WATER FROM BULL RUN

Portland's Source of Supply for Domestic Use.

THE WATER-WORKS PLANT A GRAVITY SYSTEM

The Pipe Line and the Fine System of Reservoirs—The Water Committee and the Corps of Engineers in Charge of This Work.

THE year 1894 will long be remembered as one of the most eventful in Portland's history. An abundant supply of pure water for domestic use has long been the dream of the city. The completion of the great Bull Run system, one of the most extensive and most complete water-works plants on the coast, is a realization of this hope, and it is the practical demonstration of the success of an enterprise, the final consummation of which was not looked forward to during the present century.

Primitive Portland had good water. Modern Portland is able to avail itself of a supply of the purest water from a source in the lofty elevations of the Cascade mountains that will never be exhausted, and a source, too, that will never be contaminated by the settlement of the contiguous districts, which has rendered the water from the Willamette river so objectionable for the use of Portland's people. During the long intervening period from the time that Portland first attained distinction as an important business center until the fall of 1894, a period of more than a quarter of a century, the supply of water for domestic purposes

ROUTE PIPE LINE FROM BULL RUN RIVER TO PORTLAND.

here has been taken from the river which flows by the city. This stream drains the whole of the Willamette valley, a section thickly settled and which supports on the banks of the river some of the most populous centers in the state. In addition to the sewerage from these many different towns situated along the course of the Willamette, the very character of the soil of the country it cuts through furnishes an objection to the continuous use of its waters for domestic purposes. The soil of the entire valley is a disintegrated volcanic rock, thickly covered with the decomposed vegetation and mold of centuries. During the winter rains this soil is carried in great quantities by the many small tributaries of the Willamette into this principal open drainway of Western Oregon, and these heavy deposits are swept down through the valley past Portland to the Columbia river, by which latter stream they are finally ejected into the ocean at the Columbia's mouth. While it has never been actually demonstrated that the water taken from the Willamette river and piped through Portland for domestic use is positively unwholesome, yet the possibility of contamination of the stream from the 150 miles or more of country it drains, and its muddy appearance during the winter rains, have been urged as serious objections to its continued use by the city, and the completion of the Bull Run system, by which the people of Portland are assured an ample supply of the purest of mountain water for domestic use for all time, is regarded in the light of a public work which they can take pride in referring to as one of the principal advantages the municipality has to offer in the way of needed reforms of the greatest practical import.

THE EARLY WATER SUPPLY.

Taken From Wells and Springs in the Vicinity.

THE first settlers on the site of Portland had an available source of the purest water from Balch and Caruthers creeks, sparkling brooks which poured their waters into the Willamette at this point. In addition to these small streams, water from numerous wells and springs was also utilized for domestic use in Portland during the early days of its history. Below the surface of the ground on which Portland stands and that of the surrounding country for miles, at depths varying from 30 to 100 feet, are heavy deposits of gravel through which water is constantly seeping in sufficient quantities to insure a constant supply in any well sunk to these gravel beds. Until this water was rendered unfit for domestic use by the drainage from the hundreds of houses of a well-settled town, the well water of Portland and the outlying suburbs was clear, cold, and of the most wholesome character. As Portland grew, however, the old wells were gradually filled up or turned into cesspools, and for many years past the principal source of supply of water for domestic use in that part of Portland on the west bank of the Willamette has been taken from the great river which is the main artery of commerce from this city to the sea.

THE PORTLAND WATER COMPANY.

Organization of the Company—The Great Plant It Built.

AS Portland grew, the demands of the city for a water-works system, ample to meet the demands of a prosperous town of considerable importance, became an imperative one. In 1867 a number of enterprising citizens organized what for years was known as the Portland Water Company. This company acquired the rights to the Balch and Caruthers creeks water supply, and also of the principal spring from which water for the city had long been taken. This spring they enlarged and dug deeper, and it was finally covered, making it for all practical purposes a protected well, furnishing a constant and large supply of the finest water. At this well the company set up a pump of a capacity of 300,000 gallons a day. At the same time the company built a small reservoir that occupied a quarter block at the northwest corner of Fourth and Market streets. The sole source of supply for this reservoir was the well, together with water from Balch and Caruthers creeks, and the supply was ample to meet the demands of the city for water for a number of years.

