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STREAM POLLUTION AND SEWAGE DISPOSAL

Papers by

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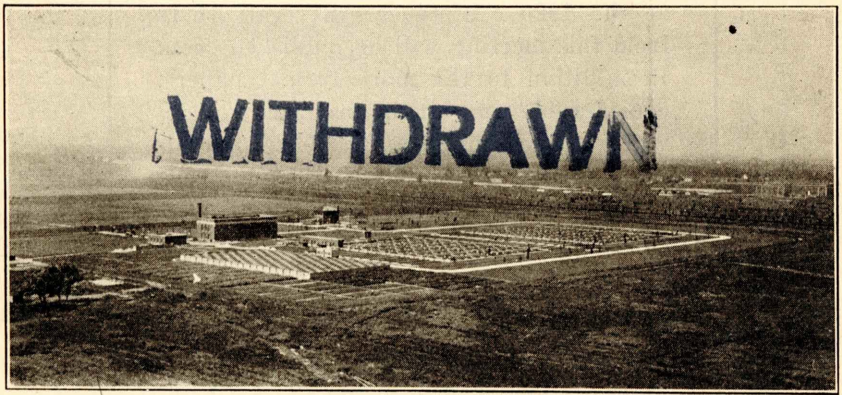
Presented at the Eighth Conference on Sewage Treatment at Ames, Iowa, October 16, 17 and 18, 1926



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CONFERENCES on sewage treatment are held annually at Iowa State College under the auspices of the Engineering Extension Department. These meetings are of a practical nature and are arranged for municipal officials and all others directly or indirectly responsible for the operation of sewage-treatment plants.

This publication contains four of the more general papers which were presented at the 1926 conference. Several others from this meeting will be published soon. In addition to the more formal papers, considerable time on the program was devoted to the consideration of the individual problems of those in attendance.

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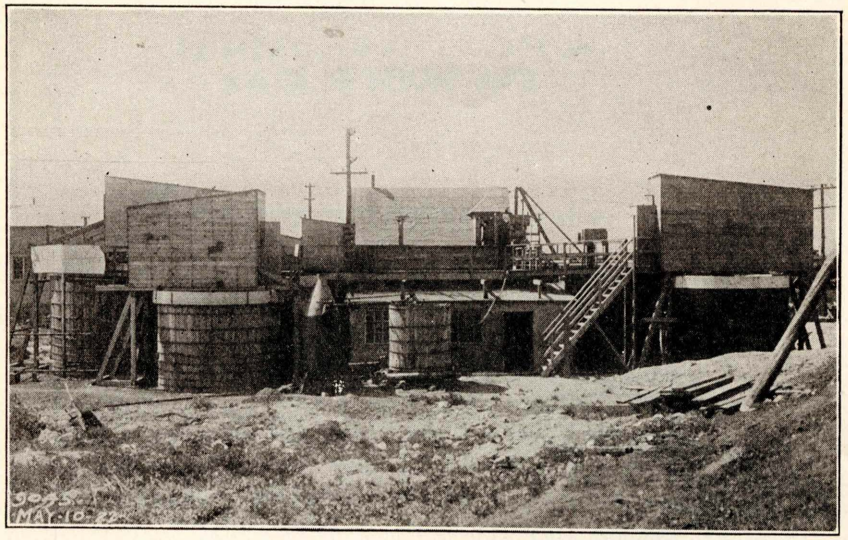

Experimental Sewage Treatment Plant at Argo Corn Products Works, Argo, Ill.

Sewage Treatment Works on the Des Plaines River, Maywood, Ill.

RECENT PROGRESS IN SEWAGE DISPOSAL and STREAM POLLUTION PROBLEMS IN THE UNITED STATES*

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Stream Pollution, including sewage disposal, is an important problem throughout the United States at present. In its widest aspect, it includes the discharge of sewage, trade wastes (from beet sugar plants, canneries, chemical, coal tar, gas, corn, metal, and milk products plants, mining operations, oil and refining, packing, the rendering plants, paper and pulp mills, tanneries, and textile industries), and other matter, whether from municipality, industrial establishment, institution, or dwelling, into bodies of water used for any or all of the following purposes: (1) human consumption as for drinking water; (2) production of food as for watering stock, irrigation, and propagation of fish; (3) disposal of wastes such as industrial wastes and domestic and municipal sewage; (4) production of power; (5) transportation; and (6) recreation, including fishing and bathing. The relative importance of this problem is well brought out in the statement of Dr. Monger, Director, Ohio Department of Health, that "at no distant date, water protection will probably be the 'livest' question confronting the sanitarian."[1]

Much has been, and is being, done towards solving stream pollution problems in various states, particularly in the last five years. Among the noteworthy developments in this period are the following: (1) cooperation between governmental agencies and private industry; (2) recognition of the joint need of sewage treatment and water purification on certain bodies of water; (3) improvement in the status of sewage plant operators; and (4) the importance of pure research in stream pollution.

Cooperation Between Governmental Agencies and Private Industries

It is recognized by all that disposal of municipal and industrial wastes has burdened water purification plants, caused water borne disease outbreaks, and produced foul and unsightly conditions making bodies of water unfit for fishing, bathing, and other recrea-

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[1]The numbers refer to references in the bibliography appended.

tional purposes. Accordingly, in the interests of an awakening public demand, municipalities and industries contributing wastes are more and more willing to alleviate the conditions. Government officials have sensed this feeling, with the result that they are investigating stream pollution matters in a manner such that all interests will be wisely served in the order of their value to the public, at minimum expenditure of public and private funds. The order of precedent of use of water resources, as stated in a progress report of the Committee on Sanitary Conservation of Streams of the Conference of State Sanitary Engineers in June, 1926, is: (1) source of public water supplies; (2) conveyance of sewage and industrial wastes after suitable treatment when and where needed; and, thereafter, as determined by local circumstances, for manufacturing, industry, power, irrigation, agriculture, fishing, recreation, or navigation.

With the realization of common interest in stream pollution has come cooperation of effort in solving the problems. This cooperation has developed among health officials themselves, between state departments of health and other state departments and between state departments and private industry. All gain through such cooperative effort, the strong as well as the weak. Examples of such cooperation and the results achieved are as follows:

1. Agreement in 1921 between Sanitary District of Chicago and U. S. Public Health Service for the survey of pollution of the Illinois River and its effect upon cities located on the river. This survey was carried out in 1921 and 1922.

2. Agreement between New Jersey and Pennsylvania State Departments of Health in 1922 regarding disposal of sewage into the Delaware River.[2]

3. Agreement between State Departments of Health of Pennsylvania, Ohio, and West Virginia in November, 1924, for the purpose of establishing uniform policies and the exchange of information on the prevention of pollution of the Ohio River drainage area. This agreement was extended in 1926 to include the health departments of Kentucky, New York, and Maryland. The health departments of Indiana, Illinois, and Tennessee have recently applied for admission to this agreement.[3] One noteworthy result of this agreement has been the elimination of most of the phenol wastes from by-product coke plants from the Ohio River, with resultant decrease in the occurrence of bad taste in water supplies of cities located on the river.

