Civil engineering Sanitary engineering

This thesis was contributed by

Mr. J. W. Knecht.

under the date indicated by the department stamp,
to replace the original which was destroyed in
the fire of March 5, 1916.

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BY

J. [illegible]   I. C. [illegible]

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THESIS

INTRODUCTION

The investigation of the water supply of East Lansing was undertaken with the idea of showing just what the prevailing conditions of the water system are with the view of determining its adequacy and showing its efficiency. It is proposed to criticise favorably or otherwise, and to recommend needed improvements in different parts of the system. We base our criticisms, recommendations and conclusions on references taken from treatises on good water supply methods as presented by recognized authorities. No attempt will be made to mention our authority on conclusions reached for each part of the system, but we prefer to summarize here, without further mention, all authorities that were used as a basis for results obtained.

They are as follows:-- Water Supply Engineering by Folwell; Treatise on Hydraulics by Merriman; Public Water Supply by Turneaure and Russell; Water Works Management and Maintenance by Hubbard and Kiersted; Chemical analysis of Water by Mason.

We are much indebted to several city officers, Prof. Vedder and Prof. Rosing for their courtesy in giving us much of the needed information.

The East Lansing water supply system was designed and constructed at an inopportune time to warrant the installation of a thorough system. This was done when the city was comparatively young in years, and consequently the amount

of funds that could be raised for this purpose was inadequate to construct a complete and reliable system.

Of course a water supply system was sorely needed at the time, and it had to be constructed.

The designing engineer was compelled to face a peculiar proposition. To be adopted his design had to fall within the limitations placed on it by insufficient financial funds and selfish demands made by the tax payers. It was a case of good engineering methods vs. inadequate funds, with the result that the former frequently had to give way .

Be that as it may, it is our purpose to show wherein the system is at fault and to present recommendations for a more desirable one, even though the city is incapable of financing it. A city may be bankrupt but that does not indicate that it should not have a desirable water supply.

SOURCE

Well.

The city obtains its supply of water from a bored well, 6 inches in diameter and 362 feet in depth. It is located near the western end of the city and at the edge of a marshy area.

Its proximity to marsh water is not to be desired on account of its contaminating effect but this feature was eliminated by precautions taken to prevent the local surface water from entering the well. This was accomplished by casing the well with 6 inch pipe down to a point well below the ledge of rock formation. The space between the casing and ground was carefully packed with bags of flax seed, thus excluding the admission of any surface contamination.

The location of this well has several advantages over any other location that could be obtained in the city, namely; its nearness to the highest point in the city, which affords an excellent location for the water tank. This close proximity of the tank to the well tends to cut down the expense of a long force main and in so doing eliminates water hammer.

The sourse of the water in the well cannot be exactly determined, but from a study of the local geological conditions we are reasonably certain that the well is fed by underground streams that flow into the Red Cedar River.

Such a conclusion is drawn from the fact that the well is too deep to admit of its source being directly derived from the Red Cedar River, or from surface waters nearby. Additional proof to the contrary is furnished by a chemical analysis of

the river water.

It is obviously true that the velocity of flow thru pores of rock formation is necessarily extremely slow on account of the great resistance offered, and it is apparent that the well is not fed from such a source. Thus it would not be consistent to believe that the well's present capacity could be maintened under those conditions.

Further investigation only strengthens the truth of our first conclusion, that the well's source of supply is of an underground stream nature.

EXHAUSTIBILITY

The amount of water which the basin of a well can furnish permanently is somewhat uncertain because of the difficulty in determining the governing factors.

The stability of ground water supply depends upon three following conditions.

1. No more water can be continuously taken out of the ground than goes into it.
2. The yield of the ground water is dependent upon the character and extent of the catchment area, and the depth of the saturated water bearing material.
3. The velocity of flow of ground water depends upon the character of material thru which it must pass in gravitating from a higher to a lower level.

We are unable to determine the amount of water that goes into the ground in this particular locality because of the length of time, and the scope that an investigation of this kind would require.

n The extent of the catchment area for a well of this depth is difficult to determine, because the investigation would involve a close study of the local geological conditions which we are not expert enough to determine.

No record was kept, and we were unable to find any person who knew of the character of the material that was penetrated in boring the well, consequently we are at a loss to determine the features that govern the velocity of the ground water that supplies the well.

The only data which we could obtain on the well's exhaustibility consists of its past and present performances and an insufficient test made by the city engineer at the completion of the well's construction.

The latter test was made by pumping from the well for a period of three hours and resulted in no appreciable lowering of the level of water in the well. It is evident that such a short test is insufficient to give a reliable knowledge of the well's stability. The city officials would not allow us to make a proposed 24 hour test, so that leaves us to determine as nearly as we can, from information given us by the pump man and data obtained during the investigation, what reliance can be placed on the well's water producing ability.

