inspection by the engineer, and no house is permitted to connect with the sewer until inspected and passed. Every outlet for waste is connected with the four inch house pipe, and trapped; a slop waste is insisted on for each house, so that nothing is thrown into the gutter or on the soil. No pan-closets or Brahma-closets are allowed where there is an air space between the trap and the pan; the use of some form
of hopper-closet is preferred. All connections with sewers are made by Y's and not by T's."

"The city lays a branch every twenty-four (24) feet, to the curb, to this the house-holder joins his iron four-inch pipe. This avoids tearing up the streets to make house connections."

"There has been, to this date, no complaint, in so far as I can find out, of sewer gas, and I cannot see how there could well be with so constant and rapid a flow of sewage, thoroughly dissolved, as was plainly visible in the mains. I learned from a prominent citizen and house-holder that the only inconvenience he had ever experienced arose from the breaking down, temporarily, of the water-works, which are on the Holly system, and which at the time depended on a single engine; for a few days he could not use his closets, for want of water."

"By gaugings taken at the head of the twenty inch mains, I found the hourly flow of sewage to be remarkably uniform. Thus from 6 A.M. till 1 A.M. the following morning, a period of twenty-four hours, the flow oscillated in centre depth from twelve and one-half to fourteen and one-half inches, the minimum area of flow being 206.5 square inches; the maximum, 245.73 square inches. From 1 A.M. until 5 A.M., a period of four hours, the centre depth of flow varied from eight and one-half inches to eleven and one-half inches; minimum area being 107.6 square inches; maximum area 186.9 square inches. Taking the twenty-four hours, the minimum flow is 43.7 per cent. of the maximum; taking the twenty-four hours of greater flow, the minimum is eighty-four per cent. of the maximum, and eight-ninths of the daily flow of sewage passed in twenty-four hours; one-ninth in four hours. This marked uniformity of flow during twenty-four hours of the day, and its oscillating character within such small limits, must be somewhat influenced by the action of the flush-tanks, which probably discharge in small groups."

"The force employed in maintaining the sewers alone, and its cost, I could not obtain accurately, as they were doing
much other work with the same men; but, approximately, a
force of four men watch and keep in order the entire system,
including the flushing-tanks, house ventilation, &c. All the
work at Memphis has been admirably and faithfully done,
under the immediate supervision of skilled engineer assis-
tants."

"In summing up my impressions of the separate system
as developed at Memphis, I would say: that it is well
planned and well executed, and fully answers the purpose
for which it was intended, and which I conceive to be pri-
marily the object of all sewerage, viz.: to carry off all human
and industrial waste with rapidity and cleanliness to its ul-
timate destination."

"The accompanying system of tile drains has also
thoroughly drained (as far as I know) the very tenacious
sub-soil of the city. As to the storm water at Memphis, it
can safely be left, from all I learn, to take care of itself."

"The errors or omissions in the Memphis system are:
First: Insufficient size in the mains to accommodate the ex-
cessive use or waste of water during severe winters, when
people allow spigots to run all the time, to prevent freezing.
During the winter just ended, Major Humphries estimates
that one hundred gallons per capita per day were often
used, which caused the mains to run full bore, and occa-
sioned a backing up of the sewage in the lower parts of the
city. This fault, of course, was not incident to all of the
system, but was an oversight in proportioning the mains,
and would not be felt during an ordinary winter.

Second: The omission of man-holes in the mains, as well
as means of opening the small pipes, without breaking them,
to remove obstructions which will sometimes occur. These
omissions are now being remedied. Man-holes being con-
structed at every five hundred feet on the mains, and when
a section of small pipe is broken into, it is replaced by a J,
shaped section, with a lid on the top of the upright stem of
the J, which can be readily removed and the cleaning tool
introduced. When these improvements are made, the
system will be very complete. The want of size in the
mains, should it become an annoyance, can only be remedied either by duplicating them, or re-building them on a larger scale. I think an error has been made in not using the fresh-air inlets, as originally intended, at the junction of branch sewers with the mains. They are useful for ventilation and observation."

IX.

Under date of 1st September, 1883, I have received a communication prepared by Mr. Niles Meriwether, Engineer in charge of the sewers of Memphis and forwarded by the attention of Mr. Anthony Ross, Superintendent of Sewers, from which the following facts are taken for your information:

The population of the city of Memphis has increased from 35,000 to 50,000 since the construction of the sewers began in 1880.

To date, about forty miles of sewers have been laid, of which four miles are mains, discharging into the river by one outlet. The remainder are laterals draining into these mains, except four and one-tenth miles of sewers constructed before the present system was adopted and discharging into the Mississippi by other outlets.

The mains are ten, twelve, fifteen and twenty inches diameter. Of the laterals, about eighty-five per cent. are six inches in diameter and the remainder eight inches, except a few short lengths which are ten inches. The mains, for the most part, are laid with a grade of two inches in one hundred feet, which is the minimum.

The minimum grade of six inch laterals is six inches in one hundred feet.

At the upper end of each lateral is located one of Field's Automatic Flush Tanks, which discharges 112 gallons in about forty seconds. It will discharge as often as it is filled, but it is believed once in twenty-four hours is sufficient.

Man-holes distributed on the mains have been added since the system was otherwise complete, experience having demonstrated the necessity of them.
No surface or roof water is permitted to enter the sewers, the system being designed and proportioned for house sewerage only.

