CONVERTING PORTIONS OF THE LOS ANGELES OUT-FALL SEWER INTO A SEPTIC TANK.

A unique method of solving a serious and unusual engineering difficulty at Los Angeles is outlined in the accompanying letter to this Journal from Mr. Frank H. Olmstead, City Engineer of Los Angeles, and described in detail in the abe report which follows, by Mr. Homer Hamlin, who is Mr. Olmstead’s deputy. The outfall sewer in question was described at length in our issue of Feb. 26, 1900, while in our issue of Feb. 16, 1900, we published a brief article on the operation of sewer. After that date it became known that the sewer used for the brickwork of the outfall was disintegrating and the ironwork rusting badly, as was noted briefly in our issue of June 22, 1900.

Experiments were made with marsh-like and other coatings and a system of ventilation was proposed. Mr. Olmstead’s letter, dated Oct. 20, 1900, is as follows:

The outfall sewer for Los Angeles, built in 1895, at an expense to the municipality of $750,000, and with a capacity of about 20,000,000, has been rendered so rapidly the last two years as to occasion general alarm as to its stability and permanence. The design of the outfall included two inverted siphons, each over three miles long, made of wood-pipe plugs, and between them a brick-lined tunnel, when this rapid disintegration of the lining material was most pronounced. The gases generated by the dilution of the sewage in its passage through the siphons, while acting as a preservative of the wood in the stave pipes, were simply eating out the life of the cement work, and the exposed metal surfaces. There were a number of remedial suggestions, among others the construction of ventilating shafts extending from the siphon to the outfall, and others the undergrounding of the entire length of this tunnel structure. Mr. Freeman, who owns the Spanish grant through which the outfall is located, forbade the erection of any such sewer to the sewer, and legally had the right to resist it. The residence at the very eastern estate house one mile away was at time reported to be unbearable; mechanical ventilation was barred by state statutes, access to the city was forbidden, by almost insurmountable difficulties in the matter.

This junction, Mr. Homer Hamlin, C. E., Chief Deputy of the City Engineer of Los Angeles, made the following report and advised the transformation of the tunnel referred to into a septic tank. It was considered that Mr. Hamlin had solved the problem by practically adopting the septic tank method, an apparent remit of the usual and acute difficulties in the outfall sewer, and immediately made requisition on the city council for $8,000 to do the work. This was granted Sept. 3, 1900, and proved sufficient in amount.

The work was done while the sewer was in commission, and was turned over to the Superintendent, Mr. Derby, in its altered and completed condition Oct. 22, 1900.

The report by Mr. Hamlin was dated July 9, 1900, and addressed to Mr. Olmstead. We reprint the report practically in full, the only omission of importance being an account of the theory of the action of the septic tank, already made familiar to our readers, by matter printed in these columns and elsewhere:

As requested by you, I have examined the disintegrating mortar in the outfall sewer of the city of Los Angeles, and present herewith a report upon the condition of the same and the means proposed to prevent further decay.

The sections of the sewer examined extend from the outlet of the first inverted siphon at Sta. 238 + 26 to the first drop chamber at Sta. 323 + 25.

The examination was thorough as possible to make with the usual amount of sewage flowing in the sewer. The sewer was entered at five points. A more thorough examination should be made before the sewer is modified, but to do this it will be necessary to divert the sewage for a few hours.

In the chamber at Sta. 328 + 35, the outlet of the first inverted siphon, the mortar and plaster are rapidly disintegrating, and, unless the leak is checked, will soon damage the structure. In the 40-in. brick sewer below, the mortar is decomposed to some depth in the joints of the brickwork, but not enough to endanger the stability of the sewer. In the chamber at the upper end of the tunnel, at Sta. 257 + 20, the disintegration of the mortar is more pronounced, especially on the roof and sides of the chamber, and the arch of the 40-in. brick sewer which arch at this point. The mortar swells during disintegration to two or three times its original bulk. The force exerted by the swelling mortar is sufficient to break or spill off the edges of the brick in flake pieces. This takes place only when the disintegration of the mortar has reached a depth of 2 in. or more in the joints of the brickwork. There has been considerable disintegration of the brick on the underside of the 30-in. brick sewer arch, and as near as could be ascertained (as it was impossible to enter the sewer), fully one-quarter of the thickness of the wall has been destroyed. This seriously impairs the strength of the sewer and should at once be taken to prevent further disintegration.

There is far less disintegration of the mortar in the tunnel proper than in the 40-in. sewer, either above or below, except that the neer cement plaster on the sides above the water line is extremely disintegrated into a soft, wet, chalky mass, easily scraped from the wall by the hands alone. The mortar in the joints of the brickwork is not affected in a depth of more than 5 in., except in a few spots, far less than at the other points noted. So far as the stability of the present sewer is concerned, it is as strong as it ever was. The amount of disintegration diminishes in passing down the sewer until the first drop chamber is reached at Sta. 323 + 54, where the sewer has a fall of about 13 ft. This fall and the consequent agitation of the water liberates a great deal of gas and water which has seriously decomposed the mortar in the upper portion of this structure. It will be necessary to replace the roof and walls of this structure above the water line.