Water was first drawn from the well for city use on October 20, 1909, and has been pumped from it every day since for an average period of 5 hours a day. We were informed by the pump man that the pump had to raise water 17 feet in one instance. This was during the month of November 1909 and marks the lowest stage of water in the well since the installation of the system.

Since we have started our investigation the water in the well has been up to the pump at all times. Very little reliance should be placed on conditions as they now exist, as this is comparatively wet season of the year. An investigation on this matter should be carried on in the dry summer months when the water would be low. Thus we find, that the limitations placed on our investigation, in regard to time, makes it impossible to secure adequate data to show how much reliance can be placed in the stability of the well's water production.

There is no telling how low the water may drop in the well in the dry season on account of the increasing demand made by the consumers, and the natural increase in consumption per capita with the increase in population. This increase will be large as shown by the rapid development of the city. The consumption per capita is larger in the dry season on account of the increase in waste to afford cooler drinking water, and also because of the large amount used for sprinkling lawns,etc.

We know that the supply is more than ample to provide for the present needs of the city, but it is a matter of uncertainty whether or not the water will reach so low a point as to render it impossible to pump in the dry season of the year.

PLANT

Pump.

The pump house is constructed of concrete blocks with concrete floors and pump pit. It is situated about 250 feet from the water tower at the foot of the slope.

It is equipped with a reciprocating pump, manufactured by the Union Pump Co. of Battle Creek. It is double acting with a 8" x 12" cylinder. The pump is in good shape and does not show signs of wear.

Power is supplied by a 12 H.P., 3 Phase, 60 cycle alternating current motor manufactured by the Burke Co. The motor is geared to the pump thru a set of four gears.

A capacity test was run on May 18th to determine the number of gallons pumped per minute. In this test the pump was shut off from the mains and allowed to pump into a barrel. From the time,and quantity of water pumped , the capacity of the pump was found.

Three tests were run and the results were as follows:

No. 1 - - - - - - - - - - - - - - - - - - -63.0[illegible] gals. per min.
No. 2 - - - - - - - - - - - - - - - - - - -63.1[illegible] " " ".
No. 3 - - - - - - - - - - - - - - - - - - -6[illegible] " " ".
Average - - - - - - - - - - - - - - - - - -63.108 " " ".

The pump is located in a pit 8' below the level of the floor, and is connected to the well by a 6 inch pipe. A vacuum gage is attached to this pipe to register the vacuum present. A six inch pipe runs from the pump to the mains, and water is pumped into the mains at the same time the t ank is filling, thus making it a direct indirect system. A pressure

gage on the pump is the only means of determining the height of the water in the tank. During our investigation it was found that the gage in use now gives incorrect readings, and the height of the water in the tank could not be determined with any degree of certainty as a correct gage would indicate. We would reccommend the installation of a float, or some measuring device be placed on the tank for the help it would give to the pump man in determining the height of water in the tank.

MOTOR.

The motor is an alternating current, three phase, 60 cycle, manufactured by the Burke Electric Co. It is rated at 12 H.P. so that when the inner casing of the cylinder is removed it will be ample to furnish power to run the pump at twice present capacity.

A test was run on the motor and pump, to find the efficiency of the two combined. The results are as follows:

Total number K W H used in 62 hours = 229.65 KWH

" " K W " = $\frac{229.65}{62}$ = 3.704 KW

" " Watts " = 3.704 x 1000 = 3704. Watts.

There is 746 Watts in 1 H.P. Hence: Total H.P. developed would be $\frac{3704.[illegible]}{746}$ = 4.[illegible] H.P.

Power is supplied by the Michigan Power Co. at a flat rate of .05 cents per K.W.H. From the test above and knowing the total pumpage for the K.W.H. consumed, we found the cost per 1000 gallons.

Total K.W.H. used during 1[illegible] days = [illegible]

220.0[illegible] K.W.H. at .05 per K.W.H. == $11.4[illegible]

Average cost per day = $.95[illegible]

Average pumping per day = 13,000 gallons.

Average cost per 1000 gallons = $.[illegible]

These results are figured on the cost of power alone, and not on station expenses. Also the amount of slip is not considered, for we were unable to determine it. However the results of April check this amount very closely, thus:

Total pumpage April 1910 = 575,000 gallons.

Total K.W.H. used at .05 per K.W.H. = 560 [illegible] ~~485~~ [illegible]

Cost per 1000 gallons = $\frac{\$[illegible].00}{575,000}$ x 1000 = $[illegible]

STORAGE

The city uses for storage an elevated tank of steel construction. This is ideally located about [illegible]' north of the well, and this position is perhaps the highest in the city.