4. The Delaware River Compact in 1925 between Commissioners of New Jersey, New York, and Pennsylvania, with definite requirements for treatment of sewage before its discharge to the Delaware River, and commensurate requirements concerning industrial wastes, and provisions concerning the degree of cleanliness of tributary streams at their confluence with the Delaware River.[2]

5. Agreement between State Departments of Health of New York and Pennsylvania in 1925 regarding the pollution of boundary streams.[2]

6. Agreement in 1925 between City of Chicago, Sanitary District of Chicago, State Departments of health of Illinois and Indiana, and the U. S. Public Health Service for the survey of the pollution of the lower end of Lake Michigan as affecting the water supplies of cities in Indiana and Illinois. This survey has been completed and a report prepared in June, 1926.[4]

7. Agreement between State Departments of Health of Michigan and Ohio in 1926 in regard to uniform policies in the control of industrial wastes in general, including wastes from beet sugar, paper, milk, and canning industries.[5]

8. Agreement between State Departments of Health of Minnesota and Wisconsin and the U. S. Public Health Service in 1926 for the investigation of the pollution of the Upper Mississippi River.

9. The National Committee on Stream Pollution for the Pulp and Paper Industry was created about April 1, 1926, with two representatives of the industry from mills each in Michigan, Wisconsin, Ohio and Pennsylvania, one in Massachusetts, one in Maine, the Secretaries of the Technical Association of the Pulp and Paper Industry and of the American Paper and Pulp Association, and the Chief Engineers of the State Departments of Health of Wisconsin, Ohio, Maryland, and Pennsylvania. This committee will obtain information concerning the unsolved problems relating to the disposal of pulp and paper mill wastes through studies and investigations being conducted by their own consulting engineer. The Association has assessed its members $15,000 per year for three years for this work.[6]

10. In 1923 the Cleveland water supply was seriously damaged by phenol wastes. Conferences of the City and State Health Departments with the local industries brought a voluntary agreement by the steel plants to stop this pollution. Within a year the three plants had completed installation of a treatment process at a cost of several hundred thousand dollars which has practically eliminated the nuisance.[1]

11. In Wisconsin the Pea Packers' Association, at the request of the State Board of Health, assessed their members $500, to assist in certain research regarding the disposal of their wastes during 1926.

12. Although tannery wastes are specifically exempted from the provisions of the Purity of Waters Act, the companies operating leather tanneries located on Pennsylvania streams have executed an agreement with the Pennsylvania Sanitary Water Board under which they are providing $35,000 to study tannery waste disposal including construction and operation of a full-scale treatment works at Instanter, Pennsylvania.[2]

13. In Michigan the canneries have assessed themselves $0.002

per case based on the 1925 pack, to make an investigation of treatment of their wastes at an experimental station at Kent.[6]

14. In Ohio the Canners' Association provided funds in 1925 and established a testing station at Canal Winchester with a consulting engineer in charge.[3]

15. The addition of industrial wastes to municipal sewage results in added public expenditure in the building of a sewage treatment plant. At Dayton, Ohio, where a complete sewerage system and treatment works is planned, studies made by the city relative to receiving into the city sewers the untreated liquid wastes from certain paper companies showed that this would increase the cost of the total plant by about 80 percent, or over $700,000. Action taken by the State Department of Health resulted in the installation of treatment methods at one of the paper plants that have produced a saving of 120 percent annually on the entire cost of the installation.[5]

16. In 1924, a meeting took place of representatives of the League of Ohio Sportsmen, Izaak Walton League, Ohio State Grange, Farm Bureau Federation, Ohio Manufacturers' Association, and state agencies to stop stream pollution. Through the work of this meeting a bill was prepared and became a state law on March 19, 1925. This act provides that the State Department of Health shall (1) approve of any new or increased discharge of industrial wastes; (2) supervise the operation and maintenance of industrial wastes treatment plants; and (3) adopt regulations necessary to prevent undue pollution of streams and to protect the public health. The plan of enforcement provides for the issuance of official orders by the State Department of Health, with the advice of an advisory council representing the manufacturing industries, sportsmen, agricultural interests, municipal officials, and others.[5]

After passage of the bill, the coke, paper, beet sugar, steel, milk, and canning industries were separately invited to conferences. Organizations of the industries for the sole purpose of collectively attacking their problems were perfected, and ways of financing them properly were devised. Executive committees empowered by each industry to conduct necessary experimentation and research were authorized. According to Mr. Waring, Chief Engineer, the State Department of Health is cooperating with the group organizations by furnishing each with a detailed list of companies and circumstances where the wastes disposal problem is causing complaint and needs attention. Agreement is reached with the committee and the particular company on the one hand and the State Health Department on the other, and the devices are installed.

The same legislature passed a sewer rental law permitting municipalities to assess property owners for sewerage service, and thereby provide for proper maintenance and operation of sewerage systems.[3]

17. The "Administrative Code" of Pennsylvania (approved June 7, 1923) created in the Department of Health the Sanitary Water Board, consisting of the Secretary of Health as Chairman, the Secretary of Forests and Waters, the Attorney General, the Commissioner of Fisheries and the Chairman of the Public Service Commission. This Board executes the statute formerly administered by the Health and Fisheries Departments, and it is also clothed with investigatory powers. Since June 1, 1925, the Board has been provided with separate funds for its work.

This board through the issuance of permits: (1) stipulates the conditions under which municipalities may lawfully discharge sewage into state waters; and (2) approves plans of sewers and sewage treatment works and supervises their operation. Although the Board lacks these powers in regard to industrial wastes, the statutes referring inferentially to industrial wastes are prohibitive in character and provide for penalties.

The Sanitary Water Board is (1) making surveys for the classification of streams; (2) furthering proper municipal sewerage and sewage disposal projects; (3) cooperating with industry to find reasonable and practicable means for disposal of industrial wastes and where possible, recovery of by-products.[2]

18. In Michigan the 1925 state legislature amended the empowering act of the Conservation Department, greatly strengthening the law regarding offenders. At the same time an act was passed permitting municipal authorities to issue bonds for sewage disposal plants without a vote of the people when such municipality is ordered by this Department or the court to build a disposal plant. The State Departments of Health and Conservation together started a campaign toward improving stream pollution conditions. Conferences were held with groups of municipalities on various river basins. At the end of each conference, orders were given each municipality requiring preparation of plans for sewage disposal plants and removal of raw sewage from the streams. After these conferences, the various industries were called in groups. Each group was required to formulate plans for the removal of their wastes from lakes and streams.[6]

19. At the meeting of the Lake Michigan Sanitation Congress on Sept. 25, 1926, President Folds of the Izaak Walton League stated that the present aim of the League is to "clean up water supplies." The cooperation of various agencies will be enlisted by the 2700 chapters of this League in studying and surveying stream conditions throughout the United States.

With such excellent results as illustrated in the foregoing examples already obtained through cooperative efforts of all parties concerned, it is believed that this method of procedure will be adopted widely and will be productive of many other and more notable achievements in stream pollution prevention in the future.

