Water supply - Oshkosh - unpublished report and maps. 1933-1934

WATER SUPPLY AT OSHKOSH, WISCONSIN

F. T. Thwaites, Jan. 1934

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The problem. Oshkosh is one of the three cities in the Fox River Valley which uses surface water for its public supply. The others are Menasha and Appleton. Inasmuch as the city water in Oshkosh was unsafe for a long period of years and, although now safe, is still of rather unpleasant taste, odor, and temperature, particularly in the summer, there has been periodic agitation to change to an underground source. The writer has herein considere first, the possibility of developing a well water supply adequate for the city, and second, how this proposed supply would compare in utility with both the existing service and with surface water treated by improved methods. The cost of developing an underground supply is not treated in detail but alternative plans are outlined and compared. Underground water supplies have the great advantage in that they are cooler and have a more pleasant taste than do most surface waters. When taken from properly constructed wells they are safe without chemical treatment, for the slow seepage of water through the earth purifies it to a degree that is difficult to attain by artificial methods. However, well waters suffer in comparison with lake and river waters in that they are markedly harder and may contain iron.

GEOLOGY

Oshkosh is underlain by two distinct classes of deposits, first, the unconsolidated clay, hardpan, and gravel at the surface, and second, the firm bed rocks below. Water occurs in both classes of deposits but in varying amounts.

Surficial deposits. The surficial deposits in Oshkosh were deposited by glacial action with accompanying waters. Such deposits are collectively termed "drift". Information on the drift in the city was mainly secured from a very large set of well records kept by Mr. Matt G. Faust, well driller, 162 Scott St. The writer is greatly indebted to him for permission to make use of this data. The drift in the city can be divided into two distinct layers. On top there is from 5 to over 80 feet of stony red clay which contains very little water. Below this is "hardpan" which consists of limestone boulders and pebbles mixed with finer material. It is gray in color and varies up to a maximum of over 90 feet thick. In a few places, however, the "clay" rests directly on bed rock. The hardpan contains little water. Locally layers of clay, sand, and gravel occur in or below the hardpan. The sand and gravel contain some water but the layers are not known to be more than a few feet thick. This formation supplies the shallow driven "fountains" along the river. These cease to flow whenever rainfall is deficient for a few years. The total thickness of drift in the city varies from 10 to slightly over 100 feet.

Bed rocks. The bed rocks below Oshkosh are shown in the accompanying diagram where a block with sides running northwest and northeast has been split to show the underground structure. Down to a depth of from 700 to 900 feet from the surface the bed rocks are fairly soft, consisting of limestone, all of which contains magnesium (dolomite), sandstone most of which is cemented with lime, and a very little shale. These "soft rocks" contain water which is very irregularly distributed. Below them lies granite and other similar "hard rocks" which contain very little if any water. These rocks are collectively termed "pre-Cambrian." The soft rocks can be divided into several distinct layers each of which is called a "formation." From the top down these formations are: (a) Black River limestone, maximum thickness in Oshkosh about 100 feet and which contains a little water; (b) St. Peter sandstone, absent in many places as shown on the map but appears to have a maximum thickness of roughly 150 feet and which contains considerable water; (c) Lower Magnesian limestone with a few "stray" sandstone layers, also irregular in thickness and distribution with a known maximum of about 160 feet and which contains water in crevices; (d) Trempealeau fine-grained limy sandstone, thickness about 60 feet and moderately water-bearing; (e) Franconia limy sandstone, thickness 120 feet and water-bearing; and (f) Dresbach sandstone, 200 to 400 feet thick and water-bearing particularly near the bottom. The last three formations named above are often termed collectively "Potsdam" or "Upper Cambrian" sandstone. The pre-Cambrian has been found in wells 22 and 27 and possibly also in wells 23 and 45.

<u>Structure of bed rock.</u> All the formations of bed rock slope or "dip" gently although irregularly toward the east. This fact is demonstrated by platting on the map the sea level elevations of some particular contact which is readily identified in well records. That chosen was the top of the St. Peter sandstone although no St. Peter can be distinguished in many wells. The unevenness of the dip is explained by the fact that the top of the pre-Cambrian is not level but is marked by hills and valleys. The later soft rocks have settled over this old surface so that we may predict the presence of a concealed granite hill by the rise in the overlying formations. This conclusion is verified in Oshkosh by the fact that the two proved discoveries of pre-Cambrian lie under a structural "high" whereas the other deep wells situated in lower places seem to have gone considerably deeper without finding hard rock. It follows that if we want to discover the maximum thickness of soft water-bearing formations we must seek it in structural "lows". The accompanying map shows by its contours (lines of equal elevation) that structural highs are located along Algoma Boulevard, in the northern part of the city, and possibly in the far southwestern part. Structual lows occur between the several highs.

QUALITY OF WATER

Rain that falls on the earth is disposed of by (a) evaporation, (b) running off into streams and lakes, and (c) soaking into the ground. The water of lakes and streams is a mixture of rain water which has run directly into them and underground water which has spent more or less time in the earth before reappearing in springs. In their passage through the ground all underground waters dissolve some of the material through which they pass. The amount they dissolve depends mainly upon what they pass through. In the region around Oshkosh the underground waters almost all pass either through limestone or through deposits which contain considerable lime.

<u>Hardness.</u> Waters which contain dissolved limestone or gypsum (calcium and magnesium compounds) are called "hard". Hardness is generally computed as though it were all due to calcium carbonate (true limestone). The result may be stated either in "parts per million " (p.p.m.) or "grains per U. S. gallon" (g.p.g.). The terms "hard" and "soft" are commonly used rather loosely, for in a region of extremely hard waters, for instance around Milwaukee or Chicago, many waters which are somewhat less hard than the average are often called "soft". Chemists usually

consider that any water with a hardness of over 100 p.p.m. (6 gr.p.g.) is hard. Hardness is of two kinds: (a) temporary or removable by boiling and (b) permanent. Chemists distinguish between these by measuring the former (the part which actually is calcium and magnesium carbonate) as "alkalinity". Permanent hardness (due mainly to gypsum) is measured by the difference between hardness and alkalinity. So far as now known hard waters are not injurious to health but they are undesirable for use with soap and for many domestic and industrial uses. When heated they deposit scale and cause much trouble when used in hot-water heaters, etc.

Iron. Some underground waters contain dissolved iron which came from (a) solution by decaying vegetation as in marshes and (b) from the decomposition of sulphide of iron (pyrite). The latter mineral is abundant in parts of the soft rock formations especially near the bottom. Iron does not show in the water when first drawn but on standing or evaporation it is deposited as an unsightly stain. It also promotes the growth of a kind of bacteria which, although not harmful to health, cause obstruction of pipe. It may also cause stain in washing clothes. If more than a third of one part per million of iron is present, trouble may be expected, unless the water is treated to remove it.

The following table 2 summarizes the available information on the quality of both surface and underground waters in Oshkosh. The hardness, alkalinity, and iron vary widely in the different formations. Mr. Faust stated that as a general thing hardness and iron both increase with depth. Owing to the fact that deep wells produce a mixture of waters of different compositions the rate at which they are pumped influences the quality of the water. If pumped at a low rate the water will probably be that which enters the well near the bottom of the pump; if pumped more other sources are drawn upon. Unfortunately no analysis of the water from the deep wells of the Wisconsin Match Co. could be secured when they are on full production. However, analyses of well waters from other cities in the region have been added to the table because the similarity of geology indicates that the results at Oshkosh could not be much different. Table 2 at end of report.

DEVELOPED UNDERGROUND WATER SUPPLIES

Table 1 (at end of report) summarizes the records of wells in Oshkosh so far as they could be secured. Nothing could be learned about many old wells. On account of the unsatisfactory city supply there is a vast number of private wells most of them shallow and used with hand pumps. Nearly every factory and many office buildings have private well supplies most of them used only for drinking water. Of this multitude of supplies the only one which is comparable with what would be needed for a city supply is that of the Wisconsin Match Co. No. 27. Little definite information could be obtained from the owners about this installation except that it is used only for air-conditioning the factory during very hot weather. Of the two wells, each of which has a deep well turbine driven by an electric motor, only one is operated at a time. According to Mr. Faust, who drilled the wells, pumping 1060 gallons per minute lowered the water from the surface to a depth of 50 feet. This means that 21 g.p.m. is produced for every foot that the level is lowered. This figure is called the "specific capacity" of the well. In any well the yield is directly proportioned to the lowering or "drawdown" until that reaches the top of the first water-bearing formation, here 100 feet. In other words the well could be pumped at the rate of about 2000 g.p.m. or 2,880,000 gallons per day if the water were lowered 100 feet. As neither of these wells has ever been pumped constantly over a period of months or years it seems doubtful if such a high rate could be maintained. The well might also produce considerable sand if pumped at maximum capacity.

According to Mr. Faust the pumping of the Match Company wells lowers the water 20 feet in a well opp9site his house about 2850 feet distant. Many reports of effects of pumping on other wells are, however, without foundation as the big well is not used all the time. Mr. Faust stated that the shallow "fountains" in the gravel along the river are not affected, but only the rock wells. The radius of influence of the big well is at least a mile at present rate of production.

The writer could not obtain any record of the yield of the old wells at the waterworks which were abandoned before they were taken over by the city. These wells are all located within a few hundred feet of one another and unquestionably simply divided the supply which could be obtained with one large modern well. At first the wells flowed into a reservoir but later they were connected directly to the pumps, a practice now regarded as dangerous because leaky suction pipes could easily draw in surface water. At best, such methods could produce only a small fraction of the water which could be obtained with modern deep well pumps. However, on account of the slow rate of seepage of water through rock formations heavy pumping lowers the level in a well to a point where it costs too much to raise the water to the surface. For this reason it is far more economical to space wells far enough apart so that they do not interfere too much with one another. Even at a distance of a mile operation of another big well can easily reduce the capacity of a given well 5 to 10 percent. The old waterworks wells are now partly covered by the new plant and it is unlikely that any of them are either large enough or straight enough to permit the installation of modern machinery.

Of the remaining supplies, the Oshkosh Brewing Company can pump about 200 g.p.m. with a suction pump. Most of the factory wells are produced with small steam pumps which deliver not over 20 g.p.m. Mr. Faust tested the office building and school wells which he drilled at 100 to 190 g.p.m. with a drawdown of 10 to 15 feet thus indicating a specific capacity of 6 to 10 for 6 inch wells which enter the St. Peter to a maximum of about 100 feet.

The above information indicates that we could probably construct a 12 to 20 inch deep well in Oshkosh with a specific capacity of about 15.

PRESENT CITY SUPPLY

The waterworks must have been located on the lake shore so as to use lake water if the wells failed. It is reported that the old water company abandoned wells because of lack of enough water but it is also stated that sand drawn from the wells injured the pumps. A modern pumping system would remove this trouble. For over 40 years the city supply has been taken from Lake Winnebago and for much of this time it has been filtered. Progressive experiments have steadily improved the quality of the product and a modern treatment plant was built in 1924. The water passes through the following steps: (a) addition of alum and "activated carbon" (wood pulp charcoal), (b) aeration, (c) sedimentation in a reservoir, (d) treatment with chlorine and ammonia with manual control, (e) rapid sand filtration, (f) storage in "clear well," (g) second chlorination, also with manual control, (h) storage in covered reservoir, and (i) pumping into mains. Bacterial tests of the treated water are made daily and it is examined for free chlorine every hour. The bacterial quality of the treated water is now satisfactory but the temperature at which it enters the mains often reaches 77F in summer. In districts where much water is used the consumer receives his water at about this temperature but in residental districts the earth cools the water to about 70 F. Aside from this high temperature in summer the principal objection to the present supply is its taste and odor both of them traceable to the high content of organic matter in the lake. It may be suggested that several improvements might be made in treatment. At present the activated carbon is so mixed with mud that it is soon lost and, moreover, it cannot absorb any of the taste due to chlorination as that process is later in order. It might well be applied, at least in part, just ahead of the filters or the water might be passed through a pressure charcoal filter as it is pumped into the mains. It is reported that such a filter in one of the store buildings gives excellent results. If the Oshkosh sewage were treated before it is discharged into the river and lake, the problem of drinking water treatment would be greatly simplified. The chlorination should be controlled automatically for the present system leads to over-dosage. None of these improvements touches the problem of temperature which, in the opinion of the writer, is the next big problem in water supply. Several plans may be suggested. First, the water might be taken from a deep basin dredged in the lake bottom. As the temperature of the ground is at a minimum at a depth of about 60 feet from the surface a basin of this depth should furnish cooler water than does the shallow lake. Objections are high cost and the accumulation of filth in the hole. Second, a part of the lake might be enclosed with dams and the water admitted where least polluted. Treatment within this reservoir could then be applied to reduce the organic matter. Third, the storage reservoir might have its bottom below 60 feet depth and the water drawn from the bottom. Objections are high cost and the fact that the earth is so poor a conductor of heat that the effect in cooling might be small. Fourth, mechanical refrigeration might be used during the summer, probably at high cost as temperature does not matter with most of the water used. Fifth, water might be taken above the city in Lake Butte des Morts where it is not as much polluted. This would involve a long main for the present plant or else entire reconstruction of the system. Decision on which of these plans is most practical must await further studies.