The house drains are all four inches in diameter, and no trap is permitted on the main drain, each fixture being provided with a separate trap. The soil-pipes are of cast-iron, with lead joints, above the ground, and extend four inches in diameter above the roof. Each house drain is consequently a ventilator for the public sewer.

For the purpose of removing the sub-soil water, agricultural drain tiles are laid in the trench with each lateral, on the grade of the sewers, or below it, which discharge, not into the sewers, but into the bayou. Additional lines of tile have been laid in streets where no sewer is located.

A large part of the trenching has been done by contract, but the pipes are laid by hired labor.

The six inch pipes, although draining houses on both sides, for a distance of three thousand feet, have never been over-charged, and have seldom been found running half full.

No trouble has been caused by sewer-gas, and the sewers are believed to be comparatively free from it.

Some of the six-inch pipes have occasionally been obstructed by sticks, bones, etc., becoming fixed across the diameter of the pipe, all of which have been promptly removed. Deposits found in the mains have been rapidly and inexpensively removed by the passage of hollow metal balls through them. These balls are about three inches less in diameter than the sewers, and, being lighter than water, are pressed against the top of the sewer and are rolled along by the force of the current. The velocity of the ball is less than that of the water, which in passing it, is deflected against the bottom and sides of the sewer so as to thoroughly cleanse it. A portion of the mains have been cleansed ten times since their construction, the laterals not at all.

Pipe laying was commenced about the 20th of January, 1880, and on July 1st of that year about twenty miles had
been laid. The first house-connections were made about March 1st of the same year.

Hourly observations in the twenty-inch main on 30th of April last, showed the greatest depth of flow 12$\frac{3}{4}$ inches at 10 a.m.; least depth 8 inches at 2 a.m. On the 13th of June, greatest depth 14 inches at 11 a.m.; least depth 10$\frac{1}{4}$ inches at 4 a.m. Floats in the same sewer gave a surface velocity of 2 6-10 feet per second, the depth being 12$\frac{3}{4}$ inches.

The following is a statement of the connections made with the system to date, but does not include those made with the old sewers discharging by outlets:

Water closets......... 4,950 Bath tubs.............. 365
Sinks.................. 3,467 Wash basins............ 321
Urinals............... 308 Privy sinks.............. 37
Cellar drains......... 34

The system of sewers appears to give entire satisfaction both to the city government and citizens generally."

The following has been enacted by the city government of Memphis as a

"HOUSE-CONNECTIONS ORDINANCE."

Section 1. Be it ordained by the legislative council, That it shall be a misdemeanor to do or cause to be done any of the following acts, except as herein provided, and any and all persons guilty thereof shall be fined not less than one nor more than fifty dollars.

Sub-Section 1. To uncover the public sewer for any purpose or make connections therewith, or uncover the public connection branches thereof, unless and except by the consent and under the supervision of the district engineer, or his duly authorized agent or agents, whose duty it shall be to insure full compliance with this ordinance in relation to connections, and a failure of duty in this respect shall subject such engineer or agents to all the penalties in this ordinance.

Sub-sec. 2. To make, or cause to be made, any such connections except as above provided, and a competent and
portion of the day, to fail to have at least one water-closet connected with the public sewer fifteen days after notification from the engineer or president of the fire and police commissioners, and to fail to have such water-closet suitably arranged for use as a urinal, unless a separate urinal is provided.

Sub-Sec. 4. For the owner or occupant of any building in which food is cooked or clothing is washed, to fail to have a suitable sink, slop-stone or hopper for the reception of waste water; provided, however, that if the water-closet is of a kind suited to such use, may receive the waste water, and the sink, slop-stone or hopper may be dispensed with.

Sub-Sec. 5. To throw or allow to be thrown or deposited on the surface of the ground or in any hole or vault in, or under the surface of the ground in the taxing district, whether public or private, except in the proper and necessary manuring of the soil, any water which has been used for domestic purposes, or any liquid or solid filth, or faeces or urine.

Sub-Sec. 6. To allow any surface water or rain water from the ground, or roofs of houses, to enter any sewer or drain or any vessel or slop-stone connected with any sewer or drain, or to admit any drainage water from any cellar to a sewer; provided, however, that drainage for cellars may be provided in accordance with the regulations, plans and descriptions in the engineer's office, and subject also to the restrictions of sub-section 1 of this ordinance.

Sub-Sec. 7. To use or cause to be used any house drains for any other purposes than those specified in this ordinance, except by special permission from the legislative council.

Sub-Sec. 8. To throw or deposit, or cause or permit to be thrown or deposited, in any vessel or receptacle connected with a public sewer, any garbage, hair, ashes, fruit or vegetables, peelings or refuse, rags, cotton, cinders or any other matter or thing whatsoever, except faeces, urine, the necessary closet-paper and liquid house-slops. And it is hereby made the duty of all citizens to aid the police in bringing.
offenders against this ordinance to punishment, and also to prevent breaches of the same. Passed March 4th, 1880.

D. T. PORTER,
Chairman Legislative Council.

Attest: C. L. PULLEN, Secretary.”

X.

I have thus endeavored to make plain to your honorable body, the peculiarities of the two systems of sewerage and it now remains for me to state the effect of each system as applied to Portland.

So far as we have any system, it is of the class known as combined; the object being to carry away all sewage including storm water.

Its defects have already been stated and are the defects incidental to the system.

In the dry season the culverts are too large and masses of putrefying matter lie in the lower levels.