It is constructed entirely of steel and cost when new $1700. The tank is 100' above the ground and the barrel is 14' high by 10' in diameter. This gives it a capacity of 10,000 gallons.

There is a 4" pipe running from the tank to the pump, with a valve located just outside of the pump house for the purpose of closing the main when necessary.

At the present time no arrangement exists to indicate the height of water in the tank. We would recommend that some arrangement of this kind be installed and also an automatic device for starting and stopping the pump.

DISTRIBUTING SYSTEM

The distributing system of the plant includes, besides the pipes, service connections, valves and meters.

The pipe line system is an intersecting one with all pipes terminating in dead ends. It is composed, as shown in the accompanying blue print, of 8 inch and 4 inch cast iron mains, with intersecting laterals of 3 and 2 inch galvanized wrought iron pipes. In a few cases the 2 inch laterals have been reduced to 1 inch.

The pipe lines are arranged to distribute the water in a satisfactory manner, but an objectionable feature is noticed, in that the pipes terminate in dead ends thus causing the existence of stagnant water which is liable to cause tuberculation of the pipes.

In many cases this can be remedied. For example, the 4 inch lateral on West St. could be extended to intersect with a pipe line laid in Howell road, thence along the Howell road and connecting to a 6 inch main at Oak Hill Avenue. This would eliminate the dead end and would produce a fresh circulation of water.

In another case the existing dead ends at the south end of the laterals on West St., Center St., East St., and Louis St. can be done away with by connecting them with a pipe line along Michigan Ave.

The arrangement of the sizes of the pipes in some sections of the city are inconsistent with those of other sections when the future growth of the city is considered. The natural tendency of the city will be to build in the Eastern portion where the land is level and offers a very desirable location. The western end of the city is more densely populated at the present time, but the increase in growth in this section will be slow. In view of these conditions, for example, it is improper to decrease the size of pipe from a 6 inch to a 4 inch as has been done, when eventually the 4 inch main that now runs along the alley between Howell road and Albert Ave. will be called upon to supply the large area lying to the north. Furthermore, in case a fire service is installed in the future, a 4 inch pipe would prove inadequate to supply the needed amount of water for that purpose.

With a given loss of head due to friction the discharging capacity of a 6 inch pipe is about 3 times that of a 4 inch of equal length, and under similar conditions. Further, the loss of head due to friction for equal lengths is over 1/7 less for 6 inch than for 4 inch pipes. Thus it is evident that the use of a 4 inch pipe in the district mentioned would prove insufficient when that district is built up. At present, however, the 4 inch main is more than adequate to supply the needs of that sparsely populated district.

The carrying capacity of all the other pipes in the city is sufficient to supply the present demand, but if the city increases in population, as indications promise, it will be but a few years before the 3 and 2 inch laterals will prove too small to supply the districts they at present feed. Deterioration of pipes enters largely into decreasing the carrying capacity of small pipes.

The loss of head due to all causes is comparatively small at present. This loss was computed by taking pressure readings at the pump house; at Hanchetts, near the end of West

St. and at Kendall near the east end of the system. A pressure gage was attached to the sill cock at the side of the house and a pressure reading was taken. Elevations on height of the gage were taken by running levels between the points mentioned and referring these to the city datum, which is on the water table at the north east corner of College Hall.

The depth of the water in the tank was measured, and from this the hydrostatic head was computed. The loss in head was then computed as given on the pages following.

The pressure gage used in taking the above readings registered 4 pounds too much when calibrated, and all readings were corrected a like amount.

The house connections used in the city are all 1inch galvanized wrought iron pipe.

Valves should be located on the mains and laterals in such a way that in case of a break in any part of the system no more than one block of houses need be cut off during repairs. These conditions do not exist at present.

In several cases the valves that are now in place were covered over with sand, and there was nothing to show their location. It was only at our request that the pump man should find the valves for us that he became acquainted with their location. It is of much importance that the man in charge of the system should be thoroughly acquainted with the location of the valves, and to see that they are readily accessible in case any break occurs in the system.

The officials in charge of the water works should see, therefore, that the man in charge of these operations becomes perfectly familiar with every detail of the system. This is

imperative from an economic standpoint as well.

METERS

The city supplies 90 houses with water, of which 60 are metered. When the system was installed the water was supplied at a flat rate without regard to the amount of water consumed by the users. Under these conditions the water was used without regard to its value and this amount was in excess of what was actually needed. In consequence of this fact the meters were installed, with the result that the actual consumption was cut down, in some cases, one half. Metering is the best method of preventing waste by consumers. This is especially desired in this city because of the poor financial condition, which demands a minimum cost cos t of maintaining the water system. This cost evidently decreases in proportion to the reduction in consumption. Meters are further to be desired, as they afford a more equitable way of proportioning the cost of water.

THE OAKWOOD SYSTEM.

