DRY WEATHER OPERATION OF A SEWAGE TREATMENT PLANT

BY

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During the months of July, 1930 to February, 1931, inclusive, the total rainfall in the Bloomington district was 9.89 inches, whereas the average rainfall for these months over a period of more than 35 years has been 20.80 inches, the former being but 47.5 per cent of the normal (fig. 1). July of this period had but 12 per cent of the normal rainfall, August 54 per cent, September 60 per cent, October 73 per cent, December, January and February, 16.5, 11.2 and 4.19 per cent, respectively, and one month, November, had more than the normal rainfall for that month, being 120 per cent.

The limited rainfall has had a marked effect on the operation of the sewage treatment plant of the Bloomington and Normal Sanitary District. By a process of screening, settling, and digestion of solids and aeration of the liquid, the plant is able to affect purification of the water averaging 90 per cent or more. The sewers of the district, serving a population of approximately 30,000, are combined sanitary and storm water sewers, hence in times of heavy rains the volume of the sewage increases materially and continues after such periods of heavy rain because of the seepage of ground water into the sewers. Before the use of treatment works for the scientific purification of sewage, sanitary engineers looked upon the diluting and scouring action of storm water as highly desirable, working for the better operation of the system. Storm water, of course, increases the load the treatment works is compelled to carry.

Because of the diluting action of storm water, and because such waters are relatively stable, it is the practice during periods of excessive flow to by-pass a portion of the water into the stream known as Sugar Creek. During the dry months covered by this report the sewage volume treated by the works, which is the volume pumped, was fairly constant (fig. 1) at about four million gallons per day, whereas the corresponding months of the other years have generally been much higher except for September 1928 when, because of very high rainfall, large amounts were by-passed.

If separate systems of sewers were in use, one designed to carry storm water and the other sanitary sewage, storm waters could be sent into the water courses without treatment, and only the sanitary sewage would need to be treated, thus reducing operating costs. The volume of sanitary sewage of the district is about four million gallons daily.

The relationship of suspended solids and rainfall is shown in figure 2. Increased rainfall and increased volume of sewage are not always accompanied by an increased amount of suspended solids, as is evident from a consideration of the unusual rainfall in July, 1929, accompanied by a low amount of suspended solids, a condition repeated in January, 1930. Prolonged and heavy rains are likely to wash sewers and pavements of accumulated solids, so that high volume is likely to be accompanied by low suspended solids. The unusually high suspended solids of November and December, 1928, and again for the same months in 1929 are accompanied by rainfall of normal amounts or less, together with a heavy inwash of leaves and such rubbish from pavements.

The low rainfall of 1930-1931 has been accompanied by fairly uniform suspended solids, making for uniform load on the plant and good operating conditions. November and December of this period did not bring the peak of suspended solids as in the two previous years because the dry weather permitted burning rubbish on the pavements.

Removal of suspended solids by the Imhoff tanks (fig. 3) averaged 73 per cent during the dry months, while the removal for the corresponding months of the other years averaged 68 per cent, showing the increased efficiency of the Imhoffs when operating under a fairly uniform load of solids from sanitary sewage. Likewise removal of solids by the entire works was greater during the dry months.

Oxygen consumed (fig. 4) is measured by the hot potassium permanganate method, using sulfuric acid. Dilution of the sewage with storm-water diminishes the oxygen consumed, whereas a more concentrated sewage has a higher oxygen consumption. In general the oxygen consumed rises as the winter months approach. The low oxygen consumed in July, 1929, is doubtless due to the diluting action resulting from the abnormal rainfall in that month. The September following was marked by a low rainfall, hence the oxygen consumed rises sharply and doubtless would have maintained that general level had it not been for more than average rainfall coupled with a pumpage higher than average. These factors indicate diluted sewage, hence descending oxygen consumption during the months October to February.

