

P 635

# FIVE YEARS OF SANITARY PROGRESS

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## REDUCING THE TYPHOID TOLL IN WEST VIRGINIA



ISSUED BY  
E. S. TISDALE, Director  
Division of Sanitary Engineering  
West Virginia State Department of Health

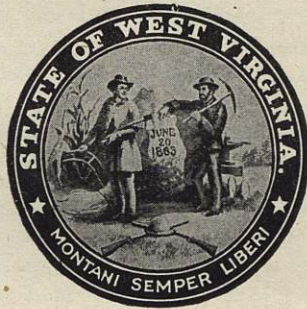


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## INTRODUCTION

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Five years have passed since the Engineering Division of the State Department of Health started its work to give the people of the State, both in the country and city, purer water to drink. It seems worth while to stop a minute as this five year milestone is passed, and look back over the path which has been traveled to see whether or not any real advancement has been made. Have the sanitary engineers been walking a tread mill or have they, as it were, climbed up the mountains at least a little way in their work, and looking back over the pathway by which they have come, can they see groups of men and women and children alive and well who, but for the better, purer water provided through the work of the Department, would be silent beneath the trees in the valley below with a gray grave stone above them, a silent tribute to the toll of typhoid, a disease which needlessly has carried away so many hundreds of lives in the past.

In the campaign against the scourge of typhoid fever in West Virginia, the most effective weapon which the State has had at her disposal during the past five years has been the Division of Sanitary Engineering of the State Department of Health. This Division was provided for by law in 1915. Its duty as outlined under the law was to co-operate with towns, cities and communities throughout the State that pure drinking water might be substituted for impure, dirty, disease-producing, drinking waters, and that the sewage and wastes from cities and towns might be disposed of in a sanitary manner.

This review of the progress made and of a few of the water-borne typhoid epidemics which have occurred in West Virginia during the last five years, should interest not only the legislators who provided the law establishing the Health Department, but also all those who follow the progress of the State in the campaign for better public health. It ought to appeal to every business man, every water works superintendent, every manager for a mining corporation. The question has a definite financial aspect. It can be readily shown that the assets of the State, the human assets, are being conserved by the provision to supply safe water. Too long have the natural resources of West Virginia been wantonly wasted. Through the work of the Division of Sanitary Engineering steps are being taken now to safeguard the human resources and effectually reduce water-borne typhoid fever.

Due to defects in the present registration laws of the State, that is, the book-keeping of the State Health Department, the complete records of births and deaths and the prevailing sickness in the different parts of the State are not available. The faulty laws should be corrected. Without records it is impossible to show the exact reduction in the typhoid death rate in West Virginia. The only way in which the progress can be clearly seen is by a study of the towns and cities where typhoid outbreaks have occurred. By noting the prevalence of typhoid in these towns now as compared with previous times in the past, we can arrive at a fairly definite conclusion as to the progress which has been made.

### Water-Borne Typhoid Epidemics

Nineteen different water-borne typhoid outbreaks investigated by the Division of Sanitary Engineering are briefly described in this bulletin so that the most common ways in which water-borne typhoid is spread through towns and cities may be illustrated. For convenience the epidemics have been divided into four groups depending upon the nature of the outbreaks.

**GROUP A** including St. Albans, Dunbar, Piedmont, West Union, Gassaway, Clay Court House, Rowlesburg, Spencer and Philippi, deals with small public water supplies where a severe infection was introduced into the community through the use of a raw, untreated river water for drinking purposes.

**GROUP B** deals with three cities, Charleston, the State Capitol, Williamson and Weston, where inadequate filtration of the river water was responsible for unsafe water with consequent typhoid epidemics.

**GROUP C** has to do with three mining towns, Ronda, Ivaton and Loma, where dug or drilled wells became infected and caused a wide spread outbreak of disease.

**GROUP D** illustrates convincingly the part that chlorine treatment of raw river waters plays in protecting a community from water-borne typhoid fever when the town or city can not afford filtration. That interruption of the disinfection process is serious seems clear from the story of the epidemics at Elkins, Fairmont and Clendenin.

**GROUP A—THE FOLLOWING NINE OUTBREAKS WERE  
CAUSED THROUGH THE USE OF AN UNTREATED  
RIVER WATER FOR DRINKING PURPOSES**

#### St. Albans—Kanawha County

One of the first serious typhoid outbreaks where the assistance of the Division of Sanitary Engineering was requested, was at St. Albans in January, 1916. Thirty-four people suffered in this typhoid epidemic and several deaths resulted. Careful investigation exonerated milk and food supplies from suspicion. It was a clear-cut case of a water-borne outbreak.

The city water was pumped directly from Coal River to the city mains with no treatment. Six miles up Coal River there had been a number of cases of typhoid at Brown's Creek in January, while in December an outbreak at Ivaton, a small town on the watershed of Coal River, had been investigated and controlled by this Department. When the result of the investigation was laid before the water company and recommendations made, their whole-hearted co-operation was immediately obtained. The situation proved to be a case of ignorance on their part that they were endangering the locality by using a raw water.

The chlorine plant recommended was purchased immediately and installed by the water company with the assistance of the sanitary engineer from this Division. The constant and conscientious care given in its operation has resulted in freedom from further typhoid epidemics in St. Albans during the years 1916-1920. The necessity for a modern filter plant has been pressed home on several occasions by this Department and now designs are being prepared for a complete and adequate purification system.

This Department's service in the St. Albans epidemic consisted first, in ascertaining the cause of the typhoid epidemic; second, taking steps to control the

outbreak and causing the installation of a chlorinating apparatus that the raw water might be disinfected in the future, thus preventing further water-borne outbreaks; third, in correcting the attitude of a water company which was ignorant of the danger of using raw river water; and fourth, in stimulating the demand for a modern rapid sand filter plant now being designed.

### Dunbar—Kanawha County

An urgent call for help to combat typhoid fever, which reached the State Health Department through the Governor's office on August 13, 1915, came from Dunbar. Here in a new but rapidly developing manufacturing community, was an example of how the process of experimenting with schemes to purify polluted river waters may react disastrously on the health of a community. Twenty-eight people were sick with typhoid fever. An infiltration crib of sand and gravel in the bed of the Kanawha River had become clogged. The river is here grossly polluted by the discharge of ten millions of gallons of sewage daily at Charleston, six miles above on the same side of the river. Finding that this scheme of filtering would not work it was abandoned, and raw water pumped to Dunbar while a pressure filter was being installed. Before the installation could be completed the typhoid fever broke out in all parts of the town, showing how closely linked together were the sewage of Charleston and the drinking water of Dunbar.

Completion of the pressure filter and sterilization by hypochlorite of lime brought about a marked reduction in the typhoid fever. However, conditions were bettered even more when liquid chlorine treatment was substituted for the hypochlorite dosing a short time afterwards. The help which the Division was able to give in the Dunbar outbreak consisted first, in making a study of epidemiological facts and ascertaining the cause of the fever; second, co-operating with the company in having installed a reliable and accurate way of using the sterilizing agent—chlorine. In this connection it is worth while to speak of the service rendered to Dunbar during the three years, 1916-1918, in loaning spare parts for this machine in cases of emergency, so that no interruption in chlorine treatment could occur. Third, most important of all, was possibly acquainting the company operating the purification plant with the fact that this Division would help out in times of trouble with the filter or chlorinator, and at all times there was a definite agency available ready and willing to help them in their attempt to furnish a safe water supply to this industrial city of Dunbar. This co-operation has resulted in a marked absence of water-borne typhoid in Dunbar.

### Piedmont—Mineral County

During 1914 one of the worst typhoid epidemics experienced in West Virginia occurred in the tri-towns—Piedmont, W. Va., Westport and Luke, Maryland. These three towns constitute a typical industrial community. The West Virginia Pulp and Paper Company operates a large paper mill at Luke, Maryland, just across the river from Piedmont, W. Va. The people of Piedmont find their employment for the most part in this mill. In these three towns, 141 cases of fever occurred in the early months of 1914, 117 cases being reported from Piedmont alone.

It seems worth while to show briefly the main features of this serious outbreak, since it brought about the immediate employment of a trained sanitary

engineer to take charge of the Division of Sanitary Engineering, which had been authorized a few months before by the West Virginia Legislature as a separate Division in the State Department of Health. The Sanitary Engineer from Maryland who investigated this outbreak, was appointed as the first Director of this Division in 1915.

Under normal conditions Piedmont and Westernport were furnished with a water supply derived from the Savage River at a point eight or ten miles distant in the mountains. The supplies were entirely separate, but both towns experienced difficulties due to the breaks or slips in the long gravity pipe lines and consequently interruptions in service were frequent. In order to provide the towns with water during such periods, arrangements were made with the West Virginia Pulp and Paper Company at Luke to pump water from the Potomac River into the town mains. Both the Westernport and Piedmont water supplies could be furnished with this water through a by-pass connection between the two systems.

Typhoid fever was constantly present in Piedmont and Westernport during the latter months of the year 1913, and early in 1914 it assumed epidemic proportions. Investigation by the State Health officials from Maryland during 1914 showed conclusively that this typhoid was water-borne. Probably the breaking of the Stony River Dam on the 15th of January, 1914, which brought flood waters and the accumulation of wastes on the watershed down the Potomac, furnished a fresh virulent infection of typhoid to the communities receiving this contaminated supply. There was a marked increase in the number of typhoid cases reported in the period from two to three weeks after this flood wave swept down the Potomac River.

The authorities at the paper mill became greatly alarmed, for their labor force was seriously affected. At one time as high as ten percent of the men employed in the large paper mill were sick with typhoid fever. Compulsory vaccination with anti-typhoid vaccine was adopted, the mill authorities furnishing all treatments free. Immediate treatment of the Potomac River water by bleach liquor which is made at the mill in the manufacturing processes, was adopted upon recommendation of the Sanitary Engineer sent from the Maryland State Health Department to take measures to control the epidemic.

Had the labor supply not been plentiful at the time of this epidemic, a partial paralysis in the industrial plant here would have ensued. As it was, the work was handicapped greatly by the necessity of constantly breaking in new men to replace those who succumbed to the attacks of typhoid fever which had been introduced through the medium of a contaminated river water. It would be difficult to imagine a better combination for producing a wide-spread typhoid outbreak than was given by the Piedmont-Westernport situation. Here was a raw river water containing all the accumulated sewage washed from the watershed into the stream by a flood wave, and this water without treatment was pumped directly to the city mains to be used for drinking purposes.

#### West Union—Doddridge County

The first typhoid epidemic investigated by the State Sanitary Engineer after the Division of Sanitary Engineering was organized, occurred at West Union, a town of 2500 people. Forty-one people had suffered from typhoid in this small town during the first six months of 1915. As the warm weather came on the outbreak became worse due to spread of the disease by flies and contact.



