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THE SALT LAKE CITY INTERCEPTING AND OUTFALL SEWER

(With inset.)

By W. P. Hardesty

Salt Lake City is situated on the eastern slope of the basin of the Great Salt Lake, and is quite diversified in topography. All of the northeast and extreme eastern portions have good natural drainage with slopes which gradually become lighter toward the southwest until the southern and western parts are nearly level. The Jordan River flows from south to north through the western part of the city, emptying into the Great Salt Lake, some eight or ten miles northwest of the center of the city. The territory on each side of the river is quite difficult to sewer, the only fall being along the course of the river, less than 2 ft. per mile at first and decreasing before the city limits are reached, so that the river becomes quite sluggish, with low-lying ground and lakes on each side. To the west, toward Great Salt Lake, the surface is practically level, with no opportunity for drainage in that direction.

The population of the city in 1890 was about 45,000 and is now estimated as from 55,000 to 60,000. The area within the city limits is about 40 sq. miles, much of which is unsettled and will not need sewers for a long time.

Prior to 1889 Salt Lake had no sewerage system and in that year the first systematic attempt at disposal of waste matters was made. The sewage was led down Fifth South St. to a sump at the river bank, from which it was pumped through a 12-in. kalamein iron pipe for two miles to the westward and emptied into a surplus canal, built to relieve the Jordan during heavy freshets, and finally discharged into Great Salt Lake. The pumping plant has proved to be much too small. It has a capacity of but 850 gallons per minute and disposes of but about 40% of the sewage delivered to it during the 18 hours per day it is operated, leaving the balance to be discharged directly into the river. The sewage has been a nuisance to parties living along the river and even a worse one to those in the vicinity of the surplus canal, and as it became evident that the disposal of all the sewage by pumping would be very expensive, the small amount at present pumped alone costing $5,000 per annum, it was decided that a new outlet must be secured.

A gravity sewer carrying off the sewage and discharging it some place north or northwest of the city was the only solution that could be offered. Surveys and plans were made by Mr. A. F. Doremus, M. Am. Soc. C. E., City Engineer, and approved by Mr. J. J. R. Croes, M. Am. Soc. C. E., of New York. The plans as adopted call for a masonry sewer, shown by the map, Fig. 1, on the inset sheet, beginning at Fourth East and Ninth South St. and extending through the city to vacant ground about one mile north of the city limits designed for use as a sewage farm. It is believed that this plan will dispose of the sewage in a satisfactory manner and at the same time render it of commercial value. All available water in this locality is eagerly sought for use in irrigation and it is thought that the sewage will fertilize as well as water the crops to which it is applied, while its higher temperature than ordinary water will be an advantage. A tract of 120 acres has been secured by the city to be used as a sewage farm and in time sewage will probably be sold to parties owning adjoining lands.

The sewer is designed to intercept the sewage from all that part of the city lying 25 to 30 ft. above the Jordan River, it being estimated that some 3,000 acres will eventually discharge into it. This area includes the best residence portion and the business center of the city and will probably furnish the bulk of the sewage for a long time to come.

As designed the total length of the intercepting and outfall sewer will be 41,400 ft., or nearly eight miles, the length and the quantities per lin. ft. of each size being as follows:

Diameter, ins.	38	42	48	54	61
Length, ft.	5,200	5,300	5,600	9,800	17,500
Concrete, cu. yds.	0.295	0.326	0 375	0.623	0.739
Brick, cu. yds.	0.109	0.118	0.132	0 222	0.261
Cement plaster inside, sq. ft.	1.105	1.222	1.396	1.521	1.862

The grade of the 38 and 42-in. sections, including the first two miles, is 0.05, and of the balance 0.04 in 100. Through the settled portion of the city the street line is followed, the sewer being laid 22 ft. from the center line, with 90° curves of 127.32 ft. radius.

Manholes are located 800 ft. apart and vitrified branch connections are placed at all street intersections and about 800 ft. apart elsewhere, within the city limits. The great size of the blocks of Salt Lake, 660 ft. sq., with 132-ft. streets, lessens the outlay for laterals, but will greatly increase the cost of house connections, many of the houses being located in the interior of the blocks.

At Second South St. a 2-ft. masonry branch will be built for connecting a main, to be built at some future time, through this street to the east end of the city, where it will receive the sewage from Fort Douglas—a United States military post situated on the bench lands, some three miles east of the center of the city. At this point the size is increased from 42 to 48 ins. At North Temple St. another 2-ft. masonry branch is to be built in the sewer to admit the surplus water of the City Creek, at present conducted west on this street through open paved conduits and flumes to the Jordan River. In time, however, when the growth of the city will require the full capacity of the sewer, this method of disposing the surplus water will have to be abandoned, and instead a main branch sewer will connect at this point. Here the diameter of sewer increases to 54 ins. At Ninth North St. a 3-ft. masonry branch will be built to admit sewage from the district below the gravity sewer. It is here that the sewer reaches its full size of 64 ins., with an estimated capacity of 35,000,000 gallons daily, which will certainly be sufficient for the city for many years to come.

In designing the sewer Mr. Doremus presented two alternative methods of construction, one calling for a combined brick and concrete structure, as shown in the sections, Figs. 2 and 3, while the other used brick alone, the brick section being continued clear around and the same thickness.

