the fill has caused a settlement of the underlying ground and a consequent elevation of the prairie close by. This movement has been evident mostly in the surface stratas, but the blue clay has doubtless been affected also.

The bearing capacity of the blue clay is questionable. Few experimental tests have been made from which authoritative information has resulted. Most of the present knowledge has been gained from buildings which have been damaged by settlement. This knowledge is sufficient, or should be, to prevent further repetition of founding anything but the lighter structures on this hazardous material. And even then, architects and engineers should warn their clients in advance of the probability of some future settlement or movement, either from the structure's own contained weight or from its proximity to some piece of construction that may cause settlement.

As the city grows and expands larger and deeper excavations for buildings, sewers, waterways, subways, etc., are inevitable. It is impossible to prevent some loss of ground, and even though this loss may not be and probably is not noticed at the time, the surrounding clay is sure to find the void and fill it.

The hardpan, sand, gravel and gray clay, when free from water, has usually a greater bearing capacity than the blue clay. The hardpan, particularly when dry, is very firmly compressed and cemented, and at times is almost as difficult to excavate as rock. When it is wet it is more readily opened up. The gray clay, due to the presence of sand and gravel mixed with it, is also firmer when dry than the blue clay, but if submerged it becomes a semi-liquid.

There seems to be no regularity in the arrangement of this conglomerate stratification, and it is extremely unwise to assume that the arrangement and class of material found in one boring or test pit holds good for a large adjacent area. However, the arrangement of this stratafication is not so important as the question of its being submerged. In the latter event its bearing capacity is certainly less. It and the underlying rock are both water-bearing, and under normal conditions they are submerged. Directly under Winnipeg the quantity of water is very much reduced and in some places entirely absent. This can doubtless be accounted for because the city and many privately owned wells are exhausting the water from this immediate section, for there is ordinarily an abundance of water in these stratas several miles from Winnipeg.

With the completion and use of the Greater Winnipeg Aqueduct, the city and owners of privately operated wells will doubtless cease pumping to a very large extent from their present source of supply. The inevitable result will be that the subterranean water will once more rise above the stratas overlying the rock.

This brings up an interesting question. Has this stratification already become sufficiently impervious from compression that a later saturation will not materially affect its bearing capacity? This question is worth careful consideration, and wherever accessible this material presents a fruitful opportunity for investigation. Also, to what extent will the alkalinity of this subterranean water cause a deterioration of concrete submerged in it? The engineer in charge of one piece of construction in Winnipeg has been so impressed by the possibilities of disintegration in concrete, that he has had it waterproofed to prevent contact with this water. To the writer's mind this is rather a costly procedure. In view of the fact that any disintegration would probably not penetrate more than an inch or so beyond the other surface, would it not be cheaper to make the piers a couple of inches larger to start with. However, the point is worthy of consideration and investigation.

We come now to a consideration of the limestone stratification. As has been pointed out in another part of this paper, the limestone was deposited in comparatively horizontal layers, varying in thickness from a few inches to several feet, and separated from one another by thin bedding planes of clay. In many cases the top layers of the stone are quite seamy and should be removed. No rock should be left that does not give forth a solid sound from a sharp blow of a sledge. With this test fulfilled the bottom is doubtless good for far more load than will be placed upon it.

Types of Foundations.—We may group the different types of foundations under the two main headings—the floating type, and the deep type—for every foundation in this district comes under one or the other of these classifications.

Floating Types: By floating type we mean those foundations which consist of spread footings, or a mattress (continuous or semi-continuous), resting on the blue clay or surface stratas, and depending on these stratas for their support.

The spread footings are, as the term implies, spread over a larger area than the wall or column presents and are intended to distribute the loading over a larger ground area.

These footings are usually made up of masonry or concrete and some of the oldest buildings have an additional timber pad next to the clay.

A mattress is merely an extensive spread footing and is continuous if it covers the entire area occupied by the supported building, and semi-continuous if it only supports adjacent walls or columns. The mattress is strengthened by reinforcing bars or grillage beams.

A mattress is far superior to spread footings in that it will prevent serious distortion and consequent cracking of the superstructure in event of unequal settlement in the building.

Deep Types: Those foundations which depend on receiving their support directly from the rock or the strata immediately overlying it by means of piles or piers are usually termed deep foundations.

Practically all the piling used in this district up to the present is of wood, but doubtless concrete piling will supplant the timber.

Timber piling, if completely submerged by water, will last indefinitely, but where the piling is partly or wholly out of the water, or is intermittently exposed to water and air, its life is considerably shortened. Of the available timber for piling, cedar seems to be the most durable under these conditions, with a life of perhaps 20 years, whereas tamarac is good for about 8 years and fir and spruce still less. The life of a timber pile embedded in the blue clay is problematical, and presents a subject well worth careful investigation. I have removed both cedar and oak piles from this clay and found them as sound as the day they were driven. On the other hand, I have removed tamarac and spruce piles which were in a very advanced stage of decay. It is, of course, possible that these piles were in poor condition before driving. It may, however, be just as true that the clay does not contain sufficient moisture to prevent some kinds of timber from rotting.

Concrete piling, either of the precast or poured-in-place types, has been used very little in this district. While they are more expensive in the first cost than the