Recognition of the Joint Need of Sewage Treatment and Water Purification on Certain Bodies of Water

For some time past sanitarians and water and sewerage works officials have been discussing the relative importance of sewage treatment and water purification as to how far each should be resorted to in providing a safe public water supply from a polluted surface stream. Fortunately, data regarding sanitary surveys of pollution and natural purification of streams published in the past few years has shed light on this discussion.

Since 1910 the U. S. Public Health Service has been making studies at Cincinnati and elsewhere of various phenomena concerned with the pollution and natural purification of streams.[7] From the data collected, methods have been derived whereby it is possible under certain known conditions to determine the extent of pollution in a stream at various points due to a source of pollution, and to estimate the pollution load at present or in the future upon a water purification plant whose source is a polluted watercourse.[8] In applying this information to the study of water filtration plants along the Ohio River, Sanitary Engineer Streeter found that only by effective use of constant chlorination were the plants able to deliver the water of such bacteriological quality as is generally considered safe for a very large proportion of the time; and that "the problem of meeting further encroachments of pollution in the Ohio River has definitely entered the phase when serious attention must be given to some plan for restricting further increase in the sewage pollution of the river."[9]

In the very thorough and comprehensive report of the investigation of the pollution of the lower end of Lake Michigan in the Calumet region in June, 1925, by Sanitary Engineer Crohurst and Past Assistant Surgeon Veldee, information is presented showing that, as a result of the large amount of municipal sewage and industrial wastes being emptied into the lake, the rapid sand filter plants of East Chicago and Whiting, Indiana, are handling loads far in excess of those ordinarily considered safe for water filter plants, and that the effluents from these plants and also from the chlorination plants at Hammond and Gary, Indiana, do not always meet the U. S. Treasury Department Standard.[4] Speaking of the findings of this survey at the Lake Michigan Sanitation Congress on September 25, 1926, Sanitary Engineer Crohurst said that it is necessary to prevent city sewage and industrial wastes from entering the lake or else treat them before discharge in order that water purification plants may deliver safe water.

State Sanitary Engineer Finch, in speaking of the recent order of the Indiana Board of Health prohibiting discharge of raw or inadequately treated sewage into state lakes, including Lake Michigan, stated that Hammond, East Chicago, and Whiting have retained engineers to plan for the proper disposal of their sewage. Cities in Michigan located on the southern end of Lake Michigan are also being required by the Michigan Department of Health to install sewage treatment works.

At the same meeting State Engineer Baker of the Wisconsin Board of Health stated that from available analyses of lake water entering the Milwaukee waterworks intakes, the B. coli index indicates the water to be polluted to a greater extent than is found desirable for treatment by a water purification plant using chlorine alone in order to insure delivery of a bacteriologically pure water. Referring to the sewage treatment plant at Milwaukee which has been claimed by a certain part of the public to be more desirable in providing a safe water than a water filtration plant, Baker said no practical methods of sewage treatment alone can be depended upon to make Lake Michigan water safe for domestic consumption; instead, there must be in addition, water filtration and chlorination plants.

Speaking on the subject of "Filtration of Lake Michigan Water" at the same meeting, Consulting Engineer Paul Hansen of Chicago said (1) it is impracticable to obtain pure water from Lake Michigan without filtration; (2) chlorination alone must be considered an emergency treatment; (3) filtration and chlorination cannot be depended upon to supply a pure water from Lake Michigan at certain places all the time.

In this connection it is interesting to note that at the present time an experimental station is being started by the Department of Public Works of Chicago to investigate the treatment including filtration of the lake water. It has been found that the water in the vicinity of the southern intakes is heavily polluted at times due to storms, heavy winds, etc., so that heavy chlorine dosage is necessary with resultant public complaint of chlorine tastes in the water.

With regard to the increase in sewage pollution of streams, Surgeon Frost of the U. S. Public Health Service has stated, "With the growth of urban population, which still continues at a rapid rate, the sewage pollution of streams and coastal waterways must increase, and sooner or later, in the absence of anticipatory control, it seems inevitable that eventually the pollution will become such that water-purification plants of the highest efficiency will not be able to deliver consistently safe effluents. To guard against this condition it will be necessary, perhaps in the near future, to limit the pollution of such inland streams as are necessary sources of water supply by such measure of sewage treatment as will suffice to keep the pollution at waterworks intakes within definite bounds."

From the foregoing it will be seen that the time has arrived where conditions on certain streams make necessary both water purification and sewage treatment plants of such completeness and efficiency as will insure the delivery of a bacteriologically safe water to the public.

Improved Status of Sewage Plant Operators

The third noteworthy development in the field of sewage disposal and stream pollution recently is the increasing improvement in the status of the sewage plant operators. The installation of sewage treatment works at Chicago, Milwaukee, Cleveland and other Ohio cities, Pasadena and other California cities, and many others has resulted in the employment of a goodly number of experienced plant operators. The number will be increased rapidly as other works now in construction are completed, and still others to be planned are placed in operation. Naturally, with increased demand and larger plants requiring more experienced and capable sewage plant operators, the renumeration will be greater.

Only one state, New Jersey, requires that sewage plant operators must be licensed. In 1918 an act of the New Jersey legislature provided for the examination and licensing of superintendents and operators in charge of water and sewage plants. The intent of this act was to insure plant officials and provide for more permanent tenure in office of efficient men. The rules and regulations of the New Jersey Health Department provide for four classes of licenses: (1) first class or superintendents; (2) second class operator; (3) third class operator; and (4) fourth class operator. The requirements differ progressively from the latter class which call for qualifications and knowledge necessary to operate or control a settling or sedimentation tank of one or two story construction to that of the first class calling for qualifications and knowledge for satisfactory supervision of a sewage treatment works including screening, sedimentation, filtration, and disinfection and for making the standard tests, both chemical and bacteriological, necessary for testing the various processes, and for knowledge of the mechanical devices used in sewage treatment works. In 1925, there were 27 candidates for sewage plant operators' licenses in New Jersey, of which 22 passed.

Unfortunately, there is no national association specifically for sewage plant operators where problems particularly affecting them can be discussed adequately and through which provision can be made for publishing regularly papers on sewage disposal. Instead there are certain state associations. The best known is the New Jersey Sewage Works Association which publishes its annual proceedings. There is also a Texas Sewage Plant Operators' Association which publishes its proceedings. In Illinois there is an Association of Sanitary Districts consisting of representatives from about nine such districts. This association is three years old. At the annual meeting sewage disposal problems are considered among other matters. Kansas has an association or conference of sewage plant operators. In Iowa there is a Conference on Sewage Treatment at which matters relating to sewage disposal and stream pollution are considered. The papers presented at this conference are published.

Plans are now being considered whereby a union of State associations with the New Jersey Sewage Works Association as the nucleus will be formed. This union is to publish an annual containing the proceedings of each state association.

There is no reason why in time the position of the sewage plant operator in the United States should not be similar to that of the operator in England, where, according to Consulting Engineer George W. Fuller of New York, the waterworks engineer and sewage plant operator are placed in responsible executive positions, taking up directly with the Committee of Finance of a town financial matters regarding the operation and improvement of their plants, and their positions are considered of importance in the life of the community.

