

the general depreciation that is bound to occur in an equipment allowed to remain idle half the time. The second fact is due the cost of necessary power to operate the system being even relatively smaller in the case of the more refined bucket carrier than in the case of carrier with buckets rigidly attached to the chains, making it even more imperative to use the carrier with pivoted buckets continually if the greatest benefits are to be attained. A comparison of the net operating cost of a bucket carrier with the net operating cost of a combined system of bucket elevator and any other conveyer so far discussed shows that the advantages of the more flexible system is rather a matter of convenience than economy. It costs more to operate a bucket carrier over a given path than it would to operate a combination of bucket elevator for the lifting operation and any conveyer, even one as relatively uneconomical as a flight conveyer, for the horizontal carry of the load. This is due, of course, to the much greater power requirements of the empty bucket carrier than is required for the similar work entailed in running both the elevator and conveyer without load. Nevertheless, bucket carriers do possess the advantage of simplicity and, though somewhat more expensive to operate than more complex systems, are excellent for many installations where the cost of operation is of less importance than convenience. Their greatest disadvantage is that a breakdown means a shutdown unless every possible provision is made to provide other means of handling part of the load while necessary repairs are in progress.

IMPORTANT FACTORS IN THE DESIGN OF SEWERAGE SYSTEMS.

IN the construction of a new sewerage system, or of new sewers, one of the problems which first arises is the question, shall the sewers be built on the combined or on the separate system, or partly on both? The question often cannot be answered without careful study, as consideration has to be given to numerous factors. Two factors of the greatest importance are the questions of cost and of sewage disposal. In a paper presented on October 7th to the convention at Wilmington, Del., of the American Society of Municipal Improvements, Mr. John H. Gregory, consulting engineer and sanitary expert, of the firm of Hering & Gregory, New York City, discusses some phases of the subject, as well as some of the relations which the sewers bear to the problem of sewage disposal, as follows:—

As a general proposition, where both sewage and storm water are to be removed in artificially constructed channels, it is probably safe to say that the cost of building a combined system, in which both the sewage and storm water flow in the same channel, generally spoken of as a combined sewer, is less than that of constructing a separate system, in which the sewage flows in one set of pipes, frequently called sanitary sewers, and the storm water in another set, called storm water drains. This is especially true where the territory to be served is more or less closely built up and the streets are already surfaced or paved.

On the other hand, in suburban territory, not closely built up and not likely to be so built up in the near future, and where the storm water is easily and quickly diverted into natural watercourses, the separate system will in general cost less, for the reason that the sanitary sewers need only be built at first, the construction of the storm water drains being deferred for a period of years, or only

such drains built as are immediately required. The cost of building a combined system in such a territory might easily be so great as to be actually prohibitive, whereas, the construction of the sanitary sewers of a separate system, as just outlined, could be carried out and would serve all requirements for a considerable period of time.

Topography an Important Consideration.—With steep grades and relatively high velocities in the sewers, it might prove more advisable, on account of the relatively small additional cost, to build combined rather than separate sewers, although the character of the development of the territory might hardly be such as to require the removal of the storm water by this means.

In narrow streets and in congested districts combined sewers have one advantage in that only one sewer is required, thereby reducing to a minimum the amount of sub-surface obstructions. True, the combined sewer will be slightly larger than the corresponding storm water drain which would be required, but the increase in size of the latter is generally so small as to be of little importance. With the separate system, however, two pipes are required, and sometimes three, when a sanitary sewer is laid on each side of the storm water drain, this condition being forced when the storm water drain has to be built so close to the surface of the street as to prevent the carrying of house connections over it.

Again, with the combined system, but one house connection is needed, whereas with the separate system, especially in closely built-up districts with paved yards and areas, two are required, one for the removal of the sewage and the other for the removal of the storm water from roofs, paved areas and other impervious surfaces. The practice of discharging storm water across the sidewalks to the gutters is not one to be recommended. The storm water is, however, sometimes removed by pipes laid just below the surface of the sidewalk and discharging at the gutter. Such pipes frequently give trouble, and often would not be low enough to drain paved areas adjacent to or in the rear of buildings. Two house connections, of course, cost more than one, but not necessarily twice as much as one.

With a combined sewer laid in the middle of the street, as is generally the case, the cost of the house connections to the abutting property owners on each side of the street is equalized. With a separate system the cost of the house connections may be greater to the property owners on one side of the street than on the other, unless the sanitary sewer and storm water drain are equally distant from the centre of the street. If the connections to the curb or property line are put in at the expense of the municipality the cost to the abutting property owners as a whole is as nearly equalized as possible.

Combined sewers are generally laid on flatter grades than separate sewers and may increase the area which can be served without pumping. They may even eliminate pumping entirely. It sometimes happens that combined sewers can be advantageously adopted for a part of the system and separate sewers for the remainder. The writer has in mind one of the large cities in the east where no pumping is required and in which three-quarters of the city is sewered on the separate system and one-quarter on the combined system. The section of the city sewered on the combined system was too low to be sewered on the separate system without pumping and it was in order to avoid pumping that this section of the city was sewered on the combined system.