DEVELOPMENT OF WELL SUPPLIES

The present maximum demand for water in Oshkosh is about 7 million gallons per day. As much of the city is as yet unsupplied with sewers it is probable that consumption of water will increase even if the population does not. The discussion of developed water supplies above showed that wells which produce 1000 g.p.m or 1,440,000 g.p.d. should be spaced at least a mile apart. Six such wells would be needed even if we do not allow for any reserve in case one or more well has to be shut down. Two di distinct plans must be considered: (a) the "unit well" system of six separate wells throughout the city and (b) six wells connected to a treatment plant where the water would be softened and, if necessary, freed of iron.

<u>Preliminary testing</u>. Before starting any plan for use of well water a test well of at least 6 inches diameter down to the pre-Cambrian is most desirable. Such a well would give definite information on the underground geology, the water capacity of the several water-bearing formations, and the quality of the water in each. Slight variations might be expected in other locations, particularly in the thickness of the St. Peter, but the basis for intellignet planning would thus be secured. The geology should be checked by means of samples taken every five feet. Whenever an important water-bearing formation has been passed through drilling should be suspended and the well tested with as large a pump as possible. The test should include determination of discharge and drawdown as well as a chemical analysis of the water. The effect of pumping on adjacent private wells should be measured and inferences should not be drawn from hearsay. The test well should not be located within several hundred feet of any old well which passes below the St. Peter for the water from different formations might "short circuit" through the old well and vitiate the results of the test. A site near to South Main and 12th may be suggested as a well there might be used in either system of development.

Unit well system. In designing a system of isolated well supplies it is necessary to consider the exisiting water mains in the city which is now designed to deliover water from the lake. The mains adjacent to a well must be large enough to keep the maximum velocity of water below 5 feet per second. For a 1½ million g.p.d. well this means at least a 10 inch main in both directions. At present much of the city has no mains larger than 6 inch. 10 inch mains reach the northwestern part of the city but 12 inch and larger are confined to the region between Parkway and 12th, mainly on and east of Main. Applying the principles heretofore stated the following tentative locations for unit wells are: (a) Water works, (b) South Main near 12th, (c) Josslyn and First Ave., (d) South Park or slightly farther north, (e) near center of 12th Ward, and (f) near Broad and New York. The first three locations are now served with 10 to 16 inch mains but the others would require extensive new mains to take care of the water economically. Exact locations would have to be determined by (a) suitable vacant or reasonably priced properties and (b) the thickness of St. Peter sandstone present as shown by test drilling. Judging from the experience in Madison each well with lot and pumping equipment would cost about $20,000. or a total of roughly $120,000 without necessary changes in mains. These might bring the total to around $200,000. Besides this it must be remembered that both pumping and maintenance costs with a unit well system will be considerably higher than they are at present with a central plant.

Treated water system. Inasmuch as the water from unit wells cannot be treated economically to reduce the hardness and iron, both of which it seems probable from Table 2 are greater in well water than in lake water; it would seem desirable to lead all water from wells to a central treatment plant. The present plant might be altered to use for this purpose. However, it is very difficult to so locate wells that the necessary new mains from them to the plant would be as short as possible. Preferably the wells should be located approximately in line to reduce the amount of pipe needed but this would place the northern and southern wells outside the city if the mile spacing is adhered to. The writer will not hazard any estimate on the cost of such a plan other than it hardly could be less than twice the cost of the unit well system. On the other hand, however, such large scale treatment of well water could be performed much more cheaply than it can be if done by individual consumers.

COMPARISON OF PRESENT AND UNDERGROUND SUPPLY

Safety. Judging from the routine tests and the history of typhoid cases in Oshkosh the present water supply of Oshkosh is safe. According to the State Board of Health typhoid is endemic in Oshkosh and is probably spread through unsafe private wells. Many of the private wells are lined with steel pipe which soon rusts out. Some of them are piped only through the clay. Some are, at least in part, old dug wells into which surface water enters easily and without doubt a vast number have unsafe tops which permit the entrance of contaminated waters. Although the formations below Oshkosh doubtless contain absolutely safe water where undisturbed by man the pumping of large city wells for a long time would greatly lower the water level. Many private wells would be dried up and neglected. Each such abandoned or imperfectly constructed well would then be a potential source of contaminated surface water which would be drawn down into the previously pure deeper supplies. Such has actually happened at Fond du Lac. To find and to seal all private wells would be difficult both from the legal and the engineering standpoints. The writer recommends that all large wells in Oshkosh be chlorinated unless cased in an approved manner to a depth below that of all adjacent wells. Such treatment of well water would not affect the taste to a material extent.

Hardness. The analyses in Table 2 show that the waters of shallow wells in Oshkosh average 28 g.p.g or about $2\frac{1}{2}$ times as hard as the present supply. Waters from deep wells average $22\frac{1}{2}$ g.p.g or slightly over twice as hard as the city supply. Adjacent cities vary from about half again to nearly six times as hard, averaging $25\frac{1}{2}$ g.p.g. The present supply averages about 9 g.p.g. From this information it seems that the best one can reasonably expect from wells is water twice as hard as the lake water. The results of test drilling might well indicate that waters from certain formations should be excluded from city wells because of undesirable hardness or iron. If such be done the capacity of the wells would be less than that of the Wisconsin Match Company. Mr. Faust stated that in his opinion the hardest water with the most iron came from the bottom of the Dresbach sandstone just on top of the granite. If the unit well system be adopted the citizens of Oshkosh will be faced with the necessity of either installing water softeners (the ordinary domestic size averages somewhat over $100. installed if no extensive change in piping be required), or paying much heavier repair costs on all apparatus such as water heaters and boilers. Soap consumption would also be larger.

Iron. Although the present city supply contains some iron such is probably derived from corrosion of the pipes and is not present in the lake. Observation of bubble fountains in the factories visited shows iron stain in the majority. The Wisconsin Match Co. well yields water which is high in iron. Some wells in the downtown district report no trouble with iron. Several adjacent cities have trouble with iron but the others do not. It is, therefore, an open question as to what extent iron would be a problem in Oshkosh well waters provided the worst of the underground waters were excluded from the wells as a result of preliminary tests. It appears that iron is worst in (a) the Trempealeau formation and (b) in the bottom of the Dresbach sandstone.

Temperature, taste, and odor. The present city water is too warm for drinking in hot weather unless cooled by the consumer. A well supply with the unit well system would deliver water to the mains at about 52 F. Observed private supplies are delivering water in the bubble fountains at from 43 to 54 F. In the "dead ends" of the city distribution system, however, the temperature of the water in hot weather might not be much better than it now is, about 70 F. If treated well water were used the aeration and softening processes would raise the temperature considerably in warm weather but exact data on this point are not at hand. So far as could be observed well supplies in Oshkosh are free from objectionable taste or odor. Most of the people are now accustomed to drinking well water so little objection would be raised to a change in the city supply. Chlorination would not affect the taste of well water.

CONSLUSIONS

(1) Sufficient underground water can be secured to supply the city of Oshkosh provided wells are spaced far enough apart.

(2) Water from wells can be expected to be about twice as hard as the present city supply.

(3) Iron may prove a serious drawback to use of well water particularly if the unit well system with untreated water is used.

(4) Well water would not be permanently safe without chlorination, but this would not affect the taste.

(5) The unit well system would be cheapest costing about $200,000 but the water could then not be softened or freed of iron.

(6) A change to untreated well water would make the supply much cooler in summer and free from objectionable taste and odor.

(7) Untreated well water would cause consumers much expense for repairs, soap, and installation of softeners; it would also be a marked expense to many industrial users. CONTINUED ON PAGE 9.

Records of wells in Oshkosh, Wisconsin

Information mainly from Matt G. Faust, also from Wisconsin Geological Survey Bull. 35, p. 631. Numbers refer to map. Figures represent depth from surface to bottom of formation in feet and depth to water in feet. Elevations, feet above sea level

No.	Owner	Elev.	Drift	Black River	St. Peter	Water	Total depth	Remarks
1.	Greenkorn	760	87	118		9	139	
2.	Golf course	750	29			1½	200	Sandstone at 170, (stray)
3.	" "	760	66	93		18	115	
4.	Paine Lbr. Co., S	755	56			flow	300	Trempealeau at 245
	" " " N	755	71			"	335	" at " "
5.	Universal Motors	760	39			3	256	Sandstone at 240
6.	Newman	765	91	140	absent	22	150	
7.	Nelson	755	83	150		11	150	St. Peter not reached
8.	North Park	750	102	128		6	200	
9.	McMillan Co.	750				flow	398	No record
10	J. L. Clark Co.	750				?	110	" "
11	Damke	765	91	160		21	210	
12	Greenlaw	765	95	180		22	190	Stray sandstone?
13	Lampert	755	75	145		4	171	
14	Schmidt	755	82	145		11	150	
15	Washburn	765	106	none		?	234	No limestone
16	Anderson	765	85	120		15	128	
17	Hanson	765	89	125		16	138	
18	Wickert	765	93	130		21	160	
19	Commercial House	760	100	none		?	178	No limestone
20	Fowler House	760	95	"		?	134	" "
21.	z Frentz	765	100		Absent	20	275	Stray sandstone at 200
22	Algoma Fountain	760	92		absent	?	695	Trempealeau at 300; granite at 680
23	Waterworks- 8 old wells 300 to 900 total depth-no records							
24	Pollock and Redford	760	75	125	thin	12	150	
25	Wisconsin Axel Co	755	76	150?	absent	11	195	
26	Heyman	765	93		absent	20	200	Stray sandstone at 170
27	Wisconsin Match Co	750	50	100	275	flow	698	Strikes granite, no record of other well
28	American Excelsior Co.	750				flow	30	Gravel well
29	Foster-Lothman Co.					?	90	
30	Morgan Co.					flow	500?	
31	Swift and Co.	755	40	115		5	130	
32	First National	760	75	107		3	200	Tested at 190 g.p.m.
33	Post Office	760	82	120		15	128	
34	Eagles Club	760	79	140		8	200	
35	Kimberly	755	91	135		8	185	
36	Krueger	760	81	120		11	135	
37	Durler	755	93	125		35	140	
38	Oshkosh Northwestern	760	85	130		9	220	Tested at 100 g.p.m.
39	Tremont House	760	80	110		?	126	
40	Wisconsin Public Service Co.	750	48	135	155	5	192	Probably a stray sandstone

Table 1, continued

No.	Owner	Elev.	Drift	Black River	St. Peter	Water	Total depth	Remarks
41	Lutz, barn	765	10	100	present	?	100	
42	Ketz	760	20	142		26	155	
43	St.Vincent School	755	20	135	202	$11\frac{1}{2}$	202	Tested at 100 g.p.m.
44	Peoples Brewery						360+	No record
45	Oshkosh Brewing Co.	Two wells, 600 and 800, no records						
46	Beernteen	755	21	130		10	180	
47	Horns Brewery	755	10	110		?	290	
48	Oshkosh Trunk Co.	755	46	110	absent	7	125	
49	Universal Motrors	755	68	115		7	150	
50	Hicks Printing Co.	760	66	114		$6\frac{1}{2}$	160	
51	St. Marys School	755	81	120		11	200	Tested at 100 g.p.m.
52	Sacred Heart School	755	17	101		12	200	" " " "
53	Wisconsin Nat. Life Insurance Co.	760	85	120		15	200	
54	Butternut Baking Co	765	98	?	absent	10	275	Trempealeau at 250
55	Nevitt	755	68	110		1	122	
56	Anderson	770	107	180		25	190	
57	St. Josephat School	765	91	?	absent	30	215	
58	Guernsey Dairy Co	755	70	112		10	220	Tested at 100 g.p.m.
59	Kuble	760	97	145		22	160	
60	Radford Bros	750	50	110		?	423	
61	Hooper	760	20	120		?	210	
62	Gillan Bros.	750	50	110		?	205	
63	Hollister	760	50	110		?	425	
64	St. Peter School	760	61	106		7	200	Tested at 100 g.p.m.
65	Boyce	750	33+			7	33	Gravel at 25
66	Normal School	760	90	?	absent	?	633	Trempealeau at 315. Not used.
67	Amos	750	60	90		?	175	
68	Carver Icecream Co	765	86	120		15	145	
69	Faust Paper Box Co.	750	24+			flow	24	Gravel at 21

Note: Depth given for lower sandstones is depth of top and where not otherwise stated sandstone extends to bottom. Elevations were taken from Neenah and Fond du Lac quadrangle maps of U. S. Geological Survey, Washington, D. C. and are given to nearest 5 feet only.