Importance of Pure Research in Stream Pollution

In the development of sewage disposal and stream pollution much research work was done in solving the various problems. Most of this research work was of the kind known as applied in that known methods of treatment are used in studying a certain waste to determine the most satisfactory process, generally in a small experimental plant or laboratory. The other type of research work is the pure or fundamental in which studies are made to determine underlying principles, such as those taking place in the biological life of a stream in natural purification. For progress in stream pollution both types of research are necessary, but pure research is of far greater importance. In general much more is acomplished for the advancement of a science in ascertaining an underlying fundamental principle. Unfortunately, pure research work is more difficult and less likely to receive the attention of the public. In stream pollution it receives much less support and recognition from appropriation bodies than applied research.

There are indications, however, that recently more attention is being given to the study of fundamental principles in stream pollution. Some of the types of research work now going on in stream pollution are briefly as follows:

1. The Sewage Substation of the New Jersey Agricultural Experiment Stations was established in 1921 in co-operation with the State Department of Health. Beginning with the present year, the Experiment Station alone is continuing the studies. This station is investigating the biology and bio-chemistry of sewage disposal. The Chemical Foundation has endowed the substation with $1,000 per annum to study certain phenomena in tank behavior. The President of the Dorr Company has established a fellowship at Rutgers University with the intention of having studies made on sludge conditioning and on separate sludge digestion at the Sewage Substation.

2. The Illinois State Water Survey is studying rates of sewage filtration with various depths of trickling filters; methods of analysis; and colloiders.

3. The Sanitary District of Chicago studies include: digestion of activated sludge with Imhoff tank sludge; collection of gas from Imhoff tanks; sludge drying on glass-covered sludge beds; use of ferric chloride for coagulant with activated sludge, the chemical being obtained from chlorinated copperas; and rates of oxygen absorption and re-aeration conditions in the Illinois River.

4. At Harvard University, studies are being made in sludge digestion according to temperature and acidity conditions.

5. At Milwaukee tests are being made on dewatering activated sludge.

6. At Schenectady, New York, studies are being made on chlorination of sewage.

7. At Iowa State College, Professor Levine is making studies of the biological treatment of creamery and beet sugar wastes, also the types of bacteria found and methods of analysis.

8. In Wisconsin experiments are being made on pea canning and pulp mill wastes. It is intended to make studies in 1927 on corn canning, creamery and other industrial wastes.

9. In Pennsylvania, treatment of tannery, phenol, mine, and other industrial wastes is being studied.

10. In Ohio disposal of creamery, canning, paper mill, phenol, acid iron and other wastes is under investigation at experimental plants.

11. In Michigan, canning, beet sugar and other industrial wastes are being treated in experimental plants.

12. The U. S. Public Health Service is making the following studies at Cincinnati and elsewhere: (1) phenomena of bacterial purification in natural streams, and the biology of plankton forms in relation to bacterial purification; (2) laws governing natural processes of oxidation in streams, and methods of making the determinations: (3) relation of pollution of raw water to quality of effluent from experimental rapid sand filtration and chlorination plant; (4) investigation of pollution of streams in various parts of the country.

13. According to a questionnaire sent to State Health Departments early in 1925, some research work regarding stream pollution was being carried on by seven departments.

From a review of the foregoing studies now going on, it will be noted that there are many different kinds of fundamental research problems to be solved. Another problem is the effect of mechanical devices upon sewage treatment.

These problems may be carried out in two ways, either through individual efforts of laboratories or scientific workers, or co-operatively. In the first case studies are made in laboratories and the principles are then tested out in sewage disposal plants; in the second case, the work is conducted by research organizations working together or dividing the problem, each taking a certain part. In both methods, information is required as to what work has been done elsewhere, also moral support and funds.

At present, a great deal of the research in stream pollution is done by individuals. In the course of such work duplication is involved, time lost, and funds and facilities are not used to the best advantage. On the other hand, it is possible through co-operative efforts to accomplish a large amount of valuable research work without duplication, with greater ease, more quickly and with more facilities. In carrying out a piece of cooperative research work, the major problem requiring solution is presented, analyzed into specific parts and divided in a systematic manner, by mutual agreement, among individuals or laboratories, so that when the work of each is accomplished, the sum total of all the efforts will furnish a solution of the problem for the benefit of all.

Instances of such cooperative research work are at hand in the case of the Committee on Standard Methods of Water and Sewage Analysis of the American Waterworks Association and the American Public Health Association, and the Association of Agricultural Chemists. Another example of cooperative work is the Union of American Biological Societies consisting of a federation of some fifteen societies of zoology, physiology, ecology, botany, and so on. As a result of the endeavors of the union, strongly supported by the National Research Council, a subvention of $350,000 for a period of ten years, was obtained from the Rockefeller Foundation for the establishment and maintenance of a much-needed comprehensive journal of biological abstracts.

Herbert Hoover in a recent address before engineers in which he made a plea for the advancement of fundamental scientific research in this country said: "The time has gone by when we can depend very much upon consequential discovery or invention being made by the genius in the garret. A host of men, great equipment, long patient scientific experiment to build up the structure of knowledge, not stone by stone, but grain by grain, are today the fundamental source of invention and discovery." In this Mr. Hoover does not overlook the genius, and wishes to provide assistants, equipment, etc., for him; but his main plea is not to depend upon the genius alone.

As Dr. Vernon Kellogg of the National Research Council so aptly states,[13] "great philanthropic foundations are inclined to count the need more than the amount of money involved. They are inclined to be generous to those who can show a real need, and especially are they inclined to be generous to more or less well-organized groups of men ready to attempt to achieve a common goal by united effort.

"The scientific body, to whose upbuilding I am at present giving all my attention and effort, wants to promote in every way possible to it the sound development and increase of scientific reasearch in this country. It wants to avoid interfering in any way with what is already going forward in this direction; least of all things it wants to dictate to any scientific man or men the things he should do. There is fortunately no possibility of the National Research Council, or any other body, ever being able to dictate to scientific men; scientific men will suffer no dictation. But it wants to help, in making things easier for scientific workers from geniuses down; it wants to influence colleges and universities to recognize ever more clearly their research responsibilities; it wants to make clear to the great industries how inescapably their success depends on scientific advance and hence that they should in every way encourage such advance; it wants to bring the support of the great philanthropic foundations, with their large financial resources, to scientific men and undertakings. And it believes in cooperation and coordination of effort.''

It would seem desirable for engineers, chemists, bacteriologists, and others interested in stream pollution to unite in some kind of organization for the advancement of knowledge of the various problems of stream pollution. Such an organization could consider the major problems in this field and by mutual agreement of various laboratories and workers, distribute the problems or parts of the problems to each for solution, and, when all units are completed, could disseminate the scientific data to all. Such an organization could seek for funds and assistance from the National Research Council, Engineering Foundation, and private industries and philanthropists, to provide equipment and other assistance for individual laboratories and to establish a clearing house for information on all phases of stream pollution. Cooperation and coordination have proven invaluable in other walks of life in the United States; it is worth while trying them out in research studies in sewage disposal and stream pollution.

