The value of this sludge as a fertilizer is based upon the quick availability of its contained nitrogen as NH_3. From growing experiments being carried out at the University of Illinois during the last 18 months, the availability of this nitrogen has been proven beyond any doubt and its value is equal to the same quantity of NH_3 contained in any of the high-grade fertilizers.

It would appear appropriate, after over two years of continuous experimental work upon sewage disposal, to present at this time a brief résumé of the conclusions reached. In forming these conclusions there are certain determining conditions connected with the Milwaukee situation, which are not common to all large municipalities, to-wit:—

The natural drainage of the present city and the area embraced within the anticipated limits of 1950 converge into one outlet, the harbor entrance.

The public water supply is secured from Lake Michigan in 50 feet depth of water at a point located about 3½ miles from the harbor entrance. This condition requires a high standard effluent of uniform quality to be produced from a sewage treatment plant.

There is no constant current in any one direction in the lake. The velocity and direction are largely due to meteorological conditions.

The only logical site for a sewage disposal plant is on or near the lake shore and the only available ground is Jones Island.

The natural island has far too small an area to locate a sewage disposal plant thereupon, and such plant must be built upon ground made out into the lake.

There is no low ground either in the city or its proximity suitable to the disposition of sludge; in fact, low ground is so scarce that those who are required to dispose of waste materials pay for the privilege of filling in the low ground. Sludge could not be used to make up land into the lake, as it would cause a nuisance which would not be tolerated by the owners of the lake front and might pollute the bathing beaches. It is considered inimical to public policy and to the future of our harbor to deposit sewage sludge in the lake. It therefore appears mandatory to either incinerate the sludge or reduce it to and dispose of it as a fertilizer.

Locating the disposal plant within the city limits, as appears necessary, prohibits a sewage treatment process which produces objectionable odors or flies.

Chemical precipitation removed the solids in suspension to a satisfactory degree, but the effluent produced did not reach the stability requirements. The sludge produced was enormous and its value was not sufficient to warrant the cost necessary to reduce it to a fertilizer. Its incineration would cost between $12 and $14 per million gallons of sewage treated.

Treatment by colloidar slate tanks gave a satisfactory effluent most of the time, but produced enormous quantities of sludge with low value as a fertilizer. The first cost of such a plant would be prohibitory.

Fine screening, considered as a single process, would neither remove sufficient suspended matter to meet the requirements nor improve the stability of the sewage.

Electrolysis was both offensive and uncertain. It had to be augmented with lime treatment and produced large quantities of sludge which was unprofitable to reduce to a fertilizer. From our experiments carried out with this process, the operating charges would be prohibitory.

Sedimentation by Imhoff tanks reduced the suspended matters about 50%, but produced a highly putrescible effluent. To satisfactorily sterilize this effluent required approximately 9 parts of chlorine, costing about $5.30 per million gallons. The sludge produced was not of sufficient value to warrant its reduction to a fertilizer, and to incinerate it would cost approximately $5 per million gallons of sewage treated.

Imhoff tank and sprinkling filters followed by final sedimentation produced a satisfactory effluent capable of being discharged into the lake without endangering the water supply. This treatment left us with the sludge to dispose of by incineration, cut out the sterilization, produced objectionable odors and flies, and required a prohibitory area of ground (nearly 100 acres) to be made up in the lake. The overhead charges for first cost of plant, under the existing conditions, add nearly $9 per million gallons to the cost of treatment by this process.

Activated sludge, if properly designed, built and operated, produces a clear, non-putrescible effluent, with a reduction of at least 95% bacteria and 98% suspended matters, and a sludge of sufficient value to warrant its reduction to a fertilizer. Its operation is odorless and free from flies and it occupies a minimum area of ground.

On the other hand, it requires constant and expert supervision for its successful operation and large operating cost for air and sludge disposal. Its cost, including all overhead, operating and sludge disposal, is estimated to be from $12 to $15 per million gallons, from which must be deducted such returns as may be obtained from the sale of the sludge, which has been estimated in preceding pages to be from $5 to $6 per million gallons, or a net cost of from $7 to $10 per million gallons of sewage treated.

Of all the processes experimented with the activated sludge appears to be the only one which fits the existing conditions in Milwaukee.

The maximum volume of air required to produce a stable effluent from the Menomonee Valley sewage, from which 95% of bacteria and 98% of suspended solids have been removed, is 2 cubic feet per gallon of sewage, based on 10 feet effective head of sewage in the aerating tanks.

The maximum aerating period for both sewage and activated sludge is 4 hours.

The percentage of activated sludge in contact with the sewage may range from 15 to 25, without materially affecting results.

The sedimentation period required is from 40 to 50 minutes. The maximum horizontal velocity is 3 feet per minute and the vertical velocity about 8 inches per minute. Uniform velocities must be maintained as far as possible.

The slopes for successfully removing sludge from the sedimentation tanks should be from 1 to 2, to 1 to 3, and it is preferable to remove the sludge through a down pipe built in the bottom of the sedimentation tank.

Breaking up the air in small bubbles increases the oxygen absorbed by the sewage in the aerating tanks, but sufficient air must be diffused through the sewage to rapidly disturb its entire volume and to maintain the solids in suspension. Baffles properly placed undoubtedly increase the efficiency of the tank.

Filtros plates are a satisfactory media for air diffusion. To maintain their efficiency they should be carefully made and placed, fairly uniform in porosity and all oil and dust should be excluded from the air passing to and through the plates.

Wood plates give smaller bubbles than filtros plates at less loss in pressure, but insufficient experiments have been carried out to warrant their adoption.

The sewage can be clarified in from one to one and one-half hours' aeration in the presence of well activated