In the rainy season the culverts are too small and become gorged in the lower levels.

The difficulty of gauging sewers, to carry off storm water in Portland, may be recognized when it is known that the average maximum rain fall during a single day in the last twelve years has been a trifle under three inches; and that notwithstanding this, there has been one day—the 13th Dec. 1882—when six inches and seven-tenths fell.

So that if we had built to accommodate the maximum fall up to 1882 the great storm of that year would have demonstrated the insufficiency of our drainage.

These are the actual facts and are patent to all citizens, so that they do not need further statement or discussion in this report.

XI.

For the construction of the separate system, the city must be divided into several drainage districts of which,
the great intercepting mains will run towards the north receiving the contents of the laterals, which will run eastward.

The high water of the Columbia backs up the Willamette to a maximum height of 22 feet above the base of grades: Assuming a fall of one foot in two thousand for an outfall conduit to convey the sewage to the dyke in the Willamette slough, where there always exists a strong outward current, we find that all points of the city higher than 34 feet above base may be drained by gravitation into that water when the Columbia river floods are at their highest.

Lower levels must be drained into a receiving tank or tanks and pumped thence into the higher outfall conduit for transportation to the slough.

If my information is correct, there are now three millions of gallons of water in daily use in Portland while the population is rapidly increasing. At Memphis a provision was made for delivering an amount equal to forty gallons per head of the population and it is now found that at certain seasons it is necessary to discharge 100 gallons per head.

In view of these facts and considering that the water supply is really the measure of the quantity of sewage, it has seemed prudent to estimate for an outfall conduit, of sufficient capacity for the conveyance of seven million gallons daily, being sufficient for a population of 100,000 inhabitants using daily 100 gallons a head of which two-thirds may enter the sewers.

The conduit necessary for such a duty on a grade of one foot in two thousand would have an inside diameter of thirty inches running full. But for greater safety, the estimate is submitted for a conduit running but two-thirds full, which would have a diameter of thirty-six inches.

As the flow would be very uniform in depth the section of the outfall conduit may be a circular ring of brick. It will be 40,000 feet long.

The accompanying map shows the division of the city into drainage districts determined by the topography, the whole tracts being estimated to use 10,000,000 gallons of
water for domestic purposes distributed uniformly over the territory.

District No. 1, lying on the ground along the river and comprising about three-twentieths of the territory (230 acres) will be drained by a 15-inch pipe sewer, extending along Front street from Yamhill to the intersection of S and Eleventh streets. This pipe will be 8,200 feet long with a uniform fall of 1.76 feet in 1,000; all below the high water line of summer floods and will be required to pass 1,000,000 gallons per day.

District No. 2 is west of No. 1, comprises about six-twentieths of the city tracts (450 acres) and will be drained by a similar 15-inch pipe sewer. As it lies along the western edge of the low flat portion of the city, it will be below the high water of summer floods, for all that portion north of Madison street. This pipe will be 10,900 feet long, extending from Market and Front streets, and following a topographical contour line as nearly as practicable to the intersection of S and Eleventh streets, with a total fall of 49.7 feet all below the hydraulic grade line, being a fall of 4.5 feet in 1,000. Its duty calculated as in the preceding case will be 2,100,000 gallons per day.

Note.—The two intercepting sewers of the first and second districts will unite at S and Eleventh and discharge into a 24-inch pipe running 1600 feet along Front street to the intersection of W and Sixteenth streets, where all the low level sewers will discharge into a pumping well.

District No. 3 lies to the south of No. 2 and is included between Front and Seventh streets, comprising about three-twentieths of the city tract (230 acres). It will be drained by a 12-inch pipe sewer running along Front to Market and zigzagging thence as nearly as practicable along a uniform grade line to the intersection of Taylor and Seventh. It will be 5,820 feet long and fall 48 feet, all below the hydraulic grade line; being 8.25 feet in 1,000. Its duty is calculated at 1,100,000 gallons.

District No. 4 lies west of No. 3 and being all above Seventh street comprises about three-twentieths of the ter-
ritory (230 acres). It will be drained by a 10-inch pipe 4,120 feet long running along Seventh street to its intersection with Taylor and falling 137 feet, all below a hydraulic grade line or 33.25 feet in 1,000. Its duty is calculated at 1,500,000 gallons.

Note.—The two intercepting sewers of Districts Nos. 3 and 4 unite at the intersection of Taylor and Seventh, and discharge into a 24-inch pipe, which, in addition to carrying the drainage of these two districts amounting to 2,000,000 gallons, must also drain

District No. 5, which lies north of Taylor street and west of District No. 2, comprising about five-twentieths (400 acres) of the city tract and demanding a duty of 1,700,000 gallons or an aggregate of 3,700,000 gallons. This pipe will be 11,400 feet long, falling 8 feet or 0.7 feet in 1,000.

XIII.

Lateral sewers should be laid under the streets that run from west to east entering the intercepting pipes along the lower edge of their respective districts by curves of not less than thirty feet radius.

In all but district No. 1, lying on flat ground along the river, as previously described; six-inch pipes for branches would be ample to pass the sewage; but the Memphis experience being clear, that this size of pipe is liable to obstructions, from sticks and especially carpenters two-foot rules, which fold to six-inch lengths while no such difficulty occurs with those of eight-inch diameter, it has seemed expedient to adopt this dimension, eight inches, for a minimum, unless indeed some provision can be made in house traps by which such objects can be removed before they enter the system.