The headquarters of the Portland Water Company at that time were in a modest building of rough boards, at the foot of Market street. In 1873 the company commenced the erection of a new pumping station on the river bank at the foot of Lincoln street. This station was completed the following year. It was supplied with a new pump and other machinery well adapted to the demands to be made on it in connection with forcing water from the Willamette river through the mains of the city. The pump was constructed by the old Oregon Iron Works, and it had a capacity of 800,000 gallons a day. In 1871 a new Worthington pump was added to this station, which increased the pumping capacity to 1,800,000 gallons a day (24 hours). Five years later the company commenced the erection of the brick building now known as the old roundhouse station. During the same year that this building was completed, the company added another Worthington pump to the plant, and the old pump made by the Oregon Iron Works was discarded. The capacity of the new pump was 3,000,000 gallons every 24 hours, thus making the combined capacity of the pumping station 4,000,000 gallons a day.

For a number of years after the erection of the pumping station on the river bank, Balch and Caruthers creeks continued to furnish a limited supply of water for domestic use in Portland, but as the city grew the limits of these streams were gradually encroached upon, and their flows finally became so contaminated from the drainage of the settlement that they were no longer available as sources of supply for pure water. In 1884 the erection of the fine water plant now known as the Palatine Hill pumping station was commenced. The land occupied by this plant covers an area of 10 acres.

In the new station at Palatine Hill were placed two Worthington compound condensing engines, which when run to their full capacity will pump 12,000,000 gallons of water a day. This is one of the most complete pumping stations in the West. The brick building which it occupies is an attractive piece of architecture and is ornamented with castellated towers at the corners. The chimney of the station is of brick, and rises to a height of 90 feet. Near the works is an elegant two-story residence, built for the use of the engineers and surrounded with green lawns and well-kept flower-beds. This station and its surrounding grounds form one of the principal landmarks along the Willamette river between Portland and Oregon City, and the beautiful location is favorably commented on by tourists, who often take the river ride from Oregon's metropolis to the city by the falls of the Willamette.

The Palatine Hill station was first used on October 21, 1894, and from that date until Bull Run water was turned into the city mains the entire water supply of Portland was pumped from this station.

THE EAST SIDE DISTRICTS.

Two Complete Water Plants—The Extent of the Mains.

The districts on the east side of the Willamette river opposite the principal business districts of Portland have never been supplied with water from the Willamette river. The East Side districts were formerly under the municipal governments of East Portland and Albina, but since the consolidation of all these outlying districts into a single municipality they have been a part of Portland. Prior to 1882 East Portland was supplied with water principally from wells. In that year H. P. McGuire and his associates formed the East Portland Water Company. This company found an available source of supply from the Hawthorne springs. These springs are located at the corner of East Twelfth street and Hawthorne avenue. This has been the source from which a considerable part of the water has been obtained since the organization of the East Portland Water Company, and, as the water is clear and cold, it has given excellent satisfaction to consumers.

In 1890 a rival company was formed in East Portland, under the name of the East Side Water Company. After this company was organized, and before the consolidation of Portland, East Portland and Albina was effected, the old municipality of East Portland had arranged to purchase the franchise and the plant of the East Side Company. The bill providing for the consolidation of these cities also contained a clause ratifying any contracts which had been entered into by either of the three municipalities of Portland, East Portland or Albina. Under the terms of this clause, Portland in 1891 purchased the entire plant and rights of the East Side Water Company. The plant thus became the property of the city, and as a public property it has since been run in direct competition with the old East Portland Water Company, which is a private corporation.