As deaths began to occur the town authorities became alarmed and requested help. As the first control measure, the town was ordered by the State Health Department to thoroughly clean and lime every privy within the corporate limits. Many dug wells showing contamination upon bacteriological examination were condemned and closed.

No single definite reason could be designated as the cause of the epidemic, but the engineer felt that the raw, contaminated creek water, pumped into the town mains and distributed to the people, introduced the initial infection. To reduce further possibility of typhoid from this source, an emergency hypochlorite plant was erected at the pump station and the water pumped into the town was disinfected.

### Gassaway—Braxton County

The typhoid epidemic during the summer of 1917 at Gassaway, which has a population of 1500, represents so well one particular difficulty wherein the Division has been handicapped that it is worthy of particular note. This feature is, that even though the investigation of a public water supply by the Division may show it to be unsafe or to have an element of danger in it, it is difficult, if the company is **obstinate** or **poor** or both, to get recommendations carried out except in the case of an actual outbreak of sickness. Gassaway is one of the small communities where a private water company was reluctant to disinfect a contaminated water supply, and as a result of the delay incurred, a bad epidemic of typhoid broke out. Then the State Department of Health took charge and carried out the necessary steps to check the outbreak and prevent further waterborne typhoid. Three conditions prevailed at Gassaway which should be kept in mind:

1. During 1917 typhoid fever was constantly present in the town.
2. Four miles above Gassaway on the stream is the county seat, Sutton, which pours all its sewage into the Elk River which latter has a rapid fall to the intake of the pump station just above Gassaway.
3. The river remains practically clear of sediment at all times making the situation one which can be easily controlled by disinfection with chlorine.

After the emergency chlorinating plant belonging to the State Department of Health had been installed to control the outbreak, a thorough investigation revealed the fact that forty-two people had been sick from typhoid in the period from January to July, 1917, in this little town of 1,500 persons. Four or five cases had occurred each month until in July the cases began to develop more rapidly.

The installation of the chlorinator was made in spite of the protest of the superintendent of the water company, who declared that his water supply was not responsible for the outbreak. It was only after the apparatus had actually been installed and operated for a period of time that the superintendent finally was convinced that no tastes or odors would be produced in the water and that the disease-producing bacteria were destroyed by the disinfection treatment.

Especially in this town during the collection of epidemiological data were many instances cited by fathers and mothers of the death of members of their family from typhoid, and of the great burden of expenses coming on them to pay the bills for the typhoid fever their children contracted from the water supply.

It had cost one man over \$1,000 in two years for typhoid sickness in his family, and a mother told of a \$500.00 bill for doctors and nursing service for her little girl, once so healthy and strong, who had now been seriously ill for many months with the fever. One after another came the tales of the ravages of this disease as data on the outbreak were gathered. Appeals for help came to this Department even from the chief surgeon of the Coal & Coke Railroad to help rid Gassaway of typhoid fever. The hospitals at Elkins to which the cases of typhoid originating in Gassaway were carried, were filled and some action was deemed imperative by the surgeon to find the cause and stop the development of typhoid in Gassaway, an important division point on the Coal & Coke Railroad.

Favorable comment has come to the State Department of Health during 1920 about how changed the conditions are now with regard to typhoid at Gassaway since steady continuous treatment of the water supply with chlorine has been carried on. Certainly it has been a worth-while accomplishment to relieve this rapidly growing town of the incubus of typhoid fever.

#### Clay Court House—Clay County

Clay Court House, a town with a population of about 1,200 people, experienced a small outbreak of typhoid fever during September, 1918. The means of introduction of the infection was rather unusual. All the cases of typhoid, which were seven in number, gave a history of going frequently to "The Fountain" and partaking freely of the soft drinks, sodas and ice cream served at this drug store in the central part of the town.

The untreated river water is pumped into the town for flushing purposes, but the people who had contracted typhoid stated that they used well water at their homes for drinking. Investigation showed that the river water was used in making the carbonated water at the drug store, however, and that this same river water was served with the ice cream and that all dishes and glassware were washed in it.

In this outbreak the typhoid germs had the distinction of being served up to their victims in the carbonated soda waters for which the patrons of "The Fountain" paid good hard cash. This "Fountain" could certainly not be called The Fountain of Youth which, in olden times, was supposed to restore vigor and vitality to those infirm in health, but it came near bringing death to its patrons. Had it not been that the influenza outbreak caused the issuance of orders closing the "Fountain," many more cases of fever might have developed before the trouble was found out and action taken to stop the use of this typhoid carbonated water.

#### Rowlesburg—Preston County

Rowlesburg, a town of 1,500 people, situated near the top of the Alleghany Mountains, furnished another instance of a town using a raw river water for drinking purposes where the State Department of Health had repeatedly given warnings of the dangerous character of the supply. These warnings were disregarded with the result that in the latter part of May, 1920, the attention of the Division was called to an outbreak of 42 cases of typhoid fever here. The epidemic was suspected to be water-borne from the knowledge by this Department of the character of the public water supply. One of the sanitary engineers was immediately sent to Rowlesburg with the emergency chlorinating outfit to

make an investigation and take measures to control the epidemic. Investigation proved that the fever was caused by the contaminated water supply. The emergency chlorinator was installed within three hours after the arrival of the engineer. A permanent apparatus was ordered by the town officials of Rowlesburg, and after it had been installed, the apparatus owned by the State was returned to Charleston to await another demonstration similar to the ones carried on at Gassaway and Rowlesburg.

### Spencer—Roane County

The Spencer typhoid outbreak of nearly 50 cases in the fall of 1920 has a different aspect from any of the previously cited epidemics caused by raw water. This outbreak furnished a clear illustration of the danger of supplementing an impounded water supply of fair sanitary quality by one derived from a grossly polluted creek.

The Spencer public water supply during years of normal rainfall, is derived from a natural reservoir in the hills made by constructing a high dam. During the winter and spring months the water is clear and fairly satisfactory for use in the household. Many people use it for drinking at such times. The fact that it is furnished in the drinking fountains at the two large public schools in Spencer is proof that the school children use it and the school authorities know it.

Due to the drought and the increased amount of water used in Spencer, the supply stored in the reservoir in the hills became low during the fall months of 1920. The water company to supplement their rapidly dwindling supply of water, laid an emergency line to the polluted creek flowing by their pump station in the middle of the town and without any notification to the people in the town, began pumping this sewage-contaminated water.

Much of the sewage of the town of Spencer is discharged into this creek, and it was inevitable that a typhoid infection would be distributed throughout Spencer wherever the water lines went when this creek water was used. The children particularly who had no way of realizing their danger, drank freely of the water furnished in the drinking fountains at school and the epidemic became wide-spread among them. The investigation by the engineers of State Health Department of the prevalence of typhoid fever and of sanitary conditions in Spencer, resulted in several very definite improvements as follows:

1. The Governor of the State, upon the advice of the State Health Commissioner, recommended and secured the passage of an emergency act by the State Legislature to allow Spencer to raise sufficient funds to build a satisfactory sewerage system and disposal plant.
2. The State Health Commissioner immediately ordered the installation of a permanent chlorinating apparatus to make safe the public water supply. The order was speedily complied with.
3. Through co-operation of the water company and the sanitary engineers, arrangements were made so that the emergency creek intake would be removed to a point farther up the stream. This will result in a better quality of water if emergencies arise so that it becomes necessary to use the creek water in the future.

### Philippi—Barbour County

Two special features characterized the outbreak of typhoid fever in Philippi, population 1,800 in January, 1921, when twenty-two cases of typhoid were

investigated by the Health Department. The first feature was the fatal delay in acting upon the advice of the Engineering Division of the State Health Department. The Superintendent of the water company had agreed to install chlorinating equipment to replace a worn out, unsatisfactory outfit. But he pleaded financial stringency and the first of the new year, 1921, was set as the date for getting the new equipment.

The second feature was the occurrence of a small outbreak of typhoid in Elkins during December and the chain-like connection between the occurrence of the disease in the two communities. Both Elkins and Philippi are situated on the Tygarts Valley River, both use this water for drinking purposes, and both towns discharge their sewage into the stream. The outbreak at Elkins, the town upstream, was reflected in Philippi within three weeks, and there is no question that the Tygarts Valley River furnished the connecting link in this sequence of events.

Emergency service by the Sanitary Engineering Division placed a chlorinator in operation within twelve hours after the Department learned that the epidemic was in progress in Philippi. No further cases developed. The permanent machine was ordered without delay, and treatment has been satisfactory since that time and the water kept safe continuously.

The nine typhoid epidemics which have been briefly described fall into the classification spoken of as outbreaks caused by untreated river waters. Such surface waters are always contaminated more or less with human sewage. Sooner or later the community using such a water, even though it is not furnished as a drinking water supply, will suffer severely from typhoid fever.

What has been the chief way in which the sanitary engineers helped such towns? At St. Albans, Piedmont, West Union, Gassaway, Rowlesburg and Philippi, either the emergency chlorinating plant owned by the State Department of Health was hurriedly taken to the scene of action and installed until the community could take steps to provide purification equipment, or an emergency hypochlorite plant was constructed so that the hypochlorite disinfecting solution might be introduced immediately into the water supply.

Two complete sets of emergency chlorinating apparatus, including small steel cylinders of liquid chlorine, are kept constantly on hand at the State Department of Health headquarters at Charleston ready for instant service. Not only is this service maintained but also spare parts for all chlorinating plants in the state, both of the wet feed and dry feed type, are available and can be loaned to the communities using chlorine in case they experience difficulties and telegraph to the State Health Department for assistance.

**GROUP B—THE FOLLOWING FOUR EPIDEMICS WERE  
DUE TO THE FAILURE OF FILTRATION PLANTS  
TO PERFORM THE WORK OF PURIFICATION  
PROPERLY**

**Charleston—Kanawha County**

The most notable example in West Virginia of how the inadequacy of a filtration plant can affect the health of a community was furnished by Charleston, the capitol of the State, during 1917 and again in 1918, when typhoid epidemics held the city in constant fear. Floods, fires, and the extraordinary demands of a city swollen nearly twice its normal size by an influx of people due to war-time conditions, constituted the combination which greatly overtaxed the filtration plant and caused a contaminated water to be pumped to the city for drinking purposes.

Typhoid fever occurred in epidemic form from April 15 to October 1, 1917. Again the next year occurred another epidemic lasting from June 1 to October 1, 1918. During the period April 15 to October 1, 1917, 210 cases of fever of a light type developed and ten deaths occurred. But in 1918 the fever took a more virulent form. Out of 170 cases reported during the epidemic, there were 31 deaths.

