1949

Papers Concerning Logan Water Works; Reports

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STATE OF UTAH, DEPARTMENT OF STATE CHEMIST

REPORT OF WATER ANALYSIS

Board of Health — Test Report No 40-31A

Salt Lake City Utah November 29, 1940

Sample Marked: Water (Canyon Mouth)

Source of Supply: DeWitt Springs, Logan Canyon

Collected by: Lynn M. Thatcher

Date Collected: November 26, 1940

Date Received: November 26, 1940

Analysis Authorized: Lynn M. Thatcher

ANALYSIS

	Parts per Million
Silica - SIO_2	2.3
Calcium - Ca	45.9
Magnesium - Mg	12.1
Sodium - Na	3.9
Chloride - Cl	6.0
Sulfate - SO_4	8.2
Nitrate - NO_3	None
Iron - Fe	None
PH	7.53
Fluoride - F	.15
Alkalinity as Calcium Carbonate	156.0
Total Solids dried at 105^0C	184.0

HYPOTHETICAL COMBINATION OF CONSTITUENTS

Calcium Carbonate	114.7
Magnesium Carbonate	34.7
Magnesium Sulfate	10.2
Sodium Chloride	9.9

ENGINEERS' REPORT OF THE CONSTRUCTION OF THE LOGAN CITY CULINARY

WATER SYSTEM, DEWITT SPRING TO DAVIS CAMP, 1949

General Statement:

On July 6, 1949, bids were open for the Logan City Culinary Water System Improvement. Bids were received from a number of contractors and alternate proposals included concrete pipe, steel pipe, cast iron pipe, and transite pipe. Following the opening of bids the engineers spent considerable time in the analysis of bids and an oral report was submitted to the City on July 7, along with an analysis table listing the various alternates and cost to the City. In the discussion with the City Commission in their meeting on July 7, it was pointed out that the Utah Concrete Pipe Company had submitted the lowest formal bid for both steel and concrete pipe. Lower bids for sections of the line were received from some contractors bidding steel pipe but with stipulations in their proposals in disregard of the Specifications and instructions. These bids were therefore considered informal and not capable of evaluation according to the Specifications. After considerable discussion between the engineers and Logan City officials, it was decided that the bid of Utah Concrete Pipe Company was the lowest formal bid and well below the estimate prepared by the engineer based on the Plans and Specifications. The City therefore entered into a contract with Utah Concrete Pipe Company on July 12, 1949, and accepted their bid according to the Plans and Specifications using concrete pipe.

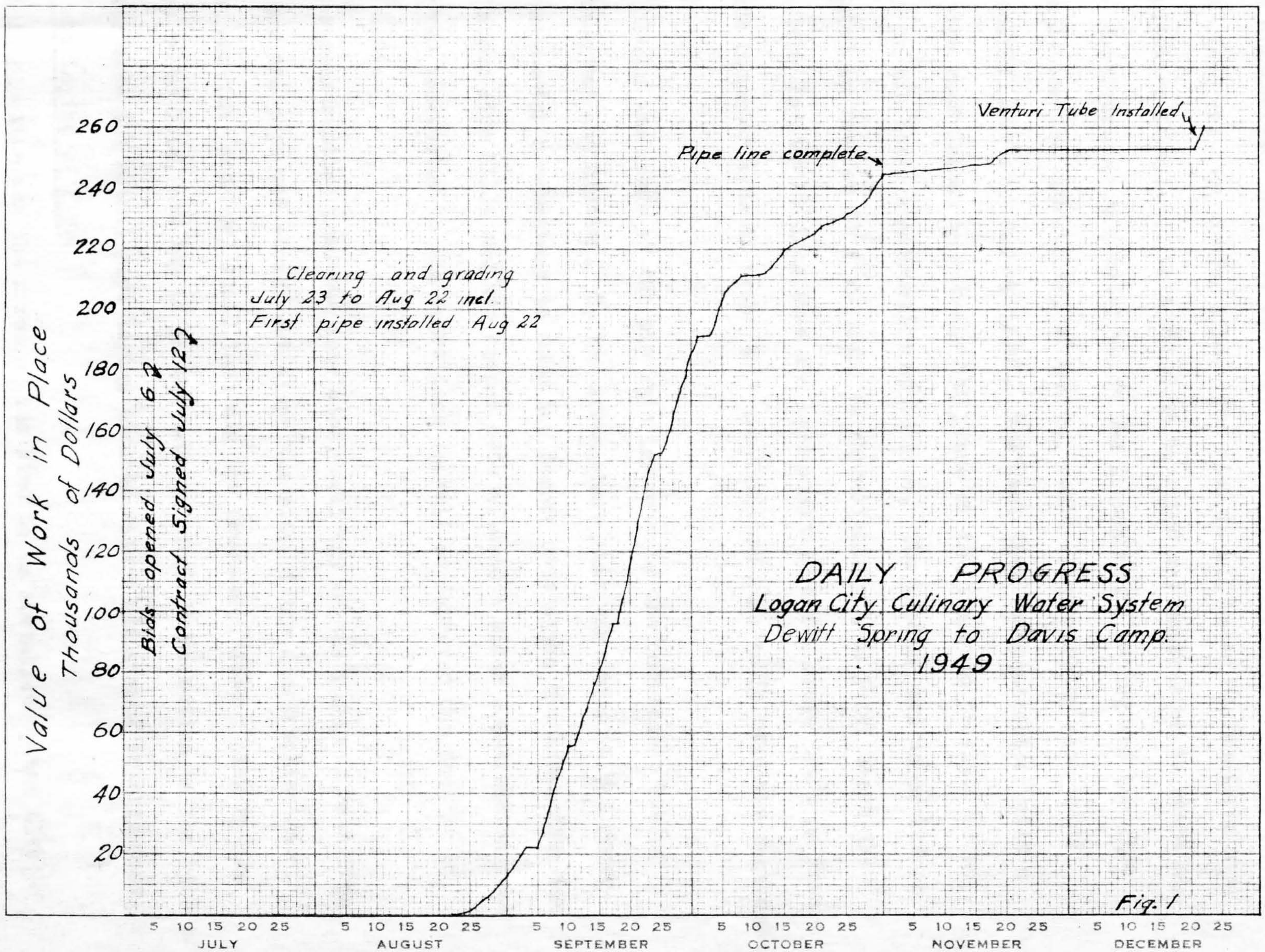
The contractor began immediately clearing the brush and trees from the right-of-way locations and started his grading operations preparatory to trenching and laying the pipe. The first heavy equipment arrived on the job on July 14 consisting of an Allis-Chalmers HD-14 Caterpillar tractor. On July 23 a second bulldozer consisting of a D-8 Caterpillar arrived for grading operations, and further increases in heavy equipment arrived on July 26 when a D-4 Cat and a Bucyrus shovel, size 20-B, were received on the job. Additional equipment arrived on July 28 consisting of a D-7 Cat with Hyster attachment.

Concurrent with the clearing and grading, the contractor began manufacture of the pipe and the first pipe arrived on the job on August 13. Pipe deliveries arrived almost daily after July 13 up until the completion of the project. The actual pipe laying began on August 22 and was continued until the completion of this phase of the work. Minor delays involving bad weather conditions or breakdown of equipment or failure to receive pipe deliveries caused suspension of pipe laying operations of a day or so during the actual construction period.

