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Physical Science

THE CHARACTER OF MINNESOTA WELL WATERS, WITH SPECIAL EMPHASIS ON THE ST. CLOUD REGION AND STEARNS COUNTY

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Information relative to the character of Minnesota well waters was first published by the Minnesota Geological Survey in Bulletins 22, 31, and 32 in 1932, 1944 and 1947 respectively. Stearns County is included in the survey in Bulletin 22, by Allison, (1932) in which analyses of 14 wells are reported. The present study comprises 40 wells in the St. Cloud region, 104 in Stearns County (including the 40 in the St. Cloud region), and 350 for the state of Minnesota (including the 104 in Stearns county).

The analyses of well waters reported here were made by rapid volumetric and colorimetric methods. These are now quite accurate and have reached a rather high degree of precision with the introduction of new methods and refinements of the old standards brought about in recent years. Total hardness, including a separate determination of magnesium, is now measured accurately by the Versenate method, which represents a very distinct improvement over the old soap solution method. The bicarbonate, carbonate, hydroxide, sulfate, and chloride radicals, too, are measured exactly by standard volumetric methods of titrimetry. By converting the components listed above into positive and negative ion equivalents it is a simple matter to calculate the total sodium and potassium components. Certain mineral constituents of water may be determined more accurately by gravimetric analysis, but it is questionable whether the higher degree of accuracy is necessary in view of the extra time and expense involved.

Table I lists the data obtained by analysis of water from 350 wells scattered over the whole State of Minnesota. There is a wide range of components from the minimum to the maximum values. The water is definitely hard. The average total hardness is 370 parts per million or 21 grains per gallon, 75% being of the carbonate type often designated as temporary hardness. Calcium and magnesium occur in the ratio of 3 to 2. 95% of the samples of water examined had a pH between 7 and 8.4, 2% were over 8.4, and 3% were less than 7. Sulfates occur in moderate amounts generally. Iron was present in 77% of the samples and manganese in 37%. Since the combined iron and manganese content is usually greater than 0.5 ppm (the critical value), city supplies

TABLE I
ANALYSIS OF WATERS IN MINNESOTA
(All figures, except pH, represent parts per million)

	Mississippi River†	St. Cloud Area	Stearns County Area	Minnesota			Remarks (Minn. wells only)
				Max.	Min.	Av.	
No. of wells	—	40	104				350 wells
Total hardness	133	314	367	1580	0	370	
Total solids	220	469	581	3368	32	604	
pH	7.4	7.4	7.6	8.6	6.4	7.6	Greater than 8.4 — 2% Less than 7 — 3%
Iron as Fe	0	1.1	1.5	30	0	1.3	Present in 77% of samples
Manganese as Mn	0	0.2	0.16	3.2	0	1.3	Present in 37% of samples
Alkalinity (M)	150	240	293	530	20	281	
Alkalinity (P)	—	—	—	140	0	29	Present in 2% of samples
Sulfates as SO ₄	21	79	90	1065	0	130	Present in 79% of samples
Chlorides as Cl	13	20*	38	653	0	32	10 ppm or less in 57% of samples
Calcium as Ca	32	76	88.4	1000#	4#	222#	
Magnesium as Mg	12.7	29.8	35	650**	5**	148**	Ca/Mg = 1.5
Sodium as Na	18.4	16.3	32.2	—	—	32	
Bicarbonate as HCO ₃	170	292	357.4	—	—	342	

† Averages of samples over a 10 year period, taken at St. Cloud.

* Exclusive of St. Cloud Reformatory wells. Average for 5 wells analyzed was 260 ppm.

As CaCO₃

** As Mg(CO₃)₂

normally need treatment for their removal. While the average for the chloride content is 38 ppm, 57% of the wells listed had less than 10 ppm. Sodium and potassium salts account for only 6.5% of the total salinity.

A comparison of well waters from the St. Cloud area and Stearns County with that of the State as a whole and the Mississippi River is also made in Tables I and II. It is evident here that well waters in Stearns County are essentially the same as those of the State. In the St. Cloud area salinity and hardness are definitely lower than in the county and state, but decidedly higher than in the Mississippi River. Bed rock is exposed in several places at St. Cloud. In view of the moderate thickness (30 to 100 feet) of the drift in this vicinity, wells are shallow and of the surface type. Water veins commonly occur in loose sand, gravel, or open-textured materials, and are often replenished by local precipitation. This accounts for the fact that well water in this area is about 20% softer on the average than in Stearns County and the State. The average hardness is 314 ppm or 18 grains per gallon, which is 136% higher than the mean value for the Mississippi River. St. Cloud wells generally have an iron content of over 1 ppm and must be treated for its removal if they are to constitute the future supply for the city.

TABLE II

Percentage of Total Solids Dissolved in Minnesota Waters

	Mississippi River	St. Cloud Wells	Stearns Co. Wells	Minnesota Wells
Fe ₂ O ₃	0.0	0.4	0.4	0.3
Ca	17.6	20.6	18.9	17.9
Mg	7.0	8.1	7.5	7.3
Na	10.1	4.4	6.9	6.5
CO ₃	46.7	39.6	38.7	34.9
SO ₄	11.5	21.4	19.4	26.5
Cl	7.1	5.5*	8.2	6.5
Total	100.0	100.0	100.0	100.0
Salinity	182.1	368.8	465.6	490.7

* Exclusive of St. Cloud Reformatory wells.

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