The State Department of Health carefully examined into the cause of the 1917 outbreak through joint investigations by the Division of Preventable Diseases and the Division of Sanitary Engineering. The conclusion was reached that the blame for the outbreak was without doubt attributable to the public water supply. Flood waters on Kanawha watershed had caused the backing up of city sewage to the intake of the water works on Elk River, thus bringing about a high degree of pollution. The filter operators at the water plant were ignorant of the real danger besides having no adequate conception of the operation methods of a modern filter plant, the proper use of the alum or the correct amount of chlorine dosage.

In order to have the opinion of a still higher authority than the State Department of Health, the city of Charleston called in the experts of the U. S. Public Health Service. Both a Sanitary Engineer, Prof. Earle B. Phelps, and an Epidemiologist, Dr. A. W. Freeman, were sent from Washington, D. C., to Charleston, to study the outbreak. The findings confirmed those of the State Health Department. The conclusions and recommendations of Dr. A. W. Freeman, Epidemiologist, are given in his report as follows:

**Summary of the Evidence**

The evidence presented above may be summarized as follows: "The infection was evidently contracted in Charleston. The chronology and distribution of the cases would indicate that the infection was present in repeated instances in some medium of food or drink of general distribution throughout the city.

"The infection was confined to those parts of the city which are supplied by the public water supply, and the sections of the city supplied by wells were markedly free from disease. The sections of the city which are unsewered, and in which surface privies are common, were also spared to a marked degree.

The infection was confined to the habitual users of the public water supply.

"Milk, ice, ice cream, shellfish and fresh vegetables could be definitely excluded as possible causes of such an outbreak.

"The absence of the disease in the unsewered sections of the city, the absence of flies at the beginning of the outbreak, and the general chronology of the outbreak would tend to exclude spread from insanitary privies by flies and other mechanical means as possible causes of the epidemic.

#### Conclusion from Epidemiological Evidence

"The conclusion to be drawn from a study of the epidemiological evidence, is that the outbreak was caused by infection conveyed by the public water supply.

#### Recommendations Made

"Recommendations were made to the water plant regarding the proper operation of the plant to cover the immediate emergency, and further recommendations were made that a competent bacteriologist be at once employed, and that the operation of the plant be placed in his hands with daily bacteriological controls of the raw and filtered water, continuous application of coagulants and a dose of chlorine approximately 0.5 parts per million. It is believed that these recommendations, if faithfully carried out, will prevent a similar outbreak in the future."

The epidemic of 1918 was much more serious from the standpoint of loss of life than the one occurring in 1917, which was investigated by the U. S. Public Health Service.

In accordance with the recommendations of the Service an expert bacteriologist and chemist had been employed in the summer of 1917 to take charge of the filter plant. He left the employ of the water company early in 1918, however, owing to the fact that his work was being nullified by the filter operators whose co-operation he could not obtain in operating the filters. It was impossible for him to train them and rely upon them to carry on the filtration plant properly in his absence. It was manifestly impossible for this bacteriologist to remain on duty twenty-four hours in a day.

The demands upon the filter plant to supply additional amounts of water to the city continued to increase daily with the influx of people to Charleston, South Charleston and Nitro. This, in conjunction with disastrous fires occurring almost simultaneously in the city of Charleston, overtaxed the filter plant far beyond its capacity. The result was the typhoid epidemic of 1918.

City, State and Federal authorities now united in their demand for action by the water company to make available additional filter capacity and the production of a safe water for the city. In response to this insistent demand, emergency wooden filters were hurriedly constructed and put into operation. The rate of chlorination was raised and maintained at a high figure of approximately 1 part per million. A competent consulting engineer was employed by the water company to design a new sedimentation basin, 1,000,000 gallons capacity, six additional filters to increase the filter plant from six to twelve millions capacity, and to provide suitable pumping equipment to meet the demands of the rapidly growing city.

Thus, it took more than one typhoid epidemic to effectually solve the public water supply problem of the city of Charleston. The cost of these epidemics to the citizens of Charleston is set forth conservatively in Table 1 on page 13.

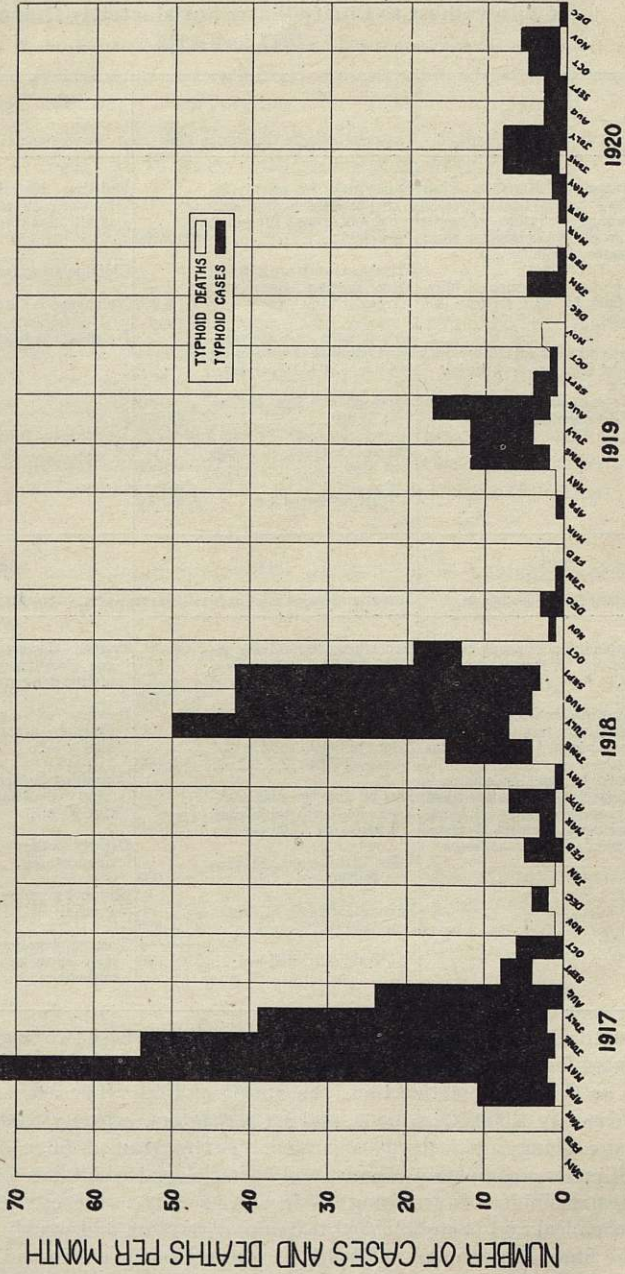
TABLE I

Loss to Charleston Citizens from Typhoid Fever Occasioned by Failure of Filter Plant to Purify Water Satisfactorily During 1917 and 1918

1917 Water Supply Conditions	1917 Financial Loss to Charleston Citizens	1917 Improvement Brought About
Flood waters on Kanawha River watershed caused backing up of city sewage to intake of water works on Elk River bringing about high degree of pollution.	Expenditure by private individuals for medical services and drugs, 210 cases at \$50.00..... \$ 10,500	Full-time bacteriologist employed by water company to take charge of filtration plant.
Lack of proper supervision of filtration plant by well trained bacteriologist.	Private expenditure of funds for nursing service, 50 cases at \$100..... \$ 5,000	Chlorine dosage raised.
Improper operation of filters with particular reference to chemicals.	Loss of time by wage earners one-fifth of total cases, 6 weeks at \$5.00 per day.. 7,200	No change in filter plant itself.
Too low treatment with chlorine in final disinfection process.	Value of lives lost, 10 lives at \$4,000..... 40,000	No change in filter operators.
	Funeral expenses, 10 deaths at \$150..... 1,500	
	Total estimated loss.... \$ 64,200	
1918 Water Supply Conditions	1918 Financial Loss to Charleston Citizens	1918 Improvements Brought About
Due to rapid influx of people to city, consumption of water increased greatly.	Expenditure by private individuals for medical services and drugs, 168 cases at \$50.00..... \$ 8,400	Trained chemist and bacteriologist placed in responsible charge of filtration plant.
Disastrous fires heavily over-taxed filter plant with result that impure water was pumped into city mains.	Private expenditure of funds for nursing service, 50 cases at \$100..... 5,000	Building of emergency wooden filters to get greater immediate filter area.
Filter plant became inadequate in every respect, sedimentation basin, filters, clear well, pumps and chemical treatment, to meet increased demands of city of Charleston.	Loss of time by wage earners one-fourth total cases, 6 weeks, at \$5.00 per day 7,560	Consulting engineer designed new plant doubling the capacity throughout.
	Value of lives lost, 31 lives at \$4,000..... 124,000	Decided betterment in filter operation methods.
	Funeral expenses, 31 deaths at \$150..... 4,650	New and more responsible operators trained.
	Total estimated loss... \$149,610	Close co-operation affected between city, state and water company authorities.

In contrast to the distressing pictures furnished by these two severe epidemics of typhoid fever, it is encouraging to look at the Charleston water supply conditions as they exist at this time, the spring of 1921. The new sedimentation basin, capacity 1,000,000 gallons, and six new filters, capacity 6,000,000 gallons daily, are being satisfactorily operated. Better trained filter operators are at work under a competent chemist and bacteriologist who takes a keen interest in his responsibility of furnishing a safe water supply to the city of Charleston. Daily chemical and bacteriological tests are carried on and weekly reports filed with the State Department of Health. Chlorination is certain and a rate of 0.5 parts per million is maintained. The result is that a safe water is being furnished to the citizens of Charleston.

TYPHOID REDUCTION DUE TO IMPROVED WATER SUPPLY CONDITIONS  
 CHARLESTON W VA. 1917-1920





What more striking evidence of the influence of proper design and operation of a filtrator plant upon the typhoid death rate of a community can be brought forward than the accompanying chart which shows Charleston's typhoid and water supply history from 1917-1920. This chart depicts the two typhoid epidemics which broke out in Charleston in 1917 and 1918 when the filter plant was of insufficient capacity to properly purify the Elk River water.

With the construction of six new filters, a large sedimentation basin, the appointment of a full-time chemist to have responsible charge of the operation of the filter plant and the training of reliable filter operators, the reduction in the typhoid death rate in Charleston was indeed great. The length of the vertical black columns on the chart show the great prevalence of typhoid during 1917 and 1918 and the rapidly decreasing amount of typhoid in the city when conditions at the filter plant were improved through the period 1919 and 1920. That the epidemic of 1918 was severe is shown clearly by the length of the white columns in 1918 on the chart. These white columns represent the number of deaths from typhoid fever.