CONCLUSIONS, continued.

(8) the existing water supply could be improved to a marked extent but no estimate of cost can be given. Taste and odor can probably be greatly improved but the high summer temperatures probably can not.

(9) Pumping and maintainance costs with any system of wells would be higher than with the present plant.

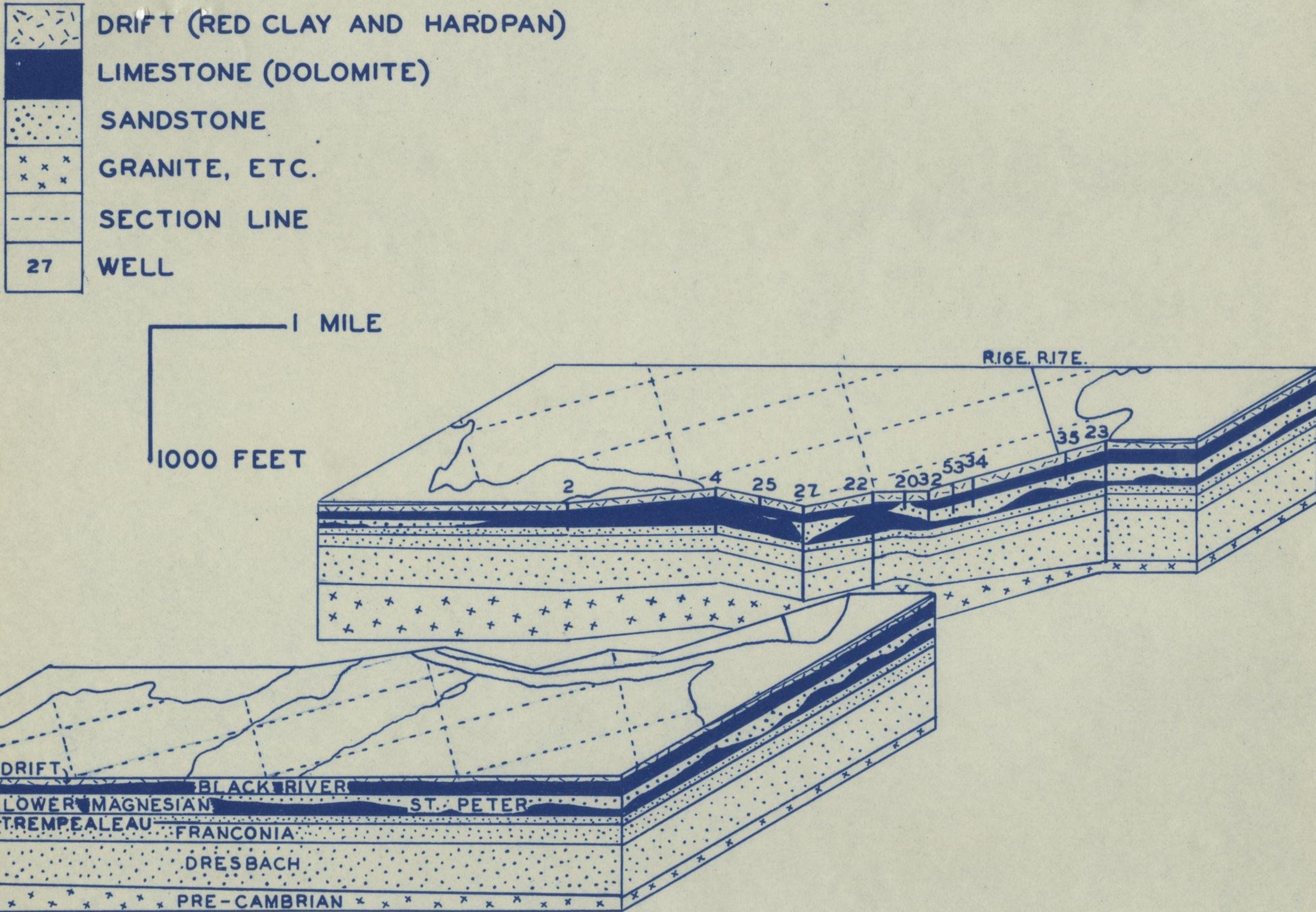
(10) It is for the citizens of Oshkosh to decide which system they prefer, realizing that the present supply is best for industrial uses and, in fact, for all purposes except drinking for which only a minute portion of the city water is used. Well water is unquestionably best for drinking water.

TABLE 2

Hardness, alkalinity, and iron of waters in and near Oshkosh.

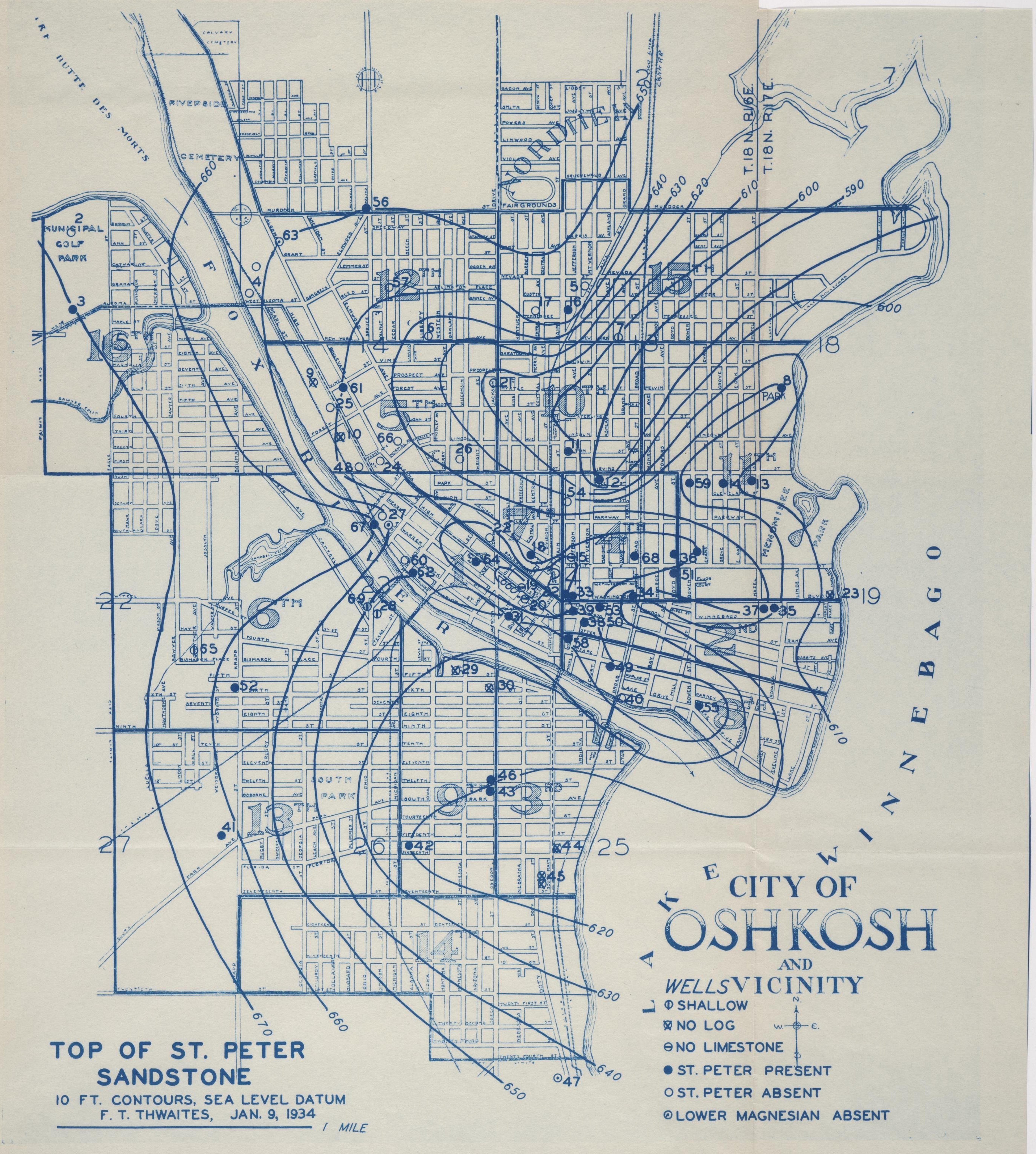
Hardness is total calcium and magnesium compounds expressed as calcium carbonate. Alkalinity is total carbonates expressed as calcium carbonate. Difference between hardness and alkalinity is permanent hardness. Alkalinity is temporary hardness. Where iron is given after a question mark the figure was computed from a determination of iron and aluminum combined assuming that they are equal in amounts. p.p.m. = parts per million g.p.g. = grains per U. S. gallon. Analyses from State Laboroatory were furnished by Dr. M. Starr Nichols.

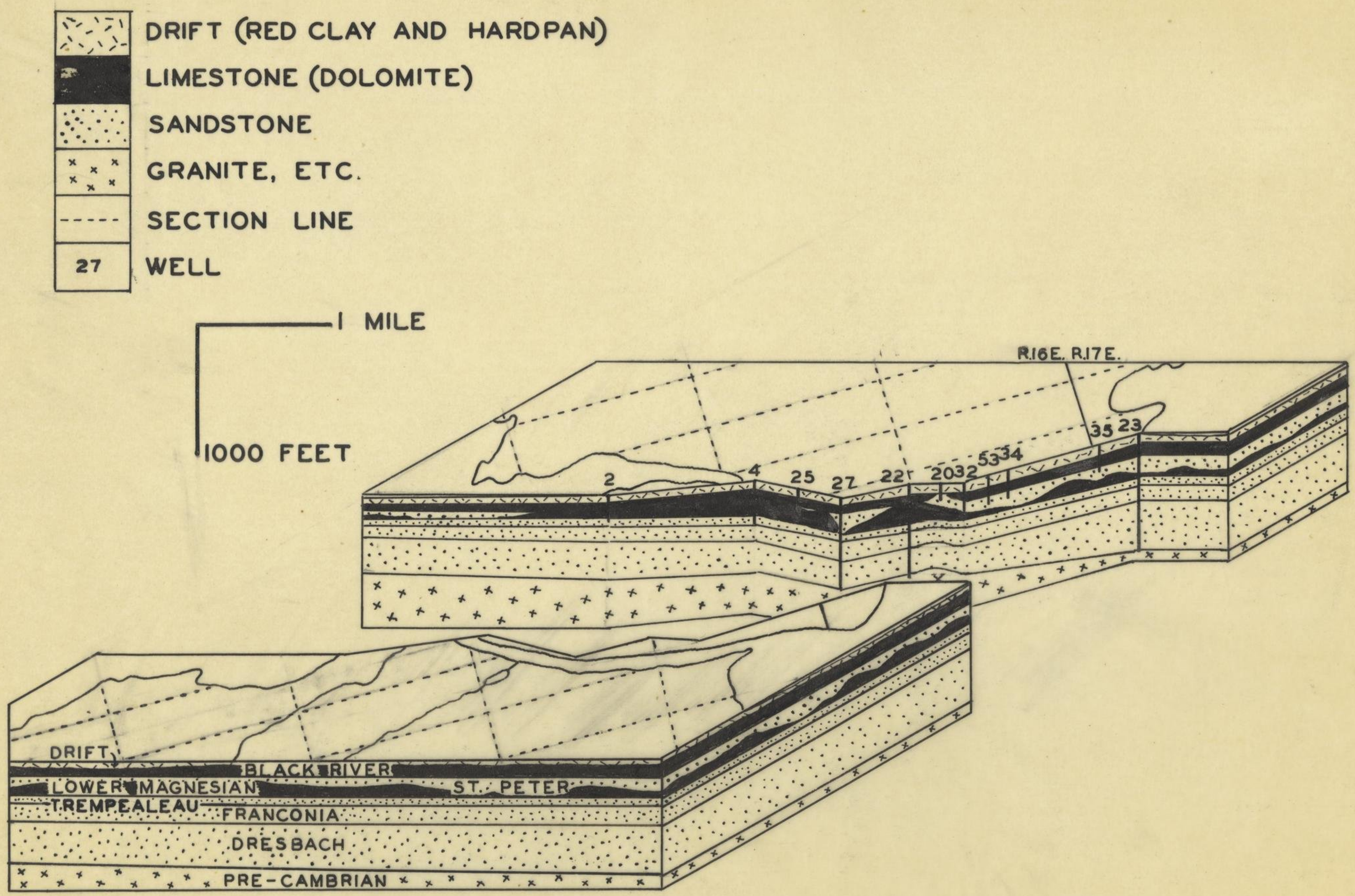
Location	Authority	Hardness ppm.	Hardness gpg.	Alkalinity ppm.	Iron ppm.
SURFACE WATERS					
City supply	State Lab.	131	8	131	0.3
" "	H. J. Schneider	172	10	132	?0.6
Fox River	Bull. 35, p.635	117	7	110	
L. Winnebago, raw	Same	173	10	168	?1.8
Same, filtered	Same	149	9	102	?0.5
L. Winnebago	Same	162	10	146	?0.5
Same	Same	117	7	111	
AVERAGE			9		
SHALLOW WELLS					
Wadkins, depth 16'	Same	275	16	211	0.4
C.M.St.P and P. R. R., 12' well	Same	330	19	320	
Same, 95 ft. well	Same	383	22	288	
Am. Excelsior Co.	H. J. Schneider	471	26	311	?1.0
316 15th St.	Same	717	41	345	?1.1
735 5th St.	Same	444	26	363	?3.4
1208 6th St.	Same	688	40	509	?1.2
1342 Durfee St.	Same	618	36	420	?0.5
947 4th St.	Same	539	31	239	?0.4
AVERAGE			28½		
DEEP WELLS					
Jackson-Algoma fountain	Same	814	47	201	?1.6
Wisconsin Match Co.	Same	334	19	241	?1.3
J. L. Clark Co.	Same	254	15	228	?2.4
Peoples Brewing Co.	Same	319	18	269	?1.0
Same	E. A. Siebel Co.	383	22	245	?2.8
Paine Lumber Co.	State Lab.	250	15	211	0.7
AVERAGE			22½		
ADJACENT CITIES					
Fond du Lac	State Lab	384	22	170	0.3
Neenah	Same	540	31	243	0.15
Green Bay	Same	237	14	192	0.8
Kaukauna	Same	757	44	178	0.3
Depere	Same	284	17	183	0.8
AVERAGE			25½		