SUMMARY

Among the recent developments in sewage disposal and stream pollution in the United States are: (1) cooperation between governmental bodies and private industry; (2) recognition of the joint need of sewage treatment and water purification in certain streams; (3) improved status of sewage plant operators, and importance of pure research in stream pollution. The desirability of cooperation among laboratories and other research workers in solving stream pollution problems is pointed out.

ACKNOWLEDGEMENTS

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IOWA'S WATER SUPPLY PROBLEM IN ITS RELATION TO SEWAGE DISPOSAL

By Hans V. Pederson
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One of the reasons for advocating the installation and proper maintenance of sewage treatment plants is to keep the waters of lakes and rivers in a condition that they may be readily treated in water filtration plants, and thereby converted into safe, satisfactory drinking supplies. One of the most important problems before the Sanitary Engineer today is that of determining how badly a stream may be polluted before a water purification plant cannot be relied upon to produce a safe drinking water.

The U. S. Public Health service has for a number of years been engaged in a study of several of our eastern rivers in an effort to determine just when it is best not to rely entirely upon the results of water filtration plants. It is realized that some definite line of demarkation must be drawn between a water supply which can be safely utilized for domestic use, and one which cannot be treated satisfactorily by any of the modern methods of water purification.

As some few rivers in the United States have already reached a state when they can no longer be utilized as a drinking water supply, and as many other rivers throughout the country are rapidly approaching such a state, let us consider for a few minutes the condition of our Iowa rivers and analyze the situation.

In a recent general survey made by the state department of health, all the cities and towns in 75 counties out of a total of 99 counties were visited. In the 73 counties there were 381 municipal water supplies. 131 of these water supplies were secured from wells less than 100′ deep, 234 were secured from wells more than 100′ deep and 16 supplies were secured from the surface sources. The survey included the entire Cedar, Iowa and Des Moines river valleys, and it is the situation in this area that I wish to discuss primarily.

Of the 16 surface supplies mentioned, 4 are secured from rivers, 3 from lakes and 9 from impounding reservoirs. Ottumwa is the only city located on the Des Moines river that secures its water supply from that source. Iowa City is the only city on the Iowa river that secures its water supply from that river and Cedar Rapids is the only city on the Cedar river that utilizes that river as a drinking water supply. All three of these cities are located well down to-

ward the lower extremity of the drainage of each river where the conditions of the water would necessarily be affected by pollution of the greater part of the upper drainage area.

In the 73 counties visited there are 35 cities discharging domestic waste directly into the rivers. The total population of these cities is approximately 375,000 or about the same size as Minneapolis or one eighth the size of Chicago. In the same area are located 8 major industries that discharge waste into the rivers. Two of these are located on the Cedar River, two on the Iowa river and two on the Des Moines River and two on Lime Creek, a tributary to the Cedar River. The amount of waste from all of these industries has not been determined but speaking in terms of oxygen demand, the waste discharged is equivalent to the waste discharged from a city of approximately 500,000.

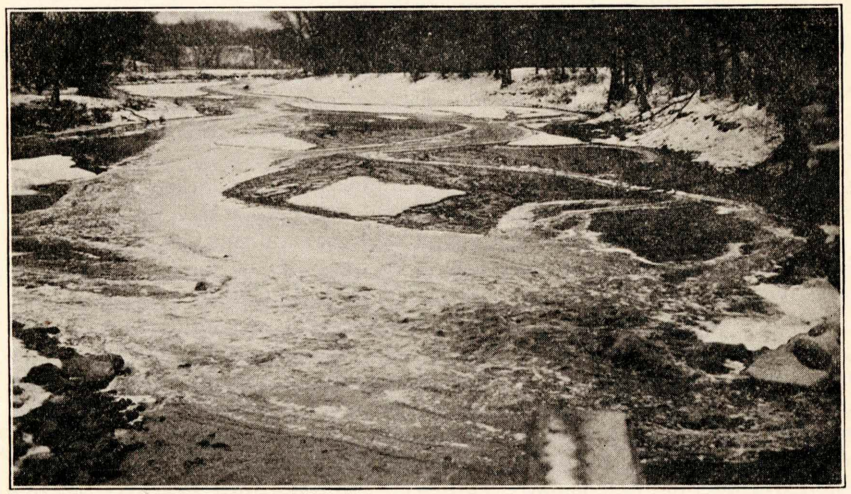
There are approximately 350 creameries in the state of various sizes. Some of these creameries discharge their waste directly into near-by streams and some discharge into the sanitary sewer system of the community. The waste from a number of the larger creameries located on small streams or connected to the smaller sanitary sewer systems having sewage treatment plants is causing considerable trouble, but taken as a whole the pollution problem which exists as a result of creamery waste is not considered serious at the present time.

The corn canning factories in the state are a source of considerable trouble during the period of time they are in operation. The wastes from these factories usually run between 1000 and 2000 oxygen demand and if it were not for the fact that they operate only from 4 to 6 weeks in the fall of the year, much more complaint would be made. The waste usually contains a high sugar content which tends to ferment, causing disagreeable odors if the water of dilution is not sufficient to overcome this tendency.

With this brief survey of the present situation a conclusion can be reached to the effect that as far as the public water supplies of the state at the present time are concerned, Iowa has no great cause to become alarmed about the stream pollution situation. Of course the three cities affected have just cause to be worried but I simply wish to point out that as far as numbers are concerned, 99% of the cities in the area under discussion, secure their water supplies from under-ground sources and are not concerned with the pollution problem at the present time.

But how about the future? Are Iowa municipalities always going to be able to secure a sufficient supply of water from underground sources? It must be admitted that this is a horse of a different color; a question which is vital. Let us take a look at the situation and attempt to draw conclusions.

Observations made in various parts of the state indicate that the head of water in certain deep wells is lowering at an alarming rate. Some wells that flowed quite freely several years ago have ceased to flow and the head of other deep wells is from 10′ to 20′ lower than when they were first drilled. Just what might be the cause of this drop is difficult to say; we can only advance theories. One sane reason seems to be that the water in the deep-lying, water-bearing sands is being pumped out faster than it can be replaced.



Stream Pollution by Industrial Waste showing winter conditions of a small Iowa stream receiving four and one-half million gallons of industrial waste daily.

According to geologists the water found in the St. Peters and Jordan sand stones comes all the way from Minnesota and Wisconsin and that it takes at least 75 years to travel the distance to central Iowa.

If it is really true that the head of water will continue to fall in deep wells in certain sections of the state due to the fact that the water is being used up faster than it can be replaced, it will mean that the unfortunately located cities and towns will be compelled either to put down more deep wells at great expense and lift the water at an excessive cost, or go to a surface supply, unless some shallow water-bearing sands can be found that will furnish an adequate supply of water.

It will be noted that in the counties in which the survey was made, the number of deep wells were about twice as many as shallow ones. Just why this is true, I cannot say. There is undoubtedly some reason but I have yet to find one that can be definitely accepted in all cases from a scientific or engineering standpoint. There seems to be an inherent desire on the part of at least 90% of our town councils to locate the wells furnishing the public water supply,

inside the town limits. There are objections for reasons not perfectly clear to seeking a water supply away from the boundaries of the community. If no shallow water bearing sands could be located within the confined limits of the town, the only naural thing to do was drill down into old Mother Earth until water was reached. It has been commonly taught that the deeper the well the better the water and although this is true only in a few cases, it may be one reason for the larger number of deep wells.