#### Williamson—Mingo County

A detailed study was made during February, 1917, of the typhoid situation at Williamson, a city of 5,000 people, and an important point of the Norfolk and Western Railroad on the Kentucky-West Virginia border. This investigation showed the important relationship existing between the typhoid case rate in the city and the design and operation of the filter plant built in 1913 to purify the Tug River water. Careful studies of all factors which bear on the prevalence of typhoid in a community—**water, milk, food supplies, insanitary privies, flies** and **contact**—were made in company with the city health officer. The two following points were brought out:

1. There is apparently no definite relationship between milk or food supplies and the typhoid fever in Williamson.
2. Typhoid seems to be ever present in the city but few cases occur during the summer months. During the fall and winter the increase in cases reported is rapid. The following table gives the distribution of cases for ten months prior to the investigation by the Engineering Division:

Date	Cases Reported to city health officer
1916	
April.....	1
May.....	0
June.....	1
July.....	0
August.....	1
September.....	3
October.....	3
November.....	8 (one death)
December.....	8
1917	
January.....	5
February (to 11th).....	2
Total in 10½ months.....	32 cases

An inquiry into the history of the water supply showed that before 1913 the water was taken direct from shallow wells in Tug River. Whenever the river was turbid the city water was muddy, an indication that practically raw river water was being pumped to the city. Typhoid fever and dysentery were so prevalent in the city that at times it was almost a physical impossibility for the Norfolk and Western Railroad to keep their men on the job due to the inroads of these intestinal diseases on the working force at the railroad yards.

A rapid sand filter plant was constructed in 1913. No sedimentation basin was provided, the alum and hypochlorite solutions being introduced into the suction line of the pump which raised the water from the river wells to the sand filters. Faulty design was practiced with respect to two features—first, no provision was made for a sedimentation period of at least three or four hours in a large basin after the alum solution was added to the river water, and second, introduction of the hypochlorite solution was made into the raw river water rather than into the filtered water. It is a practical impossibility to produce a safe drinking water one hundred percent of the time from a badly polluted stream with two such flaws in the design and operation of the purification plant.

During the summer months when the stream remained clear most of the time, the results at the filter plant showed up well, but with heavy rains over the watershed and consequent muddy water in the stream, the filter plant could not do the work of purification adequately. Recommendations were made for shifting from disinfection with hypochlorite treatment to the use of liquid chlorine which is more easily and reliably controlled. The desirability of putting the disinfectant into the filtered water was also strongly advised by the engineer carrying on the investigation.

This study of typhoid fever at Williamson showed that a decided betterment of the dysentery and typhoid fever prevalence in the city followed the building of the filter plant in 1913. But with respect to present conditions it showed that there are inherent faults in the construction and operation of this filter plant. The lack of these essential features in this filter plant throws a significant light upon the ever present typhoid fever in the city of Williamson.

#### Weston—Lewis County

Weston, a progressive city of 4,000 people, suffered seriously from typhoid fever during the summer of 1919. The filter plant broke down with the result that fifteen cases of typhoid fever were reported in June alone. It is estimated that 40 or 50 people contracted typhoid fever during the summer while the filter plant was not operated properly. It is interesting to note what disastrous results can happen in a town, which is normally supplied with a safe drinking water, when supervision and operation of the filter plant become lax with a corresponding deterioration in the quality of the water.

The West Fork River, a muddy, sluggish stream grossly contaminated with sewage from small villages just above Weston, serves as the source of public water supply. In 1913 a modern well designed rapid sand filter plant of 1,000,000 gallons capacity, was completed. Sterilization by hypochlorite of lime was used as final treatment after filtration. In 1916, upon recommendation of the State Health Department, liquid chlorine treatment was adopted. Throughout the period from 1913 to 1918 a safe drinking water was supplied to the town of Weston since the filter plant was carefully operated.

However, during 1918 and the spring of 1919 when the superintendents at

the filter plant were incompetent, rapid deterioration in the filter plant took place. The filters were abused, chemicals improperly applied, the motors for the pumps burned out, the chlorinator fell into disuse, in short, the filter plant was reduced from a good purification mechanism to a mass of junk. With the filters and chlorinator dismantled, raw river water was by-passed to the reservoir with the result that typhoid fever germs were seeded throughout the town and the fever became prevalent.

Emergency measures were taken by the State Health Department to placard the town, warning the citizens of their danger, and a new chlorinator was installed by the sanitary engineer who took these measures to check the outbreak. The people of the community finally were awakened to the real danger of the situation and a complete reorganization of the water company was brought about. A competent superintendent was again placed in charge of the water system and filtration plant. Co-operation between the superintendent of the re-organized water company and the Division of Sanitary Engineering has resulted in a complete renovation of the purification system, the establishment of daily chemical tests to determine the amounts of chemicals necessary for use, and the keeping of daily operation records of the filters. These records are filed weekly with the State Department of Health in Charleston.

Weston has furnished an enlightening example that eternal vigilance is most certainly the price which must be paid by a community, if they desire a constantly safe drinking water supplied them by the purification of a turbid, grossly polluted river water.

"A chain is no stronger than its weakest link." How truly this applies to the process of water filtration and the chain of water purification processes which produce a pure safe drinking water from a turbid, polluted river water. Each of the links in the chain must be strong and each process must be done correctly.

In the group of epidemics just mentioned, it was the failure of one of these links in the purification chain which brought upon the community sickness and death. One of the greatest fields of helpfulness in which the Sanitary Engineering Division has been and is working, is that of co-operation with the superintendents and water works managers in charge of filter plants over the State. Instructions have been given wherever possible in the carrying on of simple chemical and bacteriological tests at the filter plant in order to intelligently control the various steps in filter plant operation.

At Weston, in accordance with the recommendation of this Division, the entire filter plant has been overhauled, new sand and gravel placed in the filters, chemical tests to control amounts of soda and alum were started, and regular daily records of filter operations kept accurately and filed weekly with the State Department of Health.

With regard to conditions such as have existed at Williamson, it will be possible in the future to eliminate very largely flaws in the design of filter plants. The public health law, amended in 1919, makes the following provision:

"Cities, towns and persons shall submit to said public health council for its advice, their proposed system of water supply or of the disposal of drainage or sewage. In this section the term 'drainage' means rainfall, surface and subsoil water only, and 'sewage' means domestic and manufacturing filth and refuse. No city, town or village, and no person, firm or corporation shall establish any system of drainage, sewerage or water supply system until the same shall have been approved in writing by the State Health Commissioner; and any municipality, person, firm or corporation which shall violate the requirements of this

section shall be deemed guilty of a misdemeanor and upon conviction thereof, fined not less than one hundred dollars nor more than five hundred dollars."

Thus now it is necessary that all plans be examined in detail by the Division of Sanitary Engineering of the State Health Department and a written permit given by the State Health Commissioner before new work can be constructed. This provision of the law gives the Department an effective lever with which to work and to provide properly designed filter plants.

At Charleston daily record sheets, both chemical and bacteriological, have been kept and recommendations by this Department regarding changes in sedimentation basin, treatment with chlorine and operation methods have been put into practice. A progressive improvement has taken place during the last year at the Charleston filter plant so that the danger of further typhoid epidemics in the city due to impure water has been minimized.

The gaining of the confidence of the superintendent in charge of water filtration plants by the sanitary engineers of this Division is one of the most valuable features of the work. This accomplished, the superintendent in charge will gladly accept suggestions for bettering his plant and he will conscientiously carry out the orders of the Department. After the engineer's visit of inspection is over the superintendent's full co-operation is assured in the vitally important job of supplying a safe drinking water to the community. It is getting the orders and recommendations translated into action which really counts.

**GROUP C—IS CONSTITUTED BY A GROUP OF THREE  
TYPHOID OUTBREAKS WHICH OCCURRED IN  
TYPICAL MINING CAMPS. ONE OF THESE  
EPIDEMICS WAS VERY SERIOUS IN ITS  
CONSEQUENCES**

**Ronda—Mining Camp—Kanawha County**

As an illustration of a common means for the spread of typhoid in mining camps, the epidemic of typhoid at Ronda in the autumn of 1915 is cited. Here a dug well furnishing the camp water supply proved to be dangerously contaminated. The aid of the State Department of Health was requested on October 25, 1915, by the physician at the camp. Two hundred and thirty people lived in the little community clustering about the coal mine where the miners found employment.

The sanitary engineer from the State Department of Health visited Ronda immediately after the plea for help was received. Fifteen cases of fever were investigated carefully. All persons gave a history of using the water from a suspected dug well in the center of camp. Other food supplies were found to have no bearing on the spread of the disease. Investigation of the well and surroundings showed up the following facts:

1. A number of privies were located on the steep hillside above the well. At times of heavy rains it would be easily possible for surface water from this area to enter the well. No good protection was afforded around the curb of the dug well. It was not difficult for the sanitary engineer to reach the conclusion that the drinking water from this dug well was probably the chief agent in the spread of typhoid at Ronda.

2. Bacteriological examination of the well water showed it to be seriously contaminated.

Control measures consisted of first, condemning the well and having it effectually closed against further use; second, making provision for as wide spread a use of the preventive serum as possible; and third, taking up with the mining company the provision for a safe drinking water for the camp.

#### Ivaton—Mining Camp—Lincoln County

That typhoid fever often breaks out in a mining camp during the winter months was amply demonstrated by the small epidemic of typhoid at Ivaton, a mining camp on Coal River above St. Albans. Eight cases were reported to State Health Department from Ivaton in December and the sanitary engineer visited the vilage on December 15, 1915. Each case gave a history of using water from a poorly protected dug well at the foot of a steep embankment on which the coal tippel was located. The curbing about this dug well was not even carried to the surface of the ground. Contamination from surface water was easily possible. The corrective measures adopted here were as follows:

1. Disinfection of the well by hypochlorite of lime was immediately accomplished since there was no other water supply then available at the camp.
2. The well was thoroughly cleaned out and better protection against surface drainage furnished.

During the spring months the mining company installed a public water supply for the entire camp, this supply being derived from a new deep drilled well. In this case the mining company was convinced by the demonstration of sickness among their employees that they could not longer afford to take chances with an unsafe drinking water, but felt that it would be a worth-while investment to provide running water in the houses from a supply which they knew to be safe for drinking purposes.

#### Loma—Mining Camp—Logan County

One of the severest typhoid outbreaks ever experienced in a West Virginia mining camp occurred during July and August, 1917, at Loma, a newly developing camp in Logan County. This epidemic had several different characteristics from the outbreaks at Ronda and Ivaton. Mining operations had been going on but a short time, and though the camp location was good, the extreme haste to get out coal allowed unfortunate insanitary conditions to develop in the camp. The most glaring faults were as follows:

1. Though a number of drilled wells had been put down to furnish a drinking water supply for the camp, they had not been capped and no protection against surface drainage was provided by suitable concrete work.
2. The privies located fifty feet behind the houses had a foot or more of open space between the top of the earth pit and the bottom of the housing. The earth pits were thus open to flies and small animals.
3. Garbage, rubbish and tin cans thrown out from the houses lay littered all about the camp.
4. Flies were breeding by the millions in the open privy vaults, garbage, stable manure and rubbish about the camp.