The daily progress chart, Figure 1, shows the dollar value of the work in place by days from August 22 to December 22 when the final unit consisting of installation of the Venturi tube was completed. As this progress chart shows the dollar value of work in place and since the Specifications did not allow credit for preparatory work done, the chart indicates that the contractor made no progress prior to the installation of the first pipe. This was not true, of course, but is due to the method of payment and computing progress. The slight jogs (horizontal lines) in the progress curve indicate Saturdays and Sundays and periods when the job was shut down due to weather or other conditions. The pipe laying was completed on November 1 and after that time the contractor was concerned with the construction of the spring development units, the installation of valves, and manholes and other structures required.

Preparatory Construction Operations:

Before any actual construction was begun, the engineers met with the contractor, went over the line with him and discussed the details of the Plans and Specifications and the contractor's proposed construction schedule in order that the engineering work required could precede the construction operations. Staking out of the work began immediately after the contract was signed and stakes were set by the inspector to guide the contractor in his clearing operations. The actual clearing was accomplished primarily by brush crews chopping out the brush and trees along the right-of-way. A 20-foot strip (10 ft. each side of the center line) was cleared to allow



Value of Work in Place
Thousands of Dollars
260
240
220
200
180
160
140
120
100
80
60
40
20
Bids opened July 6
Contract Signed July 12
Clearing and grading
July 23 to Aug 22 incl.
First pipe installed Aug 22
Pipe line complete
Venturi Tube Installed
DAILY PROGRESS
Logan City Culinary Water System
Dewitt Spring to Davis Camp.
1949
5 10 15 20 25
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

Fig. 1

for operation of contractor's equipment and storing of pipe along the line.

After the right-of-way had been cleared, the heavy equipment built the construction road along the pipe center line. The road in all cases was centered over the proposed pipeline location. This was done to allow the contractor to store his pipe along the construction road after which the trench would be dug and the pipe placed. These latter two operations, of course, would eliminate the road until testing and backfill had been accomplished. The fact that the contractor built a good construction road following closely the grade of the finished pipeline aided him materially in his later construction operations. The grading was accomplished for the construction road so that it would be approximately 4 to 5 ft. above the invert of the pipe for the 24-inch size and approximately 6 ft. above the pipe invert for the 36-inch diameter line in order that the finished line would have the required cover (3 ft.)

In many places the grade of the pipe was improved by the contractor making deeper cuts than was anticipated. In the areas where this was done, it was generally to the contractor's advantage to make the deeper cuts since the areas involved consisted of steep side hills and the deeper cuts allowed a wider construction road and assisted the contractor in his operations as well as improved the profile of the finished line.

After the construction road was completed, delivery of the pipe was made from the factory and the pipe was strung out along the side of the construction road. One trenching machine (backhoe) could then dig the necessary trench, pick up the piece of pipe to be laid, and lay it in the trench. This organization on the part of the contractor made the actual pipe laying proceed with a minimum of interruption.

Manufacture and Laying of Pipe:

Since this pipeline was the first of its kind to be installed by the City of Logan and because the use of concrete pipe as a pressure supply main had been questioned by a number of Logan City citizens, the engineering and inspection were more detailed than ordinarily required in order to insure Logan City a trouble-free, completed project.

Before actual delivery of the pipe was made a plant inspection was carried out by the engineers and tests of the pipe at the factory were conducted to be assured that the pipe was meeting the rigorous specifications imposed. The pipe was manufactured by the centrifugal process, and cylinders of the concrete used were made and tested as well as slump tests of the concrete and pressure tests of the finished product. The standard compression test on 6-inch test cylinders of the concrete used in the pipe averaged 5,000 p.s.i. bursting pressure. Slump of the concrete used was 1-1/2 inches using the standard slump test. Since the pipe was manufactured to conform to variable head specifications the tests carried on at the factory for internal bursting pressure varied, depending on the pipe specifications. All pipe tested at the factory consisted of pipe 24 hours old which had been spun and then steam cured for 12 hours. Pipe to be tested was brought to a pressure of 40 p.s.i., about 92 ft. head, for pipe specified to stand a 100 ft. internal pressure and tested for leak and cracks. Since the pipes safely withstood this pressure of 92 ft. head when it was only 24 hours old, it was assumed that it would easily meet the 100 ft. head specifications after being fully cured. Tests of 200 ft. head were also made at the factory. This pipe was tested after being manufactured only 24 hours and brought to an internal pressure of 80 p.s.i. (185 ft. of head) without any noticeable leaks or fracture of the pipe. After the new pipe had been on the test rack for 20 or 30 minutes, it showed some signs of sweating, which the manufacturer explained as a normal occurrance.

In the laying process the contractor employed a backhoe to do the necessary excavation with the machine being rigged to pick up the pipe and place it in the trench. Most all of the pipe weighed in the neighborhood of 2 tons per length, which was about all the equipment could handle under the method employed. The backhoe would dig a section of trench to the necessary depth and then while it was picking up the pipe length and swining it into place, the workmen would prepare the pipe bed and do the necessary fine grading to prepare the trench to receive the pipe. Since the joint used consisted of the double rubber type gasket joint, it was necessary to place one gasket on the pipe to make the field connection. In order to insure an absolutely tight joint the rubber gasket was placed on the gasket ring on the pipe while the pipe was swining in the air in order that no brush or small rocks could be caught under the gasket causing a leak after it had been placed. After the gasket was fitted to the pipe it was lubricated with a special joint compound consisting of flax soap in order to facilitate slipping the spigot into the bell end of the pipe in place.

Continuous inspection was carried out during all pipe laying operations with an inspector being with each pipe laying crew. Care was exercised to see that the pipes were jointed in the proper manner and that a space was left between the pipe ends so that the joints could be grouted from the inside. The joint consisted of a steel sleeve being centered over the ends of the two pipes to be joined. The diameter of this sleeve, as well as the diameter of the pipe ends, was very carefully controlled in the manufacturing so that when the pipe was jointed compression of the rubber gasket contained in the basket groove on the pipe ends would be obtained. This was important since compression of this gasket formed the water seal making a water-tight joint. In order to protect the steel sleeve and to further improve the joint, the pipe ends were not butted closely together but left apart approximately 3/4 in. in order that cement grout, consisting of one part of cement and two parts of sand, could be forced into the space between the gasket and the sleeve from the inside of the pipe. This particular process of grouting the pipe from the inside was carried out by workmen inside the pipe working from a horizontal position. In some cases, the workmen preferred to crawl along the interior of the pipe, whereas in other cases they preferred to use small carts provided by the contractor.

Inspection of the interior grouting of the joints was carefully done. Following each day's laying the inspector would go into the pipe and inspect the grouting work accomplished that day, and if there were any rough spots or inferior joints having loose or hollow spots or cracks in the grouting, they would be marked for repair. The next day the grouting crew would check all rejected joints and repair them to the satisfaction of the inspector. The major part of the grouting was very well done. Occasionally the grout on the top of the pipe would fall away from the sleeve and when tapped with a light hammer would give off a hollow sound, indicating that it wasn't bedded firmly against the sleeve. Such joints were marked, removed, and repaired. Protection of the outside of the steel sleeve was obtained by placing a thin grout layer about 1/2 in. thick over the steel sleeve. Part of this grouting operation was carried on at the factory and a small section was placed in the field. Care was exercised by the contractor to see that a complete coverage was obtained on the outside of the pipe and careful inspection was made and an O-K of the joint given before any backfill was made. After the joint had been O-K'd the contractor was allowed to backfill the pipe up to its horizontal diameter.

Before any pipe was placed in the trench it was carefully inspected to see that the gasket rings had not been damaged in transit and that the pipe was absolutely sound. In a few cases, it was found that defective pipe had been shipped from the factory and these were refused on the job. Most of the rejected pipe on the job was due to damage of the gasket ring in transit. If the gasket ring or if the ends of the pipe had been damaged to the extent that a tight water seal could not be obtained, it was rejected and removed by the contractor. The care exercised by the contractor and the careful inspection made by the engineer were a major factor in the pipeline meeting the tests as required by the Specifications.