FORMATIONS BELOW OSHKOSH

F. T. THWAITES, JAN. 1934


TOP OF ST. PETER
SANDSTONE
10 FT. CONTOURS, SEA LEVEL DATUM
F. T. THWAITES, JAN. 9, 1934
1 MILE
CITY OF
OSHKOSH
AND
VICINITY
WELLS
SHALLOW
NO LOG
NO LIMESTONE
ST. PETER PRESENT
ST. PETER ABSENT
LOWER MAGNESIAN ABSENT
LAKE WINNEBAGO
FOX RIVER
BUTTE DES MORTS
MUNICIPAL GOLF PARK
RIVERSIDE CEMETERY
NORDHEIM
FAIR GROUNDS
SOUTH PARK
MENOMINEE PARK
T.18N. R.16E.
T.18N. R.17E.



FORMATIONS BELOW OSHKOSH

F. T. THWAITES, JAN. 1934

Oshkosh

Jan. 20, 1934

Mr. Matt G. Faust,
162 Scott St.,
Oshkosh, Wisconsin

Dear Mr. Faust:

Enclosed please find copies of the map I prepared for my report to the Water Board, the diagram showing the underground structure at Oshkosh, and the list of well records. The last includes a number of others than thos you gave me. The complete report was sent to the Board on Thursday. After it is made public I will be glad to send you a copy if you desire it. The list is for the most part confined to wells which either strike sandstone of go to a depth below where it is usually found. Was glad to find that my copy of the Universal Motors well was correct and wish to thank you for answering so promptly.

Hoping to see you again, and thanking you for past favors,

Sincerely,

F. T. Thwaites

WATER DEPARTMENT

(GOVERNED BY COMMISSION)

CITY OF OSHKOSH
ROOM 8, CITY HALL

OSHKOSH, WIS.,
February 3, 1934

F. T. Thwaites
R. D. 4
Madison, Wisconsin

Dear Sir:

We are herewith enclosing our check No. 222 in payment of the seven copies of reports on water supplies at Oshkosh.

Kindly credit our account with this amount.

Yours very truly,

CITY OF OSHKOSH WATER DEPT.

Albert E. Hintz
Manager

AEH:Z

RAILWAY EXPRESS AGENCY

INCORPORATED

UNIFORM EXPRESS RECEIPT—NON-NEGOTIABLE—TERMS AND CONDITIONS

1. The provisions of this receipt shall inure to the benefit of and be binding upon the consignor, the consignee and all carriers handling this shipment and shall apply to any reconsignment, or return thereof.

2. In consideration of the rate charged for carrying said property, which is dependent upon the value thereof and is based upon an agreed valuation of not exceeding fifty dollars for any shipment of 100 pounds or less and not exceeding fifty cents per pound, actual weight, for any shipment in excess of 100 pounds, unless a greater value is declared at the time of shipment, the shipper agrees that the company shall not be liable in any event for more than fifty dollars for any shipment of 100 pounds or less, or for more than fifty cents per pound, actual weight, for any shipment weighing more than 100 pounds, unless a greater value is stated herein. Unless a greater value is declared and stated herein the shipper agrees that the value of the shipment is as last above set out and that the liability of the company shall in no event exceed such value.

3. Unless caused by its own negligence or that of its agents, the company shall not be liable for—
   a Difference in weight or quantity caused by shrinkage, leakage, or evaporation.
   b The death, injury, or escape of live freight.
   c Loss of money, bullion, bonds, coupons, jewelry, precious stones, valuable papers, or other matter of extraordinary value, unless such articles are enumerated in the receipt.

4. Unless caused in whole or in part by its own negligence or that of its agents, the company shall not be liable for loss, damage or delay caused by—
   a The act or default of the shipper or owner.
   b The nature of the property, or defect or inherent vice therein.
   c Improper or insufficient packing, securing, or addressing.
   d The Act of God, public enemies, authority of law, quarantine, riots, strikes, perils of navigation, the hazards or dangers incident to a state of war, or occurrence in customs warehouse.
   e The examination by, or partial delivery to the consignee of C. O. D. shipments.
   f Delivery under instructions of consignor or consignee at stations where there is no agent of the company after such shipments have been left at such stations.

5. Packages containing fragile articles or articles consisting wholly or in part of glass must be so marked and be packed so as to insure safe transportation by express with ordinary care.

6. When consigned to a place at which the express company has no office, shipments must be marked with the name of the express station at which delivery will be accepted or be marked with forwarding directions if to go beyond the express company's line by a carrier other than an express company. If not so marked shipments will be refused.

7. As conditions precedent to recovery claims must be made in writing to the originating or delivering carrier within nine months after delivery of the property or, in case of failure to make delivery, then within nine months and fifteen days after date of shipment; and suits shall be instituted only within two years and one day after the date when notice in writing is given by the carrier to the claimant that the carrier has disallowed the claim or any part or parts thereof.

8. If any C. O. D. is not paid within thirty days after notice of non-delivery has been mailed to the shipper the company may at its option return the property to the consignor.

9. Free delivery will not be made at points where the company maintains no delivery service; at points where delivery service is maintained free delivery will not be made at addresses beyond the established and published delivery limits.

Special Additional Provisions as to Shipments Forwarded by Vessel from the United States to Places in Foreign Countries.

10. If the destination specified in this receipt is in a foreign country, the property covered hereby shall, as to transit over ocean routes and by their foreign connections to such destination, be subject to all the terms and conditions of the receipts or bills of lading of ocean carriers as accepted by the company for the shipment, and of foreign carriers participating in the transportation, and as to such transit is accepted for transportation and delivery subject to the acts, ladings, laws, regulations, and customs of oversea and foreign carriers, custodians, and governments, their employees and agents.

11. The company shall not be liable for any loss, damage, or delay to said shipments over ocean routes and their foreign connections, the destination of which is in a foreign country, occurring outside the boundaries of the United States, which may be occasioned by any such acts, ladings, laws, regulations, or customs. Claims for loss, damage or delay must be made in writing to the carrier at the port of export or to the carrier issuing this receipt within nine months after delivery of the property at said port or in case of failure to make such delivery then within nine months and fifteen days after date of shipment; and claims so made against said delivering or issuing carrier shall be deemed to have been made against any carrier which may be liable hereunder. Suits shall be instituted only within two years and one day after the date when notice in writing is given by the carrier to the claimant that the carrier has disallowed the claim or any part or parts thereof. Where claims are not so made, and/or suits are not instituted thereon in accordance with the foregoing provisions, the carrier shall not be liable.

12. It is hereby agreed that the property destined to such foreign countries, and assessable with foreign governmental or customs duties, taxes or charges, may be stopped in transit at foreign ports, frontiers or depositories, and there held pending examination, assessments and payments, and such duties and charges, when advanced by the company shall become a lien on the property.

To Destination Office: Oshkosh Wis

Consignee: Water Dept

Enter Date Shipped: Jun 18 192

Street Address or Non Agency Destination: R R City Hall

№ 2343

Name of Forwarding Office: **(636-P) Madison, Wis.**

Declared Value	Value Charges
50 00	

Piece-s	Article	Description	Weight	Express Charges
1	Roll blueprints		4	39

Shipper: F. T. Thwaites

Class	Paid Beyond	C. O. D.

Shipper's Street Address

PREPAID (Original)

Scale or Rate	Verified by	Return Charges Write in YES or NO
	Shepard	

1

(Form 12)

SHIPPER'S PREPAID RECEIPT

NOTE—The Company will not pay over $50, in case of loss, or 50 cents per pound, actual weight, for any shipment in excess of 100 pounds, unless a greater value is declared and charges for such greater value paid.

RAILWAY EXPRESS AGENCY

INCORPORATED

Received shipment described hereon, subject to the Classifications and Tariffs in effect on the date hereof. Value herein declared by Shipper to be that entered in space hereon reading "Declared Value," which the Company agrees to carry upon the terms and conditions printed hereon, to which the Shipper agrees and as evidence thereof accepts and signs this receipt.

Number of Pieces: 1

F. T. Thwaites — For the Shipper

Shepard — For the Company

Hour: 2 40 P M

Dec. 11, 1933

Mr. Albert E. Hintz, Manager,
Water Department, City of Oshkosh,
Room 8, City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

After you left the other day I talked over the matter of making the survey at Oshkosh with the head of our department, Dr. Leith. He thought that in view of present conditions I was entirely justifed in making a lump sum charge for the work. It was formerly the custom to charge cities only for actual expenses but an account of the cuts in salary it is no longer possible to do this. The work will be done during my vacation for I have my last class on Dec. 20 and plan to come up to Oshkosh the next morning. If agreeable to you I will charge fifty ($50.00) dollars for the job of rendering a report on the probable yield of wells, necessary spacing, chemical and bacterial quality of such supply compared with present supply, and so forth but will not touch upon costs. I gather that your department can estimate those after I have made my report. The above sum will include my expenses in the field, typing of report, blueprints and drafting provided not to exceed two nights be spent away from here. It will not include any second trip should such be necessary, nor supplying more than the number of copies of the report requested at termination of first trip. No chemical or bacterial analyses other than those furnished gratis by the State Laboratory will be included.

Very truly yours,

F. T. Thwaites

Dec. 18, 1933

Mr. Albert E. Hintz, Manager,
Water Department, City of Oshkosh,
Room 8, City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

I have not as yet recieved any answer to my letter of Dec. 11 giving terms for a survey of the water situation in your city. Please advise me if I am to come up on this coming Thursday or not. Under present conditions I cannot afford to make a trip without authorization in writing. If this letter crosses one to me please disregard it.

Very truly yours,

F. T. Thwaites

WATER DEPARTMENT
(GOVERNED BY COMMISSION)
CITY OF OSHKOSH
ROOM 8, CITY HALL

OSHKOSH, WIS.,

December 18, 1933

F. T. Thwaites
R. D. 4,
Madison, Wisconsin

Dear Sir:

I received your letter of December 11, 1933, regarding the survey that you will make at Oshkosh.

Your terms are entirely satisfactory to us and we shall be awaiting your arrival soon after December 20, 1933.

Yours very truly,

CITY OF OSHKOSH WATER DEPT.

Albert E. Hintz
Manager

AEH:Z

Mr. Albert E. Hintz, Manager,
Water Department,
Room 8. City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

I drawing up a map of underground water conditions in Oshkosh for my report I am unable to locate the well of G. P. Nevitt on Lake Drive for the reason that this party no longer lives on that street (1928 directory). Could you kindly supply the missing information?