The water supply for that part of the East Side located within the former municipal limits of East Portland and supplied by the city from the old East Side Company's plant is pumped from wells driven to a depth of about 200 feet. This depth insures a constant supply of the purest water, as it is obtained below the seepage area of surface drainage. These wells, however, do not furnish a sufficient supply for the territory the plant covers, especially during the summer months, when large quantities of water are used for irrigation. The standpipe of the city works on the East Side has therefore been connected with the pipes of the Albina Light & Water Company, which affords a sufficient supply at all times.

Provision has been made for supplying water to the East Side districts from the Bull Run pipe line. This water will be taken out of the lower reservoir at Mount Tabor. At the present rate of consumption on the East Side, this reservoir will hold sufficient water to furnish the East Side districts with water for an entire week should it become necessary at any time to cut off the direct supply from Bull Run. Should the water ever be shut off from Bull Run for a longer period than one week, it would become necessary to obtain the supply for old East Portland from the Albina plant.

Up to the present time no provision has been made for supplying the northern districts of the city on the east side of the river and known as Albina with water from the Bull Run plant. Albina at the present writing, however, has an adequate supply of good water, and, with the mains now laid throughout that part of Portland, connection with the Bull Run system can be easily made at any time, should it be deemed advisable to supply Albina with this water.

THE WATER COMMITTEE.

Act of the Legislature of 1885 Which Authorized Its Formation.

IN 1885 the population of Portland was about 25,000. The daily consumption of water at that time was about 4,000,000 gallons. The rates charged for water by the old Portland Water Company would today be termed excessive. These rates, together with other objectionable features connected with the private ownership of a water plant for so large a city as Portland, finally led to an agitation of the project of the city's owning and conducting a complete plant of its own. This agitation culminated in the passage of an act by the legislature on November 25, 1885, authorizing the municipality of Portland to purchase or construct and to operate a system of water works adequate to meet every demand of the city for water. By this same act a committee of 15 of Portland's leading citizens was empowered to exercise the authority conferred on the city regarding the purchase and operation of the water plant. The original water committee was made up as follows: John Gates, F. C. Smith, C. H. Lewis, Henry Failing, W. S. Ladd, Frank Dekum, L. Fleischner, H. W. Corbett, W. K. Smith, J. Loewenberg, S. G. Reed, R. B. Knapp, L. Therkelsen, T. M. Richardson and A. H. Johnson. John Gates died April 27, 1888. His place was immediately filled by the appointment of C. A. Dolph. The vacancy made by the resignation of F. C. Smith, on October 8 following, was filled by the appointment of C. F. Sitton, who was succeeded on his death, in May, 1890, by C. H. Raffety. Mr. Ladd, one of the original members, died in February, 1893. The act authorizing the appointment of this committee was amended by the legislature in the same year, and H. W. Scott and C. H. Carey were appointed in place of W. K. Smith and T. M. Richardson. Two members of the water committee, A. H. Johnson and Frank Dekum, died during 1894. The committee today is composed of the following members: Henry Failing, C. H. Lewis, L. Fleischner, H. W. Corbett, J. Loewenberg, S. G. Reed, R. B. Knapp, L. Therkelsen, C. A. Dolph, C. H. Raffety, H. W. Scott, G. P. Frank and C. H. Carey.

Mr. Failing has been chairman of the committee since it was first organized, and the office of treasurer has been filled by C. H. Lewis. Philip C. Schuyler was clerk of the committee until his death, in October, 1889, when Frank T. Dodge was appointed to succeed him, an office the latter gentleman has filled successfully since that time. The members of the subcommittee on the construction of the Bull Run line are: George P. Frank (chairman), Henry Failing, J. Loewenberg, C. A. Dolph and L. Therkelsen.