Testing:

The Specifications, as written for concrete pipe, provided that the concrete pipe should meet the same water leak test as would be allowed for cast iron. These Specifications are in accordance with the American Water Works Assocation Standard Specifications and allowed a maximum leak of 100 gallons per inch of diameter per mile per day. In all cases the test procedure consisted of bringing the pipe to the working head specified and holding it at this pressure until it had met the conditions of the Specifications. As soon as a section of pipeline was completed it was filled with water and put under pressure to begin the test. The bulk heads to seal the ends of the pipe, as well as meters and gauges and installation of all testing equipment, was furnished by the contractor. The test meter consisted of a recording water meter calibrated to gallons and tenths of gallons in order that the volume of water entering a pipe during any specific period could be very carefully determined. Pressure gauges consisted of standard gauges reading from zero to 100 p.s.i. Bulk heads were made by welding a cap to the steel flange used for the joint. The bulk head was then slipped over the end of the pipe and braced strongly with timbers to prevent any displacement. After the installation of all testing equipment was complete, the pipe was filled with water and then allowed to stand for about 24 hours before it was brought under pressure. The pressure was then increased to about half the specified working pressure and held for a number of days and then finally brought up to the full test pressure.

It is interesting to note that when the pressure was first placed on the line it seemed to sweat considerably and many of the pipe lengths actually showed dampness on the outside of the pipe, the water being forced through the shell of the pipe to the outside. In this first stage of the test the pipe, in all cases, required more water to maintain the test pressure than was allowed by the Specifications. HoWever, as the test progressed the amount of water required to maintain test pressure dropped off, as can be seen by the examination of two test curves of test data collected for the 36-inch pipe and 24-inch, heavy wall pipe. This apparent ability of the pipe to seal up under pressure cannot be fully explained, although it is believed to be due partially to a delayed curing of the pipe. Most of the pipe delivered on the job was not fully cured, much of it reaching the project within 10 days after it had been manufactured. This fact led us to believe that complete curing of the pipe had not been accomplished, and when put under test pressure the curing of the pipe was continued. However, the pipe in all tests definitely sealed up under pressure and the water necessary to maintain the test pressure diminished as the length of the time of the test increased. Examination of the test curve for the 36-inch pipeline from Spring Hollow to City Dam (Fig. 2) points out the peculiarities of the test very nicely. This test was of 2,048 of pipe and, according to the Specifications, a loss of 1.25 g.p.m. at 20 p.s.i. would be allowed to maintain the test pressure. After water had been in the pipe for about 45 hours the meter was installed on the pipe and the pressure brought to 20 p.s.i. During the first few hours of actual testing about 2-1/2 g.p.m. (twice the allowable) was required to maintain the test pressure. After the water had been in the pipe 75 hours the pipe met the Specifications, although the test was continued in order to determine the sealing characteristics. After over 100 hours the loss required to maintain the test pressure had dropped below one gallon per minute, which was well within allowable and the pipe was accepted and the test discontinued and complete backfill of the pipeline accomplished. While pressure was on the line, patrols were made to see if any wet spots developed or if there were any noticeable leaks that should be repaired. This patrolling of the pipe during tests disclosed that one joint in a total of over 2,000 in number in the entire line leaked sufficiently to require a field repair. This was accomplished and the joint made absolutely tight.

In the second test curve (Fig 2a) it will be noted that the same general tendency of the pipe to seal up under pressure was evident. In the case of the test curve for the 24-inch heavy wall pipe accomplished at 65 p.s.i. working pressure, considerable difficulty was encountered in keeping the test in operation due to pump failures. The pumps used to maintain the pressure on the pipe were all of a gasoline engine driven type and after a hundred or so hours of operation, motor trouble was encountered and it was difficult to maintain the pressure. However, it will be noted that the test curve in this case shows that the pipe had the same characteristics of sealing up and eventually met the Specifications; although from the time the test actually started until the pipe was accepted was approximately 320 hours. Five test sections were made and similar data were collected for all five to those indicated on the two curves. The pipeline met the leak test as specified in all cases before it was accepted and backfill made.

After the pipeline was completed the installation of the necessary valves, the construction of the springhouse improvement, and the recording and control room was carried forward.

Some design changes were advisable in the project during the progress of the work. The major change, which involved a saving of over $3,000 to Logan City, took advantage of the flexibility of concrete pipe to meet various pressure requirements. At the point the static pressure on the line amounted to 75 ft. of head it was decided to install 125 ft. pipe up to the point that the static head reached 100 ft. In the Specifications and Plans as bid, this was specified as 200 ft. head pipe to be consistent with other competing materials. However, immediately after the award of the concrete bid it was decided to take advantage of the 125 ft. head pipe and make a saving of some $3,000 to Logan City. Other features, which were changed slightly, involved the change of the alignment through the property owned by Mr. Bott. This design, which cost the city some $400 and was done primarily to comply with Mr. Bott's wishes in the vicinity of Zanavoo Lodge. The alignment as planned anticipated the installation of this section on the south side of the river, which if carried out would have removed a substantial part of a birch groove and would have generally scarred the south side of the river in the vicinity of Zanavoo

Lodge. Mr. Bott felt that this would have damaged the scenic beauty of the Lodge and requested the City to move the location to the north side of the river crossing the flat land in this area. This increased the length of the alignment slightly but was considered to be simpler construction, although two additional river crossings were involved. This feature was definitely for the convenience of Mr. Bott and, as part of the agreement, the City placed additional outlets in the line that could be tapped for future development of this area. In the construction of this change, however, it was found that the river crossings were of considerable trouble and that the general profile was not greatly improved and since it cost the City additional money to make this change and also increased the unit cost of construction to the contractor, it is the opinion of the engineers that this is the only point at which the location would be changed if construction were to be done again, the original location being considered to be the most desirable.

One other small design change involved the elimination of the drain at the measuring vault. An excellent concrete job was obtained at the measuring structure, there being absolutely no sweating or dampness inside the vault with the exception of the bottom of the pit constructed to receive the mercury pot of the Venturi recording equipment. Since the drain involved the construction of about 600 ft. of small diameter pipe which drained into the river and since the river in high flow stages might actually cause the river to back up in the drain line, it was considered that this phase of the project should be eliminated and a sump pump installed. The cost of the drain was deducted from the contract price and the money saved should be "earmarked" for the construction of a sump pump and power line.

It is recommended that this phase of the project be considered by the Logan City Engineer for immediate installation as soon as the wiring of the recording and control room is complete. Since it will be necessary to bring power in for the recording equipment, it is felt that the same power line might serve a small sump pump operated with a flow switch at a saving to the City of about $500.

At the present time the project is considered by the engineers to be complete and the contractor is to be commended for his fine cooperation and work in installing a workable and acceptable project.

Population Estimates

Some means of predicting the growth of Logan City is necessary in order to estimate future water supply needs. For the purpose of studying past growth characteristics, studies were made of the growth of several Utah cities, as well as Logan; the growth of Utah total and Utah urban population; growth of the Utah State Agricultural College and the growth of Logan primary and secondary school population. These curves are shown in Figs. 1 and 2 in which population is shown in percentage of the 1940 population. Most of these data for the cities and the state were taken from the U.S. Census. The 1948 Logan population (16,300) is based on an actual count by the Logan Planning Board and includes non-resident students. It is believed many such students are not included in the U.S. Census count. Estimates by the U.S. Census placed the 1945 (adjusted for service men) population of Utah at 647,000. The curves, Figs. 1 and 2, indicate that the growth of Logan City has closely paralleled the growth of the major cities of the state and the state as a whole.