The Oakwood line of pipes, which is owned by the estate of A. C. Bird and which receives its water supply from the city, and the Chase system, which is entirely independent of the city, are both shown on the maps.

The Oakwood 3 inch line is connected to the city's 6 inch main at the intersection of the Howell road and Evergreen Avenue by means of 2 one inch pipes. Previous to the time of this connection the Oakwood system was supplied by the college, but the water was suddenly cut off and a hurried connection was made to the city main. This accounts for the present inefficient connection.

LOSS OF HEAD

Levels were run from the city datum, located on the water table on the N.W. corner of College Hall, to the S.W. foundation pier of the water tank and to the house sill cocks at the eastern and western ends of the pipe lines of the city. These points were taken because they are located at the extreme limits of the pipe line and thus give the maximum loss of head in the system.

Data.

Height of S.W. pier above datum - - - - - - -= 1[illegible].7'

" " top of tank " pier - - - - - - - =11[illegible].0'

" " sill cocks at [illegible] part of city - - -= 5.4'

" " " " " [illegible] " " " - - - -= .[illegible]'

Depth of water in tank at time of pressure readings- - = 1[illegible].5'

Height of water level in tank - - - - - - - =1[illegible].3'

Pressure at eastern part of city - - - - - - = 4[illegible].5#

" " western " " " - - - - - - -= 45.0#

Since h = 2.304 p - then: the height to which the water would raise in a piezometer tube at these points would be 2.304 x pressure reading.

In the east H = 2.304 x 4[illegible].5 = 100.[illegible] ft.

" " west H = 2.304 x 45. = 10[illegible].7 ft.

Since there was no flow of water in the pipes at these points, the velocity head is 0.

There h = H + H

Where h = loss in head.

H = head at tank.

H H = Piezometer heights of water at the eastern and western points in the city respectively.

(Loss of head cont'd.)

Thus $h = H + H$

$h =$ 1[illegible].[illegible] $-$ (1[illegible].[illegible] $-$ [illegible].4) $=$ [illegible]3' loss in head.

$h = h - H$

$h =$ 1[illegible].6 $-$ (10[illegible].7 $-$.[illegible]) $=$ [illegible].7 ft.

POPULATION

The population of the city is largely made up of residents who depend upon the college, in one way or another, for a livelihood. There are no commercial industries in the city at present, and it can safely be said, that the possibilities for the city's future development along this line are remote.

The future population of the city will be dependent largely upon the growth of the college. Its locality is attractive and pleasant for suburban homes, and its close proximity to Lansing makes it a desirable location.

Any prediction on the future population of a small city can scarcely be relied upon because of the many unlooked for important changes which are constantly occuring. In the accompanying diagram we show what we think will be the probable population of the city.

In 1900 the number of residents regardless of students was about one hundred and in 1910 it was estimated at eight hundred and fifty. This would indicate a steady increase during the past nine years. Considering the price of real estate and the probable increase in the number of students, we have drawn the curve as shown in the blueprint. This would give an estimated population of seventeen hundred in 191 . We have every reason to beléive that the college attendance will not increase much over 2000 and at this figure it will probably remain almost constant. The city will however increase at a steady rate.

PURITY

In examining the supply of water as to its purity we conducted chemical analysis on samples taken from different wells thruout the city. These samples were taken with the view

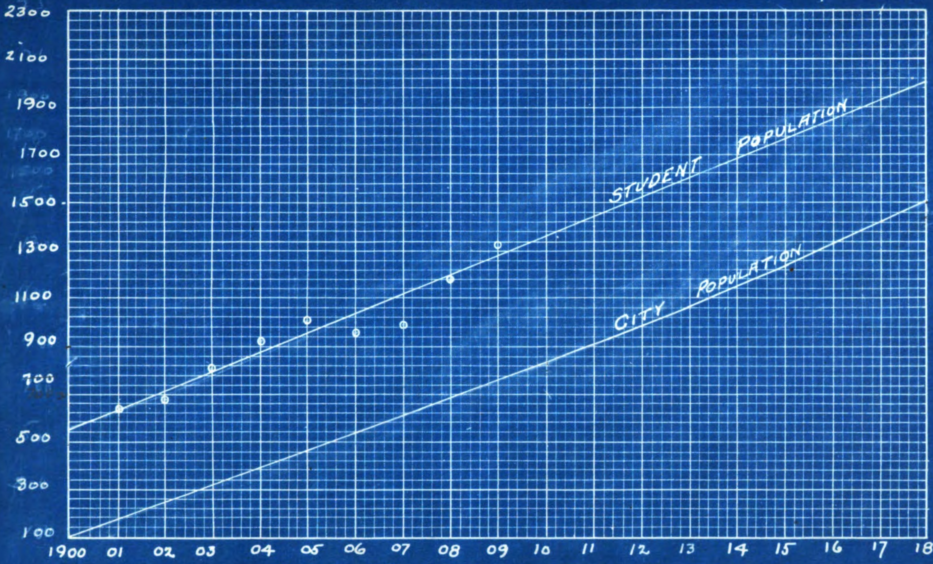

DIAGRAM SHOWING POPULATION OF
EAST LANSING, MICH.

of determining whether the city has obtained the best possible supply. Samples were taken from Chase's, Robinson's, Churchill's and the City Well. These samples were examined chemically and the results are as follows;

Chase's Well.