Colonel Isaac W. Smith was appointed chief engineer of the city water works in December, 1885. The entire Bull Run pipe line has been constructed under the direction of Colonel Smith as chief engineer, and evidence of his great ability is seen in the completion of one of the most complete water-works systems of the West. James D. Schuyler, consulting engineer, has had direct charge of construction of the reservoirs.

By an act of the legislature of 1885, the water committee was given authority to issue and sell nontaxable bonds, for the payment of which the credit of the city of Portland was to be pledged. The amount of these bonds was not to exceed $700,000, and they were to run for 30 years and draw 5 per cent interest. The proceeds from the sale of these bonds were to be used for the purchase of a water plant suitable for the demands of the city, and to extend the same if necessary. The $700,000 in bonds sold under this act were issued on January 1, 1887, and the proceeds were used for the purchase of the complete plant of the old Portland Water Company and for extensions and repairs to the same. In 1893 the committee was authorized by the legislature to issue additional bonds to the extent of $2,500,000. The money received from the sale of these bonds was to be used in the construction of the Bull Run system, which has just been completed.

Of the $2,500,000 bond issue of July 1, 1893, $2,000,000 has been sold to date. A considerable premium was realized on the sale of some of these bonds, and a few only were sold at a discount. The entire premium received from these sales has amounted to $202,950 70, and the amount of discounts $8750, making the net amount received for premiums $194,200 70. The sale of these bonds has been made only after bids have been advertised for in the coast and the Eastern papers. Nearly all of the bonds have been sold in the East, a few of the first issue only having been taken in Oregon. An effort was made in the legislature to make the second issue of $2,500,000 nontaxable, but the act which was passed was vetoed by Governor Pennoyer.

The act of the legislature appointing the Portland water committee also provided that when, in the judgment of the committee, the new water-works system shall be ready for use the committee shall select from their own number five commissioners for the respective terms of two, four, six, eight and ten years, who shall exercise the power and authority given to the city to keep, conduct and maintain water works. When the several terms of these commissioners shall expire, their successors shall be elected by the voters of the city, each for the full term of 10 years. The act further provides that at the expiration of five years after the appointment of the commission, or the completion of the new water-works system, the rates charged for water in Portland shall be sufficient not only to meet all operating expenses of the plant and the interest on the bonds, but also to furnish annually a sum of money not to exceed 2 per cent of the par value of the bonds, which shall be invested, under the direction of the commission, with the view of furnishing a sinking fund for the final redemption of the bonds.

Immediately after the appointment of the water committee in 1885, the project of bringing water from Bull Run river, a clear mountain stream which finds its source in the Cascade range east of Portland, was carefully considered with a view of determining its feasibility. Several surveys for the proposed route from Portland to Bull Run were made under the direction of Colonel Smith, the chief engineer, and it was finally determined that a gravity system could be constructed, the water reaching the city through a conduit about 31 miles in length. This conduit would convey the water to a point at an elevation of 403 feet above the level of the lower districts of Portland. From this point Colonel Smith proposed to carry the water to a reservoir to be constructed in the City Park at an elevation of 290 feet, the total fall of the water being 426 feet from the headworks to the City Park. He estimated on August 2, 1892, the cost of a pipe line of ample carrying capacity to supply at Portland 25,000,000 gallons a day would be $2,200,000, in addition to the $461,000 already expended for preliminary surveys, purchase of rights of way, and the extension of the distribution system of the plant purchased from the Portland Water Company. An estimate of the cost of the line made previous to this was less than that made by Colonel Smith, but from the very thorough investigation of the chief engineer the committee was satisfied that his estimate was a correct one, and the plans for bringing Bull Run water to Portland were made on the last estimate.

The water committee in considering the proposition to bring water from Bull Run to Portland used every precaution in obtaining the necessary rights on the stream to insure the success of the undertaking. Two men were engaged to locate on government land in two localities bordering on Bull Run river, covering that part of the land bordering on the stream where it was proposed to locate the headworks of the new water system. After these men had settled on their respective claims the committee ordered two additional surveys for the route to be made. They thus had one of three routes to choose from, and the present route was only finally decided on after it had been determined to the entire satisfaction of the committee that this was the most favorable of the three.