In the lower districts eight inches will be the proper size for laterals, and thus all the street service sewers of the city will be of uniform dimensions.

Four inches diameter has been found suitable for house branches which are connected with street sewers without traps and are carried three or four feet in the same size above the roof of the house, which they serve. They should
always connect with a lateral and never be permitted to enter a main. While it is an advantage to pursue the custom sometimes adopted, of laying house branches up to the curb of sidewalks, the expense is so considerable that I am not free to recommend it in this case. But, apart from the question of expense, Portland is subject to a peculiar difficulty in the way of apportioning such a distribution of pipes so that I have not made any estimate of its cost. The city has been laid out to give the extraordinary width of fifty feet front, to house lots.

So fixed is the prejudice of our people against crowding and in favor of little lawns and gardens, that men go continually farther and farther from the city centre to reside, rather than live upon twenty-five feet lots. Yet all observing men, noting what is going on in the business districts, recognize that as property becomes more valuable, lots will be subdivided.

To meet the difficulty, I may properly advise that in laying the street service it shall be provided, with capped Y branches at every lot of fifty feet to accommodate two four-inch house branches; thus avoiding the system of breaking into the sewers. Of course it should be made obligatory that all house connections be made with this Y branch. This plan is to a certain extent followed at the present time in Portland.

XIV.

An important adjunct of the system will be the use of automatic flushing tanks and drain tiles.

Flushing tanks are placed at the head of laterals. In Memphis, they are made to hold 112 gallons each and are so connected by a spigot with a small pipe from the water supply system of the city as to fill once in 24 hours. A syphon, entering the head of the sewer, operates to empty the tank the instant it is filled; an operation occupying but forty seconds and by means of which the pipes are cleansed of all putrefying matter.
Drain tiles are placed in the trench with the sewers; they are led to the nearest water course without reference to the sewer outfall. As leakages are liable to occur in the best constructed work and as an excavated trench however well refilled will always gather water from the neighboring earth, these tiles prevent the unwholesome saturation of the soil and do much to remove the dampness proceeding from rains and the consequent humidity of the atmosphere. They are inexpensive in cost and labor, being but one-inch diameter along the laterals to three inches under the mains.

Manholes will be required at distances of about 560 feet apart or one at the corner of alternate blocks on the main pipes.

Fresh air inlets should be placed at the points of connection between the laterals and mains. Where the mains change direction between manholes a fresh air inlet will be convenient to assist observation by a cheaper means than a manhole.

Hand holes may be placed at each street intersection of the laterals by the insertion, at time of construction, of a vertical T, covered with a lid easily removed for the insertion of the pill or wire used in cleaning.

XV.

Having considered the construction of the new system in full detail, it becomes necessary to make a disposition of the storm water falling on the city; and of the old sewers.

Storm water is at present conducted along street gutters to catch basins for delivery to the sewers.

Such economy has been practiced in the disposition of gutters in Portland, that excessive volumes of water are concentrated in some single lines endangering the safety and permanence of streets and impeding traffic.

After a careful study of the streets and grades it appears that by a judicious distribution of gutters all storm water may be carried upon the surface without inconvenience to traffic or danger to property; and may be allowed to run
into its natural outfall, which is ultimately the Willamette river.

It should be kept in mind that our rains, washing the filth from the streets, occur in winter when there is a strong outward current in the river; whereas in summer, when the Willamette is backed up, there are no rains to speak of and therefore no danger of polluting the river by surface filth.

In the lower parts of the city, where the street grades are flat, it is essential to build the gutters with especial attention to their accuracy for obtaining free action.

There is one advantage of the interposition of this flat territory, between the hills and the river, that I have never seen noticed, though it is of immense value to a town located on navigable water; it is, that material brought down the steep side-hill gutters by the rapid velocity of the streams will drop or deposit the heavier portion upon the lower streets whence it is easily removed, instead of depositing it in the river to be excavated by the expensive system of dredging. Such material as is carried to the river by so low a velocity as that encountered in the flat streets will be conveyed well out of the Willamette by its strong winter current.

The old sewers amounting to an extent of twelve and a half miles and built at a cost of $97,940 or about $8,000 per mile, cannot be properly thrown away and need not be, as, with some inconsiderable outlay they may be adapted to the new system, for which I have so arranged the grades of the intercepting sewers that the existing lines may be admitted to them. As they will be larger than required by the new duty they will have to perform it is advisable that the flushing tanks should have a greater capacity for flooding them, than is used in the new pipes.

But they cannot be let into the new mains without throwing the catch-basins into disuse; which should, to this end, be disconnected and closed up, while, at the same time good gutters are provided along the streets for the storm water.
XVI.

I have thus, as briefly as is consistent with a clear explanation of the subject, described the system of sewerage, which I respectfully recommend for adoption, to your honorable body, and nothing remains to fulfill this part of my duty but to present estimates of the cost, premising that the expenditure will be progressive, extending over as long a term of years as may be deemed proper; taking care only, that whatever sewer is built shall be a correct feature of the general plan.

But I do most earnestly recommend that the present system of emptying sewage into the river and thus polluting the water supply be corrected before the next June floods in the Columbia river, by the construction of the necessary intercepting sewers and the outfall conduit to the Willamette slough.

In this connection it is proper to say that the kitchen gardens in the city and its suburbs are using the city sewage wherever there is a means of deflecting it to the purpose, so that a discussion of the fertilizing value of the material would be a superfluous work to a citizen of Portland. That portion of country through which the outfall culvert must run is low and is now being developed to some extent for gardening. It is very likely therefore that the sewage may soon find a market before reaching the river.