Nitrates ------ ----------- --.0[illegible] parts per 100,000.

Chlorides-- ----------------- None present.

Free Ammonia-- ------------- .0[illegible] parts per 100,000.

Albuminoid Ammonia ----------- None.

Odor-------------------------- None.

Color-------------------------None.

Churchill's Well.

Nitrates - - - - - - - - - - - - - None.

Chlorides - - - - - - - - - - - - None present.

Free Ammonia- - - - - - - - - - - -.0[illegible] parts per 100,000.

Albuminoid Ammonia - - - - - - - None.

Odor - - - - - - - - - - - - - - - None.

Color - - - - - - - - - - - - - None.

Robinson's Well.

Nitrates - - - - - - - - - - - - - .0[illegible] parts per 100,000.

Chlorides - - - - - - - - - - - - Trace.

Free Ammonia - - - - - - - - - - .1[illegible] parts per 100,000.

Albuminoid Ammonia - - - - - - - None.

Odor - - - - - - - - - - - - - - - None.

Color - - - - - - - - - - - - - - -Slightly milky on standing.

City Well.

Nitrates - - - - - - - - - - - - - None.

Chlorides - - - - - - - - - - - - None.

Free Ammonia - - - - - - - - - - .08 parts per 100,000.

Albuminoid Ammonia - - - - - - - - - None.

Odor - - - - - - - - - - - - - - - None.

Color - - - - - - - - - - - - - - - - Slightly milky on standing.

Thus it is seen that all of the waters analyzed were of a desirable purity, and all would make satisfactory water supplies.

All of the samples show a presence of organic matter in the state of decomposition, as shown by the presence of Free Ammonia. This organic matter is, however, not in large enough quantities to lower the value of the water as a feasable supply. No organic matter not yet decomposed , whether living or dead, was found, as shown by the absence of Albuminoid Ammonia.

In view of the fact that no nitrates were found we are lead to believe, by this evidence, that the water is free from sewage pollution, and is safe to use.

The fear of future contamination of water supply from increased population and cultivation of the catchment area is very remote, since the prolonged intermittent filtration which the water receives tends to exhaust or to render harmless the organic matter that may have been originally dissolved, while any organic matter which may have been dissolved from the subsoils is probably of a vegetable nature and harmless.

Numerous complaints have been received from the city consumers living along the mains in the extreme east and also the extreme west end of the system because of the color and staleness of the water. This is due to the fact that the mains terminate in dead ends, which prevents the constant flow necessary to carry off the rust and other sediment.

A bacteriological analysis of the water at the pump house performed by A. Northrup shows the absence of germs of the colon type, thus indicating that there are no germs which would be harmful to the health of the people of the city.

Every effort should be made on the part of the city to keep the systems free from sewage pollution. Although a drain has been built to carry off the water from the swamp bordering the well, it is not performing its function, and steps should be taken to remedy this.

Valuable aid in the maintenance of the quality of the water supply is afforded by sanitary examination of the catchment area. A complete examination includes: an examination of the catchment area, reservoir; a physical examination of the water, a bacteriological examination, and a chemical analysis.

FIRE SERVICE

The water supplied by the city is used for domestic purposes only.

The fact that the tank is filled twice a day causes a varying pressure in the mains and consequently in the house connections. This fact gives rise to no real inconvenience when we consider that equal pressures are not a necessity for the use to which it is put. As long as there is a reasonable flow of water maintened thru the house faucets, it is all that is to be desired.

The system provides for no fire service as there are no hydrants in the city. We were told that the tax payers objected to the installation of a fire system because of the increased cost, and their belief that it was an unnecessary expense, in view of the fact that there has not been a fire in the city during the past fifteen years.

Such an assumption is obviously erroneous for a fire might break out at any time.

If there were fire hydrants installed in the city the system would be in a position to accomodate one fire stream of a capacity of 11[illegible] gallons per min., which is the quantity needed for a residential district in which the buildings are so situated that fire does not greatly endanger adjacent property. As this city is built up of residential districts which are not thickly populated, such an expedient as stated above could be used to some advantage by making a few changes in the system as it now exists.