With the above described conditions prevailing, there came on heavy rains. The general slope of the ground was toward the drilled well which was patron

ized most by the people in camp. The surface wash from almost the entire camp was brought quickly to this well, and due to the inadequate protection at the top it became heavily contaminated with a typhoid infection from the camp itself. Thirty-five people in camp contracted typhoid fever and four deaths occurred as a result of this infection of the water supply. With flies present in countless numbers and a decided absence of sanitation in the camp, secondary cases were common. Everything that the mining company could do availed little to stop the spread of typhoid. On August 6th the superintendent telegraphed the State Health Department for aid and a sanitary engineer was sent to his assistance to control the spread of typhoid fever.

A terror had already attached itself to the camp. Many families were moving away in fear and dread of the typhoid fever which seemed to be spreading to all families. Control measures which were recommended to the mining camp authorities and which were immediately carried out, were as follows:

1. The drilled wells which had been first disinfected by hypochlorite of lime treatment were capped tightly and protected by a concrete slab. Thus no further infection of the well could take place.

2. The open space between the earth vaults and the privy buildings was effectually closed so that excreta could not be spread around the camp by flies. The privies were limed and screened.

3. A scavenger system to care for garbage and rubbish about the camp was instituted. The grounds about camp were thoroughly cleaned up.

4. Anti-typhoid inoculation was furnished free by the mining company to all employees who could be induced to take it. Most of the people in camp were inoculated.

The large mining companies of West Virginia are more alert now than formerly to the necessity of supplying a safe drinking water to their miners. In some of the mining camps large amounts of money are spent installing public water supplies, in building aerating plants and filters for removing the iron from the water, and in seeing to it that the water for drinking is made safe.

However, the small camps in a great many cases have neglected this vital matter. The infection of the wells at Ivaton, Ronda and Loma, with the resulting typhoid outbreaks in the camp, should teach how costly it may be to overlook the protection of the water used for drinking in the camp. The body wastes must receive proper disposal. The wells, be they dug or drilled, must be safeguarded against the entrance of surface water. It is **good business** for the mine superintendent to see that the men in his camp are kept well. A safe drinking water supply should be one of the first considerations of a successful mining camp.

**GROUP D—PICTURES THREE COMMUNITIES WHICH  
SUFFERED GRIEVOUSLY FROM TYPHOID DUE TO  
A LACK OF APPRECIATION OF THE ROLE  
PLAYED BY CHLORINATION IN PROTECT-  
ING THE WATER SUPPLY**

**Elkins—Randolph County**

The city of Elkins, with a population of 7,500 people, experienced a severe epidemic of typhoid fever in March, 1918. Over one hundred people suffered from the infection introduced into Elkins through the medium of the public water supply. Eighty patients were personally visited and epidemiological data obtained by the engineer from this Department making the investigation. One point of particular interest was, that but a single case of the disease was reported to the State Health Department. The sorry plight of Elkins in the midst of a serious typhoid epidemic was discovered by accident by one of the sanitary engineers of the Department who learned from a conductor on the Coal & Coke train, the startling information that over one hundred people in Elkins were sick with typhoid fever. This particular fact speaks volumes upon the need of proper registration laws in West Virginia.

The sanitary engineer, upon learning of the outbreak and suspecting the water supply, proceeded directly to Elkins. Here an investigation revealed the following important events which all have an important bearing on the outbreak.

1. The chlorine gas supply for the chlorinator which had been installed by this Department in 1916, had become exhausted, and for a period of over sixty days raw, untreated water had been pumped into the city mains with no notification of this fact given the people.

2. During the last week of January the heavy rains and melting snow brought about a flood stage on the Tygarts Valley River. The accumulation of wastes upon the watershed throughout the winter months, notably from Valley Head and Mill Creek where considerably typhoid fever had occurred, was swept down the river quickly by the flood waters and brought to the Elkins water supply intake.

3. The chlorine gas which the city authorities had been frantically trying to obtain since the start of the outbreak, arrived on the same day that the sanitary engineer reached Elkins. A high rate of dosing with chlorine was adopted in order to get rid of any possible infection that might remain in the water system.

The city and private hospitals were filled with typhoid patients many of whom were seriously ill. It is not possible to report the exact number of deaths which took place in Elkins on account of the poor reporting of vital statistics, but several deaths occurred for the infection was virulent. The very best co-operation was given the sanitary engineer by the city officials after his arrival on the scene. In controlling the outbreak, the following steps were taken:

1. The water system, including intake well, reservoirs and distribution system, was thoroughly flushed out.

2. The anti-typhoid inoculation was given free at one of the large hospitals in Elkins through the personal efforts of the surgeon in charge. Here hundreds of people received treatment.

3. Chlorination at a rate of 1.0 part per million was adopted until bacteriological tests showed the water to be safe.

It seems clear that the State Department of Health has been able to render a distinct service to the City of Elkins; first, in getting a chlorinator installed here in 1916 as a means of disinfecting the raw water which, until 1916, had been pumped to the city untreated, for drinking purposes; second, the sanitary engineer assisted materially in the control of the severe typhoid outbreak in 1918 occasioned by a shortage of chlorine gas.

The Division has on many occasions visited Elkins to urge both through newspaper articles and by personal talks, the building of an adequate filtration plant. Public opinion will probably soon demand this very necessary improvement of the Elkins water supply. Preliminary designs for a proposed filtration plant have been drawn up by a competent firm of consulting engineers. Table II gives a conservative estimate of the cost of this epidemic to Elkins.

TABLE II

## What Shortage of Chlorine Gas Cost Elkins in Lives and Money

1918 Water Supply Conditions	1918 Financial Losses from Typhoid Epidemic	1918 Improvements Brought About
1. Heavy rains on Tygart Valley River watershed caused flood conditions.	1. Expenditure by private individual for medicine and doctors' services, 100 cases at \$50.00..... \$ 5,000	New chlorinator duplicate unit installed, provision made to prevent any future chlorine gas shortage.
2. No treatment of water with chlorine gas during flood period due to chlorine gas becoming exhausted.	2. Private expenditure of funds for nursing services, 25 cases at \$100.00..... 2,500	Plans drawn by prominent consulting engineer for rapid sand filter plant. Not yet installed.
	3. Loss of time by wage earners one-fifth of cases, 6 weeks, at \$5.00 per day.. 3,600	Wide-spread use of anti-typhoid serum to prevent secondary cases of fever in families where disease occurred.
	4. Value of lives lost, 3 lives at \$4,000..... 12,000	
	5. Funeral expenses, 3 deaths at \$150.00..... 450	
	Total estimated loss.... \$23,550	

## Fairmont—Marion County

The wealthy city of Fairmont, with a population of 20,000 people, fine roads, good public buildings and beautiful homes, located in the midst of the Consolidation Coal Company field, suffered severely from typhoid fever during the spring and summer of the year 1918.

During the first nine months of the year, 122 cases of fever were reported to the city health commissioner. The epidemic was distinctly water-borne, appearing in all parts of the city wherever the water mains went. The distribution of cases for the seven months, February-September, 1918, was as follows:



February.....	10
March.....	9
April.....	5
May.....	3
June.....	36
July.....	35
August.....	24

Total 7 months..... 122 cases

The increase in the number of cases during the months of July and August was brought about by the rapid spread of the typhoid fever in the section of the city where the foreign population lived. Through ignorance of the way typhoid fever was spread, and by the medium of flies and contact, a secondary infection of considerable magnitude developed. Investigation of water supply conditions brought out the facts that, though a filtration plant had been built in Fairmont in 1906, it was wholly inadequate and the water was being entirely by-passed. It is of interest to note that this type of filter plant was called the Upward and Downward System of Sand Filtration. By means of it water could be filtered either upward or downward through the sand filter. Sufficient to say that its design was impractical and the system of purification was nothing more nor less than a huge experiment by the engineer who installed it. Fairmont paid the price of the experiment, three hundred thousand dollars (\$300,000.00). The amendment to the public health laws passed in 1919 which provide for approval of all new water supplies in the State by the State Health Commissioner, will prevent any other expensive experiments like this being tried out on West Virginia cities. A chlorinator had been installed two years previous to the time of this investigation to ascertain the cause of the prevalence of typhoid in Fairmont. The chlorinator was unsatisfactory in design and operation. The engineer found it boxed up ready to go back to the factory for repairs. It had been this way for two months.

Realizing that the city of Grafton, situated about thirty miles up the Tygarts Valley River from the Fairmont water works intake, had been experiencing a bad epidemic of typhoid, and knowing that five millions of gallons of sewage were being discharged daily by Grafton into this river, it took no great degree of imagination on the part of the sanitary engineer to come to a conclusion as to the probable origin of Fairmont's typhoid fever. With no safeguard on the Fairmont water supply it was clear sailing for Mr. Bacillus Typhosus, the typhoid fever germ, direct from the sewer outfalls of Grafton via the Tygarts Valley River to the Fairmont water system and the stomachs of the water consumers in Fairmont.

The water commissioner co-operated heartily with the sanitary engineer in taking steps to control the epidemic. An order was immediately placed for a properly designed chlorinating apparatus, shipment to be made immediately. A sanitary engineer again visited Fairmont and made the installation of the chlorinator when it arrived a short time later. The city has experienced but little typhoid during 1919 and 1920, for the chlorinator has been conscientiously and regularly operated during this period. Complete plans have been prepared for a modern water purification plant by a competent firm of consulting engineers. As soon as the city's finances will permit, this plant will be constructed.

Table III shows in a concise manner the conditions causing the outbreak,

the toll in money and life exacted from the citizens of Fairmont, and the improvements which have already been brought about and are contemplated in the near future.

TABLE III

What Typhoid Fever Cost Fairmont Citizens During a Seven Months Period in 1918

1918 Water Supply Conditions	1918 Financial Aspect of Typhoid Fever Outbreak	1918 Improvement Effected
On the watershed of Tygart's Valley River, the source of Fairmont's water supply, at Grafton, 30 miles above Fairmont, a bad typhoid epidemic occurred in spring of 1918.	1. Expenditures by private individuals for medical service and drugs, 122 cases at \$50.00..... \$ 6,100	New chlorinator of satisfactory make installed.
The filter plant of poor design and insufficient capacity, was entirely by-passed to furnish sufficient water to Fairmont.	2. Private expenditure of funds for nursing services, 40 cases at \$100.00..... 4,000	Continuous operation of chlorinator January 1919 to January 1921.
Chlorinator of poor design had failed to operate and no disinfection of raw river water was carried on.	3. Loss of time by wage earners one-sixth of cases, 20 workers, 6 weeks at \$5.00 per day..... 3,600	Complete plans for modern water purification plant drawn by consulting engineer employed by city of Fairmont.
	4. Value of lives lost, 5 lives at \$4,000..... 20,000	
	5. Funeral expenses, 5 deaths at \$150.00..... 750	
	Total Estimate Loss.... \$34,450	

### Clendenin—Kanawha County

Clendenin, a rapidly developing oil town, appealed to the State Health Department in 1916 to send a sanitary engineer to suggest to them, if possible, a means of reducing the ever present typhoid fever in their community. Investigation showed that the ever present typhoid in this community was undoubtedly mainly attributable to the fact that raw river water was being furnished the town for drinking purposes.