I also found that my record of the well of Dixie Club could not be located. Is not this outside the city?

My notes on the well of the Carver Ice Cream Co. seem to be incomplete. Could you please call Mr. Faust and get the full figures?

The above will be greatly appreciated. I had a long talk with Mr. Warrick of the State Board of Health yesterday, also called up Mr. White in regard to the water supply at the Northern State Hospital.

Very truly yours,

F. T. Thwaites

MANAGER—THE MAYOR
SECRETARY—ALBERT E. HINTZ
SUPT. CONSTRUCTION—PETER GEFFERS
CHEMIST—H. J. SCHNEIDER

WATER DEPARTMENT
ROOM 8 - CITY HALL

City of Oshkosh
WISCONSIN

WATER COMMISSIONERS
LLOYD D. MITCHELL, PRESIDENT
CORPORATION COUNSEL
H. T. HAGENE, COUNCILMAN
GEORGE H. RANDALL, ENGINEER
A. H. SCHMIT, COMPTROLLER
SEC. OF COMMISSION

January 8, 1934.

F. T. Thwaites
Science Hall
Madison, Wisconsin

Dear Mr. Thwaites:

I received your letter this morning and wish to give you the following information:

Geo. P. Nevitt lives at 250 Lake Drive. He still has a well which is 5 inches, clay 65 feet, hard pan 67½ feet, lime stone to 110 feet, sand stone to depth of well 122 feet, water which is from surface.

In regards to the Carver Ice Cream Co. at 146 Merritt St.: They have a five inch well, clay to 80 feet, hard pan to 85½ feet, lime stone to 120 feet, sand stone to depth of well 145 feet, water 15 feet from the surface.

In regard to your question about the well for the Dixie Co.; wish to inform you that this well is located five miles out of the city of Oshkosh on the lake road. This well is a five inch well, clay to 10 feet, hard pan to 43 feet, lime stone to 70 feet, sand stone to depth of well 125 feet, flowing water.

Hoping this information is what you wanted and hope you are making steady progress on report. If there is any further information that you would like please do not hesitate to write me as you go along.

Yours very truly,

CITY OF OSHKOSH WATER DEPT.

Albert E. Hintz
Manager

AEH:R

Jan. 18, 1934

Mr. Albert E. Hintz, Manager,
Water Department,
Room 8, City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

Enclosed please find by bill for $50.00 for seven copies of my report on water supply at Oshkosh.

my
The reports and the maps of the city which you lent me are being sent via express prepaid. There was no map for Wards 1 and 8.

It is too bad that I was unable to finish the report for the meeting of yesterday but it was just out of the question. Mr. Faust replied that my copy of the log of the Universal Motors well was correct instead of his.

I did not take up the suggestion of public drinking water fountains as that would have to be financed outside the regular waterworks system.

Trusting the report is what you need, I am,

Very truly yours,

Additional copies of report will cost 15 cents each postpaid. Following our custom I will, unless you request me not to, file a copy of the report with the State Board of Health.

F. T. Thwaites

Jan. 18, 1934

Mr. Albert E. Hintz, Manager,
Water Department,
Room 8, City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

I am sending enclosed by bill for $50.00 for 7 copies of my report on water supply at Oshkosh. The reports and the maps of the city which you lent me are being forwarded by express prepaid. Please note that I did not recieve a map

WATER COMMISSIONERS
R. M. THIESSEN, PRESIDENT
FRANCIS S. LAMB, SECRETARY
HENRY P. HUGHES
JOSEPH P. STIER
FRANK H. JOSSLYN

ALBERT E. HINTZ, MANAGER

WATER DEPARTMENT

(GOVERNED BY COMMISSION)

CITY OF OSHKOSH
ROOM 8, CITY HALL

OSHKOSH, WIS.,

January 13, 1934

Prof. F. Thwaites
R.D. 4
Madison, Wisconsin

Dear Sir:

The Board of Water Commissioners is to have a meeting on January 17, 1934. Will it be possible for you to have your report in at this time?

If you will be unable to send us the report at that time, please write and let us know.

Yours very truly,

CITY OF OSHKOSH WATER DEPT.

Albert E. Hintz
Manager

AEH:Z

No. ______ 4540

DRAFTING ROOM
PRODUCTION ORDER
UNIVERSITY EXTENSION DIVISION

Name: Prof. Thwaites   Address: Private

Date Ordered: 1/15/34   Wanted: ______   Delivered: ______

Kind of Work	No. Wanted	No. Plates	Size of Plates	Rate	Price	Remarks
V.D.	1	1	3	10	30	Gordon 15
"	1	1	1½	10	15	
V.D.	1	1	1	10	10	
B.L.P.	12	1	1½	2½	45	map
"	12	1	1	"	30	Block diagram
B.L.P.	5	1	3	2½	37	section 6+5=11
B.P.	3	3	1	1½	14	Finger Lake
	2	1	1	1½	3	structure maps
				Total cost of work	$1.84	

Paid 1/15/34 [signature]

4+ 6+ 11

White = White Prints or Blue-line Prints
Pos. = Photostat Positives
Neg. = Photostat Negatives
BP = Blue Prints
VD = Van Dykes
Oil = Oiling Charge

PLEASE PAY BOOKKEEPER IN ROOM 107

Cost of Oshkosh prints

	15
	20
	45
	30
blue prints	1.10 12
stencils	1.30
postage	.15
Travel	10.00 200 mi @ 5¢
express	39

Table II
Hardness, alkalinity and Iron of ~~[illegible]~~ waters at and near Oshkosh

x .0582 hard. gpg | gpg | $CO_3 \times \frac{100}{60}$ 1.66 | $Fe_2O_3 + Al_2O_3$

gpg	Location	Source of analyses	Hardness ppm	Alk. ppm	Iron ppm		Total Solids
	SURFACE WATERS						
8	" "	M. S. Nichols State Lab	131	121	2.4	0.3	
10	City supply	H. J. Schneider	172	132	~~1.2~~	1.7	—
7	Fox River	Bull 35 p 635	Ca 26.2 mg 12.4 117	(110)	—	—	129
10	L. Winnebago (raw)	"	Ca 35.4 20.4 173	(168)	(2.5)	3.6	196
9	" (filtered) 1911	"	32.8 16.2 149	(102)	(1.7) —	2.4	182
10	"	"	33.4 19.0 162	(146)	(1.0)	1.5	192
7	"	"	26.2 12.4 117	(111)	—	—	129
	SHALLOW WELLS						
16	Watkins 16' well	"	8.35 16.0 275	(211)	0.4		372
19	CM STP & P RR 12 ft well	"	66.7 39.1 330	(320)	—	—	361
22	" 95' well	"	73.1 48.2 383	(288)	–	—	395
26	Am. Excelsior Co 30' well	H. J. S. no iron	471	311	2.0	2.8	—
41	316 15th St	"	717	345	2.3	3.3	—
26	735 5th	"	444	363	6.9 —	9.9	
40	1208 6th	"	688	509	2.5	3.6	
36	1342 Durfee	"	618	420	1.0	1.4	
31 av 28 1/2	947 4th	"	539	239	.8	1.1	
	DEEP WELLS						
47	Jackson - Algoma	"	814	201	3.7	5.3	
19	Wis. Match Co (small pump)	"	334	~~241~~	2.7	3.9	✓
15	J. L. Clark Co 110 ft well	" Iron	254	228	4.8	6.8	
18	Peoples Brewing Co	"	319	269	2.0 —	2.9	
22	" "	E. A. Siebel Co	383	245	5.6	8.0	
15	Paine Lbr Co	State Lab	~~250~~ ~~92 37~~	211	.7	—	—
22 1/2	ADJACENT CITIES						
22	Fond du Lac	State Laboratory	384	170	0.3		
31	Neenah	" "	540	243	0.15		
14	Green Bay	" " (1928)	237	192	0.8		~~186~~
44	Kaukauna	" " "	757	178	0.3		
18	~~De Pere east~~	~~Bull 35 p 250~~	319	258	0.6		427
17	De Pere (west)	Bull 35 "					
17	~~De Pere~~	State Lab	294	292	0.8		363

25 1/2

Green Bay 1933

265	162	.3
240	234	1.2
245	222	2.8
220	160	0
215	180	.5
240	192	0
6) 1425	1150	4.8
237	192	.8

De Pere

	H	A	Fe
1	280	188	.4
2	300	184	2.4
3	280	186	.3
4	275	184	.2
	4) 1135	732	3.3
	284	183	.8

Fond du Lac

385	170	.1
550	152	1.0
330	182	.2
420	164	.2
310	162	.1
350	206	.3
340	154	.2
7) 2685	1190	2.1
384	170	.3

✓ = Fount ■ = Weidman   Depths   Table 1

No	Owner	Elev	Red	Gray	Gravel etc	BR	St P	LM	T F	D	Gr	TD	WL
1	Greenkorn 364 ~~Power~~ Power	758 ~~768~~	75	87		(640) 118	~~139~~					139	9
2	Golf Grds	750	20	29		580 ~~170~~	ab ~~200~~	(580) 170	(200)	?		200	1½
3	City Golf	763	8	66		93 (670)	115					115	18
4A	Paine Lbr Co S	755	40	56		—	ab	510 245	T 300			300	flow
4B	" " " N	755	55	71		—	ab	510 245	T 335			335	"
5	Universal Motor	760	25	39			? ab	520 ?240	T 256	[illegible]		256	3
6	Newman N.Y. & Liberty	765	20	91		140 625	ab	150				150	22
7	A. Nelson 92 E N.Y.	755	32	53	redcl. 83	150 (605)	not P 13					150	11
8	North Park	750	15	102	sand 18	(620) 128						200	6
9	McMillan Co	760										398?	flow —
10	J.L. Clark Mfg Co	750										110°	—
11	J.F. Damke Fulton & Main	765	60	91		160 (605)	210					210	21
12	Greenlaw 69 E Irving	765	14?	95	clay 40-65	(585) 180	190	not St P?				190	22
13	Lamport 235 Hazel	755	20	75		145 (610)	171					171	4
14	H.M. Schmidt 174 Grove	755	7	82	buel 40-50	145	150					150	11
15	Judge Washburn	765	.	106		ab	234					234	—
16	S.H. Anderson 665 Main	765	20	85		645 120	128					128	15
17	H.E. Hanson 430 central	765	16	89		640 125	~~135~~ ab	138				138	16
18	Carl Wickert 53 Church	765	14?	93	buel 20-85	635 130	160					160	21
19	Commercial House Light & H.	760		100		(660+) ab	178					178	—
20	Fowler House	760		95		ab	134					134	—
21	T.R. Frentz	765	10	100		(565? 200)	ab	275				275	20
22	Algoma Fountain	760		92		—	ab	(460) 300		680	695	695	(flow)
~~23~~	~~J.P. Gould~~ 2nd 10th Alg & Jackson	750	(old well at WW)	20		690 080 70	455					~~455~~	~~100?~~
24	Pollock & Redford 453 Algoma	760	70	75		635 125	ab?	150		F		150	12
25	Wis Axle Co 571 High	755	50	76		(605? 150)	ab	195				195	11
26	S. Heyman 244 Wis	755	20	93		595? 170	ab	200	strong ?			200	20
27	Wis Match Co	750		50		650 100	275			698	698	698	0
	" " "computed"	750	—	50		111	ab	(468) ~~284~~ (350)	426	675½	667½	667½	0
28A 69	Faust B. Box Co	750	75	28	24	~~77~~	~~ab~~	~~284 (350)~~	~~491~~	~~635½~~		24	flow
28B	Am. Excl. Co											30	flow
29	Foster-Lothman Main & 4th											90	—
30	Morgan Co Oregon & 6th											300?	flow
31	Swift & Co Light St	755	40	ab		640 115	130					130	3
32	1st Nat. Bank	760	—	75		650 107	200	Tested at 190 gpm				200	3
33	U.S. P.O.	760	57	82		640 120	128					128	15
34	Eagles Club	760	10	78	9-79	620 140	200					200	8
35	H.H. Kimberly 421 Wash	755	18	91		620 135	185					185	8

