filing purposes. It is helpful also, where the topography is complex, to have a small scale map to bring out the general features of the country more prominently than is possible with several separate maps. In transferring topography to the small scale map it is essential to transfer the street lines and main drainage lines and divides with a fair degree of accuracy. The absolute correctness of intermediate points is not so essential since final locations and estimates will be made from the large scale maps. These maps will be of great value in future municipal work if they are filed in the city offices so as to be available.

The method of preparation of these maps will depend largely on the tastes and previous experience of the engineer in charge of surveys. It is possible to make fairly good maps by the method of transit topography and a draftsman to plot the transitman's notes, but the cheapest and most accurate method is by plane table surveys. By this method there is so much less detail left to the draftsman's imagination. It is necessary to use the transit and level to secure adequate control for plane table surveys, and distances, such as length of streets, should be chained unless accurate maps showing such lengths are available. In open country a transit survey to locate control points not less than 1,000 feet apart should be made and level bench marks established every 1,000 feet in distance and at least every 20 feet in elevation. With the control points plotted on plane table sheets about 20″ by 30″ and a party consisting of topographer, recorder and rodman, maps can be made which will be superior in their general accuracy to maps made by the transit method, and will be almost as cheap.

In these maps all existing sewers should be located and their exact elevations determined, even if it is necessary to dig them up to do so. Attention needs to be given to the grades of water and gas mains parallel to the new sewers, since they may interfere with the house laterals.

Before proceeding to lay out a system on these maps it is necessary to consider whether a storm sewer must be built in the near future in streets now served by existing combined sewers, if no storm sewer is to be built the old sewer will be used if possible as a part of the new system. If a storm sewer needs to be built, the question arises whether the existing sewer is of sufficient capacity to serve as a storm sewer for the area. The fact that it has so served is not evidence that it will continue to do so under new conditions incident to prospective street improvements, etc. In this case, in order to obtain the best design, it becomes necessary to practically lay out a storm sewer system for the town. It will usually be found that the old sewers are too small to be used for storm sewers. In a case in mind in only one instance was the old sewer of sufficient capacity to provide proper drainage. Here the old sewer was used for a storm sewer and a new sanitary sewer built. Questions of the efficiency of the existing sewers as sanitary sewers also affect the design. It is possible that they are entirely too large to be self-cleansing when the drainage of the street no longer enters to periodically flush them. This fact, combined with the infiltration of ground water, may be serious enough to warrant the construction of a new sanitary sewer. Unless the street is to be immediately improved, or the use of the old sewer makes a considerable detour in the direct route of the new construction necessary, however, it will be best to use the old sewer for a sanitary sewer if its grade permits. In case it develops into an active nuisance a new sewer to take its place can always be laid later.

A further point deserving of more consideration than it usually receives, especially in small communities, is the securing of proper ventilation of the sewers. The common method in large cities is by the use of ventilating ducts through the houses to the roof. In small communities it will be found, however, that a large proportion of the houses have house-traps, which prevent the circulation of air through the sewers and ventilating ducts. In such cases it is necessary to secure the passage of an ordinance prohibiting house-traps or ventilate the sewer through perforated manhole heads. It is usually easy to secure the passage of the ordinance, but where the town does not have a plumbing inspector it is a difficult matter to enforce it. The enforcement of such an ordinance is, however, so essential to prevent nuisances from foul-smelling manholes that every effort should be made to secure competent inspection of the installation of house fixtures.

For sewers of small sizes the use of vitrified clay or tile pipe is universal. Vitrified pipe, however, is so subject to breakage, due to the unyielding character of the material and the imperfect bedding of the pipe usually secured, that more attention should be given to the prevention of breakage than is commonly done. It is a common practice to place a concrete or timber foundation under sewers where the bottom is soft. The restriction of this foundation to soft bottom indicates an intention to provide against settlement rather than against breakage. In this connection it is interesting to note a discussion of the strength of sewer pipe by Dean A. Marston and A. O. Anderson, of Iowa State College, in which they conclude from their observations that (1) it is impossible to prevent cracking of the larger sizes (over 15″) of pipe by precaution as to bedding and laying the pipe or refilling the ditch; (2) that pipe cracks more readily on hard, unyielding bottom than on soft bottom; (3) that it is necessary to require the contractor to carefully shape the bottom of the ditch to conform to the surface of the under half of the pipe; (4) and to carefully bed the pipe in sand or granular material; (5) that sewer pipe cracks from such slight distortions as compared with the yielding of the most solidly packed earth filling that it is not possible to prevent cracking by side-tamping at the mid-height; and (6) that when the above precautions do not prevent failure it is necessary to bed the pipe in concrete up to its mid-height or else use stronger pipe. These conclusions are not verbatim as given in the Record, nor do they comprise all of their conclusions, but they state the gist of their conclusions as to prevention of failure by care in laying pipe.

Their statement that pipe cracks more readily on hard bottom than on soft is illuminating when regard is had to the practice of placing concrete foundations on soft foundations only. Their conclusion (3) as here enumerated is practically impossible in hard and stony soils, and is almost never done in any soil. In any soil such a requirement entails an amount and quality of inspection rarely given to pipe sewer construction. Conclusion (4) seems more possible of attainment, but would require that the trench be excavated larger and deeper than the outside of the pipe and the granular material placed and tamped around and under the pipe. Their conclusion that "sewer pipe cracks from such slight distortions as compared with the yielding of the most solidly packed earth filling that it is not possible to prevent cracking by tamping the ditch filling on each side of the pipe at mid-height," indicates the equal impossibility of preventing cracking by excavating the bottom of the ditch to a cylinder true to the line and grade of the outside of the pipe. An attempt to secure this condition will result in leaving narrow cavities under the pipe too small to be tamped full of earth, and "slight distortions" of the pipe will be very apt to occur.