From the many examinations heretofore made upon the condition of the outfall sewer, it is evident that the disintegration of the cement mortar is caused by the chemical action of the sewer gases upon the hydraulic cement in the mortar.

As no determinative chemical tests have been made of these gases, it is impossible to state their chemical formula or nature, but they are probability the usual gases given off by sewage during putrification, viz.: given off by carbonized hydrogen, light carbonated hydrogen, carbonic acid and carbonic oxide, "must not be supposed, but cannot be explained, however, that decomposing sewage constantly emits any one of these gases in an isolated state, nor are all of them in combination at any one time. The emissions assume sometimes one form, sometimes another, according to the nature of the organic substances in the sewage, its velocity, temperature, amount of possible oxidation, age and other conditions."

The sewage in the outfall sewer is subjected to unusual conditions, namely, a slow passage under hydraulic pressure through two long inverted siphons. The first siphon extends from the settling chamber, across the valley to the two hills near Inglewood. This siphon is 9,650 ft. in length, the lowest point of which is about 40 ft. below the inlet, 20 ft. below the outlet, and 30 ft. below the hydraulic gradient from the settling chamber to the outfall.

When the usual amount of sewage (about 9 sec. ft.) is passing the settling chamber, it will require about four hours for the sewage to pass through the first inverted siphon, and the velocity of flow will not exceed 1.15 ft. per second, if the entire section of the pipe is open.

With no low a velocity, a large percentage of suspended organic matter or sludge must settle to the bottom, where it decomposes or is broken up and carried out by the current in a slowly divided state. These conditions are favorable for a partial putrification of the sewage. During this process, much gas is generated, which, however, cannot escape being retained in the sewage by reason of the hydraulic pressure with the siphon, but which immediately begins to emanate from the sewage as soon as it is released from pressure at the outlet. A familiar example of water retaining the gas under pressure is the water forced in ordinary sods or carbonated water, which is charged with carbon dioxide under pressure. The gas immediately escapes from the water when the pressure is removed. By a similar process, all the gas generated during the putrification of the sewage while in the siphon is released in the sewer below.

The cause of the disintegration of the mortar in the brickwork is the concentration of the gases, and the presence of condensed moisture on the walls of the sewer. The examinations made seem to warrant the following conclusions:

The vapor or moisture given off from the sewage condenses in drops on the cold walls of the sewer, and is probably the only moisture which reaches the interior of the sewer above the surface of the sewage. The amount of moisture on the walls is at times almost enough to make them dripping wet.

The gases escape from the sewage at the lower end of the inverted siphon, when it is released from the hydraulic pressure, and fill the sewer and tunnel below. By chemical analysis the elements in these gases unite with the oxygen in the air and form carbonic acid, carbonic

*Vax Notman’s Science Series, No. 5, p. 12.
The average composition of artificial Portland cement is as follows:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Calcium oxide</td>
<td>62.00</td>
</tr>
<tr>
<td>Silica</td>
<td>23.60</td>
</tr>
<tr>
<td>Magnesia</td>
<td>3.00</td>
</tr>
<tr>
<td>Alumina</td>
<td>3.30</td>
</tr>
<tr>
<td>Sulfur trioxide</td>
<td>0.10</td>
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</tbody>
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A composition of the amount of lime in normal cement and the stored cement in the sewer, shows that it has lost 95% of the original amount of lime, and then a residue is left.

It may be of interest to note that the drops of water on the salt and water observed in the previous experiment show a different stage: (1) An ordinary drop of water, apparently pure, that forms the top of this drop and gas emanating from the sewer. The samples of water from the sewer and gas emanating from the sewer show a slightly higher percentage of free calcium lime and carbon dioxide gas than the samples of water from the sewer. It is generally allowable in a good practice to use the decrease of the sewer, as acids of any nature and waste the best quality of cement. The composition of the sewer, as

The object in introducing a septic tank into a sewage disposal system is to neutralize the residual septic organic matter, especially that held in suspension in the sewer, known as sludge. It is necessary for the proper removal of the sludge that the following conditions be fulfilled: The sludge must be free from oxygen. The sewage must remain quiescent long enough to allow the precipitation of the sludge to take place. Time must be allowed for the gas to pass and for the gas to be neither added to nor reduced by the sludge. When the liquid remains quiescent and the sludge is not subjected to oxygen, it can be properly explained. The action of a septic tank should be continuous. If the sewer and tank are modified as proposed, will the conditions be favorable for the process of septic decomposition?

In answer to this question a comparison will be drawn between the conditions in a septic tank and the conditions in a sewer which will exist in the outfall sewer when modified. All the sewage is collected in the settling chamber, and in no case will its passage through the chamber, or in its entrance to the septic tank, the first condition necessary in a septic tank, the absence of absorbed oxygen, is obtained. Therefore, the septic tank will be designed to meet the following conditions:

- Total time from settling chamber to settling chamber: 3.21 hours
- Velocity of flow in the settling tank: 1.53 ft. per sec.