The right of way for the new pipe line from Bull Run river at the proposed location of the headworks to Portland was another serious difficulty the committee was called upon to solve. This was finally settled, however, by August, 1886, and the way was thus paved for the commencement of active work on the construction of the line.

About $40,000 had been expended in surveys and in the purchase of water rights, right of way, etc., before the committee was in condition to begin work on the line. As the estimate of the engineers provided for the expenditure of considerable more money in the construction of the proposed Bull Run system than the committee was authorized to expend, it was decided to devote the rest of the money received from the sale of the first issue of bonds to the construction of an efficient distributing system. They depended on the legislature to authorize sufficient additional bonds to construct the Bull Run system, and in perfecting the distributing system of the city they kept constantly in view the demands that would be made on this system when Portland's supply should be taken from the Bull Run river.

THEY BOUGHT THE PLANT.

The Committee Paid $461,676 to the Old Company.

THE purchase of the plant of the old Portland Water Company by the city water works committee was only consummated after long delay and considerable haggling regarding the price that should be paid for the plant. The Portland Water Company claimed that its investment in the plant was somewhere between $800,000 and $900,000. The company, however, realized the necessity of making every reasonable concession to the city, and expressed a willingness to sell at the lowest named figure, viz., $800,000, the stockholders agreeing to stand the loss of the uncertain number of dollars represented by their investment in the plant in excess of that amount. The committee, however, before finally deciding to spend nearly $1,000,000 of the city's money for the purchase of a plant built by a private corporation, decided to take an inventory of the property in the Portland Water Company's possessions. They were surprised to discover that a plant, equally as complete and as serviceable as the one which was offered them for $800,000, could be duplicated for $320,000. It was this discrepancy between the figures of the water company and those of the committee that threatened to block the committee in its attempt to purchase the complete water-works plant already in successful operation here, and this seemed a difficulty at the time for which it did not seem possible to find a happy solution.

The committee, after carefully considering the franchises of the Portland Water Company and the completeness of that corporation's plant, covering as it did the entire district included within the city limits, finally decided to make the offer of $460,000 for the entire property of the company. This offer was rejected. The Portland Water Company had been the foe of the water committee from the time that its organization was first authorized by the legislature, and it was through the influence of this company that the measure before the legislature authorizing the issue of additional bonds for the construction of the Bull Run system was twice defeated. Realizing the hopeless feature of the struggle against the committee, a fight in which the committee had the united support of all of Portland, the company finally decided to sell all its rights in the Portland water-works plant to the committee, and the transfer was effected on January 1, 1887, for the price of $461,676.

Immediately on taking possession of the plant the committee reduced the rates formerly charged for water by the Portland Water Company one-half. After paying the interest on the bonds already issued, and meeting all operating charges of the plant, the committee was surprised to find at the end of the first year after the plant had passed under its control that its income had yielded a net revenue of $50,502. This income was earned, it must be remembered, on rates for water that were just one-half those charged by the Portland Water Company, which in itself furnishes the key to the strenuous opposition the committee had been forced to meet from the private corporation which formerly owned the city water-works system.

The net income from the city water-works system from the time it was purchased by the committee from the Portland Water Company in 1887 to November, 1894, was $792,721 61. This amount virtually represented the profit of running the plant for that time. Of this, the sum of $224,-139 50 had been expended in meeting matured interest on bonds sold, $373,187 13 had been devoted to the purchase of additional pumps for the Palatine Hill station and for mains leading into the city, and the balance, $256,344 98, had gone into the fund for the construction of the new water-works system and for the extension of the mains of the distributing system.

