patch of land. This well was sunk in April, 1913, and at a depth of 192 feet water was found under conditions which were predicted in the report.

Quality of Water.—Well water in the prairie districts is charged with lime salts, caused by contact with different kinds of limestone. This is common to almost all well waters in the West. As already stated, when the ice sheets were passing over the country a large quantity of rock was transported. The harder rocks survived the process of crushing better than the soft rocks; hence it is that in some districts hard rock boulders are to be found on the surface. It is estimated by the geologists that about 90 per cent. of the surface boulders are of hard rock and 10 per cent. soft rock, but in the substrata the proportions are reversed, and we find 90 per cent. of gravel is limestones of various kinds.

Water readily absorbs salts and gases, and, consequently, in its passage through the soil and different stratas, mineral salts are being absorbed. In addition to salts, water absorbs gases, and, as carbonic acid gas is present in the air and in the ground, it is taken up by the water, and this increases its solvent powers. When the water finds an outlet to the atmosphere, such as in the form of springs, some of the carbonic acid gas is lost and it becomes less heavily charged with lime and, consequently, a limited natural softening process takes place.

The water as supplied to Regina, for instance, contains carbonate and sulphate of lime and carbonate and sulphate of magnesia and other chemical constituents. These salts cause the water to be "hard," and the problem is how best to soften it. Hard water used in boilers causes sludge and scale to be formed, and these in time not only reduce the efficiency of the boiler, but also tend to cause overheating of the plates and other troubles.

The hardness of water is usually divided into two classes, namely, temporary hardness and permanent hardness. As already explained, water absorbs lime salts more readily when it contains carbonic acid gas. By heating the water, this gas is driven out and the carbonate of lime held in solution by means of such gas becomes insoluble, and its greater part, together with magnesium carbonate, is precipitated and forms sludge. Temporary hardness is that part of the total hardness which is precipitated by boiling.

Boiling will not have the same action on the sulphate, chloride or nitrate of lime or magnesia, as these salts remain soluble. Permanent hardness represents these salts as well as the parts of the carbonates of lime and magnesia not precipitated by boiling. Temporary and permanent hardness, however, are relative terms, to denote the characteristics of hard waters.

Apart from the use of hard water for industrial purposes, it is of importance to consider it from the domestic viewpoint. One part of carbonate of lime decomposes 6.12 parts of stearate of sodium, and, as soap usually contains only 60 to 70 per cent. of stearate of sodium, about 9.5 (say, 10) parts of soap are required. Consequently, if 100,000 gallons of water per day are consumed in washing, cleaning and other purposes, in which operations soap is necessary, it is a simple calculation to ascertain the consumption of soap necessary to produce lather.

Each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is equivalent to 10,000 gallons of water, requires about ten pounds of soap to obtain lather. This is equal to 100 pounds per 100,000 gallons. Water obtained from wells in the prairies contains, say, 20 parts of carbonate of lime per 100,000, so that the total theoretical consumption of soap will be 2,000 pounds per 100,000 gallons.

Soap is retailed at about ten cents per pound; therefore, one ton of soap will cost about $200, or about $2 per 1,000 gallons.

We will now consider softening of the water by means of lime. Carbonate of lime, $CaCo_3$, is nearly insoluble, but when carbonic acid gas is present, soluble bicarbonate of lime is formed. Dr. Clark's process, which has been in operation all the world over, in one form or other, for about half a century, consists of adding quicklime or slaked lime to the water, with the result that the active lime at once combines not only with the excess dissolved carbonic acid in the water and forms the practically insoluble carbonate of lime, but also robs the bicarbonate of lime of its semi-combined carbonic acid, so as to effect practically a total precipitation of all the lime present as carbonate. The active lime thus effects exactly the same result as would be produced by boiling.

In softening water by adding lime, theoretically, 0.56 parts of quicklime is required to remove each one part of carbonate of lime in 100,000 parts of water. In practice, however, more quicklime is required. Adopting the same basis for calculation, as is the case of the soap consumption, each part (or one pound) of carbonate of lime per 100,000 parts (or pounds), which is the same as 10,000 gallons of water, requires 0.56 parts or pounds of quicklime to remove the carbonate of lime. This is equal to 5.6 pounds per 100,000 gallons. The water contains, say, 20 parts of carbonate of lime per 100,000, so 112 pounds of quicklime are necessary. With lime at one cent. per pound, the cost of softening such water is $1.12 per 100,000 gallons, or 12 cents per 1,000 gallons. The actual cost will probably be nearly twice as much. It will thus be observed that softening by lime is, theoretically, about eighteen times cheaper than by soap.

Prairie water, however, as already stated, contains other salts than carbonate of lime, and we will see what it means to adopt a softening process to reduce them to an economical minimum. That will mean the adding of quicklime as well as soda ash.

Assuming that prairie well water contains:—

20 parts per 100,000 of calcium carbonate.
3 parts per 100,000 of magnesium carbonate.
15 parts per 100,000 of magnesium sulphate.

The quantity of quicklime to remove the calcium carbonate with the theoretical amount already mentioned, 112 pounds per 100,000 gallons.

The theoretical quantity of soda ash necessary to remove most of the magnesium carbonate will be 37.6 pounds, and to remove the magnesium sulphate 130 pounds per 100,000 gallons.

The cost will, theoretically, be:—

112 pounds of lime at one cent per pound....	$1.12
167.6 pounds of soda ash at three cents......	5.03
Total	$6.15

The cost of lime and soda is, therefore, equal to about six cents per 1,000 gallons, but in actual practice it will be more. To this must be added the cost of labor, superdivision, capital charges, etc. As the cost is high, it is desirable to ascertain to what extent the hardness can be reduced, having regard to our local conditions with respect to cost of labor and materials. But this the author will not follow further at present.

Before any softening scheme can be undertaken with any degree of confidence and satisfaction, it is essential to obtain results of mineral analysis of the water to be treated, which is different to sanitary analysis. It must be clearly understood that the foregoing figures are only approximations submitted to illustrate the nature of the problems confronting the engineers in the West.