Recently I have become suspicious that one reason for the larger number of deep wells in comparison to the shallow ones is the failure on the part of the citizens of a community to really know anything about the various sources of water supply that might be available near their locality. In traveling up and down the state I have been impressed with the utter lack of knowledge concerning the various possible sources of water supply which might possibly have been developed by the community. In fact I would say that not over 5% of our cities or towns have full and complete knowledge of the various sources of water supply available or having such information have developed the source in an economical and sanitary manner. Our state department of geology has published a large volume on water supplies of the state but this volume contains only data on wells that are in existence. No attempt is made to discuss other possible shallow sources of water than those which have actually developed.

Iowa's stream beds and valleys abound with shallow water-bearing sands. We know a little about these sand deposits but the vast majority of sand pockets capable of producing a large quantity of water are as yet undiscovered. It has been demonstrated within the last year that certain communities of the state have in the past spent great sums of money in an effort to develop a deep well system when they might have developed an excellent shallow water-bearing sand which they never dreamed existed until a survey disclosed its location.

I do not wish from these statements to leave the impression that I favor a shallow well in all cases over the deep well. My purpose is simply to point out the fact that in case the deep water bearing sands give out or it becomes too costly for certain communities to operate a deep well system they might, within reason, be able to develop a shallow water bearing sand hitherto unknown, located within a radius of from 5 to 10 miles from the center of population instead of developing a polluted surface water supply.

Some cities are so unfortunately located that it is predicted that they will be compelled to develop a surface water supply within the next 25 to 30 years. Counting the border river towns there are a total of 30 cities in the state that secure their public water supply from a surface source. That there will be twice this number inside of 50 years is considered a conservative estimate. Some of their sources will of necessity be rivers, but the larger number will consist of impounding reservoirs which can be controlled to some extent.

Conclusions concerning the future water supply problems of the state of Iowa can be summed up as follows: The number of cities compelled to develop surface waters as a source of drinking water supply will increase. It is only a question of time until our larger

Victims of Industrial Waste—sixty miles downstream.

cities will be compelled to turn to a surface supply or spend equally as great a sum of money developing distant shallow water-bearing sands. If all the cities and towns in the state that are finding it costly to operate a deep well system or who have found that it is both difficult and costly to develop deep underground water-bearing sands, would secure all the information concerning the possible available sources of water, they may find themselves much better off than they ever expected. With all the information and data at hand many towns may find that they have an equal chance to develop a shallow water-bearing sand as a surface supply.

It should be considered a crime to rob the ground of its supply of water and waste it. Every deep flowing well, no matter where it is located, not utilized as a drinking water supply or for industrial purposes should be plugged up tight. No town or city in the state should attempt to change a source of water supply or spend a great deal of money developing an additional supply until they have acquainted themselves with all the various sources of water available and have all the facts to enable them to decide which source would be the best to develop.

All cities and towns and all industries located on rivers or tributaries of rivers that are being utilized as a source of public drinking water supply should begin at once if they have not already done so to establish a constructive program for raising funds to finance the installation of sewage treatment plants or to take care of those plants already in existence. If no effort is made on the part of these cities to control the pollution of streams, future generations living in a number of unfortunately located cities may be made to suffer for lack of an adequate and safe drinking water supply. The conditions of the majority of the rivers in Iowa are not so badly polluted at the present time that the water cannot be treated in water purification plants and made safe for drinking purposes, but with the increase in population and corresponding increase in the pollution, the condition of some of the major streams may all too soon reach a state where the water cannot be utilized as a drinking water supply.

The majority of our Iowa municipalities will, with proper care, be able to depend upon the state's natural underground water resource as a drinking water supply for many years to come, but the unfortunately located cities will either have to make a stand for the prevention or control of stream pollution, or be content to sit back and watch other more fortunate cities all around them grow while they decay. For just as surely as there is day and night, a city or town without an adequate and safe drinking water supply will fall by the wayside in the development of future progress.

The question before the state is: Shall 90 to 95% of the state's population be permitted to pollute the streams and destroy the only natural source of drinking water supply for the other 5 or 10%? I leave this question for your consideration.

THE DISPOSAL OF TRADE SEWAGE

By C. H. Currie
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Trade wastes are distinguished from the usual domestic wastes of a community, and may require separate methods of treament. This may consist of complete separate treatment, or of sufficient preliminary treatment to produce wastes, which may be turned in with the community sewage and finally purified in the community sewage-treatment plant.

The importance of the proper disposal of trade sewage is becoming more apparent every year. Many of our smaller communities are finding that their sewage-treatment plants, which in the past may have given good satisfaction, are unable to treat properly the sewage they receive. The increase in dairying and the consequent increase in dairy wastes produced in small towns, together with the sewage from canning plants, sugar-beet plants, and many other industries, often put a load of concentrated wastes upon the municipal treatment plant that it cannot be expected to handle.

This does not mean that all towns having small creameries, or even that all towns having small canneries, may be having trouble with trade sewage at the present time. The carelessness of employees, in many creameries, permits too much of the washings with a feeding value to waste into the sewer. This may increase the concentration of the creamery waste to a point where proper functioning of the sewage-treatment plant is seriously disrupted, and a nuisance is created. The most serious problems in trade-waste sewages are the nature and concentration of these wastes. Many trade sewages, such as creamery and cannery wastes produce acid fermentation, and either totally or partially interrupt the proper digestion of solids in the settling tanks, thus causing total or partial disruption of the entire sewage-treatment plant. Until very recent years little has been known of the nature of the trouble caused. The advance in the science of sewage-treatment, however, and especially the active studies being made by bacteriologists and chemists, are showing us that trade sewages usually present individual problems that need to be worked out by themselves.

Methods of Disposal

There are three general ways in which trade sewages may legitimately be handled: (1) by fine screening with sufficient dilution to

prevent undue stream pollution or to constitute a public nuisance; (2) by a partial treatment of the trade sewage in order to destroy the acid-forming bacteria or to change this sewage to the equivalent of ordinary domestic sewage, so that it can be run into the municipal sewer system and put through the treatment plant in the regular course; (3) by the complete treatment of the trade sewage, so that the resultant liquid can be wasted in any stream or storm sewer. The nature of this treatment would, of course, depend upon the nature of the trade sewage itself and might present a considerable problem.

Disposal Problems Compared

Many industries, such as canning plants and sugar-beet plants, operate but a very short period in the year, but their daily volume of sewage may be large. The cost of a sewage-treatment plant of the sort usually designed for municipalities, would probably be so high that it might mean the moving or abandonment of the industry in favor of another locality. It is quite possible, however, that much cheaper treatment plants may be constructed by utilizing available materials. The elimination of labor in the design of a municipal plant is important; while in a plant handling trade wastes (but only operating for a short season), this item is not so important. The question of pumping is somewhat similar. While this operation should be avoided in municipal plants where possible, pumping might well be warranted in the handling of short-season trade sewage, when by so doing the capital investment can be reduced.