Since the ownership and control of the water-works system passed to the city the distributing mains within the municipal limits have been increased from a total length of 27 miles to over 75 miles. A new pump, with a capacity of 12,000,000 gallons a day, has been erected at the Palatine station, and two additional pumps, with a combined daily capacity of 4,000,000 gallons, have been provided for the high-service pumping station at the corner of Seventh and Lincoln streets. These are high-duty Holly pumps, adapted either to pumping direct into the reservoirs or into the mains as may be desired. With these pumps there is a direct saving of at least 40 per cent of the fuel formerly required to furnish power to operate the old Worthington low-duty pumps. Under the management of the water committee, the capacity and efficiency of the water-works plant has been greatly increased, the rates formerly charged for water have been greatly reduced, and after meeting all fixed charges of operation and paying the interest on the bonds the committee has been enabled to divert nearly $300,000 from the profits of running this plant to the construction of the Bull Run system.

The following table, as showing the increased demands that have been made on the plant while under the control of the committee, will show how carefully the city's interests have been guarded in handling this great property. It shows the consumption of water in Portland, by years, from January, 1886, to January, 1894:

Year.	Gallons per annum.	Average per diem.	Maximum use during year.	Average for August each year.
1886	1,431,000,000	3,920,000	.....	4,670,000
1887	1,728,000,000	4,716,000	6,250,000	5,200,000
1888	2,153,000,000	5,900,000	8,578,000	6,730,000
1889	2,576,000,000	7,056,000	9,706,000	8,390,000
1890	3,421,000,000	9,415,000	11,200,000	10,663,000
1891	3,863,000,000	10,031,000	13,500,000	12,000,000
1892	3,116,939,000	8,537,000	14,800,000	10,652,000
1893	3,641,000,000	9,900,000	17,000,000	16,798,000
1894	4,042,000,000	11,105,000	16,000,000	13,500,000

The following table was prepared by Mr. Frank T. Dodge, the efficient clerk of the water committee. It shows not only the gross earnings of the plant from the time the committee took charge of it up to the present time, but it also gives the operating expenses and net earnings during this time. The rapid increase of cash receipts and net revenue, in sharp contrast to the slight increase in the operating expenses, is especially worthy of note:

Year.	Cash receipts.	Operating expenses and repairs.	Net revenue.
1887	$97,503	$47,001	$50,502
1888	113,682	54,792	58,890
1889	148,106	51,467	96,639
1890	181,310	71,497	109,813
1891	214,218	63,994	150,224
1892	237,301	58,832	178,469
1893	227,501	63,357	164,144

For 1894 the total cash receipts up to December 1 were $193,196. Estimated receipts for the month of December brings this amount up to $210,196 for the year. The disbursements during 1894 up to December 1 were $49,588, and the estimated expenditure for the month of December brings the total amount of disbursements up to $54,588 for the year.

The above table does not include the sum of $69,757 due from the city for water used during the years of 1891, 1892 and 1893 (water used principally for fire service, the parks, and for street sprinkling). The water committee claims that the city council should pay for this water out of the general fund, as is done by nearly all cities owning their water-works systems. Nearly every prominent building in Portland today pumps its own supply of water which is obtained from depths 100 feet or more below the surface through driven pipes. The buildings which are thus supplied, however, pay nothing for the additional fire protection afforded by the great extension of the distributing system of the city water works. The committee has expended at least $140,000 in laying large pipes throughout the city. These mains were designed especially to afford a sufficient pressure to insure an ample protection against fire in all the business district of the city. The act of the legislature authorizing the appointment of the water committee empowered this committee "to establish rates for the use and consumption of water by the city and the inhabitants thereof." These rates were fixed with the view of affording an income necessary to meet the running expenses of the plant, to pay interest on bonds and to afford a revenue sufficient to meet the extraordinary charges of placing the distributing system in a condition to meet the extra demands that have been made on it by the introduction of Bull Run water. The amount of $2000 a month, which the committee has charged the city for the water used for municipal purposes, has not been paid by the city for the three years past, and as a result the entire charges of keeping up this expensive plant have fallen on the individual water consumers. The extra burden these consumers are compelled to bear by the refusal of the city to meet the charge of the water committee for water furnished, is shown by the statement that the committee stands pledged to reduce the family rate for water one-third below the rates now charged at any time the city may agree to pay for the water the municipality is regularly consuming.