Estimates of future population for a fairly large region may best be made by considering the possible industrial and agricultural development of the region. In 1940, it appeared that Utah had begun to approach the practical ultimate development of her resources and that further population increases would be at a low rate. With the advent of the steel industry during the war, and the development of plans for diverting Colorado River water into Bonneville Basin and the production of large quantities of electrical energy on the Colorado River, considerable expansion during the next half century is anticipated. The most comprehensive investigation of this possibility was made by the Federal Power Commission in 1945.* A long-range plan of power and agricultural development was considered. This study concluded that development of the agricultural and power resources would begin immediately and continue until about 1990, when they would be rather fully developed. Curves showing estimated population up to

1970 resulting from this development were computed. Three of these curves for Power Region I, with 1940 population as an index, are plotted in Fig. 3. Power Region I includes all Utah counties north of Juab, Sanpete, Wayne, and San Juan counties.

In extending a population curve for Logan, it was considered that the population growth has closely followed that of the state and region as a whole. Using the estimated Power Region I urban population as an index, the predicted population curve is shown by Fig. 4. Beyond 1970, the curve is rather arbitrarily drawn, keeping in mind that resource development is anticipated to continue until at least 1990.

Future Water Requirements

In 1944, the maximum daily use of Logan City was 5,340,000 gallons with a daily average of 2,582,000 gallons. The pipe line must, of course, be designed for the daily maximum. It is estimated that the 1948 peak day required 6,000,000 gallons. Using the extended population curves for base population, the maximum daily use was 392 g.p.d. in 1944 and 370 g.p.d. in 1948. In 1944, only 1522 of 3133 private connections were metered. In 1948, there were approximately 3450 connections, of which all but about 250 were metered. These maximum daily demands appear to be in line with Utah minicipal experience. It is felt that they might eventually be reduced to some extent, if necessary, to accommodate future growth, Estimated future maximum daily water demands are shown in Table 1.

Table 1. Estimated future maximum daily water demands for Logan City

Year	Estimated Base Population	Estimated Water Needs @ 375 g.p.d. c.f.s.	Estimated Water Needs @ 375 g.p.d. m.g.d.	Estimated Water Needs @ 300 g.p.d. c.f.s.	Estimated Water Needs @ 300 g.p.d. m.g.d.
1950	16,600 16832	9.66	6.25	7.74	4.98
1960	21,400 (18731)	12.40	8.02	9.90	6.42
1970	25,600	14.85	9.30	11.85	7.68
1980	29,300	17.00	11.00	13.60	8.80
1990	33,000	19.30	12.48	15.40	9.90
2000	36,000	20.90	13.50	16.70	10.80
2010	38,000	22.00	14.25	17.65	11.40
2020	40,000	23.20	15.00	18.55	12.00

* "Power Requirements Survey, State of Utah," Federal Power Commission, Bureau of Power, San Francisco Regional Office, 1946.

3-17-63 QAB-

Notes Regarding Logan City Water Development Plan.

Existing Natural Flow Right - DeWitt Spring = 10 cfs

Present Well Development Capacity

No 1	=	12 cfs
No 2	=	10 cfs
No 3	=	8 cfs
No 4	=	

Population From 1950 study (Adjusted)

	Population	Use @ 375 gpd cfs	mgd	Max Rate = 300% of Ave cfs	mgd.
1970	24000	13.95	9.0	41.85	27.0
1980	28000	16.30	10.5	48.90	31.5
1990	32000	18.60	12.0	55.8	36.0
2000	36000	20.90	13.5	62.7	40.5

Notes 4-1-63
Art Case of Catepiler Tests

Engine
Gen 6%
Motor 10%

Gear Head 2%

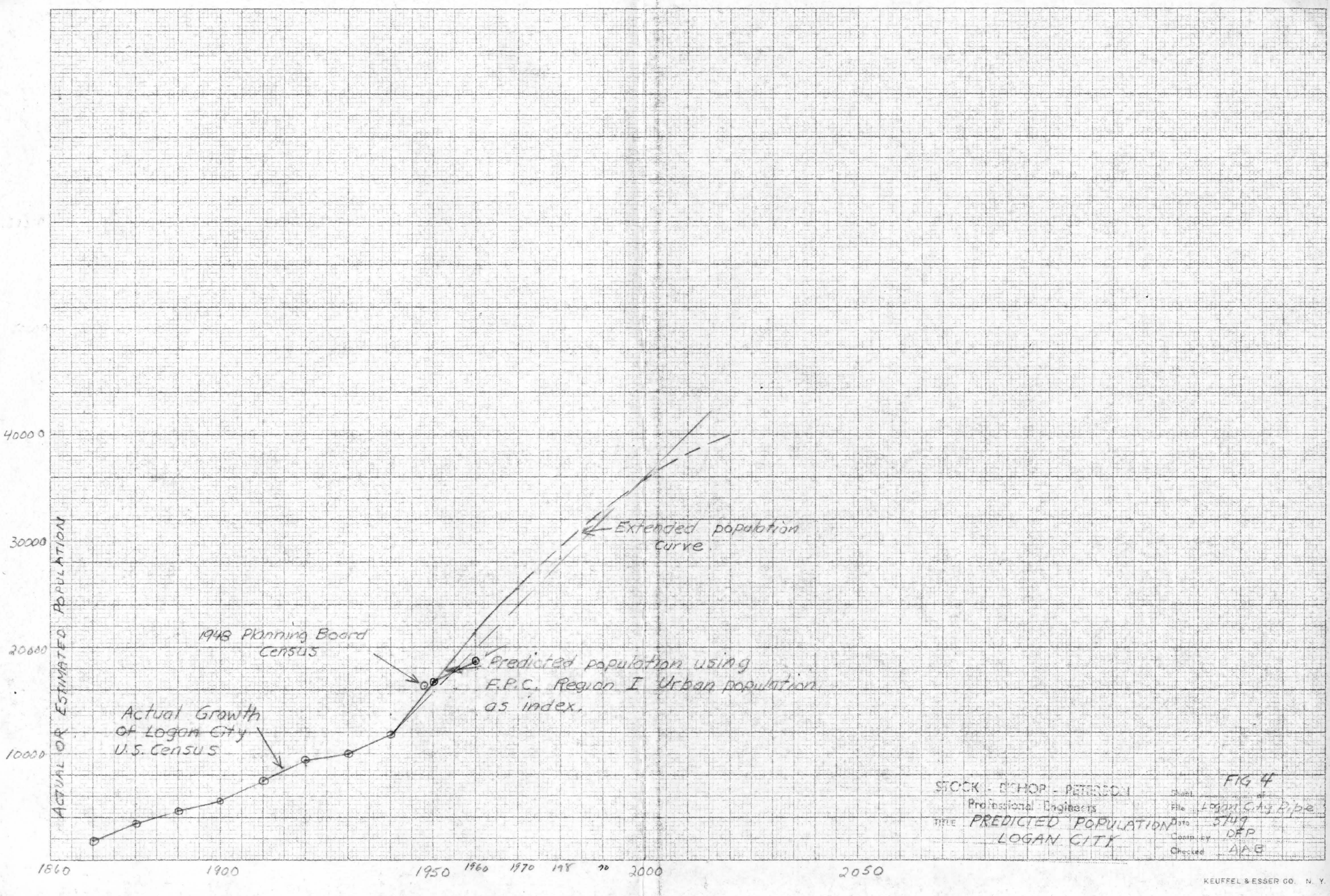
94 x
89
846
752
83.66

Gas Engine Operating Cost 600 HP
2x16 Power Cost

3.56 per Hr from UP+L 720 Hrs.