After a presentation of the importance of disinfecting the river water to the town officials in conference, immediate action was taken to procure a chlorinating plant. The water in Elk River, a mountain stream furnishing the supply, is clear at nearly all times and chlorination was considered the best treatment with the finances available. Following the installation of the chlorinator, the reduction in typhoid in Clendenin was marked. However, on February 12, 1917, a typhoid outbreak of fifteen cases, mostly among the children of the town, was reported from Clendenin. Investigation by the Division found that the following events had occurred.

On January 22, 1917, heavy rains on the entire watershed of the Elk River had brought on a flood. The thick mud and leaves carried by the rapid mountain torrent had clogged the little strainer in the chlorinator so rapidly that it was impossible to keep the apparatus running. The machine for introducing chlorine into the river water was therefore shut down for a number of hours when conditions were at the worst. Untreated water was pumped into the

city mains. Without doubt, the infection which caused the small outbreak of fever during the first part of February, may be attributed to the failure of the chlorinator during flood stage of Elk River.

In order to overcome such clogging of the apparatus in the future, a contrivance was devised which has not only worked admirably here at Clendenin but also has been adopted all over this State where chlorinators are treating raw river waters. On the water line leading to the apparatus a piece of pipe 8 inches in diameter and 3 feet long, was inserted in a vertical position. The muddy water flowing through this pipe became quiet with the result that dirt, sand and sediment sank to the bottom of this stilling chamber, the clearer water passing on to the chlorinator. Since the adoption of this device the chlorination treatment here has not been interrupted and the chlorinator has effectually safeguarded this community from water-borne typhoid fever. That the services of the engineer were appreciated by the people of Clendenin is evident from a conversation which took place between a druggist of Clendenin and one of the engineers, when he visited the town on an inspection trip during 1920.

It became necessary for the engineer to go to the local drug store for a small quantity of strong ammonia to test the chlorine apparatus for leaks. After supplying the ammonia the druggist said, "What are you going to do with that little bit of strong ammonia?" When it was explained that it was for use in connection with the chlorine apparatus which disinfected the water supply, he said, "Well, you State Board of Health fellers gave my business a bad knock in the head when you had that chlorine machine put in. Why, the money people spent here in my store for medicines in treating typhoid used to amount to thousands of dollars in a year. Before you came we always had typhoid, were never free from it; now we hardly ever have any. I'll bet that little machine saved eight or ten lives in this town during the last year alone. So you see it hit my drug business. But I'm glad you came and we're mighty glad to get rid of the fever, you bet. A town that has typhoid all the time gets a bad name." The engineer who had been working in Clendenin was well repaid for his work that day by these words, and felt that at least one little town was beginning to appreciate the value of the preventive work such as the Department carries on.

The experience of these three communities illustrates the futility of installing an apparatus for disinfecting drinking water if for any reason interruption in its operation is to occur. The basic law where chlorination is the sole safeguard on a water supply which must be observed, is continuous treatment of the water with chlorine gas. The recommendations of this Department to every community that is obliged to depend solely upon chlorine treatment to safeguard the drinking water, are definitely to provide either duplicate apparatus or spare parts for the machine so that immediate repairs can be effected in case of breakdown. Thus no interruption of chlorine treatment can occur.

In order that unfortunate lapses of chlorine treatment like the Elkins happening may never again occur, a postcard system of weekly reporting was adopted in 1918. All persons in charge of water works where chlorine apparatus is maintained are required to mail the card shown herewith properly filled out, each Saturday night, to Charleston. Through a period of two years this simple system has proved practical and helpful. It has stimulated interest in the chlorinator operation by the men in charge, has kept the office in touch with all the chlorine plants constantly. In times of emergency special parts for the chlorine machines have been loaned to the cities and water companies so that interruptions have been reduced to a minimum.

The key to the success of this weekly reporting plan of checking up chlorine treatment has not been the force of the law but the personal contact between the water works official and the sanitary engineers of the Department. Through a necessarily slow process of gaining the thorough confidence of the man in charge of the pump station and bringing to him a realization of his duty to protect the community from water-borne typhoid fever, the progress to the present time has been attained.

TOWN.....COUNTY.....

CHLORINATING PLANT REPORT. WEEK ENDING SAT....., 192....

Date	Gallons Water Pumped Per Hour	Rate Chlorine Dosing	River Conditions	Trouble and Remarks
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

Engineer in Charge.....

These nineteen scattered outbreaks which have been briefly described under four different groupings, have been cited with a view to showing some of the various phases of water-borne typhoid fever. How much money is unnecessarily spent when a city or town has a typhoid epidemic and how much does it cost a person to be sick with typhoid, are two questions worth while asking in appraising the preventive work which the Division is carrying on. If a man supporting a family becomes sick with typhoid fever, what tax is levied on him by this disease? On an average, his doctor's bill and nursing service and medicine totals over \$100.00. His pay envelope which usually contains \$35.00 to \$50.00 on Saturday night is empty for many weeks. Typhoid fever keeps him in bed sometimes for months, and when he does recover he is weak and listless, unable to do his best work. The average cost per person has been carefully reckoned up by public health workers, life insurance presidents and business men, and amounts to at least \$150.00. For every fifteen persons in West Virginia who become sick with typhoid, one dies. Human life is too precious to reckon in dollars and cents, but based upon the productive power alone, that is, the material goods a man or a woman can produce, economists have figured the worth of human life. The cost is placed at \$4,600, but to be conservative, the figure of \$4,000 will be accepted in this discussion. This takes account of young boys and girls who are not yet working and producing. Every case of typhoid then costs

\$150.00, and for every death we can say conservatively that \$4,000 worth of productive power must be subtracted from the community. **Human lives and work performed** bring wealth to a city or town. Just as truly, **loss of life and loss of productive power** bring loss to a community. It may be interesting to look at the financial side of the account and figure out the separate and total levy on these eighteen communities as a toll by typhoid fever. Wherever the exact number of deaths could not be ascertained from the records filed with the Health Department or by individual investigation in the field by the Division, the average figures for the registration area of the United States will be assumed, that is, for every fifteen cases of typhoid, we may expect one death from the disease.

The total money cost of these nineteen outbreaks amounts to nearly half a million dollars. What has been pictured here have been only the cities and towns where typhoid has been called to the attention of the State Health Department by the members of the staff being in the field and discovering the epidemics or through requests for help from health officers, from interested individuals or mining companies. In nearly every case **only a three months' period** for each town or city has been considered out of the total interval of time of five years, 1915-1920.

#### TOLL OF LIFE AND MONEY FROM NINETEEN TYPHOID OUTBREAKS

TOWN	Cost of Sickness	Cost of Deaths
St. Albans.....	34 cases at \$150..... \$ 5,100	2 deaths at \$4,000..... \$ 8,000
Dunbar.....	28 cases at \$150..... 4,200	No deaths
Piedmont.....	117 cases at \$150..... 17,550	8 deaths at \$4,000..... 32,000
West Union.....	41 cases at \$150..... 6,150	4 deaths at \$4,000..... 16,000
Gassaway.....	42 cases at \$150..... 6,300	3 deaths at \$4,000..... 12,000
Clay Court House.....	7 cases at \$150..... 1,050	No deaths
Rowlesburg.....	42 cases at \$150..... 6,300	2 deaths at \$4,000..... 8,000
Spencer.....	50 cases at \$150..... 7,500	3 deaths at \$4,000..... 12,000
Philippi.....	22 cases at \$150..... 3,300	No deaths
Charleston, 1917.....	210 cases (see table)..... \$ 22,700	10 deaths (see table)..... \$ 41,500
Charleston, 1918.....	168 cases (see table)..... 21,960	31 deaths (see table)..... 128,650
Williamson.....	32 cases at \$150..... 4,800	1 death at \$4,000..... 4,000
Weston.....	50 cases at \$150..... 7,500	2 deaths at \$4,000..... 8,000
Ronda.....	15 cases at \$150..... \$ 2,250	1 death at \$4,000..... \$ 4,000
Ivaton.....	8 cases at \$150..... 1,200	No deaths
Loma.....	35 cases at \$150..... 5,250	4 deaths at \$4,000..... 16,000
Elkins.....	100 cases (see table)..... \$ 11,100	3 deaths (see table)..... \$ 12,000
Fairmont.....	122 cases (see table)..... 13,700	5 deaths (see table)..... 20,000
Clendenin.....	15 cases at \$150..... 2,250	1 death at \$4,000..... 4,000
Total 19 typhoid outbreaks....	Cost of sickness absolutely preventable..... \$150,160	Cost of deaths preventable \$297,150

#### Wheeling—Ohio County

The deplorable situation which the city of Wheeling presents from the standpoint of its public water supply and high death rate from typhoid fever, calls for a classification all its own, and therefore the city of Wheeling has not been considered under any of the four preceding classifications.

Wheeling, the largest city in West Virginia, with a population of over 55,000 people, enjoys the unhappy distinction, if it may be called a distinction, of possessing a notoriously bad water supply, derived from the grossly sewage-

polluted waters of the Ohio River, and until 1919 this dangerously contaminated water was pumped into the city without even disinfection treatment by chlorination. Wheeling has had to pay dearly in lives and money for her negligence in not providing a safe and satisfactory drinking water supply for her citizens.

Dr. A. W. Freeman in his paper, "Typhoid Fever and Municipal Administration," read before the Indiana Water Supply and Sanitary Association in February, 1917, stated that the rating of zero was placed by U. S. Public Health Service on this water supply in a study which was made of 24 cities of 25,000 population or over in the Ohio Basin. Careful investigation by the U. S. Public Health Service officials showed that the deaths in the City of Wheeling from typhoid for the period 1910-1914, totaled 120 and the average death rate per 100,000 from typhoid fever was 56.8. Now, in the spring of 1921, Wheeling still remains an ignominious example of **what not to do** with regard to a public water supply.

Assuming that the same death rate as in 1910-1914 held for the period 1914-1919 or until December, 1918, the time when chlorination of the public water supply was adopted, let us ask what would be a conservative estimate of the monetary loss to Wheeling for sickness and deaths by typhoid fever during the last decade only.