The jacket that is now used in the cylinder of the pump to decrease the capacity, could be removed to allow its maximum displacement, which is double its present capacity, and by closing the valve on the pipe leading to the tank, approximately 1[illegible] gallons per minute could be forced into the mains. If the Chase system is taken over by the city, as recommended, its pump could be used to produce additional pressure; also as a safe guard against the city well being exausted.

Besides the protection afforded by the maintenance of a fire service, it would decrease the fire insurance rate to a great extent.

It must be insisted that an efficient fire service is absolutely essential and its construction is earnestly recommended.

MAINTENANCE

The maintenance of the system should be carefully looked after and frequent inspections should be made.

At present the system is not inspected regularly and no stated time has been set for flushing the pipes. In the case of small mains tuberculation occurs to a greater or less extent from the corrosion of the iron which lessens the carrying capacity of the pipes. To prevent this the pipes should be flushed frequently. Owing to the fact that there are no fire hydrants on the system, it can only be flushed on the dead ends. The pipes have been flushed twice since starting operations, the second time on May 20th, and the odor and bad taste of the water was very noticeable.

Flushings should be made at a favorable time so as to render the risk of an interruption in the supply as small as possible. Furthermore we would recommend that it be made at a convenient time, say at midnight, so that the water would have time to regain its original clearness by morning.

The valves should be inspected and any repairs should be made promptly.

Careful attention should be given the pumping machinery in order that the highest possible efficiency will be obtained. This is made possible by frequent inspection and skillful attention on the part of the employes.

CONSUMPTION TEST

To determine the daily consumption per captia, and also the total daily consumption, a twelve day test was run. The test was started May 3, 1910 and was discontinued May 15, 1910.

On May 3rd, just before starting the test the depth of water was measured in the stand pipe, and a reading of the wattmeter at the pump house was taken. Instructions were given the man in charge of the pump to record the time of starting and starting of the pump, and the number of revolutions per minute at the start and at the stop of each pumping. On May 15th when the test was ended the depth of water was again found and a final reading of the wattmeter was taken.

By knowing the time and the number of strokes per unit of time we were enabled to find the total number of strokes of the pump. Knowing the displacement of the cylinder we obtained the total consumption, by multiplying the total time spent in pumping by the displacement per minute. From the meter readings we were enabled to determine the cost of pumping per 1000 gallons.

DATA ON CONSUMPTION [illegible].

Date	Time of starting.	Time of stopping.	Revls. at start.	Revls. at stop.	Consumption.
May 3	5.0[illegible] PM	7.[illegible] PM	35	35	[illegible]707.[illegible]
	6.44 AM	8.27 AM			
May 4	5.4[illegible] PM	7.[illegible]1 PM	35	35	17415.[illegible]
	7.45 AM	10.00 AM			
May 5	6.04 PM	[illegible] PM	35	35	17[illegible]7.[illegible]
	7.[illegible]7 AM	[illegible].47 AM			
May 6	6.[illegible] PM	9.10 PM	35	35	1[illegible].[illegible]
	7.4[illegible] AM	10.[illegible] AM			
May 7	6.[illegible] PM	[illegible].[illegible]4 PM	35	35	1[illegible]10[illegible].7
	[illegible].1[illegible] AM	10.5[illegible] AM			
May 8	5.[illegible] PM	7.[illegible]7 PM	35	35	1[illegible].4
	[illegible].4[illegible] AM	10.11 AM			
May 9	[illegible].[illegible] PM	7.4[illegible] PM	35	35	[illegible]7.7
	[illegible].1[illegible] AM	10.[illegible] AM			
May 10	[illegible].[illegible] PM	[illegible].1[illegible] PM	35	35	1[illegible]4[illegible]7.[illegible]
	7.[illegible] AM	1[illegible].[illegible] AM			
May 11	5.44 PM	[illegible].0[illegible] PM	35	35	1[illegible]7[illegible].5
	7.0[illegible] AM	10.1[illegible] AM			
May 12	6.[illegible] PM	[illegible].[illegible]0 PM	35	35	1[illegible].2
	7.[illegible] AM	[illegible] AM			
May 13	[illegible] PM	7.5[illegible] PM	35	35	17[illegible].2
	7.[illegible]1 AM	11.0[illegible] AM			
May 14	6.00 PM	[illegible] PM	35	35	[illegible]410.1
	[illegible] AM	1[illegible].[illegible]7 AM			
May 15	5.2[illegible] PM	5.[illegible] PM	35	35	147[illegible].[illegible]
		TOTAL CONSUMPTION			[illegible].[illegible]7.[illegible]
		DAILY AVERAGE			1[illegible],[illegible].

Remarks:-- Reading of wattmeter = [illegible]4[illegible].6
Height of water in tank = [illegible]7'
Final reading of W. Meter = [illegible]7[illegible]

Total watt-hours used = [illegible]

PLANS AND RECORDS.