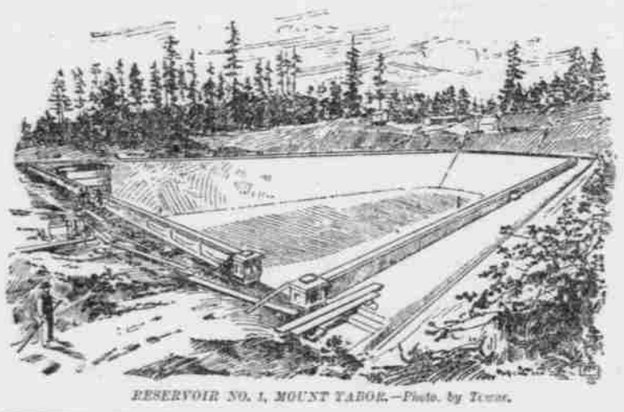
TRENCH FOR PIPE LINE, NEAR HEAD WORKS.—Photo. by Towne.

THE BULL RUN SYSTEM.

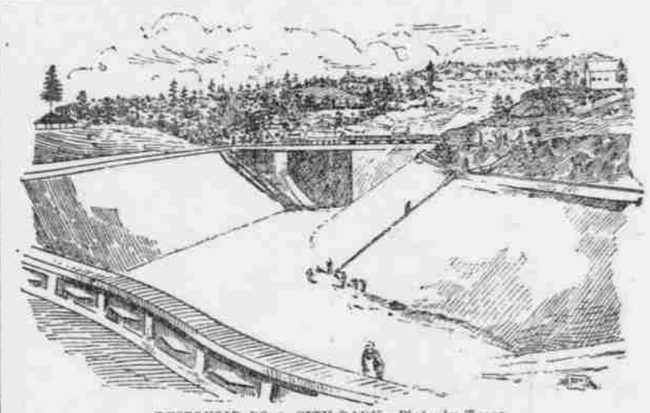
The Most Complete Water-Works Plant in the Northwest.

THE act of the legislature of 1891, authorizing the bond issue by the city of Portland for the construction of a suitable water-works plant, contemplated an issue of bonds to the amount of $2,500,000. Through a clerical error in copying the bill after its passage, in which the amount of bonds to be issued was printed in one part of the sheet containing the provisions of the act as $2,500,000, and through the complications which arose from the passage of the act by the same legislature, incorporating the cities of Portland, East Portland and Albina, the water committee was compelled to delay the commencement of the work of constructing the Bull Run system until the convening of the legislature in 1893. At this session the legislature made the necessary correction in the former water bill, and early in that year the active work of construction on the Bull Run line was commenced. Before this work was inaugurated, however, the committee had taken steps to secure a reservoir site for East Portland. It had built good roads along the proposed route of the pipe line, and all the specifications had been prepared with the view of beginning work in earnest on the line just as soon as the necessary authority to sell bonds could be secured from the legislature. It was hoped to have the entire system completed and in working order by December 31, 1894.