Records of wells in Oshkosh, Wisconsin 38

No.	Name	Elev	Cl	Hp	Gr etc	BR	S-P	LM, T, F	D	Gr	TD	WL
✓36	Gust. Kruegor 84 Boyd	760	25	81		635 120	135				135	11
✓37	Ruhler EA 404 Wash.	755	38	93	so Cl 38-55	630 125	140				140	35
✓38	Oshkosh Northwestern	760	30	85		630 130	220	tested at 100 gpm			220	9
39	Tremont House (Hotel Hay ~~...~~)	760	~~50~~	80		650 110	205				126	—
40	Wis Pub. Service Lime Dale Broad St	750	35	48		(615) 135	155 Sh 156	not st peter (192)			192	5
41	Lutz, barn	765		10		665 100	—				100	—
✓42	Ketz, Frank	762	5	20		620 142	155				155	26
43	St. Vincent School	755	14?	20		620 135	200	202 tested 100 gpm			202	11½
44	Peoples Brewery 120 Oregon										360+	—
45	Oshkosh B. Co	—									600e 800	—
✓46	Beernteen, John 1124 Oregon	755	14	21		625 130	180				180	10
47	Horns Brew.	755		10		645 110	290				290	—
✓48	Oshkosh Trunk Co	755	45	46		635 110	ab	125			125	7
(49	~~Universal Motors~~ 89 Ceape	755	52	68		640 115	150	uncertain			150	7
50	Hicks Ptr. Co	759	49	66		645 114	160	~~not ...~~			160	6½
51	St Marys Sch	755	10	81		635 120	200	tested 100 gpm			200	11
52	Sacred Heart	755	17	—		655 101	200	(100 gpm)			200	12
53	Wis. Nat. Life	760	30	85		640 120	200				200	15
✓54	Butternut Bk. Co	765	83	98		~~...~~	ab	T (515) 250 ~~275~~			275	10
✓55	Nevitt, G P 250 Lake Drive	755	65	68		645 110	122				122	1
✓56	Anderson, L	770	13	107		650 180	190				190	25
✓57	St. Jozafat	765	65	91		—	ab	~~215~~			215	30
58	Guernsey Dairy	757	60	70		640 112	220	tested 100 gpm			220	10
✓59	Kuble, CB Bowen St	760	20	97		615 145	160				160	22
60	Radford Bros	750		50		640 110	423				423	—
61	Hooper, M (near Omro)	760		20		640 120	210				210	-
62	Gillan Bros Jackson & Marion	750		50		640 110	205				205	
~~63~~	~~Foster C courtsoller~~			~~10~~		~~68~~					~~68~~	
63	Hollister S 900 Algoma	760		30		650 110	425				425	
✓64	ST Peter School	760	45	61		654 106	200	tested 100 gpm			200	7
✓65	F. Boyce 228 Guenther	shallow 20	—		gr 25	33					33	7
66	Normal School	760		90		—	ab	(445) 315			633	—
67	Hollister Ames	750		60		660 90	175				175	
gn 68	Carver Ice Cream (67 sec 28)	765	80	86		(645) 120	145				145	15

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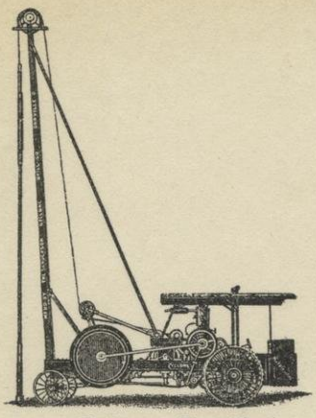


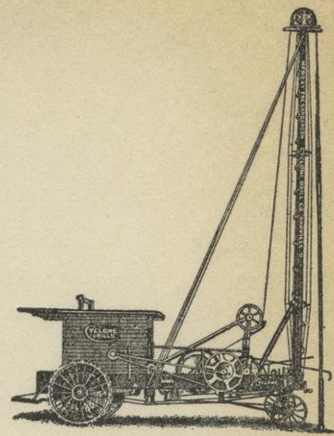
MATT. G. FAUST & SON

ARTESIAN WELL DRILLERS

DEEP WELLS, PUMPS, PIPE FITTINGS, ETC.

Thirty-five Years Experience

162 SCOTT STREET
OSHKOSH, WISCONSIN



Estimates Furnished

Telephone 3536

Jan 16, 1934

Mr.F.T.Thwaites
Science Hall
Madison Wisconsin

Dear Mr.Thwaites:

In regards to your letter of Jan 15, I am sory I made an error in the copy I gave the Water Board, the correct copy of the Universal Motor Co well is,
clay to 25 ft
hard pan to 38½
lime stone to 240
sand stone to dep of well 256
38½ ft of 8 inch pipe
water 3 ft of surfes,

In refering to the Wisconsin Match Co well I have no recoard Idrew up that log from menory simply to show Water Board where they could expect to get water,

My records of wells in the northwestren part of city show onleny one lime stone but the lower part is a sandy lime which I think is the second lime stone joining the first lime stone, in this sandy lime we often have small layers of sand stone which will preduse from 1 to 15 gal of water per minute.

I hope you will find this imfernation satisfactory and if I can give you eny more I will be glad to do so,

Please do not hesitate in asking.

Sincerely

Matt G.Faust

Matt G. Faust

Water supply for Oshkosh, Wisconsin

F. T. Thwaites

The problem

Geology

~~and~~ surficial deposits

bed rocks

Quality of water

Developed underground water supplies

~~Comparison of present~~

Present supply

Development of underground supplies

Comparison of present and underground supply

<u>The problem</u>. Oshkosh is one of the few cities in the Fox River Valley which uses surface water for its public supply. The others are Menasha and Appleton. In as much as the ~~public~~ city water in Oshkosh was unsafe for a long period of years and is still of rather unpleasant taste and odor particularly in the summer there has been periodic agitation to change to an underground source. The writer has ~~endeavored to~~ herein considered first, the possibility of developing an undergeound water supply adequate for the city, and second, how this proposed supply would compare in utility with the existing service and with surface water treated by improved methods. The cost of development of an underground supply is not treated in detail but several alternative plans are outlined.

<u>Geology-general</u>. Oshkosh is underlain by two distince classes of deposits, first, the unconsolidated clay, hardpan, and gravel at the surface, and second, the firm bed rocks below. Water occurs in both classes of deposits but in varying amounts.

<u>Surficial deposits</u>. The surficial deposits in Oshkosh were deposited by glacial action with accompanying waters. Such deposits are collectively termed "drift.". Information on the drift in the city was

Underground supplies have the great advantage in that they are cooler and have a more pleasant taste than do most surface waters. When taken from properly constructed wells they are decidedly safer. However, they suffer in comparison with lake and river water from a markedly greater hardness and the presence of iron.

secured from a very full set of well logs kept by Mr. Matt G. Faust, well driller, 162 Scott Street. The writer is greatly indebted to him for permission to make use of this data. Well logs and exposures in excavations show that the drift can be divided over most of the city into two distinct layers. On top there is a stony red clay from 5 to over 80 feet thick. This contains no water. Below the "clay" there is "hardpan" consisting of a mixture of limestone pebbles and boulders with clay and silt. It is gray in color and the thickness varies from a maximum of over 90 feet down to localities where it is absent and the clay rests on the bed rock. In a few places there are thin layers of blue clay either on top of or within the "hardpan". In one well (No. 7, see list and map) red clay is reported below the "hardpan". Along the south side of Fox River and at North Park sand and gravel occur in a layer a few feet thick either within or below the "hardpan". The "hardpan" contains no water but the sand and gravel does and is the source of the numerous shallow "fountains" along the river west of Oshkosh. No investigation was made of the gravel deposits west of the city but when the writer visited one of the pits in 1914, he noticed that this gravel lies upon bed rock and contains little or no water.

The total thickness of drift within the city varies from 10 to slightly over 100 feet.

Bed rocks. The bed rocks below Oshkosh are shown in the accompanying diagram where a block with sides running northwest and northeast has been split to show the structure. The bed rocks down to roughly 700 feet below the surface consist of limestone all of which contains magnesium and is therefore correctly called "dolomite", and sandstone almost all of which is cemented with lime. There are some very thin layers of shale. Below these relatively soft bed rocks which accumulated under the sea, there is granite and other hard rock most of which was once molten. The bed rocks down to the granite contain water but it is very irregularly distributed. The "hard rock" or "pre-Cambrian" contains little or no water. The upper or "soft rocks" can be divided into several distinct layers each of which is called a "formation". From the top down these are: (a) Black River limestone maximum thickness in the city about 100 feet, and contains little water, (b) St. Peter sandstone which is absent in many places as shown on the map but appears to have a maximum thickness of roughly 150 feet and contains considerable water, (c) Lower Magnesian limestone, maxiumum thickness roughly 140 160 feet but locally absent and which contains water only in crevices, (d) Trempealeau formation of fine grained limy sandstone and sandy limestone, thickness about 60 feet and only slightly water-bearing, (e) Franconia limy sandstone, thickness 120 feet, water-bearing, and (f) Dresbach sandstone, coarsest near bottom, averaging about 200 feet thick, and a good water producer. The bottom of the soft rocks is known to have been reached in wells No. 22 and 27 where granite was found under the sandstones. It was probably attained in the deeper wells at the waterworks and Oshkosh Brewery (nos. 23 and 45.)

Structure of bed rock. All the formations of bed rock slope or "dip" gently although irregularly toward the east. This fact is demonstrated by platting on the map the sea level elevations of some particular contact which is readily identified in well records. That chosen was the top of the St. Peter sandstone although no St. Peter can be distinguished in many wells. The unevenness of the dip is explained by the fact that the top of the pre-Cambrian is not level but is marked by hills and valleys. The later soft rocks have settled over this old surface so that we may predict the presence of a concealed granite hill by the rise in the overlying formations. This conclusion is verified in Oshkosh by the fact that the two proved discoveries of pre-Cambrian lie under a structural "high" whereas the other deep wells situated in lower places seem to have gone considerably deeper without finding hard rock. It follows that if we want to discover the maximum thickness of the soft water-bearing formations we must seek it in structural "lows". The map shows by its contours or lines of equal elevation that structural highs are located along Algoma Boulevard and in the northern part of the city and possibly southwest of the city. Lows occur between the two highs and south of the Algoma Boulevard high.

Map here
Table I

Quality of underground waters. In their passage through the earth all underground waters dissolve some of the material through which they pass. Waters which contain dissolved limestone or gypsum (calcium and magnesium compounds) are called "hard". Harness is generally computed in terms of limestone only (calcium carbonate) and the result may be stated either as "parts per million" or "grains per U. S. gallon". The terms "hard" and "soft" are generally used rather loosely for in a region of extremely hard waters for instance around Milwaukee or Chicago many waters which are somewhat less hard than the average are often called soft. Chemists usually consider that any water with a hardness of over 100 parts per million is "hard". Hard waters are not injurious to health so far as now known but are undesirable for many domestic uses When heated they deposit scale and they destroy a large part of the soap used in washing making a deposit of slimy insoluble lime soap. Another undesirable substance is iron. Iron is dissolved in great abundance near to marshes and where sulphide of iron in the rocks is undergoing dedomposition. Iron does not show in the water when first drawn but on standing or evaporation it is deposited as an unsightly stamin. It also promotes a growth of bacteria in the pipes which although not harmful to health cause obstruction. If more than third of one part per million of iron is present trouble may be expected unless the water is treated to remove it. The writer has not endevored to tabulate the full analyses of waters in and near to Oshkosh but has summarized in the following table what is known of the hardness and iron. Unfortunately few analyses show the iron alone so that all that can be done is to indicate the presence or absence of iron stains where the water is used.

The amount of hardness and iron varies greatly in the different formations. Mr. Faust stated that as a general thing both increase with depth. This fact renders the analyses of waters from Oshkosh thus far made at the city waterworks of little value as a criterion of what would obtain in the water from large wells ~~produced~~ pumped at a high rate when all formations are drawn upon. When a well is pumped at a low rate it makes little difference whether it is shallow or deep as the water nearest the surface makes up the bulk of the product. Unfortunately no analysis of the water from the deep wells of the Wisconsin Match Company could be secured when the wells are on full production drawing on all the productive formations. ~~The best that can be done is to consider the quality of the waters obtained from deep wells in adjacent cities on both sides of Oshkosh.~~ The similarity of geology however prohibits any marked difference in the waters beneath Oshkosh from those on either side.

Table II

Hardness is of two kinds: (a) temporary and (b) permanent. In the table the p0rtion which is temporary and is removable by boiling is designated as "alkilinity". The difference between hardness and alkalinity approximates the amount of permanent hardness. In only ~~one~~ two analyses in Oshkosh was the iron determined as such. In the others the amount stated is computed from a determination of iron and aluminum combined and is, therefore, at least three times too large. In many places iron stains in bubble fountains are the sole evidence of iron in the water.