Our preliminary investigation was badly delayed owing to our inability to find the desired data which go to make up the plans and records of the water system.

After numerous conferences with city officials, we finally found a few of the ill-kept maps and notes.

The blue prints showing the sewerage and water systems were bandled to-gether with a rope and without regard to classification. These were found in the basement of the Library building. Upon examination we found only one blue print which was of any value to us in our work. This print had been folded and creased and was almost unfit for use. It was the only map the city possessed of their water system, and showed in pencil the location of the pipe lines.

However , it may be said, another blue print was found shortly before we terminated our investigation showing the location of the pipes and of a few valves. This blueprint was in good condition.

The city's surveying and field notes were presented to us in the same chaotic state. These notes were kept in four field note-books which were used regardless of the different engineering features of which the notes were a part. Titles that of necessity should accompany the notes were often omitted, and this made it necessarily difficult to trace or identify the purpose of the notes.

The note-books contained no exact location, size or depth of pipe lines, valves, etc., also no bench marks or other details which should be properly recorded.

No trace trace of an office book, in which the notes should appear in their final forms for future and convenient reference, could be found.

RECOMMENDATIONS OF PLANS AND RECORDS.

An important requirement for the successful management of a water works system is a complete set of plans and records. These should be accurate, should be up to date and simple of interpretation.

No dependence should be placed on scattered and incomplete notes in numerous field books, nor upon the memory of any person having charge of the works. The value of an exact method of keeping and recording all plans and records may in the outset seem to savor of unnecessary refinement, but the changes which are bound to take place in a growing city, with the result that old land marks are lost, street lines relocated, changes made in the management of the department, and so on, clearly shows that any extra effort expended for the proper preservation of data is a wise action.

In the case of the distribution system, accurate plans should have been made from surveys made during the work of construction. Here is a case in which a change in the personnel of the department since the works were constructed makes it difficult for a person not familiar with the construction to draw up the plans and records which would be as valuable as those which should have been on record from the start.

At any rate this data should be procured in the most thorough manner possible.

The record plans should preferably be made on heavy paper, mounted on linen, as plans on tracing cloth are not very desirable because of durability and in addition cannot be ac-

curately sealed owing to the shrinkage in the material.

All construction features pertaining to the distributing system should be carefully recorded on the maps.

A good plan is to have one map of the entire city drawn to a small scale showing all pipe lines but no details. This map could be drawn in sections and each section labeled for identification. These strips, or division of city, may then be mapped to a large scale which would show all details.

There is great need of a suitable place for storing the maps and records. This can easily be taken care of by the use of a cabinet which can be obtained at very little expense.

A change in the method and thoroughness of recording the written notes is recommended. It would be more convenient and desirable to use a note-book for one particular purpose and see that the book is given a title to correspond ; especially is this desirable when the notes appear in their final form in the field note book.

All construction details should be recorded and preserved. Records should give the size, location, depth, and exact arrangements of old pipes, specials, valves, and all other appurtenences of the system, as well as details concerning gas, sewage, or other pipes. This data can be obtained from other departments or during excavations made during the time of construction.

A pumping station record should be kept in which an account of daily electrical power used and the daily pumping should be entered. Also any repairs made and their cost should be recorded. A record of pressure and vacumn gage readings should be kept.

The pump man should make a report weekly to the water

works committee, the report to include all of the above data, together with any other detail that would demand the committee's attention.

CHASE SYSTEM.

Mr Chase's water supply system is owned by him and is operated independently of the City's system.

The well which supplies his system is a bored well [illegible]0' in depth and cased with a [illegible]" pipe. In a test made after the well was driven it was found that [illegible] gallons per minute could be pumped without lowering the level of the water. At the present time, however, only 30 gallons are pumped per minute.

An alternating single phase motor is used to drive the pump, which has a capacity of [illegible] gallons per minute. An automatic arrangement is used to start and stop the pump.

At the time of our investigations there were 25 residence connections of which [illegible] were metered. Mr. Chase stated that the probable daily consumption was between [illegible] and 6000 gallons, and that the probable consumption per month was between [illegible]000 and 7000 gallons for each connection.

The storage tank is constructed of wood with steel supports. This tank is 64' above the ground and is [illegible]' high. It has a capacity of 2600 gallons.

At the present time there is [illegible]' of [illegible]" galvanized pipe in the system, and this amount is entirely adequate to supply the present demands.

Mr. Chase stated that the present cost was about 7 cents per thousand gallons, and the income nets him about [illegible]% on his investment. The system represents an outlay of $17[illegible]. exclusive of the cost of the well.