XVII.

Estimate of the cost of sewer ing Portland by means of the separate system.

District No. 1 comprises the lowest portion of the city territory where the sewers thus far laid are placed so deep that it will be cheaper to lay new drains than to raise the old, while the latter may be availed of to convey storm water.

The estimate therefore contemplates the sewer ing of the whole district and is as follows:
MAIN.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,200 lin. ft. 15-inch sewer laid at $1.00 per lin. ft.</td>
<td>$8,200</td>
</tr>
<tr>
<td>25 Y branches for laterals 15x8 at $1.20 each in excess of the plain pipe which they supercede</td>
<td>$30</td>
</tr>
<tr>
<td>25 air inlets with iron gratings at $7.00 each</td>
<td>$175</td>
</tr>
<tr>
<td>15 manholes with iron gratings at $50.00 each</td>
<td>$750</td>
</tr>
<tr>
<td>5,000 cubic yards excavation and back-filling at 25 cents per yard</td>
<td>$1,250</td>
</tr>
</tbody>
</table>

Total cost of main for District No. 1: $10,631.00

LATERALS.

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>42,100 lin. feet of 8-inch lateral sewer pipe at 50 cents per foot</td>
<td>$21,050</td>
</tr>
<tr>
<td>42,100 lin. feet of 2-inch agricultural drain at 24 cents per foot</td>
<td>$1,052</td>
</tr>
<tr>
<td>24,000 cubic yards excavation and back-filling at 25 cents per yard</td>
<td>$6,000</td>
</tr>
<tr>
<td>1,200 double Y branches 8x14, to receive house drains, at an excess over plain pipe which they supercede of $1.50 each</td>
<td>$1,800</td>
</tr>
<tr>
<td>25 flushing tanks to be placed at head of laterals at $50.00</td>
<td>$1,250</td>
</tr>
<tr>
<td>150 covered T branches to sewer as hand holes at $2.00 each</td>
<td>$300</td>
</tr>
</tbody>
</table>

Total cost of laterals for District No. 1: $31,452.00

Aggregate cost of mains and laterals in District No. 1.

$42,103 for 50,300 feet of sewer, being about 84 cents per foot or $4.420 per mile.

*District No. 2* already contains sewers on sixteen streets, which may be connected with the new system through the 15-inch main. The ultimate of the district will be as follows:
MAIN.

10,900 lin. ft. 15-inch sewer laid at $1.00 per ft. $10,900 00
10,900 lin. ft. 3-inch agricultural drain tile at 3 cents per foot ................................. 327 00
180 Y branches for laterals 15x8 at $1.20 each in excess of plain pipe, which they supercede ... 216 00
9 Y branches 15x15 to receive old sewers at $3.00 each ...................................................... 27 00
6 Y branches 15x12 to receive old sewers at $3.00 each ...................................................... 18 00
41 air inlets with iron gratings at $7.00 each .......................................................... 287 00
23 manholes " " " $50.00 each .......................................................... 1,150 00
7,600 cubic yards excavation and back filling at 25 per yard ............................................... 1,900 00

1,200 lin. ft. of 24-inch main to convey discharge of Districts Nos. 1 and 2 to pump well at $4.00 4,800 00
1,200 lin. ft. 3-inch agricultural drain pipe at 3 cents per foot ......................................... 36 00
4 Y branches for laterals 24x8 at $3.00 each .......................................................... 12 00
1 manhole with iron grating at 50.00 " .......................................................... 50 00
4 air inlets " " " 7.00 " .......................................................... 28 00
1,800 cubic yards excavation and back filling at 25 cents per yard ....................................... 450 00

Total cost of mains for District No. 2 ........................................ 20,201 00

LATERALS.

43,200 lin. ft. of 8-inch sewer pipe at 50c. per foot $21,600 00
43,200 " 2-inch agricultural drain pipe at 2 cents per foot ........................................... 864 00
22,000 cubic yards excavation and back filling at 25 cents per yard ................................ 5,500 00
1,248 double Y branches 8x4 to receive house drains, at an excess of cost over plain pipe which they supercede, of $1.50 each .......................................................... 1,872 00
34 flushing tanks at heads of laterals $50.00 each .......................................................... 1,700 00
180 covered T branches to serve as hand holes
$3.00 each ........................................... 260.00

Total cost of laterals for District No. 2 . . . . . . . $31,796.00

ADJUSTMENT OF OLD SEWERS TO NEW SYSTEM.

Work of excavating and back filling on 15 old
sewers at $100.00 each ................................ $1,500.00
Cutting off or shutting up 75 catch basins at
$10.00 each ........................................... 750.00

Total cost of District No. 2 ................................ $54,247.00

Of this amount $3,330 concerns 6,800 feet of that part of
the main laid to receive the old sewers; the balance of $41,917 is the cost of putting in 43,800 feet of main and laterals
all of the new system, being a cost of 924 cents per linear
foot or $4.884 per mile, for the new work.

District No. 8 already contains sewers on nine streets,
which may be connected with the new system through the
12-inch main. The estimate of the District will be as fol-
lows:

MAINS.