Disposal of Beet-Sugar Wastes

The case of a sugar beet company may be taken as an illustration. This summer an experimental plant has been worked out in an attempt to determine: (1) Whether a direct trickling over beds of stone would produce a stable effluent that could properly be discharged into the creek, and to determine the cheapest materials that could be used as a filtering medium, if such a method of purification proved satisfactory. To that end a temporary trickling filter with five compartments has been constructed—one with cinders from the company's power plant; a second, using screened cinders from the same source; a third, using sized or double-screened cinders; a fourth, using broken tile, which can be secured very cheaply; and a fifth, using screened gravel.

The probable amount of liquid that will have to be treated at this sugar-beet plant, will eventually run in the neighborhood of six million gallons per day. If crushed granite of the sort usually employed in Iowa were used, on the basis of two million gallons of liquid per acre per day (which may be high), the cost of the filter stone alone would be approximately $90,000. Should gravel prove a satisfactory medium, the cost for the material alone would be approximately $60,000. Should the broken tile prove satisfactory, the cost of the material in place would be approximately $35,000. Should screened cinders be used, the cost would be about $28,000. Should the cinders, as they come from the cinder pile, prove satisfactory, the total cost in place would be approximately $20,000.

You can see from this specific case that it is well worth the while of any industry to make a careful study of its problems, as there is a possibility at least of a tremendous saving in capital investment.

Effect of Trade Wastes on Sewage

As an illustration of the effect of a trade waste upon a sewage, a certain sewage-treatment plant designed and built some years ago, operated very satisfactorily until a canning plant dumped its sewage into the city sewers. Thereupon the Imhoff tanks immediately went out of commission, foaming violently, causing disagreeable odors, carrying over solids to clog the trickling filters, and in general disrupting the sewage-treatment plant for the period of the canning season, and some weeks afterwards.

A careful analysis of the liquid from this canning plant has since been made from samples taken at the plant, from the creek above the plant, and from the creek about a half-mile below the plant. While the samples from the creek above the plant showed some pollution, it was insignificant compared with the pollution below the plant. The waste liquid itself showed a great tendency toward acid fermentation as the first stage, which was undoubtedly the primary cause of trouble at the municipal treatment plant.

The analysis of the waste from this particular cannery indicates that it acts very similarly to the waste from a typical creamery. Possibly the same general method of treating creamery wastes might well be tried out on this canning-plant waste.

It would probably be necessary, however ,to add fine screening in order to remove the coarse corn waste, pea hulls, tomato seeds and skins, and similar material ordinarily found in canning-plant wastes.

There is no general rule by which a community may solve its particular problem, but each community owes much to its industries, and should cooperate with them in securing expert advice to solve their mutual problems in the most economical and efficient manner.

STEAM POLLUTION AND ITS EFFECTS

By N. T. Veatch, Jr.
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We are all fairly familiar with the results of stream pollution as evidenced by the black, ill smelling water of some familiar stream, but there seems to be a general lack of understanding on the part of the public at large, in regard to the importance of this question, and its relation to public welfare. The popular conception of "stream pollution" seems to be synonymous with "nuisance" as regards offense to smell and sight, whereas this feature is but one of the phases of the subject and by no means the most important.

The protection of our streams, and other bodies of water as well, is nothing more or less than the protection of a national resource, in fact, one of our most valuable national resources, since it concerns the all important question of public water supply and therefore, concerns all city dwellers in locations where ground water supplies are not available. Some industries, as fisheries, are entirely dependent on reasonably pure stream water and all industries are dependent on water supplies of some nature.

By no means the least important feature of this question is the fact that it is becoming more and more acute each year through the increase in urban population, the increase in the number of municipal sewer systems, the increase in industries which produce objectionable trade wastes and in the rapidly increasing number of cities which are being forced to use surface water to get an adequate supply.

The increase in the urban population of the United States is shown in the following table adopted from the U. S. Census which shows that the urban population of the United States in 1920, exceeded the rural by approximately 3 million, and there is every indication that this excess will continue to increase.

	1900	1910	1920
Population of U. S.	76 million	92 million	106 million
Rural	46	50	51.5
Urban	30	42	54.5

There seems to be no available authentic data on the number of sewer systems in the U. S. but, based on experience in the central west it may be stated that at the present time a town of 2,000 without a municipal sewer system is decidedly exceptional, and that probably 75% of these systems have been built in the past 20 years. It is therefore, reasonable to assume that within 20 years, practically all towns of 1,000 and over will be served with sewers. Similarly, there seems to be no available authentic data in regard to the change of municipal ground water supplies over the country to surface water, but again judging from experience in the central west where numerous cities have had to make this change, through inadequacy of ground water supplies, this factor is important.

The manual of the American Waterworks Association estimates the number of water works in the United States as 9,850 in 1924, of which 36% are surface supplies. In view of the fact that practically all of the cities in excess of 30,000 are included in the 36% it is probably safe to say that 75% of the urban population of the United States is served by surface water from streams, lakes, or artificial reservoirs, and that approximately half of this number or 20 million persons, are served from water supplies taken from streams which are subject to pollution from municipal sewage, trade waste, or drainage from barn yards or feed lots. When it is considered that the above condition exists at such important centers as Philadelphia, Pittsburgh, Baltimore, St. Louis, Cincinnati, Louisville, New Orleans, Kansas City, Omaha, Oklahoma City and many others, the importance of this question may be seen.

The present standard of purity as set forth by the International Joint Commission in 1913, in extensive investigation of boundary waters, considered as safe for surface waters which are to be purified by modern plants, consisting of settling and coagulating basins, filters and sterilizing equipment, demands that "the raw water shall not have objectionable odor, color, or taste, and shall not contain more than 500 bacteria of the intestinal type (B Coli) per cubic centimeter." Practice has shown that the above is not a bad standard to shoot at although satisfactory water is produced at many places where this standard is often exceeded, but the fact remains that the use of such water is dangerous and puts too heavy a load on the purification plant. This extra burden surely should fall on those agencies causing the pollution, which calls for purification of sewage and trade wastes where pollutions exceed a safe limit. As a matter of fact some of the streams of the country are called upon to furnish water for municipal water supplies at a rate which in the aggregate exceeds the flow of the stream at times. This was true of the Verdegris River in Kansas in the fall of 1917, when the aggregate amount of water used by Kansas municipalities along its course, was approximately three times its flow at the Oklahoma State line.

The chief source of stream pollution is undoubtedly municipal sanitary sewage which may be made up of anything, but which is reasonably uniform except as to trade wastes.

For the study of stream pollution the character of sewage is customarily reported as solids both in suspension and in solution, as organic matter in the form of total nitrogen and "Oxygen Consumed," and as "Biochemical" or "Biological Oxygen Demand" which last is a measure of the oxygen required to mineralize the organic matter in the sewage.

Bulletin No. 143 of the U. S. Public Health Service states that average domestic combined sewage without major trade waste will contain the following constituents in grams per capita per day.