A consolidation of the two systems would be recommended by us for by so doing the system owned by Mr. Chase could be used as an auxillary plant in case of an extraordinary demand was made upon the city's supply. This could be accomplished by connecting Chase's system so that the water could be pumped directly into the mains, thus giving a direct system, the over flow to run into the city tank.

[illegible].

The total amount of money raised by the city to construct and maintain the present water system was $1[illegible],[illegible].00. Of this amount $[illegible],7[illegible].[illegible] was raised by issuing bonds at the rate of [illegible]% interest per annum. There are nine bonds in all, eight are issued for $1000. [illegible] and one for $7[illegible].[illegible]. These bonds were issued on November [illegible], 1[illegible], and the first bond falls due on March 1, 1[illegible]. This is the bond for $75[illegible].[illegible] while the $1000.00 bonds fall due at the rate of one a year until 19[illegible].

Of the remaining $[illegible].00. raised, $1[illegible]0[illegible].[illegible] was derived from special city taxes, and $[illegible]00. was borrowed from a Lansing Bank.

It is not the intention of the present City Common Council to create a sinking fund for the purpose of paying up the bonds but rather to wait until the first payment upon the principal is due and then raise the money by special taxes, or by issuing new bonds.

Of the amount raised by note from the Lansing Bank, $[illegible]00., $100. has already been paid and the present plans of the Common Council are to raise $1,[illegible]. by taxation of which an amount equal to the balance of the note is to be used. $750. is to be used to purchase the [illegible] distributing system from

the estate of A. C. Bird. Also it was planned to lay a 4" pipe line along Abbott road with part of this amount.

The only source of revenue the city gets from its water system is from the sale of water.

There are [illegible] houses using water of which 60 are metered. A flat rate per year is charged the unmetered houses as follows:

5 Room houses or less---- $4.[illegible] (each additional room $.[illegible]0)
Wash room- each --------- $1.[illegible]
Water Closet ------------ $[illegible].00
Bath tub ---------------- $[illegible]
Additional bath tub ----- $[illegible].00
Cows each --------------- $1.[illegible]
Horses each ------------- $1.[illegible]
Water Motor ------------ $[illegible].00
Sill cocks ---- --------- $[illegible].00

The metered houses are charged at a rate of .[illegible] for the first thousand gallons used and $.[illegible] for each additional 1000 gallons. This rate is higher than the average rates thruout the country, but is justifiable for the present in view of the fact that the system is new and a high revenue must be had to affset the heavy cost of construction. An additional source of revenue could be derived by charging an annual meter rent. This is the custom in quite a number of our American cities and the average rental is $1.[illegible]0 per meter, per year. This fee is used in meeting the expense of maintenence and depreciation of the meter.

The city has not as yet paid for its meters, but it is planned to pay for them from the revenue derived from the sale of water.

The average cost of operation per month, outside of repairs, is as follows:

Average cost of power --- [illegible].

Engineer's service ------- [illegible].

[illegible] --- [illegible]

[illegible]

The average returns for the sale of water is $[illegible] per month, making an average profit of $[illegible] per month which is [illegible]% profit on the investment.

Water Fund.

Following is a financial statement of the receipts and expenditures of the water fund ending Mar. [illegible], 19[illegible]. We were unable to obtain the expenditures from Mar. [illegible] to date:-

Disbursements up to Mar. [illegible], 19[illegible] - - - - - - - $11772.[illegible]

Receipts up to Mar. [illegible], 19[illegible] - - - - - - - - - [illegible]

Balance on hand Mar. [illegible], 19[illegible] - - - - - - - - - [illegible]

CONCLUSIONS.

As a result of our investigation we find that the water system at the present time is adequate and desirable to supply the city for the purpose for which it was constructed, namely: domestic use. If an efficient fire service were to be established the system could not supply the needed amount of water. It has been shown, however, that one fire stream could be maintained under the present conditions, but it is evident that one fire stream is insufficient to render good service.

We have shown that the City well's supply cannot be depended upon, which brings into consideration the safety or reliability of the operation. Further, the plant contains no auxillary pump and no arrangements have been made for the installation of such a pump in case the present one should be incapacitated. This violates the first requisite of an efficient water supply system, in that it should be safe and reliable of operation at all times.

The inefficiency of the present system is shown by these facts: no fire service is maintained; inconsistency in the sizes of water pipes with the respect to the demands made upon them; and the inequity of the water rates (both flat and meter rates being in vogue). The consumption per capita is 50 gallons per day. This was computed from data gotten from our consumption test. If the meters were used on all houses this consumption would be lessened materially.

The system is inadequate in that it is not capable of supplying sufficient water for the future needs of the city, and as a whole shows a lack of systematic design, in which good engineering methods were sacrificed for the sake of false economy.

A BLUE PRINT OF THE CITY OF EAST LANSING SHOWING THE LINE SYSTEM, IS TO BE FOUND IN THE POCKET.