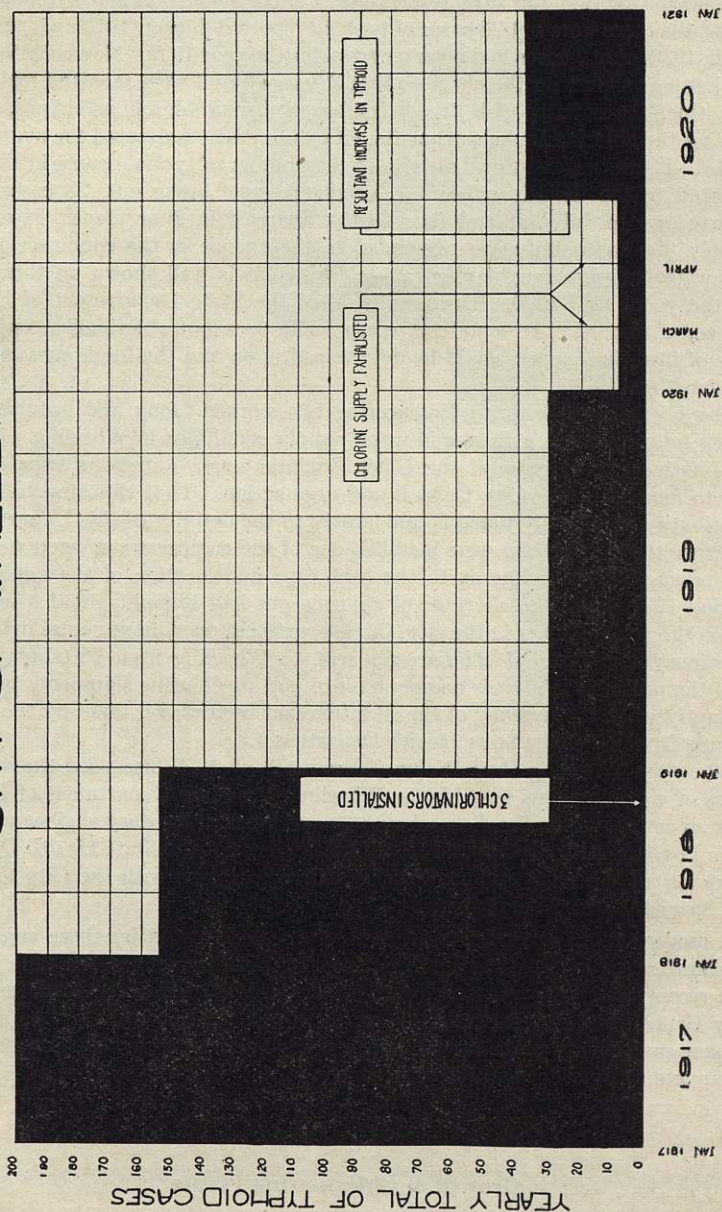
### WHEELING

#### Loss to Wheeling Citizens in Past Nine Years from Typhoid Fever Due to a High Typhoid Death Rate Occasioned by Dangerous Public Water Supply Conditions

Water Supply Conditions	Financial Losses to Wheeling Citizens	Improvements Brought About
Raw Ohio River water furnished for public water supply.	1. Expenditure by private individuals for medical services and drugs, 3,300 cases at \$50.00.....	1. Chlorination established in December, 1918, following vigorous campaign by State Health Department.
Pollution of Ohio at Wheeling great due to discharge of sewage of Pittsburg and other large cities above Wheeling into the Ohio River.	2. Private expense of nursing services, 800 cases at \$100.00	2. Action by Pure Water Commission and City Council in 1920 authorizing preparation of mechanical filtration plant plans following refusal of State Health Department to permit use of wells in Ohio River.
	3. Loss of time by wage earners one third of cases, 6 weeks at \$5.00 per day....	
	4. Value of lives lost, 220 at \$4,000.....	
	5. Funeral expenses, 220 at \$150.00.....	
	Total estimated loss for year period.....	

Over one million, three hundred and fifty-six thousand dollars, \$1,356,000, were needlessly wasted in Wheeling in the nine years, 1910-1919. Though the State Department of Health, through the Sanitary Engineering Division, had constantly urged the installation of chlorinating apparatus during 1917 and 1918, it was not until December, 1918, that the city of Wheeling finally accepted the recommendations and took action to provide the necessary chlorination equipment. It is interesting to note the remarkable results accomplished by chlorine treatment alone in the following two years in bringing down the Wheeling morbidity rate from this disease.

EFFECT OF CHLORINATION ON YEARLY TYPHOID TOTALS  
CITY OF WHEELING



### Reduction of Typhoid at Wheeling

The dense black areas on the chart on page 29 show a typhoid case rate of 200 and 155 for 1917 and 1918, respectively. After the installation of disinfection apparatus there were but 28 cases of typhoid reported during 1919 and up until April, 1920, only 7 cases had been reported for the year 1920. Now what caused the jump as shown on the chart so that 37 cases in all were reported for 1920? Just this, the country-wide freight embargo during March and April, 1920, help up the chlorine tanks so that the city water went untreated for over three weeks. There was an immediate rise in the number of typhoid cases in the city reported to the health officer. A small epidemic broke out, 28 cases were reported up to July 1st and four deaths occurred in June alone. How sensitively this community has responded to the change in the condition of this city water supply brought about by chlorination is well shown on this chart for the years 1917-1920. The prediction of the State Department of Health has come true, that it would be worth while to adopt chlorination until the type of filtration system could be determined upon and the funds provided for constructing it.

The Division of Sanitary Engineering has worked long and arduously in trying to bring about a change in water supply conditions in Wheeling. Before chlorination was introduced the Chief Engineer made numerous trips to the city to meet with the City Council and urge action. That this step to install chlorination was finally taken is due largely to the activity of this Department.

Before the chlorinators were installed one of the engineers conferred with the city engineer of Wheeling as to the best type and location of the apparatus. During 1920, when the shortage of chlorine gas had brought about a marked rise in the typhoid fever in the city, this Department was instrumental in having emergency shipments of chlorine gas sent to Wheeling from Pittsburgh, Pa. Also the railroads lent their co-operation in getting chlorine shipments through promptly when the urgency of the situation had been shown them by the Engineering Division of the State Health Department.

When the Wheeling Pure Water Commission of 1920 discussed the various types of water systems possible for Wheeling, the State Department of Health took an active part in the discussions. One of the best sanitary engineers of the U. S. Public Health Service and the Chief Engineer of the State Health Department visited Wheeling and conferred on three occasions with the City Council and Special Water Commission.

A modern rapid sand filtration plant was recommended by these engineers, a definite stand being taken against the use of shallow wells in the Ohio River. The recommendations were accepted by the Pure Water Commission and the City Council and definite action was taken in December, 1920, by the council to have preliminary plans for a modern water purification system prepared by a competent firm of consulting engineers.

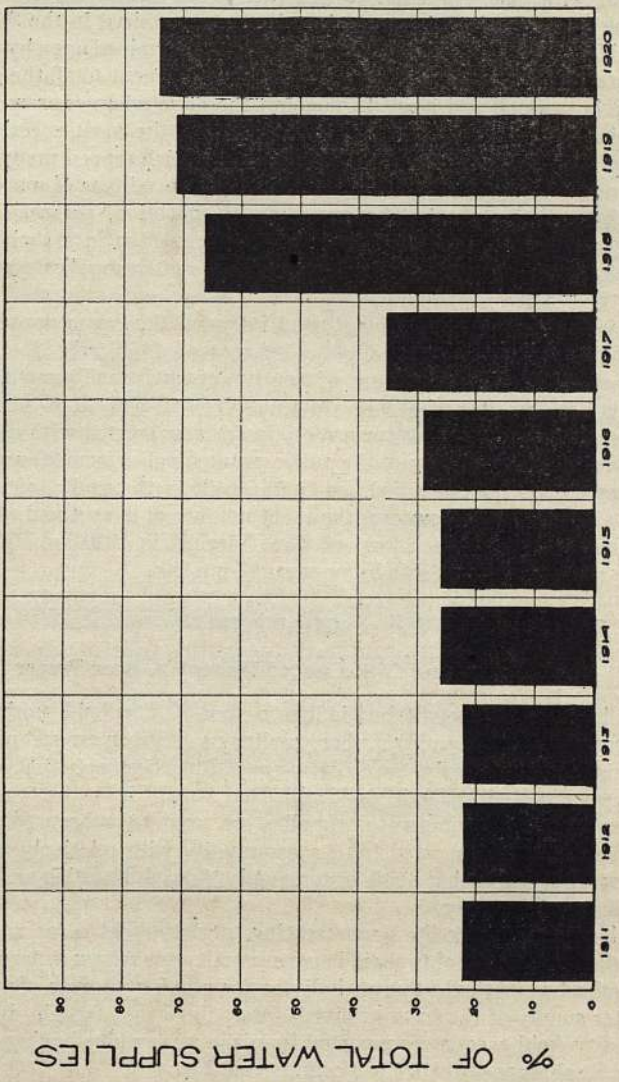
### CHART I

#### Growth of Chlorinating Plants

The stimulus given to the use of liquid chlorine in water purification throughout West Virginia by the work of the Sanitary Engineering Division, is strikingly illustrated by this chart on page 31. In 1911, 20 percent only of the public water



PERCENTAGE OF WATER SUPPLIES CHLORINATED 1911 - 1921  
WEST VIRGINIA



supplies in West Virginia were receiving disinfection treatment with chlorine. At a few of the larger cities only, this process was employed through using hypochlorite of lime in conjunction with the sand filters to purify the water.

Referring to the chart, it is clear that the percentage of water supplies receiving treatment with chlorine remained practically the same from 1911 until 1915 when the Division of Sanitary Engineering was organized in the State Department of Health. At this time a definite plan was determined upon by the Director to introduce as rapidly as possible chlorination treatment to all the public water supplies, both small and large, throughout the State wherever raw river waters were being used for drinking purposes, as one of the most effective means of checking the annual crop of typhoid epidemics which reaped many lives and a great amount of needless suffering and needless expenditure of money for medicine, doctors and nurses. The campaign of education, persuasion and compulsion combined, was vigorously pursued and resulted in a rapid rise during the next few years in the percentage of public water supplies receiving disinfection treatment with chlorine.

Five years after the Division started its work there was approximately 75 percent of all the public water supplies being treated. Nearly all of the remaining 25 percent of the supplies now without treatment, are of ground water origin and do not require treatment with chlorine. Over 95 percent of the public water supplies in West Virginia of surface origin are now treated with chlorine. The extension of the disinfection of the public water supplies from 20 percent in 1911 to 75 percent in 1920, has had a definite result in the saving of lives of men, women and children. However, the exact number of lives saved can not be set down since the registration laws of West Virginia in 1920 are still inadequate and the reporting of deaths is by no means complete.