Bountiful – Check on Reserve Fuel storage.

For Nat. Gas engine 7,500 BTU per BHP Hr
For Duel Fuel Diesel Gas 12000 " " " "



ACTUAL OR ESTIMATED POPULATION
40000
30000
20000
10000
1860
1900
1950
1960
1970
2000
2050
Extended population curve.
1948 Planning Board Census
Predicted population using F.P.C. Region I Urban population as index.
Actual Growth of Logan City U.S. Census
Professional Engineers
PREDICTED POPULATION LOGAN CITY
FIG 4
KEUFFEL & ESSER CO. N. Y.

Population of Logan. U. S. Census – 1940

	Logan		Ogden		Provo			Salt Lake
1948	16,300 (137.5)							
1940	11,868	100	43,688	100	18,071			149,934
1930	9979	84	40,272	92	14,766	81.6	93.6	140,267
1920	9439	79.5	32,804	75.2	10,303	57.2	78.9	118,110
1910	7552	63.6	25,580	58.5	8,925	49.4	61.8	92,777
1900	5451	46	16,313	37.4	6,185	34.2	35.8	53,531
1890	4565	38.6	14,889	34.1	5,159	28.6	29.9	44,843
1880	3396	28.4	6069	13.9	3,432	19.0	13.8	20,768
1870	1,757	14.8	3127	7.2	2,384	13.2	8.5	12,854
1860			1464	3.4	2,030	11.2	5.5	8,236

~~Provo~~	Utah Urban Pop		Utah Rural Pop	Utah Tot Pop	
1945				647,000*	117
1940	305,493		244,817	550,310	
1930	266,264	87	241,583	507,847	92.2
1920	215,584	70.4	233,812	449,396	81.5
1910	172,934	56.7	200,417	373,351	67.8
1900	105,427	34.5	171,322	276,749	50.2
1890	75,155	24.6	135,624	210,779	38.2
1880	33,665	11.1	110,298	143,963	26.0
1870	15,981	5.2	70,805	86,786	15.7
1860	8,236	2.7	32,037	40,273	7.3
			11,380	11,380	2.1

Logan School Children – Grades 1-12

1948-49	2693	92
47-48	2523	86.4
46-47	2709	95.7
45-46	2834	97
~~42-43~~		
40-41	2925	100
35-36	3156	108
30-31	3016	103
25-26	2890	99
19-20	2310	79

* Est. by Power Survey

Estimated Population

Power requirements Survey - Federal Power Commission. Dec, 1946

Power area I includes Northern Utah North of Juab, Sanpete Wayne and San Juan Counties.

	Total Area I Population	Index 1940	State Population	Index
1940	465,393		550,310	
1950	642,850	138	750,000	136
1960	820,300	177	950,000	172.3
1970	955,800	205	1,100,000	200.0

	Area I Urban + Non Farm	
1940	391,037	
1950	546,950	140
1960	712,300	182
1970	835,900	214

[Confidential]

(3)

Confidential

Peak demand - 6,000,000 g.p.d.
Low day 2,750,000 " " "

1944

Low day	12/10/44	1,130,000
Peak	7/28/44	5,340,000
ave		2,582,000

Putting in Res. - 5,560,000 g.p.d.

1944 - (Flat rate - 1,610
Metered - 1,522
private 3133

Total (private) 3450
approx 250 not metered
Plus parks, churches, etc
City parks

College uses from 7 million to 9 million gallons each month for college campus

P.O. estimate - 19,000
Call Yeates at P.O.

3,000 people ^est in college & city housing area

a total of 9 meters on this

ave [258 g.p.d.] flat rate ave

Confidential

Confidential

1944 - Water use

Low day - $\frac{1{,}130{,}000}{13{,}600}$ = 83 gpm/cap.

High day - $\frac{5{,}340{,}000}{13{,}600}$ = 392 g.p.m/cap.

at this time city was only about ½ metered.

Est 1948 Water Use.

High Day $\frac{6000000}{16000}$ = 375 g.p.d./per capita

~~Low D~~

Average flat rate use is 258 g.p.d/per capita

Year	Est Base Pop	Max Water Needs @ 375 m.g.p.d	c.f.s	Max Water Needs @ 300 m.g.p.d	c.f.s
1950	16,600	6.25	8.70	4.98	6.94
1960	21,400	8.02	11.15	6.42	8.92
1970	25,600	9.60	13.35	7.68	10.70
1980	29,300	11.00	16.30	8.80	12.24
1990	33,000	12.48	17.40	9.90	13.75
2000	36,000	13.50	18.80	10.80	15.0
2010	38,000	14.25	19.80	11.40	15.9
2020	40,000	15.00	21.00	12.00	16.7

60
60
3600
24
144
72
86400

$$\left(\frac{gal}{day}\right)\left(\frac{day}{sec}\right)\left(\frac{cu.ft}{gal}\right) = \frac{1}{(86400)(8.33)} = \frac{1}{719{,}000}$$

ULTIMATE SIZE OF PIPE

Tot Length - 26,400
Length above dam - 5850
Length below dam - 20,550

30 / 23 / 65

Available head below dam - 5021 / 4836 / 185' / 11

Tot Head 194'

I)

Assume 5,850' of 36" pipe -

Head Loss

Cfs	Q= 20	25	24	22.5
5.850' @ 36"	4.50	7.02	6.4	5.7
20 550' @ 24"	135.5	209.	197.0	173
	140	216	203.4	178.0

say 23.5 c.f.s.

II)

Cfs	30	32
5850' @ 36"	9.95	11.6
20550' @ 27"	162.5	185
	172.0	197.0

say 31.5 c.f.s.

The diameter of the pressure line should not be increased without increasing the diameter of the flow line around the dam in order to keep some pressure in line around dam

III)

	21	22.5
5850' @ 33"	7.83	8.9
20550' @ 24"	150.0	173.0
		181.9

say 23. c.f.s

IV)

	30	27
5850 @ 36"	9.95	8.0 ✓
10,380 @ 24"	155.50	124.6
(10,170 @ 30)	47	37.1
	212.5	169.7

say 29 c.f.s

Check Performance immediately after Construction

Total length of pipe	26.400'
Amount in this contract	16.330'
	10,070'
24" steel pipe	3.000
20" steel pipe	7,070'

16330
5850
10480
3000
13480'

Say - 5850' - 36"
13.480' - 24"
7170' - 20"
26,400 — Tot.