Developed underground water supplies. The table at end of report summarizes the records of wells in Oshkosh which appeared to be important to the present study. On account of the unsatisfactory city supply there is a vast number of private wells ranging from shallow wells with a hand pump. Nearly every factory and many office buildings have private supply of drinking water. Of this multitude of supplies the only one which is at all comparable with what would be needed for a city supply is that of the Wisconsin Match Co. (No. 27). Little definite information could be obtained from the owners about this installation except that it is used only for air-conditioning the factory during hot spells in the summer. Of the two wells, each of which has a deep well turbine diven by an electric motor, only one is operated at a time. According to Mr. Faust, who drilled the wells, pumping 1060 gallons per minute lowered the water from surface to a depth of 50 feet. This is equivalent to a production of about 21 g.p.m. per foot of drawdown, a quantity called the "specific capacity" of the well. Until the lowering of the water reaches the top of the highest productive formation, here 100 feet, the yield is directly proportional to the lowering. A lowering or "drawdown" of 100 feet should, therefore, produce roughly 2000 g.p.m. or about 2,880,000 gallons per day. As the wells have never been pumped constantly for month after month, it highly doubtful if such a rate could be maintained indefinitely. According to Mr. Faust the pumping of these wells lowers the water 20 feet in a well opposite his house about 2850 feet away. Many reports of effects of pumping on adjacent wells are, however, without foundation, as the big well is not used all the time. The match Company wells do not affedt the shallow or drift fountains according to Mr. Faust but only rock wells. The radius of infulence is probably nearly a mile at present rate of production.

~~Of the shallower~~ ~~other wells~~ there seems to be no record of what the old wells at the waterworks would yield. These wells were all located within an area of a few hundred feet and unquestionably interfered with one another. At first they flowed into a reservoir but were later connected directly to the pumps. Such methods gave a yield which was only a small fraction of what could be obtained with modern deep well pumps or air lifts, for the water could not be lowered over 25 feet. It is improbable, however, that any of these old wells are large enough in diameter or straight enough to permit the installation of modern pumping machinery. Of the remaining supplies, the Oshkosh Brewing Company can pump ~~roughly~~ about 200 g.p.m. with a suction pump. The Oshkosh Northwestern well is pumped with an automatic air pump which runs only when water is drawn. Most of the factory wells are produced with small steam pumps which ~~produce~~ deliver not over 20 g.p.m. Mr. Faust states that the office building and school wells which he drilled will produce about 100 to 190 g.p. m. with a drawdown of ~~not over~~ 10 to 15 feet. This indicates a specific capacity of 6 to 10 from wells which for the most part do not enter the St. Peter more than ~~90~~ 100 feet.

Present city supply. The old water company first used eight artesian wells but abandoned them because of apparent lack of sufficient quantity of water It is also reported that the pumps drew so much sand from the wells that repair costs became prohibitive. For over 40 years the supply has been taken from the lake and for much of this time it has been filtered. Progressive experiments have steadily improved the quality of the product. At present treatment is carried out in a modern plant. It consists of the following steps: (a) addition of alum and activated carbon (charcoal), (b) aeration, (c) sedimentation in reservoir, (d) treatment with chlorine and ammonia with manual control, (e) rapid sand filtration, (f) storage in clear well, (g) second chlorination with manual control, (h) storage in reservoir, and (i) pumping into mains. Bacterial tests of the treated water are made daily and it is examined for free chlorine every hour. The bacterial quality of the treated water is now satisfactory but the temperature at which it enters the mains often reaches 77 F. in the summer. However, through much of the city the water is cooled by the ground to not over 70 F. Obviously in large mains where much water is being used the cooling is less than in residential districts. Aside from high temperature in summer the principal objection to the present supply is the taste and odor which are reported to be present in summer when the lake is high in organic matter.

It may be suggested that several improvements might still be made in treatment. At present the activated carbon is so mixed with mud that it is soon lost and moreover, it cannot absorb any of the chlorine taste as that is added afterward. It might be also applied directly before the water passes into the filters or else the water might be passed through a pressure carbon filter as it is pumped into the mains. It is reported that such a filter gives excellent results in one of the store buildings. It must be realized that the large amount of raw sewage which is discharged not far from the intake makes the treatment problem excessively difficult at Oshkosh.

It would be better to have the chlorine dosage regulated automatically so as to reduce overtreatment. Completion of sewage treatment works would greatly simplify the problem of water purification.

It is also possible to refrigerate the water as it passes into the mains. Such would unquestionably reduce the taste and odor problem and from the engineering standpoint is feasible. The financial aspect of the problem of refrigeration is, however, much more serious and it must be realized that the requisite machinery would be idle most of the year. It was also suggested that a hole several acres in area and 75 feet deep be dredged around the intake. In such a deep place the water of the lake would be cooled by contact with the earth. The writer believes that such a project would not be feasible not so much because of its cost (excavation would be almost all in the "clay") but because such a hole would receive so much rubbish drifted along the bottom by waves and currents that it would become very foul and stagnant. A much more feasible plan would be to place the bottom of storage reservoir much deeper in the ground than at present. The minimum earth temperature accurs at a depth of roughly 60 feet from the surface. At such a depth the stored water would be cooled by the earth to a very marked extent, the amount depending upon the rapidity with which water was changed. The low capacity of earth for conducting heat might make the results disappointing but nevertheless the writer feels that were the palnt to be built over agian such an idea might be more feasible than mechanical refrigeration. Another possible improvement would be to take the water from above the city where it is less polluted or to build an impounding reservoir in the lake. The water would be freed of organic growth by use of copper sulphate

Lake Butte des Morts

Softer?

~~Development of underground supplies.~~ The present maximum demand for water in Oshkosh is about 7 million gallons per day. As much of the city is as yet unsupplied with sewers it is probable that consumption of water will increase even if the population does not. The discussion of developed water supplies above showed that a deep well which produces 1,600,000 g.p.d. will affect wells nearly a mile away. It ~~certainty~~ seems reasonably assured that wells which produce 1000 g.p.m. or 1,440,000 g.p.d. should be spaced at least a mile apart. If we calculate on needing 8 million g.p.d. in the near future six such wells would be needed at once without allowing for any reserve in case one or more has to be shut down. Two distinct plans must be considered: (a) a unit well system of six isolated wells throughout the city discharging ~~raw~~ water into the mains and (b) six wells preferably all in a line ~~about a mile between each one~~ discharging water to the present treatment plant where it would be softened and if necessary freed of iron beforebbing pumped into the mains. Before starting with either plan a test well down to the pre-Cambrian ~~which~~ is most desirable. Such a well should be at least 6 inches in diameter so as to permit installation of a deep well turbine for test purposes. The geology should be carefully checked by means of samples taken every five feet. Whenever an important water-bearing formation has been passed through drilling should be stopped and a test run for several days. The test should include measurments of discharge and drawdown as well as water analysis. The effect on ~~adjax~~ other deep wells should be noted wherever possible and conclusions should not depend upon hearsay only. The test well should not be located too near to old wells for the reason that there waters from different formations may "short circuit" through the open hole of the old well and thus give misleading results. The writer suggests a site on or near to South Main St. not far from 12th Street. This place is low on the geologic structure and is close to the 12 inch main in case the well should be used. Such a test might seem costly but the information obtained would enable a much more intelligent to be reached than is now possible.

Another favorable site would be not far from the north side of North Park. The north west part of the city is unfavorable because the St. Peter sandstone is absent in so many places that no idea could be gained of its capabilities. The drilling of a test well and its thorough study should precede any decision either to keep the present supply or to embark on either of the proposed plans of underground supplies.

Unit well system. It is difficult to design a system of 6 wells sufficiently spaced which are at the same time located in favorable geologic situations and not too far from existing large water mains. The present system of mains is planned to take water from the lake only. Large parts of the city have no mains larger than 6 inch. A 16 inch main leads from the waterworks to North Main St. A 12 inch main leads north to Parkway and west to North Main and another goes south on Main to 12th. The northwestern part of the city is supplied by 10 inch mains. For taking the discharge of a large unit well it is desirable that a 10 or 12 inch main lead away from it for some distance. Tentative locations for unit wells are (1) Waterworks, (2) South Main and 12th, (3) South Park, (4) Josslyn and First Ave., (5) near center of 12th Ward, and (6) near corner of Broad and New York. Three of these locations (3)(5) and (6) would require extensive new mains to take care of the water economically. Exact locations would have to be determined by (a) suitable vacant or reasonably priced properties and (b) the amount of St. Peter sandstone present. Judging from the experience of the city of Madison each well with lot and pumping equipment will cost about $20,000, or a total of roughly $120,000 without the necessary changes in mains. These would probably bring the total to around $200,000. The pumping and maintenance costs of a unit well system are necessarily higher than those of a central plant with surface water.

__Treatment plant system__. In as much as the water from unit wells cannot economically be treated to reduce the hardness and iron both of which it seems probable from Table 2 would be greater in well water than in the lake, it would seem desirable to lead all water to a central plant where such treatment could be applied. To locate sufficent wells within the city not too close to oneanother and yet within economical distance from the present waterworks seems almost impossible. The present treatment plant which could be converted at less expense than the erection of anew one is not so located but that several miles of large water main would be needed to bring the product of wells to it. The writer will hazard no estimate of the cost save that it undoubtedly would be much greater than the cost of the unit well system.

Comparison of present and underground supply.

__Safety__. The present water supply ~~would~~ seem to be as safe as any can be made as demonstrated by the routine tests and the history of typoid cases in the city. According to information from the State Board of Health typoid is endemic is Oshkosh and is probably spread by unsafe private wells. Many of the private wells are lined with steel pipe which soon rusts out. Some of them are piped only through the clay. Some are ~~inxthex~~ at least in part old dug wells and without doubt a vast number have unsafe tops which permit the easy entrance of contaminated waters. Were large city wells to be operated over a long period of time the private wells would in large part be dried up ~~but~~ each neglected well would ~~present~~ a danger point where unsafe water might be drawn down ~~and~~ into the lower formations. The experience with unsafe and abandoned wells at Fond du Lac demonstrates that such subsurface contamination of deep wells is probable in Oshkosh. The writer recommends that all well supplies for the city be chlorinated. ~~With~~ clear well water ~~this~~ would not affect the taste to a meterial extent.

Hardness. The analyses tabulated in Table 2 show that beyond serious question the present supply is decidedly softer than any which can reasonably be expected from wells. The waters from the ~~rather thin~~ gravel bed along the river seem to be $2\frac{1}{2}$ times as hard as the present supply. This fact coupled with the limited area and thickness of gravel removes this source from consideration. If we could get enough water from the St. Peter and possibly the upper part of the Dresbach sandstones, a fact not demonstrated at present, we might be able to supply the city with water no harder than that obtained at the Peoples Brewery and at Fond du Lac. Such water would be roughly twice as hard as the present supply. It will be noted that the waters at Neenah and Kaukauna run up to over four times as hard as the lake water. The single exception is the reported hardness at Green Bay. In view of the ~~abundant proof of high~~ testimony of other adjacent towns the writer is convinced that the water there must actually be obtained at a shallow depth and not from the supposed source. As a general rule the hardness increases with depth. According to Mr. Faust the hardest water was obtained from the very bottom of the Wisconsin Match Company well.

Iron. Although the present city water contains iron it is probably derived from corrosion of the pipes and is not present in the lake. Unfortunately the existing analyses of well waters in Oshkosh do not indicate the true amount of iron. observation of bubble fountains demonstrates that almost all of the factory supplies give bad iron stains. Some report trouble with clogging of the pipes. Mr. Faust reported that the most iron was found in the bottommost water at the Wisconsin Match Company. The Paine Lumber Co. wells with 0.7 p.p.m. of iron derive their water from the Trempealeau formation which contains much iron. No trouble was reported with iron at the Oshkosh Northwestern or the breweries and it is not a problem in adjacent city supplies. It is, therefore, not certain that with the avoidance of the lowest Dresbach water iron would be serious in a city supply but on the other hand it might well be.

Temperature, taste and odor. The present city supply is too warm for drinking in hot weather. A well supply would yield water to the mains if untreated at a temperature of about 52 F. Observed private supplies were supplying water at the bubblers near est the pump at from 43 to 54 F. ~~Thexadvantage~~ So far as observed the well supplies with the possible exception of the lowest water are free from objectionable taste and odor. The advantage of wells in giving cool water would be decidedly lessened if the water is treated although exact data on the resultant rise of temperature in summer are not at hand.

Conclusions.

(1) Sufficient underground water can be secured to supply the city of Osh kosh if wells are spaced far enough apart.

(2) the best well water which existing information indicates is present is ~~roughly~~ about twice as hard as the lake water.

(3) Iron might prove to be a serious drawback to well supplies although it could easily be removed in a softening plant.

(4) well supplies would not be permanently safe without chlorination.

(5) the unit well system would be cheapest but the water could not be softened. Treated well water would be very expensive

(6) ~~the~~ a change to ~~harder~~ untreated well water would cause much trouble with hot water fixtures and boilers which now use city water and would affect other industrial users of water such as laundries. It would force upon the public the installation of private water softeners, few of which cost less than $100 each installed and in many homes ~~this~~ would involve extensive changing of pipes.