## CHART II

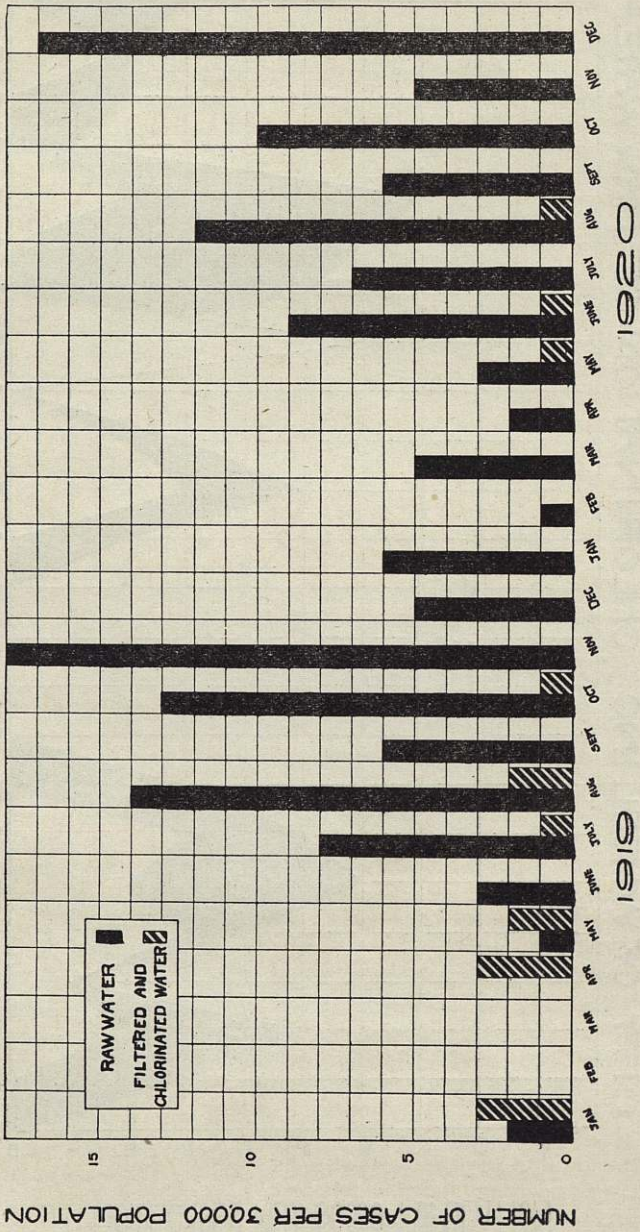
### Filtered and Chlorinated Water Vs. Raw Water

In order to show the marked influence upon the typhoid morbidity rate in a number of different localities where sanitary conditions are comparable except for the public water supply, the chart on page 33 has been prepared. The typhoid fever cases reported to the State Health Department from the towns and cities where untreated drinking water supplies are used have been contrasted with those typhoid cases reported from a community with relatively poor sanitary conditions, but possessing a safe water supply through filtration and chlorination of a polluted river water.

The long solid black lines representing total typhoid cases reported, show the marked prevalence of typhoid in a community where raw water is used, while the small zebra marked columns indicate the relative absence of typhoid when the water supply of the town or city is filtered and disinfected. In the months when no typhoid cases were reported from the community having a safe water, there is an absence of the striped columns on the chart.

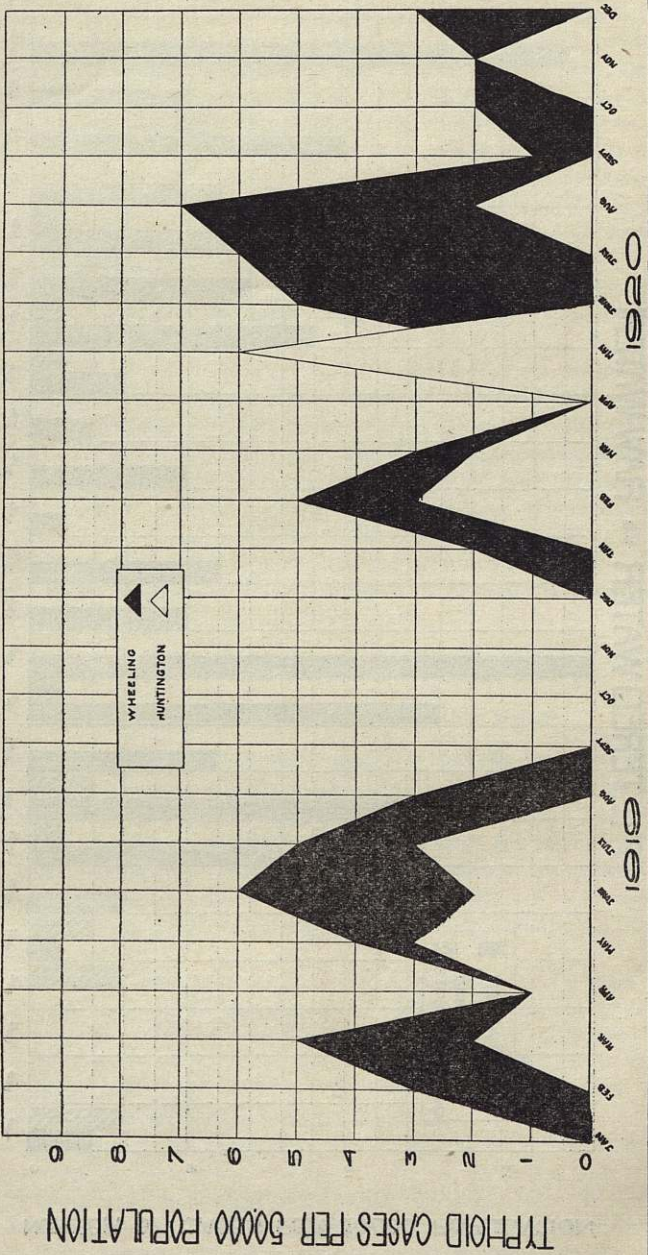
From this chart made up from actual typhoid cases reported, it must be clear that in the towns of the State using raw surface waters, there is a high typhoid rate and in those using filtered, chlorinated water the rate is low. It is simply one more case where history is repeated, this time having the case proved by West Virginia facts, namely, that it is always unsafe to allow the use of raw waters for drinking purposes unless the source of the supply is of unquestioned purity and unless the supply is safeguarded until it is pumped into the city mains.

TYPHOID FEVER CASES IN WEST VIRGINIA  
 FILTERED WATER vs RAW WATER



WEST VIRGINIA UNIVERSITY  
 LIBRARY  
 MORGANTOWN, W. VA.

CITY OF HUNTINGTON - FILTERS AND CHLORINATION  
 CITY OF WHEELING - CHLORINATION OF RAW WATER



WHEELING UNIVERSITY  
 LIBRARY  
 1000 UNIVERSITY AVENUE  
 WHEELING, WEST VIRGINIA

## CHART III

## Chlorination Vs. Filtration and Chlorination

The chart on page 29 has given a convincing proof of the influence upon the health of Wheeling citizens of disinfecting the raw, highly polluted and turbid Ohio River water with chlorine gas to kill the disease-producing bacteria. The reduction in typhoid cases and deaths in Wheeling is well demonstrated.

Chart III shown on page 34 carries the proof of the health value of water purification processes one step farther, and compares over a period of two years the conditions of typhoid incidence in Wheeling and Huntington, two cities of approximately the same size, with fairly good sanitary conditions, both of which use the Ohio River water for drinking purposes.

Wheeling disinfects the water with chlorine, Huntington uses both filters and chlorine in the purification process. Huntington is able to reduce its water-borne typhoid to a low figure while Wheeling probably does not get more than 70 to 80 percent of all water-borne typhoid, since chlorination alone is not a complete safeguard. The jagged black area on the chart representing total typhoid cases reported in Wheeling looms up far in excess of the white jagged area which corresponds to Huntington's typhoid cases. With the pollution at the intake of the water works about the same, with sanitary conditions in the two cities comparable, what facts can account for the persistently higher rate from typhoid fever throughout a period of two years, other than the difference in the water supply of the communities.

The remedy is plain—let Wheeling adopt a proper filtration system and that, together with chlorination, will effectually rid the city of water-borne typhoid fever.

The presence of typhoid fever in any town, city or state is a disgrace in this modern age. Now the elimination of typhoid is wholly a problem of administration; there is no longer any mystery about the cause and prevention of typhoid. The brief recital of the great reduction of the prevalence of this disease in these nineteen towns and cities in West Virginia should be sufficient to show you that the outlook is hopeful. **We are making progress.** But here in West Virginia only the start has been made. There are over one-half a million people being served by public water supplies, and these water supplies must be made safe and kept safe at all times for drinking purposes. It is the distinct job of the Division of Sanitary Engineering of the State Department of Health to bring about this desired result.

Typhoid fever has exacted a fearful toll on the people of West Virginia during the last decade. In Wheeling alone the toll in lives and in money needlessly spent was more than \$1,350,000 in the period 1910-1920. The total estimated loss in the nineteen water-borne typhoid epidemics exclusive of Wheeling which are mentioned in this bulletin and which were investigated and controlled by the State Department of Health, amounted to nearly one-half million dollars.

Is it not worth while to put a small percent of the money loss occasioned by the ravages of typhoid fever into real preventive work, and thus lessen the tax or toll which typhoid has levied in the past? That the Engineering Division of the State Health Department has done fairly effective work is shown by the results accomplished in these nineteen cities and towns of the State, but more sanitary engineers and added funds are needed to bring about safe water supplies throughout West Virginia. As has been so admirably stated by Mr. H. A. Whit-

taker, the Director of the Division of Sanitation in Minnesota: "IT IS A WISE STATE THAT APPROPRIATES TO SAVE HER OWN LIVES."

Just as this bulletin is ready to go to press the State Legislature is convening for its second session during 1921, having recessed forty-five days since the bills were introduced at the first session in January. On the front page of the morning newspaper, March 14, 1921, is the deplorable news that one of the honorable members of Legislature, Charles Avis, of Logan, W. Va., has this day died of typhoid fever. He was hale and hearty when he was with you at the first session only a few weeks ago. What an object lesson! One of your ablest legislators taken from this very legislative session by an absolutely preventable disease at a time when he is most needed for the service of the State. This Legislature will be negligent indeed if it fails to heed this lesson. Pass the budget for the State Health Department as recommended by the Budget Committee which has given the matter thorough consideration, that the progress which has been made in these last five years can go on with increased momentum and that water-borne typhoid fever may be stamped out forever from West Virginia.

No better memorial can be given for this comrade of yours in the Legislature, Charles Avis, than the resolution by your Honorable Body that this useless wastage of human life shall not go on, and that the provision be made for carrying out the resolve. Give the State Department of Health adequate funds and it will repay your investment many hundred, even thousand fold.