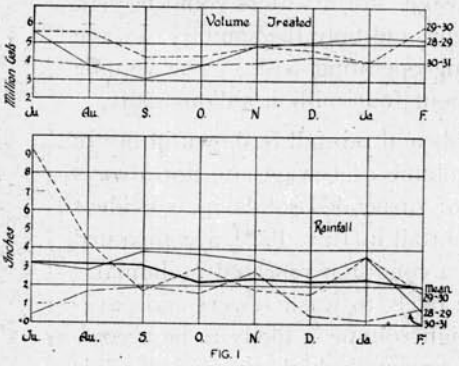

FIG. 1

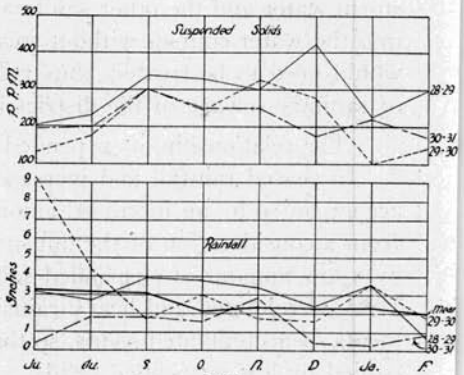

FIG. 2

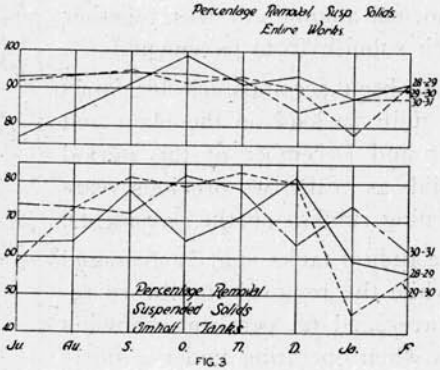

FIG. 3

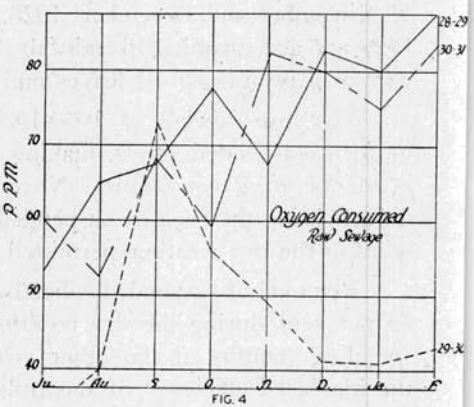

FIG. 4

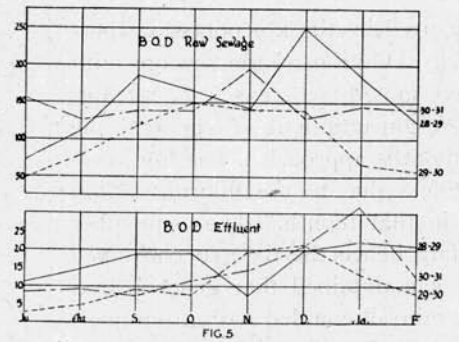

FIG. 5

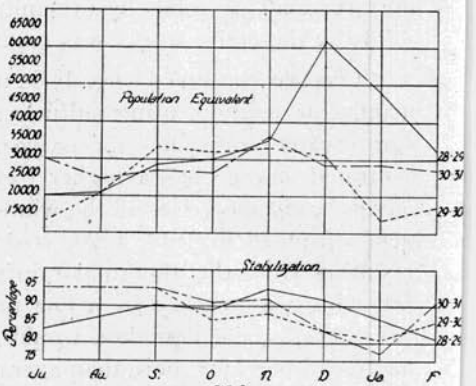

FIG. 6

FIGS. 1-6. Graphs showing (1) relation of rainfall to volume of sewage treated, (2) relation of rainfall to suspended solids., (3) removal of suspended solids, (4) oxygen consumed, raw sewage, (5) biochemical oxygen demand, and (6) percentage stabilization and population equivalent.

Biochemical oxygen demand measures the oxygen requirement of sewage samples when incubated for a five day period at 20 degrees centigrade. It will be observed that the dry months of 1930 and 1931 (fig. 5) had a fairly constant biochemical oxygen demand, while the months for the other years had fluctuating biochemical oxygen demand values. Likewise the plant effluent had a constant biochemical oxygen demand during 1930 and 1931 except for the months of December and January, when the high values were induced by a necessity of plant operation, while the corresponding months of the other years show considerable fluctuations.

The stabilization of the sewage (fig. 6) which is the ratio of the biochemical oxygen demand of the raw sewage to that of the effluent, was generally better for the dry months, preceding winter, than for the corresponding months of the other years.

The population equivalent, which is calculated from the biochemical oxygen demand of the raw sewage, is more uniform for the dry months, being about 30,000, than for the months having unusual rainfall.

In conclusion, it is apparent:

1. That the dry months of 1930-1931 had so little rainfall that the plant operated on practically sanitary sewage only.

2. That substitution of sanitary sewage for combined sewage would reduce operating costs by decreasing the volume of sewage to be pumped.

3. That the suspended solids in sanitary sewage are more nearly uniform than in combined sewage.

4. That the Imhoff tanks show a uniform removal of suspended solids as against the greater fluctuations produced by combined sewage, and likewise the removal of solids by the entire works is uniformly better for sanitary sewage than for combined.

5. That the instability of the sewage as measured by oxygen consumption and biochemical oxygen demand are more uniform for sanitary sewage than for combined.

6. That the diversion of storm water into water courses would be desirable, thus separating it from sanitary sewage, which separation would make possible more uniform and better operating conditions of the treatment works.

The writer wishes to express his appreciation to the Board of Trustees of Bloomington and Normal Sanitary District and to Mr. Harry E. Wilson, Superintendent, for the opportunity and means of making the study.