(7) Well water would be cooler and freer from taste and odor than the present supply, but the present supply could be decidedly improved in all respects except that of high summer temperature which could only be improved by expensive alterations

(8) It is for the citizens of Oshkosh to decide which system they desire, that which furnishes the best drinking water or that which best meets the ~~needsxof~~ requirements for other purposes which consume by far the largest part of the supply. A well supply will in any case be more expensive than the present

City of Oshkosh—Legal Dept.

LLOYD D. MITCHELL, Corporation Counsel

Jan. 16, 1934

Mr. Albert E. Hintz, Manager,
Water Department,
Room 8, City Hall,
Oshkosh, Wisconsin

Dear Mr. Hintz:

Yours of the 13th did not reach me until last night. I am sorry to say that it will not be possible to complete typing the report in time to reach you tommorrow. I expect I have spent more time on it than I should have but as I got interested in the problem went farther into it than I need have. However, the seven copies will be ready to send in a few days as it must be out of the way for another rush job.

Thank you for the letter answering mine about some of the well records. Since then I wrote Mr. Faust about another record which did not check with his copy.

The drawings are now all blueprinted. The text will be mimeographed for with so many copies it would have taken two typings on the carbon system. I have talked over the matter of costs with our superintendent, Mr. Smith so can give a reasonably correct estimate for a unit well system. A treated water system would cost much more but it would be a big job to figure this out.

Sincerely,

F. T. Thwaites

North Park
200 ft 6" well
72 ft of clear sand stone

Sacrad Heart school
200 ft 6" well
100 ft of clear sand stone
pumping 6000 per hour ✓

Wis National Life Ins. Co
200 ft of 6" well
80 ft of clear sand stone

First National Bank
210 ft of 8" well
103 ft of clear sand stone
pumping 11400 Gal per hour = 6)1140 (190 6 54

Universal Motor Co 140 error in my notes?
256 ft of 8" well
116 ft of clear sand stone 3 ft below the surface

~~Eagel's Club house~~
~~Eagles Stable~~ house
200 ft of 6" well
60 ft of clear sand stone
8 ft below the surface

1060
60)63600
60
30

Wisconsin Match Co.

12 inch well 698 ft deep
pumping 63600 gal.per hour
a draw down of 50 ft. in 10 hours pumping
effecys wells ½ mile away
makes a draw down of 20 ft. on well¼ mile away
this well is only pumped in extreme hot weather
this well has 600 ft of sand stone of which 200 ft is good clear water bearing sand stone 400 ft of it that is filled in with a matter of other rock such as lime slate and shale and is not water bearing

698 ft.

soil

50 ft.

lime stone not water b[illegible] bearing

50 ft

good clear sand stone water Bearing

175 ft

sand stone not water bearing

400 ft

good clear sand stone water bearing
water is very hard and contains a large quantity of iron

23 ft

Granite

T. R. Frentz 494 Jackson St
275 ft of 5" well
75 ft of clear sand stone

Butter nut Baking Co. Main St
275 ft of 5" well
25 ft of clear sand stone

St Jozafat School
215 ft of 6" well
no sand stone
pumping test 900 Gal pe hour

not over 20' d d

6)90(15 gpm
6

~~Daily~~ Dairy Northwestern
220 ft of 6" well
90 ft of clear sand stone
pumping 6000 Gal per hour

100 gpm

Guernsey Dairy Co. 36 State St
220 ft of 6" well
pumping 6000 Gal per hour

St Peters School
200 ft 6" well
100 ft of clear sand stone
pumping 6000 Gal per hour

John F. Danke corner of Fulton & Main St
210 6" ft well
50 ft of clear sand stone

St Vincent School
202 6" ft well
73 ft of clear sand stone
pumping 6000 Gal. per. hour

St Mary's School
200 ft 6" well
80 ft of clear sand stone
pumping 6000 Gal. per. ~~hour~~ hour.

Pain Lumber Co ~~Sou~~ South. side of rive
300 6" ft well
55 ft of clear sand stone
north side of River
335 ft well
90 ft 6 of clear sand stone

Science Hall,

Univ. of Wisconsin,

Madison, Wis.

Jan 15, 1934

Mr. Matt G. Faust,
168 Scott St.,
Oshkosh, Wisconsin

Dear Mr. Faust:

In checking over the well records you so kindly let me copy when in Oshkosh I find that there is a conflict of figures with the record of the Universal Motors well in the northeast part of town. I have depth to Sandstone given as 240 feet making the sandstone one of the lower ones instead of the St. Peter. Your copies which you made for one of the Water Board give this figure as 140 feet in which case it would make the sandstone the true St. Peter of "first sand". Could you please tell me which figure is correct.

I find that the St. Peter is absent in many wells especially in the northwest part of the city and along Algoma Boulevard. The confidental log of one of the Wisconsin Match Company wells which I have also shows no St. Peter whereas your log shows no "Second lime". I have assumed that the two wells are different. In a number of wells, particularly the T. R. Frentz and S. Heyman wells, the sandstone occurs at a level such that I have concluded that it must be a "stray sand" in the "second lime."

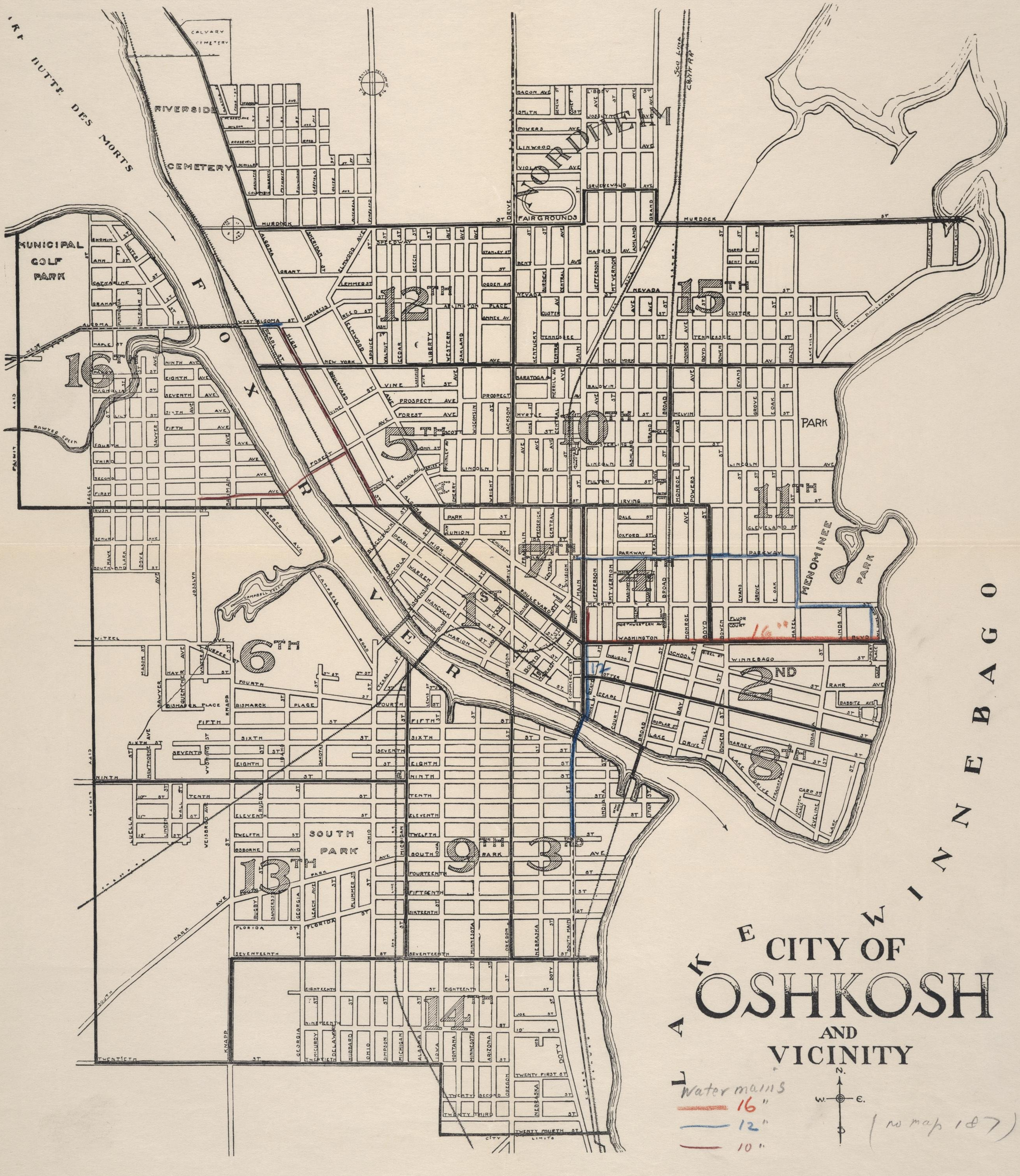
I will greatly appreciate any help you can give me and will send you a copy of the list of wells and the maps. The full report must, of course, be delivered first to the Water Board.

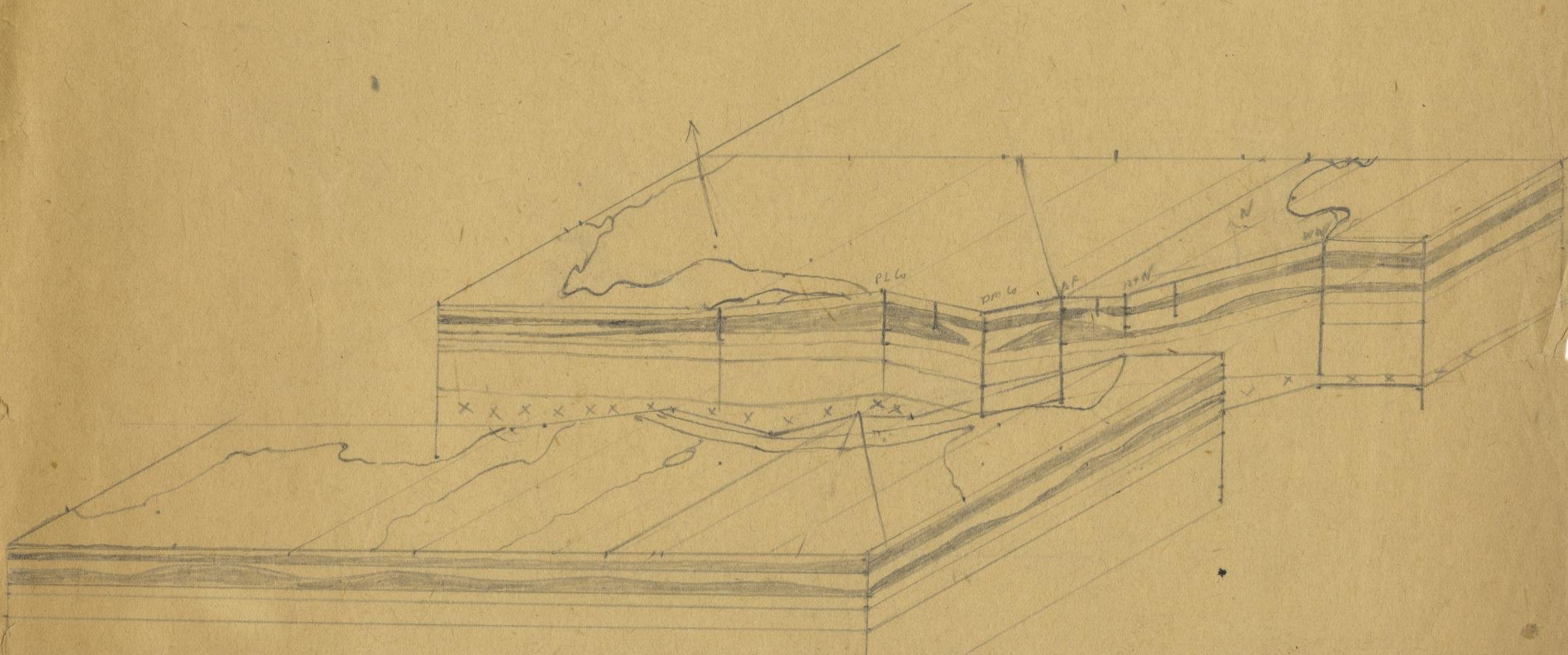
Sincerely,

F. T. Thwaites

City of Oshkosh—Legal Dept.

LLOYD D. MITCHELL, Corporation Counsel





PLG
DMG
AF
N
WW

City of Oshkosh—Legal Dept.

LLOYD D. MITCHELL, Corporation Counsel