4836
139
4975

4836
174
5010

Q =	16	18	19
5850'-36"	2.87	3.63	4.04
13480'-24"	57.50	72.80	80.8
7170'-20"	81.2	102.0	113.2
	141.6	178.43	198.0

18.8. c.f.s

assume - $Q = 27$ c.f.s
$D = 36''$

LOSSES

Velocity Hd =

$V = \frac{27}{7.069} = 3.82$ '/sec $\qquad h_v = \frac{\overline{3.82}^2}{64} = 0.228 \leftarrow h_v$

Entrance loss - assume slightly rounded.
$K_0 = 0.25$

h_e 0.057

Measuring Loss -
(Carl Painter) 0.5

Outlet losses
assume Total velocity head is lost —

Total losses say 0.8'

Friction Losses

$h_f = (1.4)(5.85) = 8.19'$
0.8

say 9.0'

Elevation at dam 5030
9
5021

Existing Pipe

Summary Water Use Logan City -

1961

	April	May	June	July	Aug	Sept	Total
Diverted		950	1100	1010	1030	850	4940
Allowed By Court		615	595	615	615	595	3035
Excess		335	505	395	415	255	1905

1962

	April	May	June	July	Aug	Sept	Total
Diverted	372 *	1039	1055	1218	1142	1071	
Allowed	297	1039	1055	615	615	595	
Stock	55	—	—	184	106	90	
Exchange Pumped	—	—	—	~~17~~	503	~~487~~	
Excess	20	—	—	488 / ~~482~~	83	101	
				123			
	20			480		386	886

Total for two years [2791]

Check on actual dates for 1961
Check on exchange application

Decree operative only ½ Mo

AAB-

Summary of Water Use - Logan City

1961

	April	May	June	July	Aug	Sept	Total
Diverted	–	950	1100	1010	1030	850	4940
Allowed By Court	–	615	595	615	615	595	3035
Excess over right	–	335	505	395	415	255	1905

1962

	April	May	June	July	Aug	Sept	Total
Diverted	372*	1039	1055	1218	1142	1071	
Allowed	297*	1039	1055	615	615	595	
Stock 100 sh	55	–		184	106	90	
Pumped	–	–		17	503	487	
Excess	20	–		402	-83	-101	238

* Estimated based on proratta

LOGAN CITY WATER DEVELOPMENT
Required

With the possibility of an Extreme Drougth year upon us the priority of completing the well program seems to hold top priority. The needed improvements should take about the following order of priority

1. Complet drilling and testing wells Nos 1, 2 and 4 (Jan 1963)

2. Install Booster Pump on Well 3 (May)

3. Install Pumps on wells No 1, 2 + 4 and booster pump on one of them (June)

4. Install 16" line interconnecting wells (1963) and link 10th N with reservoir directly and with tie at 9th E.

5. Install throtteling valve on Canyon line (by May 1963)

The above Items seem to be urgently required and within 5 years These additional Items should be budgeted

1. Completion of distribution network according to master plan (⅕ each year for 5 yrs)

2. New 1 million gallon Reservoir on South Side of River. with supply line

3. Replacement of 20" canyon line with 30"

Analysis City Water System

Assume Peak Flow at Present time = 20 cfs = 13 MGD

Asume Normal Use is Proportional to Area

Assume Present Distribution System serves areas as Follows

Area 1	served from	high reservoir
" 2	" "	12" lines on 7th + 10th N
" 3	" "	10" branch on 4th N
" 4	" "	6" branch of 10" line on 4th
" 5	" "	10" Main St line

Approximate Areas as Follows

No	Area	% Total	Approx Flow cfs	Approx Flow MGD
1	450 Ac	18.3	3.66	
2	370	15.0	3.0	
2a	130	5.3	1.06	
3	370	15.1	3.02	
4	390	15.8	3.16	
4a	70	2.9	.58	
5	680	27.6	5.52	
Total	2460 Ac	100.0	20.0	

Flow in 24" line reservoir to Eighth East = 16.34 cfs
Flow per 10 ac block = 1/123 cfs   12.3 blocks per cfs

Assume Main Supply Lines should have pres drop of 10/1000 at average flow.

With 16.34 cfs 24" has h_f of 6.5/1000   C = 100

Line connecting well should have 10 cfs capacity at 10/1000 h_f with C = 100 this requires 18" pipe

If 1 psi per 100 is allowed 10 cfs requires 15" pipe

Use 16" connecting line - roughly equivalent to 2-12"

Assume New 1 Million gal Reservoir on Bench South side of River set with Elevation same as Existing reservoirs. If connection line between the reservoirs and distance is 5000' the 16" line will feed the new reservoir 1 MGD with WS difference of 2.5', for ½ MGD on about 0.7 ft total diff in ws elevation is required. If res is 20' deep and W.S. drops 10' below full level the supply to the new reservoir would be at about 2 M.G.D. With res empty line discharge would be 3 M.G.D.

Perhaps New Reservoir should be hooked directly to canyon line with a modulating valve of its own. This complicates the electrical and other control

Suppose a 24" line is used to connect reservoirs Flow Rates as follows

Water Surface diff in Res ft	Flow Rate in MGD 16"	24"	30"
1'	.65	1.7	3.0
1.5	.75	2.2	3.9
2.0	.86	2.5 ✓	4.6
5.0	1.44	4.17	7.2
10.0	2.0	6.1	10.8

Since ws elevation may fluctuate in both reservoirs it looks as if at least 24" line between reservoirs should be used, if the throttling is done with only 1 valve at existing reservoirs. If seperate throttling valve is used on new reservoir and connection is made direct to canyon line a 16" pipe could be used.

Logan City Distribution System
Summary Pipe Required

Size	Approx Length (ft)	Cost Unit	Cost Total	Remarks
24"	5000	15 ?	75 000	From existing Res to New Res on S. Bench
16" ✓	15 000	10.00	150 000.00	to interconnect well system
16"	4 800	10.00	48 000.00	Tie to New Res.
12"	4 800	6.75	32 400	to Loop system
10"	4 800	6.50	31 200	To Loop system
8"	11 000	4.45	48 950	To Loop system
6"	74 000	3.43	253 820	To loop system
4"	10 000	2.61	26 100	Service
		sub	665 470	
Valves				
24"	2	1000.00	2 000	
16"	(17) 29 / 58 ✓	750 / 750	21 750 / 43 500	
12"	14	206	2 884	
10"	14	157	2 198	
8"	32	101	3 232	
6"	216	66.75	14 418	
		G Total.	733 702	

Assume Trenching + Backfill @ $1.00 per ft all sizes
Assume laying at 5¢ per dia inch -
Assume valves installed at laying price and 2 req per block

use 680 ft/Block

Pipe Required

Size	Blocks	Ft	Remarks
16"	22	15000	to interconnect wells
16"	7	4800	to connect to New Reservoir
24"		5000	to interconnect reservoirs
12"	4	2700	10th N to 6 N on 3 E.
6"	54		West of Main Salvage 1B 4"; 31 B 2" - 1 B 3"
6"	54		E of Main Salvage 11 B 4"; 35 B - 2"
10"	7		W Main salvage 4 B 2"
4"	8		W Main Sal 4 B - 2"
4"	6		E Main Sal 4 B 2"
8"	9		W. M. 2 B 4, 1 B 2
8"	7		E M. 5 B 4 1 B 2
12"	3		7th N to 10th N on 9th E

Notes 12-1-62

Design Conditions for regulating Valve on Logan City Canyon Line - Dewitt Springs to Reservoir

1. Throttle the supply from the spring so as to prevent overflow at the distribution reservoir

2. Maintain positive pressure on the entire line from the reservoir to the spring.

3. Valve to open or close to maintain a near constant level in the reservoirs

4. Maximum opening of the valve limited by the spring production which varies throughout the year. This may require a sensing device in the spring which will prevent further opening of the valve when overflow at the spring ceases.

5. Incremental openings shall be such that no water hammer will be produced in the canyon line

6. Additional lowering of the reservoir water surface with full spring discharge will cause the well to cut into the system.

7. Valve must be independ of any single reservoir

cell so that any cell may be taken temporarily out of service for cleaning or repairs. (This may require a sensing device in all reservoir cells

Considerations Re: location

1, At Reservoir. This will gaurntee that there is pressure in the line all the way to the spring providing the spring Q is not exceeded. This will however produce maximum operating pressure in the line and maximum static pressure if valve is fully closed. The pressure at the end of the concrete pipe will be as follows for static conditions

(Concrete Design 200' head) Spring Elev 5030
End Concrete Pipe 4880
150' or 65 psi

In the steel pipe where it crosses the river (this is the low point in the line)

4868
4670
200

Spring Elev 5030
River Crossing 4670
360' = 157 psi (Max static) (No WH)

4868

86 psi
157 psi
71 psi increase

2. Valve at Spring

This will produce possible flow line conditions in certain sections of the line except for peak flow making infiltration possible if all joints are not tight. This does not seem satisfactory.