The specifications for the construction of the Bull Run pipe line and reservoirs fully described the work to be done and the methods of payments on contracts. These were furnished to all persons and firms who expressed a desire to bid on this work. Every possible safeguard was taken to insure the best results from contractors on this work, and each bidder was required to furnish with his bid a certified check for a stipulated amount as assurance to the committee that he would accept the contract if it was awarded to him, and that he could furnish the necessary bonds for the faithful performance of its provisions. As a further assurance of good faith on the part of contractors, the committee stipulated in most of the contracts it let that a deduction of 10 per cent should be retained from the payments provided for in the monthly estimates until the expiration of a certain length of time after the completion of the work. In the case of the contractors who furnished the steel and cast-iron pipes and the submerged pipes, the committee stipulated in the contracts that the contractors were to keep these pipes in repair for a period of six months after they were completed, and then turn them over to the committee in perfect condition, before they could draw the money due them, represented by the deferred payments of 10 per cent on the monthly estimates. In the construction of the entire system the committee has accepted no work from contractors until a sufficient time has elapsed after the completion of the work to demonstrate that it has been properly done, a time especially provided for in the contracts. Under the direction of the chief engineer, inspectors have carefully examined every piece of work connected with the construction of the new water-works plant, both in the field and in the shops where the material for this work was being turned out. These inspectors made regular monthly reports to the engineer in charge, who promptly ordered the condemnation of any material that was found in the least defective.



RESERVOIR NO. 1, MOUNT TABOR.—Photo. by Towne.



RESERVOIR NO. 3, CITY PARK.—Photo. by Towne.

The Bull Run system consists of the headworks, a system of gates and conduits where the Bull Run river is tapped, a conduit of a total length of 30 miles which conveys this water to the city, and four reservoirs of a combined capacity of 68,000,000 gallons. In addition to the pipe line and reservoirs, the committee in the construction of this system has built numerous roads, a number of good bridges, and has made some very heavy rock cuts to expedite the work of construction.

The headworks are located on Bull Run river about 25 miles below the lake, and 21 miles distant from the reservoirs at Mount Tabor. The elevation of the headworks is 710 feet above low-water mark of the Willamette river. These works consist of an in-take canal, 15 feet wide, 3 feet deep, and with a provision for a fall of four inches along its entire length of 400 feet. This canal terminates in a square tank from which the water flows through the great steel pipe to the city of Portland.

Mr. Schuyler, the consulting engineer, in his report of June, 1893, said: "If the canal is plastered or smoothly pointed, it will carry over 100,000,000 gallons daily." This is an index of the magnitude on which the entire Bull Run system has been constructed. The entire absence of sand, mud or sediment of any kind in the Bull Run river, as well as the freedom from drift, has greatly facilitated the work of constructing the headworks, and this has insured an easy control of the water taken from the stream for the use of Portland, which will always be an important factor in the economical running of the plant."

During the dryest season of the year, Bull Run river at the headworks carries an average volume of water of about 75,000,000 gallons a day. The average discharge of the river at this point is about 150,000,000 gallons a day. The capacity of the pipe discharging into the high-service reservoir at Mount Tabor is from 25,000,000 to 26,000,000 gallons a day. The bridges and rock cuts for the pipe line are of ample dimensions to allow an additional parallel pipe to be laid over the present right of way at any future time from the headworks to Portland, thus doubling the present available source of supply, and this work can be done, too, without interfering in any way with the regular flow of water through the pipe line now constructed. It is estimated that the single pipe line now laid will furnish sufficient water to meet every demand of a city of 200,000 population.

PIPE LINE AND RESERVOIRS.

Care Exercised in the Selection of Materials.

THE diameter of the steel pipe which conducts the water from the head works to the high-service reservoir at Mount Tabor is 42 inches on light grades and 35 inches on heavy ones. Its total length is 24 miles. This pipe line crosses the Bull Run river twice in its course down the canyon of the stream, and also crosses the Sandy river at one point by a bridge with a span 300 feet long. The grades and diameters of the pipe along its course from the head works to Mount Tabor have been so adjusted as to insure as nearly as possible a uniform flow through its entire

BIRDSEYE VIEW, RESERVOIRS 2 AND 3, CITY PARK.—Drawn by E. M. Boyle.

RESERVOIR NO. 4, CITY PARK.—Photo. by Towne.