Total solids	439
Dissolved solids	330
Suspended solids	109
Total nitrogen	11.4
Oxygen consumed	51.5
Biological oxygen demand	100

For a city of 10,000 persons, therefore 1,000,000 grams or 2,204 lbs. of oxygen will be required daily for sanitary sewage.

Trade wastes are of course more variable and require special study in each instance. They may range from sawdust which has practically no effect on the water, to wastes from coal tar product works which cause objectionable tastes in waters in several million dilutions of pure water.

Several specific waters have been studied and found to contain total nitrogen and oxygen consumed as shown in the following table which also gives the approximate equivalent of the waste in terms of sanitary sewage.

ESTIMATED AVERAGE AMOUNTS OF TOTAL NITROGEN AND OXYGEN CONSUMED CONTAINED IN VARIOUS INDUSTRIAL WASTES, PER UNIT OF PRODUCT, RAW MATERIAL OR LABOR, WITH APPROXIMATE EQUIVALENTS IN DOMESTIC SEWAGE.*

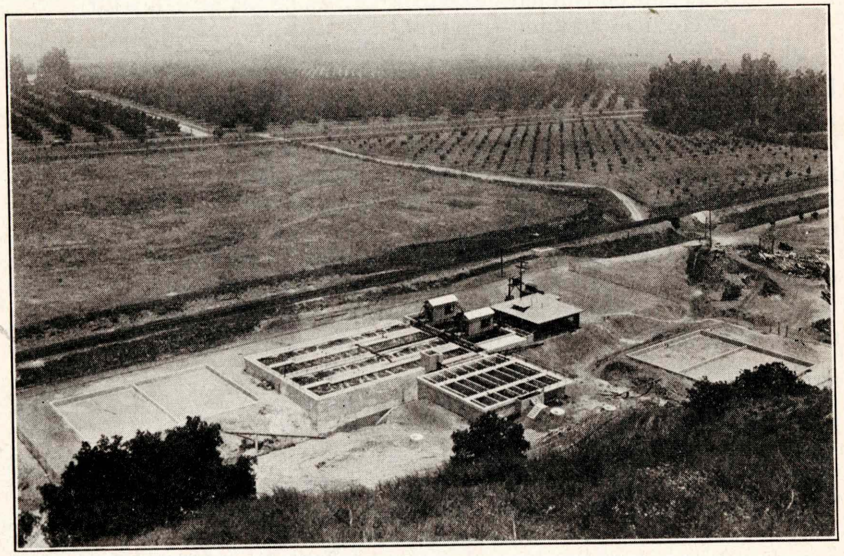
Nature of waste	Unit of measurement	Grams per unit		Approximate no. of persons required to produce the equivalent of this waste in domestic sewage
		Total nitrogen	Oxygen consumed	
Slaughter house	1 animal	238.6	183.7	7
Pork packing	1 animal	243.1	307.5	9
General packing	1 animal	171.5	344.2	8
Glue making	1 employee	3,193.3	4,427.1	102
Soap making	1 employee	27.2	2,084.7	33
Wool scouring	100 lbs. raw material	340.2	1,551.3	30
Wool cloth dye and scour	100 lbs. raw material	704.4	7,112.4	124
Cotton cloth, bleach and dye	100 lbs. raw material	1,111.3	6,159.9	115
Paper—sulphate pulp	1 ton pulp product	1,315.4	647,741.0	13,000
General paper mill	1 ton paper product	19,504.8	729,937.6	780
Straw board	1 ton product	5,715.4	151,502.4	2,500
Tanning	1 skin	163.3	1,261.0	22
Creamery**	100 lbs. butter fat	.90	7.90	14
Corn products** refining	100 bushels	....	....	500

*Adopted from Table 46. United States Public Health Service Bulletin No. 143.
**Estimated from a number of analyses.

As a matter of historic interest only, it may be stated that in the production of one barrel of distillery product, the waste produced is equivalent to the sewage from approximately 50 persons.

Generally speaking therefore, it is possible to convert the pollution by trade wastes into its equivalent in sanitary sewage and from this figure to determine the required dilution or treatment necessary to prevent pollution. The dissolved oxygen in stream water will vary from approximately 14 p.p.m. at 35 deg. F. to approximately 9 p.p.m. at 70 deg. F. provided the stream is not already polluted and therefore less nuisance is caused by a given amount of sewage in equal amounts of water in winter than in summer.

From the above stated figure of 2,204 lbs. which represent the



Activated sludge plant at Pomona, California, serving Pomona, La Verne and Claremont.

daily amount of oxygen required to mineralize the sewage from 10,000 persons, and assuming that 5 p.p.m. of oxygen may be given up by the stream at any time without causing serious nuisance or damage to fish life, it may be estimated that a flow of 80 cubic feet per second or 8 cubic feet per second per 1,000 population will be ample for dilution. Such calculations are misleading however, and cannot be generally applied since so much depends on the local condition of the stream. In the past some authorities have stated that a flow of 4 cubic feet per capita is ample while recently the Royal Commission in England has recommended a dilution of 27.8 cubic feet per second per 1,000 persons.

Self purifications of streams is a factor in this problem, but is badly misunderstood. For instance, we have often heard the statement that the Missouri River purifies itself in 7 miles, but this may

or may not be the case. Self purification is a factor of time, since certain chemical and biological changes must take place and therefore, the velocity of the stream, its turbidity, turbulance and other factors must be considered.

Mr. Langdon Pearse states that the Illinois River on one test absorbed 205,000 lbs. of oxygen from the air while flowing a distance of 65 miles which fact merely shows that oxygen for self purification can and does come from the air, but this figure cannot be considered for general application, since it represents a certain set of conditions which may or may not be duplicated elsewhere.

Ohio River pollution studies by the United States Public Health Service show that the time of flow from Pittsburgh to the Mississippi River may be anything from 14 days to 129 days, depending on the river stages which fact again emphasizes the point that each instance of pollution is a problem in itself.

This is a very sketchy outline of some of the features of the stream pollution problem, but serves to show that streams have a definite capacity for biological disposal of sewage and trade waste and that if the municipalities, and other sewage and trade waste contributors along the stream, control the amount of pollution which they contribute, by properly designed and operated sewage disposal plants, the streams can be kept in good condition, not only as regards nuisance but as regards water supply, fish life and other features.

The solution of this problem is obvious and calls for

1. Treatment of sewage and trade wastes at their source, to an extent to be determined in each individual case.
2. Maintenance and careful operation of sewage systems and disposal plants.
3. Purification of water at intakes of water supplies, to the extent necessary for safety.
4. Careful operation of water purification plants.

This requires the determination of the extent of purification needed at both ends of the line and for this information we must rely upon information gotten by the government and state health authorities, which are doing immensely valuable work along this line, and deserve better support from the public than they have received in the past.

Organizations such as the Isaac Walton League are working toward the return of our streams to their original purity and that the problem is being recognized by legislators is evidenced by laws in nearly every state. It is doubtful however, if this problem can be solved by legislation alone and the solution will probably come only when the public as a whole realizes just how far its welfare depends on proper protection of our streams. When this occurs, prompt action by local organizations will be taken to the end that the necessary work be done.

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