6,400 lin. feet 12-inch sewer laid 65c. per lin. foot $3,501.00
6,400 " 8-inch agricultural drain tile at 3
cents per foot ........................................... 162.00
7 Y branches 12x8 at $1.00 each .......................... 7.00
7 branches 12x12 to connect with old sewers $1.00 7.00
1 branch 12x10 " 1.00 1.00
1 " 12x15 " 1.00 1.00
23 air inlets with iron gratings at $7.00 .................. 161.00
61 manholes " 50.00 4,350.00
4,400 cubic yards excavation and back filling at
25 cents per yard ...................................... 1,100.00

Total cost of mains ................................... $9,490.00
LATERALS.

15,000 lin. feet 8-inch lateral sewer at 50c. per ft. $7,500 00
15,000 lin. feet drain tiles 1-inch at 14c. per foot. 225 00
12,000 cubic yards excavation and back filling at 25 cents per yard. 3,000 00
700 double T branches 8x4 to receive house drains of cost over plain pipe which they supercede, of $1.50 each. 1,050 00
18 flushing tanks at $50.00 each. 900 00
48 covered T branches to serve as hand holes at $2.00 each. 96 00

Total cost of laterals. $12,771 00

ADJUSTMENT OF OLD SEWERS TO NEW SYSTEMS.

Work of excavating and back filling on old sewers at $100.00 each. 900 00
Cutting off or shutting up 32 catch basins at $10 each. 320 00

Total cost of District No. 3. $23,481 00

Being about $1.15 per lineal foot on mains and laterals of new systems or $6.072 per mile, of which it may be remarked, that a considerable part of this estimate is for new main passing and receiving old sewers.

District No. 4 occupies in part the highest ground in the city and is a tract on which settlement is extending towards the west and south. The lower section of the district is in the heart of the city, while the southern and western sections are in the suburbs. This estimate is therefore limited to the territory bounded by Grant street on the south, and Twelfth on the west.

As the city is rapidly increasing in population, which extends towards the west and south in this district, I have thought it prudent to estimate for portable, wrought-iron
flushing tanks, which may be moved forward as the sewers are extended; but, for this purpose wooden barrels or tierces may be used as long as their duration is temporary. The estimate for the district will be as follows:

**MAINS.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,120 lin. feet 10-inch sewer laid 50¢ per foot</td>
<td>$2,060.00</td>
</tr>
<tr>
<td>4120 “ “ 2 “ drain tiles at 2¢ per foot</td>
<td>82.00</td>
</tr>
<tr>
<td>10 Y branches 10x8 at $1.00 each</td>
<td>10.00</td>
</tr>
<tr>
<td>8 “ “ 10x12 to receive old sewers $1.00</td>
<td>8.00</td>
</tr>
<tr>
<td>1 “ “ 10x10 “ “ “ “ 1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>19 air inlets at $7.00 each</td>
<td>133.00</td>
</tr>
<tr>
<td>7 manholes at $50.00 each</td>
<td>350.00</td>
</tr>
<tr>
<td>4,000 cubic yards excavation and back filling at 25 cents per yard</td>
<td>1,000.00</td>
</tr>
<tr>
<td><strong>Total cost of mains</strong></td>
<td><strong>$3,644.00</strong></td>
</tr>
</tbody>
</table>

**LATERALS.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>23,400 lin. feet 8-inch lateral sewer at 50¢ per ft</td>
<td>$11,700.00</td>
</tr>
<tr>
<td>“ “ 1 “ drain tiles 1¢ per foot</td>
<td>351.00</td>
</tr>
<tr>
<td>20,000 cubic yards excavation and back filling at 25 cents per yard</td>
<td>5,000.00</td>
</tr>
<tr>
<td>560 double Y branches 8x4 to receive house drains of cost over plain pipe which they supercede at $1.50 each</td>
<td>840.00</td>
</tr>
<tr>
<td>19 flushing tanks at $50.00 each</td>
<td>950.00</td>
</tr>
<tr>
<td>113 covered T branches to serve as hand holes at $2.00 each</td>
<td>226.00</td>
</tr>
<tr>
<td><strong>Total cost of laterals</strong></td>
<td><strong>$19,067.00</strong></td>
</tr>
</tbody>
</table>

**ADJUSTMENT OF OLD SEWERS TO NEW SYSTEM.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work of excavating and back filling eight old sewers at $100.00 each</td>
<td>$800.00</td>
</tr>
</tbody>
</table>
Cutting off or shutting up 35 catch basins at $10 each. ........................................... $350.00

Total cost of District No. 4 ........................................... $23,801.00

Being about 85 cents per linear foot of mains and laterals of $4.188 per mile.

District No. 5, like No. 4, occupies land extending towards and well up to the hills the western section of which is as yet but sparsely populated. This section may, also, properly be provided with portable iron flushing tanks. The estimate is for a territory extending west to Twenty-first street, and north to Y; and is as follows:

**MAINS.**

11,400 linear feet of brick sewer (single ring running 17 linear feet per M of brick) $1.50 laid per linear foot, this price to include extra work of cutting out invert ........................................... $17,100.00

11,400 linear feet of drain tiles 3-inch at 3.00 cents per foot ........................................... $342.00

26 branches to receive all 1/2 laterals (being single lengths of 8-inch or other pipe, excess of cost for laying, over and above linear measurement, which is included in estimate for laterals) $1.00 each ........................................... 26.00

26 air inlets at $7.00 each ........................................... 182.00

19 man holes 50.00 ........................................... 950.00

16,000 cubic yards excavation and back filling at 25 cents per yard ........................................... 3,750.00