3. Valve at Davis camp

A valve located approximately at Davis Camp in the canyon at an elevation below the reservoir would provide minimum pressure conditions for section of line under highest head and insure positive pressure on all the line except for a short section immediately below the valve. Elevation of valve at approximately the elevation of the bottom of the reservoir would elimate any flow line conditions below the valve. (Perhaps a Modulating Altitude Valve (No 208) at this location in the canyon would do the job)

The main problem here as I see it is the

9-192-a. July 1937

Combined Discharge
Logan River
1962

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File Number { Washington 10-1090.00 / District ——

Daily Combined [redacted] Discharge, in Second-Feet, of Logan River; Utah Power & Light [redacted] Co's tailrace; and Logan, Hyde Park, and Smithfield Canal
Near Logan, Utah for the Year Ending September 30, 1962

Used rating table dated ——

Drainage Area 218 Square Miles. Water-Stage Recorder Stevens A-35 (Each Station) Ratio 1 : 6

Gage Read to ______ Once / Twice a Day by ______

Gage heights used to half tenths between ____ and ____ feet; hundredths below and tenths above these limits.

Max. Disch. 1140 Sec-ft. at 7a.m. on May 9 (G. H. —— ft.). Max. G. H. —— ft. at —— on ——
daily Min. Disch. 60 Sec.-ft. on Dec. 11 (G. H. —— ft.). Min. G. H. —— ft. on ——

Day	October Gage height	October Discharge	November Gage height	November Discharge	December Gage height	December Discharge	January Gage height	January Discharge	February Gage height	February Discharge	March Gage height	March Discharge
1		90		91		81		67		72		89
2		86		91		82		74		74		91
3		84		86		88		76		73		86
4		86		87		86		77		75		88
5		83		84		81		74		78		88
6		89		79		80		77		78		92
7		90		81		75		79		81		94
8		91		85		76		85		84		91
9		92		89		76		78		81		91
10		94		85		67		62		91		89
11		90		86		60		62		128		90
12		87		83		65		79		168		78
13		85		78		76		84		156		80
14		84		80		78		77		146		79
15		84		83		79		78		132		76
16		85		80		80		76		136		84
17		83		80		81		76		121		85
18		84		76		80		80		116		89
19		82		78		81		76		108		89
20		85		83		86		79		111		93
21		83		82		84		72		107		96
22		87		78		80		70		104		95
23		88		82		73		64		104		102
24		87		82		75		67		98		97
25		82		80		80		74		92		93
26		88		83		82		82		98		100
27		88		84		74		81		87		87
28		96		78		76		73		76		95
29		92		77		77		69				105
30		86		81		77		70				123
31		85				74		72				116

Day	April Gage height	April Discharge	May Gage height	May Discharge	June Gage height	June Discharge	July Gage height	July Discharge	August Gage height	August Discharge	September Gage height	September Discharge
1	1.09	124		623		626	5.0	398	1.99	221	1.54	179
2	1.09	127		558		655	4.78	385	1.99	222	1.63	183
3	1.27	145		540		693	4.60	375	1.90	217	1.63	183
4	1.57	182		598		692	4.4	366	1.90	216	1.63	180
5	1.81	200		696		630	4.0	347	1.90	214	1.54	176
6	1.81	202		800		593	3.83	338	1.90	214	1.63	182
7	1.81	218		904		554	3.83	335	1.90	211	1.54	178
8	1.81	208		1020		517	3.63	326	1.81	205	1.54	179
9	1.72	195		1080		516	3.63	322	1.81	203	1.54	179
10	1.72	198		1070		541	3.32	317	1.90	212		179
11	1.81	219		991		572	3.02	305	1.90	211		176
12	2.38	267		958		605	3.02	300	1.81	204		174
13	3.32	319		888		628	3.32	317	1.72	197		174
14	4.4	369		811		631	3.63	325	1.72	197		173
15		431		738		617	3.02	304	1.72	195		170
16		488		666		589	2.72	291	1.72	191	1.45	168
17		545		609		533	2.58	283	1.63	189	1.36	159
18		602		564		500	2.43	274	1.72	190	1.45	168
19		633		536		509	2.38	265	1.63	189	1.54	170
20		705		534		519	2.38	264	1.63	186	1.45	162
21		619		519		532	2.25	255	1.63	183		162
22		491		519		520	2.25	255	1.63	182		162
23		496		512		503	2.25	254	1.63	182		161
24		591		515		490	2.13	248	1.63	183		163
25		650		515		472	2.13	243	1.63	181		163
26		713		516		460	2.03	239	1.54	176		162
27		688		496		442	2.03	234	1.54	172		162
28		899		501		430	2.03	236	1.45	166		164
29		834		512		419	2.03	234	1.45	167		169
30		703		510		407	1.99	227	1.45	161		162
31				571			1.99	223	1.54	174		

	Calendar Year 1961	October	November	December	January	February	March	April	May	June	July	August	September	Year
Total	45,759	2,696	2,472	2,410	2,310	2,875	2,851	13,061	20,870	16,395	9,085	6,011	5122	8
Mean	125	87.0	82.4	77.7	74.5	103	92.0	435	673	546	293	194	171	
Second-feet per square mile								27.61			92.63	53.32	45.21	
Run-off in inches								54.8			183.7	105.8	89.8	
Run-off in acre-feet	90,760	5,350	4,900	4,780	4,580	5,700	5,650	25,910	41,400	32,520	18,020	11,920	10,160	170,9
Maximum	390	96	91	88	85	168	123	899	1,080	693	398	222	183	1,0
Minimum	60	82	76	60	62	72	76	124	496	407	223	161	159	6
											614.9	614.9	595.1	

Quarter: Computed / Checked / Date 10-25-62
Quarter: copied Disch. / Disch. checked / Date 10-25-62
Quarter: G. H. copied / G. H. checked

9-192-a. July 1937

Daily Combined [redacted] and Discharge, in Second-Feet, of Logan River; Utah Power & Light [redacted] Co.'s tailrace; and Logan, Hyde Park, and Smithfield Canal

[redacted] Near Logan, Utah for the Year Ending September 30, 1961

Drainage Area 218 Square Miles. Water-Stage Recorder Stevens A35 (Each Station) Ratio 1 : 6

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Gage Read to ______ Once / Twice a Day by ______

Combined discharge Logan River 1961

File Number { Washington 10-1090.00 / District ______ }

Used rating table dated ______

Gage heights used to half tenths between ______ and ______ feet; hundredths below and tenths above these limits.