Following are the amounts of the respective kinds of work upon which bids were invited, together with the prices and corresponding amounts bid by the successful bidders, Houlahan, Griffith & Morris, of Salt Lake, and Hobson & Wilkerson, of Ogden:

Nature of work.	Quantities.	Price.	Amount.
Earth excavation	73,700 cu. yds.	.40	$29 480
Earth excavation and back filling	116,000 "	49	56,840
Solid rock excavation.	10 "	$6.00	60
Solid rock excavation and back filling	50 "	7.00	350
Embankment	500 "	.25	125
Tunneling in earth	25 lin. ft.	11.25	281
Tunneling in solid rock.	350 "	17.00	5.950
Concrete masonry	23.700 cu. yds.	6.69	158,553
Brick masonry	8,400 "	9.99	83,916
Cut stone masonry	50 "	20.00	1,000
Rubble masonry	200 "	6.50	1,300
Dry rubble masonry	200 "	4.50	900
Cement plaster	65,370 sq. yds.	.33	21,572
Rip-rap	500 cu. yds.	2.00	1,000
Lumber in the work	2,000 M. ft. B. M.	30.00	6,000
Total			$367,327

The only change in quantities for the all-brick construction was that 25,400, instead of 8,400, cu. yds. of brick masonry were required, and only 500 cu. yds. of concrete. The bids for construction with brick alone were nearly $15,000 more than those given above. The same contractors were the lowest bidders in each case. The choice between the two plans rested with the city engineer and Board of Public Works, under whom the work is being done, subject to the confirmation of the city council, and was somewhat complicated by the efforts of parties interested in the selection of materials. The old arguments as to the use of home material and greater employment for the laboring man were urged with much zeal. The city engineer preferred the combined construction and it was finally adopted.

Fig. 2 shows a section of the 32-in. portion of the sewer; the 42 and 48-in. portions have the same thickness of brick and concrete. Fig. 3 shows the 64-in. portion which has the same thickness of material as the 54-in. A special 64-in. section, used beneath three railway crossings, referred to below, is shown by Fig. 4.

The specifications call for the best hard-burned brick laid in Portland cement mortar, composed of 1 part of cement and 2 parts sand. The concrete is composed of 1 part Portland cement to 4 parts sand and 5 parts of screened gravel. The inside of the sewer is plastered with a mortar composed of 1 part Portland cement and 1 part sand, a coat ½ in. thick being laid on. The outside of the brickwork also receives a coat ½ in. thick of the mortar used in its construction.

The style of manhole is shown by Figs. 5 and 6. Fig. 5 showing a manhole in the 42-in. section, that in the 38-in. being similar, and Fig. 6 showing a manhole in the 64-in. portion of the sewer, the same type having been used for the 48 and 54-in.

Fig. 7 shows the details of the manhole covers, as designed. The locking device is simple in construction and admits of ease and certainty of operation. Fig. 8 shows the connection for the force mains from the proposed plant near Ninth North St.

It is proposed at some distant day to collect all the sewage from the bottom lands along each side of the Jordan and conduct it by a sewer paralleling the river to a sump at Ninth North St., thence to be pumped against a head of probably 20 ft. along this street into the gravity sewer. The route of the sewer as adopted is, in general, quite direct, necessitating some very heavy cuttings and some fills. At Hot Springs, a bathing resort in the northern part of the city, a spur from the mountains projects well out into the valley, at the point of which are located the springs. Here a tunnel 375 ft. in length has been put through without any difficulty, the material being mostly a stiff clay or shale that required but little timbering and allowed of a very clean and uniform cross-section, thus requiring very little extra excavation outside of the sewer section. About one-half mile north of the city limits the Great Salt Lake & Hot Springs Ry. is crossed at an acute angle, requiring 104 ft. of a special construction, while farther on the Union Pacific and the Rio Grande Western railways are crossed at a still more acute angle, requiring each 150 ft. of the special construction. As the intrados of the sewer arch is but about 4 ft. below the rails for each of these three crossings, a very strong and substantial construction had to be adopted, which is shown in Fig. 4. The cost of the sewer where built after this section will be about $20 per lin. ft. The cost of the masonry alone of the 64-in. sewer, as shown in Fig. 3, will be about $8 per lin. ft.

Trouble with water has been experienced in the construction of the sewer, and for much of its length drain boxes have been used. A layer of gravel has been placed below much of the concrete bottom and plank foundations have been employed in some very wet places. But little trouble has been experienced from caving, even in very deep cuts, bracing, of course, being freely used. A trench 7 ft. 5 ins. in width answers for the largest size of the sewer. Lagging, of course, has to be used in shallow cuts and in fills to form the back of concrete walls while being built. Figs. 9 and 10 are views of the sewer in process of construction.

About 14,000 ft. at the lower end of the sewer will be finished in 1893 at a cost approximating $180,000. It will probably take until the end of 1894 to complete the work.*

* We have received a letter from Mr. A. F. Doremus, City Engineer, dated Dec. 20, 1893, in which he states that on account of unfavorable weather the work has been stopped for some time; also that there is a controversy between the city and the contractors, which may result in a mutual agreement for the abandonment of the contract. In any case it is expected that the work will go on in the spring.