Total cost of mains ........................................... $22,350.00

**LATERALS.**

47,300 lin. ft. of 8-inch lateral sewer at 50c. per ft. $23,600.00

1" drain tiles at 1 cent per ft. 472.00
40,000 cubic yards excavation and back filling at 25 cents per yard ........................................ $10,000.00
1,344 double Y branches 8x4 to receive house drains at $1.50 per branch ........................................ 2,016.00
26 flushing tanks at $50.00 each ............................ 1,300.00
99 covered T branches to serve as hand holes at $2.00 each ..................................................... 198.00

Total cost of laterals ........................................ $37,586.00

ADJUSTMENT OF OLD SEWERS TO NEW SYSTEM:

Work of excavating and back filling three old sewers at $100.00 each ........................................ $ 300.00
Cutting off and shutting up fourteen catch basins at $10.00 each ................................................ 140.00

Total cost of District No. 5 ................................ $60,376.00
Being about $1.03 per linear foot or $5,440.00 per mile.

Pumps and Outfall.—It has already been explained that Districts Nos. 1 and 2 will drain into a pumping well at the intersection of Y and Sixteenth streets whence the sewage will be raised to the head of the outfall conduit at the intersection of Y and Twentieth streets.

The maximum for which I have made provision in the sewers will be 3,000,000 gallons per day, but no such duty as this will be required of the pumps for a long time.

At first, the pumps, probably for the next three to five years, will not receive the sewage of the entire district, the work of laying and completing such drainage being likely to occupy that length of time; but when the sewers are all in, it is well understood that the districts will not yet have received their full population. In this view of the case therefore I have thought it well to estimate for a small pump and engine in the beginning; and another similar set of machinery may be placed in position when it becomes neces-
sary to be augmented as the requirements increase. At present, if the whole of the two districts were sewered the pumps would have to raise but about two-thirds of 1,350,000 or 900,000. I believe, however, that a present pumping capacity of one-half that value or 500,000 gallons per day will be ample for a few years; being 350 gallons per minute. It is proper also to say that the pumping from this well will be required only when the Willamette is too high to allow natural outlet for the water and sewage; until the river's shores below and near the town have become so populated as to forbid pollution of its waters below as well as above the town.

The estimate for machinery, etc., will be as follows, as nearly as I am able to determine:

**Land for Works 50 x 100** .................................................. $ 3,000 00

**Pumping engine, Gaskell's Duplex pump with boiler, foundations, well, house, coal bunkers, etc., for a duty of raising 500,000 gallons a day from the height of 16 feet above base of city grades to 43 feet above same base** .......................... 12,000 00

**Pump main from pump to outfall conduit 2,000 lin. feet of 10-inch iron pipe laid at $1 50 per ft** .......................... 3,000 00

**Excavation and back filling 500 cubic yards at 25 cents per yard** .......................... 150 00

**Total cost of pumping sewage from low to high level** .................................................. $18,150.00

**Outfall from pump well to river for use in season of low water** .................................. 1,200 00

**Outfall from end of pump main to Willamette slough** .................................................. $19,350 00

**Tank and gates** .................................................. $ 1,000 00

40,000 lin. feet of brick circle 36-inch inside diameter 2,542 M of brick at $1 00 per M .......................... 38,130 00

75 manholes with iron gratings at $30 00 .......................... 2,250 00

55,000 cubic yards of excavation and back filling at 20 cents per yard .......................... 11,000 00
Special works on account of low lands and water courses ........................................ 5,000 00
Right of way through private property to the slough ........................................... 10,000 00

$67,380 00

**SUMMARY OF ESTIMATES.**

Sewerage of District No. 1 ........................................... $42,103 00

```
  "  "  "    2 ........................................... 54,247 00
  "  "  "    3 ........................................... 23,481 00
  "  "  "    4 ........................................... 23,861 00
  "  "  "    5 ........................................... 60,376 00
```

Pumping machinery and appurtenances ........................................... 18,150 00
Outfall conduit from pumping well to river ........................................... 1,200 00
Outfall conduit from high level to Willamette slough ........................................... 67,380 00

Total cost of completed works ........................................... $290,798 00

Add 20 per cent. for superintendence, engineering, changes in prices, insurance, contingencies and unforeseen accidents ........................................... 58,160 00

Total ........................................... $348,958 00

This sum of about $350,000 is what I suppose it will cost to build a complete system for all that part of the city territory over which improvements and settlement have thus far extended, comprising about 1,500 acres.

But no one would think of suggesting that so extensive a scheme should be executed immediately with our limited population.

If, however, we are to save this town from disease by pollution of the river, the mains must be built and the present sewers conducted below the town.
The prominent and greatest objection to this system of sewerage, that will suggest itself to the citizen is the disposition of the surface water.

This has been the universal objection, wherever the separate system has been recommended; but it has finally given way before continued, intelligent discussion.

When this fact is stated to a resident of Portland, his invariable reply is, that other places do not have so great a rainfall as this town, which is a popular mistake, if it were important, which it is not.

The true question is concerning the quantity of water that falls in any one shower of short duration; and a peculiarity of our rainfall is lack of violence, when compared with other regions.

It is certainly true that we have a few heavy showers; but it is equally true that when we have had such showers our culverts have failed to carry their fall away in safety; they invariably become gorged.