Day	October Gage height	October Discharge	November Gage height	November Discharge	December Gage height	December Discharge	January Gage height	January Discharge	February Gage height	February Discharge	March Gage height	March Discharge
1		117		110		103		97		90		84
2		117		112		106		95		89		83
3		116		111		108		90		90		80
4		119		112		102		90		85		81
5		114		110		99		91		84		82
6		115		108		87		93		90		83
7		118		115		89		97		89		83
8		121		110		101		97		89		77
9		122		108		102		92		90		82
10		122		103		97		94		98		80
11		122		108		97		94		98		82
12		121		110		93		94		95		82
13		121		118		94		92		93		81
14		116		121		95		94		91		87
15		116		121		93		93		88		88
16		116		120		92		91		88		96
17		116		119		98		92		87		98
18		115		112		99		91		87		90
19		115		112		98		89		83		90
20		116		104		97		86		85		84
21		114		108		95		88		85		87
22		114		109		100		87		88		94
23		115		110		94		88		86		96
24		115		108		94		89		84		99
25		116		112		96		90		87		104
26		113		108		96		90		78		106
27		112		110		96		78		77		100
28		111		108		94		77		86		88
29		112		92		85		87	-	-		91
30		112		110		94		96				90
31		110				94		92				92
Total		3,599		3,319		2,988		2,814		2,460		2,740
Mean Second-feet		116		111		96.4		90.8		87.9		88.4
Per square mile												
Run-off in inches												
Run-off in acre-feet		7,140		6,580		5,930		5,580		4,880		5,430
Maximum		122		121		108		97		98		106
Minimum		110		92		85		77		77		77

Day	April Gage height	April Discharge	May Gage height	May Discharge	June Gage height	June Discharge	July Gage height	July Discharge	August Gage height	August Discharge	September Gage height	September Discharge	Year
			Apr		May		June		July		Aug + Sept		
1		93	4.6	203	7.7	333	10	158	5.7	111	4.6	96	
2		99		242	10	332		159		111		96	
3		111		257		330		153		112		96	
4		143	5.4	269		314		156		110		97	
5		144		270		313		158		109		96	
6		130	5.0	246		305		154		111		91	
7		123	4.6	241		301		148	5.4	112		88	
8		120		225	8.4	299		143		109		89	
9		116		223		295		143		107		90	
10		112		252	10	281		142		104		91	
11		106		301		273		140		104		91	
12		113		302		264		135	5.0	106		90	
13		116		276		252		133		105		91	
14		109		279		242		133		108		90	
15		109		268		237		133		104		88	
16		106		260		232		132		105		87	
17		103		247		225	8.4	126	4.6	103		88	
18		113		239		219	8.0	125		101		98	
19		140	5.4	244		219		126		96		101	
20		148		273		210		126		97		93	
21		141		293		208	7.7	126		98		97	
22		140		315		199	7.3	124		98		92	
23		141		361		197		120		97		89	
24		137	5.0	375		190		118		98		91	
25		128	4.6	371		189	6.9	117		99		89	
26		123		382		181		114		98		88	
27		121		387		176	6.5	115		98		85	
28		117		390		169	6.1	116		96		87	
29		136	5.0	382		167		115		93		89	
30		172	6.1	371		165		113		94		88	
31				352				112		95			
Total		3,710	1163	9,096	304.5	7,317	260.6	4,113	155.2	3,189	142.6	2,742	1384 48,087
Mean Second-feet		124		293		244		133		103		91.4	132
Per square mile													
Run-off in inches													
Run-off in acre-feet		7,360		18,040		14,510		8,160		6,330		5,440	95,380
Maximum		172		390		333		159		112		101	390
Minimum		93		203		165		112		93		85	77

Calendar Year 1960: Total 69,021; Mean 189; Run-off in acre-feet 136,900; Maximum 781; Minimum 77

Max. Disch. Daily 378 Sec.-ft. at 10am on May 28 (G. H. — ft.) Max. G. H. — ft. at — on

Min. Disch. 77 Sec.-ft. on Jan.28, Feb.27, Mar.8 (G. H. — ft.) Min. G. H. — ft. on

Quarter: First, Second, Third, Fourth — Computed, Checked, Date 10-30-61; Disch. copied, Disch. checked, Date 10-30-61; G. H. copied, G. H. checked, Date

U. S. GOVERNMENT PRINTING OFFICE 16—65518-1

Total cfs Days = 1149.2

AF = 2275.5

TEST OF LOGAN CITY PUMP STATION

June 17, 1963

1. Check to see if throttling valve will hold reservoir level

    a) Waste as much from distribution system and mains as convenient

2. Waste from spring or elsewhere in flow line to see if throttling valve will overide on spring forebay level signal

    a) Adjust as may be needed

3. As reservoir is pulled down see if well cycle will function

    a) adjust time delay on waste to canal to allow for clearing up

    b) check back pressure valve to protect impeller on pump
    (There should be a sign in the house on this)

4. Place system back in normal operation and check response of pumping station to low line pressure

    a) adjust cut in pressure

    b) check correction for dynamic head

    c) adjust cut out pressure

Dean F. Peterson

REPORT OF INSPECTION OF
CONTROLS FOR MAIN CITY LINE
AND FOR PUMP STATION

June 22, 1963

A- There are 4 automatic features to be checked:

1- Pump control from reservoir
2- Pump control from line pressure
3- Valve control from reservoir
4- Valve control from Spring

1. Pump control from Reservoir

The reservoir sensing element is a bubbler tube fed by a compressor and tank. Bubbling air at about 20 psi is set at around 1 CFM or less by needle valve in control panel. The pressure in the bubbler line measures the elevation of the water over the bottom of the bubbler line and activates a mercoid switch if it falls below a preset level. Upon return to a predetermined level, the mercoid switch is turned off. Set points should be: Turn on 6' of head; turn off 14.0' head. The circuit has been tested and pump turn on and off checked out, however, vendor's representative was unable to calibrate switch on desired turn on, turn off pressures. It may be necessary to draw reservoir down to do this.

2. Pump Control from Line Pressure

This is in parallel with circuit 1 so either pressure deficiency or reservoir drop will close the circuit and start pumps. Both reservoir demand and pressure must be satisfied to interrupt circuit, thus this satisfies the required system logic. Turn on pressure should be about 60 psi, although based on operation experience this may be changed. At exactly 100 psi, the flow from the reservoir in the main would be zero, above this it would flow back to reservoir, so shut off recommended is 98 psi. Vendor's representative planned to simulate line pressure at these values by cracking the gate valve and throttling the relief valve and thus setting the mercoid switches. I left them at 11:30 PM Thursday, June 20, and understood they would make this calibration before leaving for Salt Lake.

3. Valve Control from Reservoir

Reservoir level is recorded by pen on the lower chart in control house. The other purple lever is the set point which is set on bubbler tube head desired. The proportional setting is the percentage that the system will be maintained, thus the valve will close in to hold within this percentage. This guards against sudden opening or closing, thus preventing water hammer and should be set at 10 percent. Set point of 13.4' is recommended. The operation of this phase was checked out and functions satisfactorily.

4. Valve Control from Spring

The depth of the water above the pressure diaphragm is telemetered from the spring and recorded by the red pen on the lower chart. On June 20, this was 5.3'. The other purple lever is the set point. If this is set at 4.3', then there will be 14" of water over the pipe inlet and this setting is recommended. This circuitry was checked and found to function properly. There is a proportional setting also which was left at 5%. It is believed this should be raised to 10%.

In checking the circuitry for other features of the panel the vendor's representative turned off the power to the panel. This caused the spring level pen to drop past the set point to zero. In turning the circuitry on, the spring recorder responds slowly. Under this condition the system is activated and notes an apparent spring level deficiency and closes the valve. Since the proportional was set at zero, this caused the valve to close immediately remaining closed until the spring signal moved the pen back to 5.3'. This would cause water hammer. The vendor's representative interrupted the power several times under these circumstances June 20 evening and this is believed to be the cause of the pipe line damage. The pipe line was closed by manual operation to full static pressure when we were checking the pump on Monday, June 17 with no apparent damage.

CAUTION:

Interruption of the power to the panel will cause loss of spring level signal. On restoration of power the system will sense a false spring level of zero and close valve. If proportional is set at some value near 10 percent this may prevent or reduce the water hammer, although it would be safer to always set point level to zero before reactivating the circuit and then reset after the spring level signal is reactivated. This point