It is claimed that the lower streets were made impassable by rain water before the sewers, such as they are, were built; and it is said that this was in spite of good gutters. I have heard this claim made by respectable citizens, whom it is not pleasant to dispute. Nevertheless, the truth is, that no system of gutters has ever been designed or built for this city, i.e., no proper distribution of storm water has been designed by which every side of every street has been made to take a share of the rainfall. On the contrary, the custom has been and still is, to concentrate the flow of water into a single line of gutter by which it shall be led to a catch-basin.

If the rainfall were distributed as it should be, by the construction of gutters on both sides of all streets, the gorging of a gutter would be of little moment, since the water, at that point, would always have a second channel to serve as a waste weir. I repeat, what I said above, that whatever detritus is left on the streets, is so much saved from the
river to be taken out by the expensive system of dredging, if allowed to enter that stream. Concerning this subject of surface drains it is only necessary to add that excellent and ample gutters can be built in this city, of stone blocks for $1,000 a mile; and that we are paying $800 a mile for insufficient open plank gutters.

XIX.

I have thus, gentlemen, fulfilled the duty you assigned me of devising a system of sewerage for Portland. There is nothing original or new in what I have submitted; everything has passed out of experiment and become established truth. I claim, only, that under the light of large experience in this branch of my profession, I have industriously and impartially studied the latest improvements in sanitary art and have allowed no opportunity for learning the results of the best experience to pass unheeded.

All of which is respectfully submitted by your obedient servant,

ALFRED F. SEARS, C. E.
PAY OF SPECIALS FOR 1879.

390 witness fees, paid by "persons convicted" .... $ 663.00
266 " " "city" ........................................ 452.20

Total .................................................. $1,115.20

BOARD OF PRISONERS FOR 1879.

<table>
<thead>
<tr>
<th>Month</th>
<th>Paid to</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>L. Besser</td>
<td>$295.58</td>
</tr>
<tr>
<td>February</td>
<td></td>
<td>231.00</td>
</tr>
<tr>
<td>March</td>
<td>P. Norton</td>
<td>$129.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>54.60</td>
</tr>
<tr>
<td>April</td>
<td></td>
<td>140.56</td>
</tr>
<tr>
<td>May</td>
<td></td>
<td>147.00</td>
</tr>
<tr>
<td>June</td>
<td></td>
<td>99.96</td>
</tr>
<tr>
<td>July</td>
<td></td>
<td>138.32</td>
</tr>
<tr>
<td>August</td>
<td></td>
<td>194.36</td>
</tr>
<tr>
<td>September</td>
<td></td>
<td>215.04</td>
</tr>
<tr>
<td>October</td>
<td>Burton House</td>
<td>125.85</td>
</tr>
<tr>
<td>November</td>
<td></td>
<td>100.50</td>
</tr>
<tr>
<td>December</td>
<td></td>
<td>148.95</td>
</tr>
</tbody>
</table>

Total .................................................. $2,020.72

The price paid to L. Besser was 50 cents per day, by ordinance; to P. Norton, 14 cents per meal, by contract; to Burton House, 15 cents per meal, by contract.

LODGEERS.

There have been 124 persons furnished with lodgings during the year.

STREET LAMPS.

Forty-nine gas lamps have been reported as not being lit, and 4 as being dirty and giving poor light; and 104 oil lamps as not being lit, and 109 as being smoky and giving poor light.

CITY JAIL.

The lower story of the Police Building, used as the jail, is in rather poor condition, and inconvenient; and I would recommend to you, and through you to the Common Council, an entire remodeling of that portion of the building; and that special attention be called to the drainage, as the effluvia arising from the accumulation of filth and decayed substances under the building, if continued until and during the hot season, will, without any doubt, breed sickness among the inmates, and, perhaps, spread through the neighborhood.
Saloons.

There are a number of saloons, where females are found, to entice persons to visit those places, and especially young men and minors; and I would recommend, through you, that the Common Council pass an ordinance, or amend section 5 of ordinance No. 2,354, making it the duty of the Chief of Police to arrest all females found loitering in or around, or going in or coming out of saloons. Under our present ordinance, this evil cannot be reached; and I am fully convinced, if a more rigid policy was pursued, that the number of places of the above character would be less; thereby confining the business of selling liquor in the hands of parties that would not willfully and designedly violate the law regulating their business; and, although it might reduce the revenue to the city in a slight degree, it would prove less injurious to the public. At this date, there are 115 places licensed where liquor is sold by the drink.

Opium dens.

Another evil, and a rapidly growing one, is the habit of opium smoking, which is ruining the health and destroying the minds of many of our young men and girls; a habit once contracted that can very seldom or never be broken off. There are a large number of these dens, kept principally by Chinese, where men and women, young men and girls—some not over 13 years of age—congregate and indulge in this vile and filthy habit, and sleep off the stupor; subject to the insults and indignities that may be committed upon them by those not under the influence, and by the Chinese themselves. Some of the females who frequent these places are married and have families, and young girls of the most respectable class of society. Could their names be published, society would stand amazed.

It is almost impossible for the police to find out these places, as they are generally in rooms, to reach which it is necessary to pass through dark, winding passages, and doors fastened and guarded, sometimes requiring a guide; and when the den is reached, all is dark, the inmates having escaped over roofs and by underground passages. Some more stringent and severe measures should be taken to break up these dens of infamy. No wonder that so many of our young girls fall from virtue. From the best evidence I have, there are about 500 to 600 white males and females who visit these dens in this city. By the ordinance, the fine shall not exceed a certain amount, while I think the lowest penalty should be expressed in the ordinance.