INVESTIGATION OF POLLUTION

OF THE

CEDAR RIVER

From Cedar Rapids to Rochester
1949-1950

REPORT

and

SUPPLEMENTARY REPORT

on the

INVESTIGATION OF POLLUTION

OF THE

CEDAR RIVER

From Cedar Rapids to Rochester

1949 - 1950

By the

DIVISION OF PUBLIC HEALTH ENGINEERING

STATE DEPARTMENT OF HEALTH

Des Moines, Iowa

December, 1950

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STATE DEPARTMENT OF HEALTH
DIVISION OF PUBLIC HEALTH ENGINEERING
DES MOINES

Town Cedar Rapids | Date October 13, 1949 to September 21, 1950

Report on Pollution of Cedar River below Cedar Rapids | Approved [signature] Director, Division of Public Health Engineering

By R. J. Schliekelman and Arthur Dennis

INTRODUCTION:

In September, 1931, the larger cities located along the Cedar River, including the City of Cedar Rapids, and several of the industries which were located in these cities were called before the State Department of Health under provisions of the Stream Pollution Law to show cause why orders should not be issued requiring the abatement of the pollution of the Cedar River at these points. At this hearing, a report was presented by the Division of Public Health Engineering of the State Department of Health, setting forth in detail the results of a river investigation carried on from 1927 to 1931. This report and the testimony taken from citizens along the Cedar River indicated gross pollution of the Cedar River notably below Cedar Rapids and Waterloo. Studies of the pollution of the Cedar River were continued from 1932 to 1934, inclusive, and a supplementary report written on the data which was collected during this period.

Although no orders were issued following the hearing held in 1931, the City of Cedar Rapids began construction of the sewage treatment plant in the fall of 1933 and the plant was placed in operation during the summer of 1935. At the time of its design, the sewage treatment plant at Cedar Rapids was planned to take care of not only the domestic wastes from the city but also from the majority of the industrial plants contributing polluted material, the principal of which are the Quaker Oats Company, Penick & Ford Corn Products, and Wilson & Company meat packing plant.

The construction of the treatment plant at Cedar Rapids eliminated the pollution of the Cedar River below Cedar Rapids and the construction of similar plants also abated the pollution conditions in other regions of the Cedar River. However, greatly increased populations in some of these cities and the very rapid expansion of the food processing industry has over-taxed the capacity of a number of these treatment plants and has contributed to the renewed pollution of the river to some degree. As a result of this increased load on the stream from various Iowa communities and because of a large source of pollution existing at Austin, Minnesota, additional studies of the Cedar River from the Minnesota line to Vinton, Iowa, have been continued from 1940 to the present.

During October, 1949, a pollution survey of the Cedar River in the vicinity of Cedar Rapids was begun together with plant investigations of the various industrial waste outlets which are discharging directly into the Cedar River. This study was begun in response to petitions from the 16th Avenue Commercial Club in Cedar Rapids and the Linn County Fish and Game Club, requesting an investigation of the pollution problem in the Cedar River at Cedar Rapids. These groups reported pollution of the Cedar River contributed principally by the discharge of various industrial wastes from the Quaker Oats Company, Penick & Ford, Wilson and Company, and by the discharge of organic wastes apparently from the Cargill Soybean Plant and other industries through the Third Avenue storm sewer. The groups reported that the discharge of these wastes occasionally created odors in the south part of the city through which the river flows and that the growth of undesirable pollutional forms of algae and fungus growths, such as Sphaerotilis natans, were stimulated in the river with these pollutional growths being noted as far down stream as the Palisades-Kepler State Park, approximately 10 miles below Cedar Rapids.

II SCOPE OF INVESTIGATION

The present investigation includes the collection of river samples from the Cedar River above and below Cedar Rapids as well as plant surveys and collection of samples from industrial wastes discharged directly to the Cedar River.

Stream samples were collected at selected points from the Cedar River, beginning at a point at the county bridge near Palo about eight miles above Cedar Rapids to the bridge on Highway No. 1 near Rochester, Iowa, located approximately 20 miles directly east of Iowa City. Stream sampling was begun on October 13 and continued until September 21, 1950. A series of four samples was collected during the period in the reach from Palo to Rochester with additional plant and river samples collected for additional information.

During the period of investigation, grab samples were also collected of the industrial wastes discharged by the Quaker Oats Company, Penick and Ford, Wilson and Company, and the Third Avenue storm sewer outlet into which the wastes from the Cargill Soybean Plant and other industrial wastes are discharged. Other sources of pollution investigated included the discharge of a milk waste from a storm sewer at the end of Avenue E, N.W. and an outlet from the Rock Island shops.

Complete plant surveys were not made of the industries except to determine the major source of wastes with no definite studies being made toward methods of elimination of the wastes. Grab samples were collected to determine the approximate strength of the waste and estimates of quantities were obtained either from observation or plant records.

III SCOPE OF TESTS:

Determinations in the field included temperature readings, pH determinations, and dissolved oxygen determinations. Samples for B.O.D. determinations were taken to the laboratory at Des Moines or to the laboratory at Iowa City where these determinations were completed. Samples for chemical analyses were preserved, iced, and forwarded to the laboratory at Iowa City for analysis. These determinations included ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, organic nitrogen, and the various total, suspended, and dissolved solids determinations.

All tests in the field and in the laboratories were carried out in accordance with procedures set forth in "Standard Methods for the Examination of Water and Sewage" of the American Public Health Association.

IV SIGNIFICANCE OF STREAM POLLUTION:

The pollution of a stream with sewage or industrial wastes is objectionable for the following reasons:

1. Sewage and industrial wastes contain millions of bacteria, many of which may be pathogenic or disease producing.

2. All sewage and most industrial wastes contain unstable organic material which in being converted to harmless stable material robs the stream water of oxygen.

3. Sewage and industrial wastes contain solids which are objectionable when they are floating downstream and which settle to the bottom of the stream bed causing objectionable sludge deposits when undergoing decomposition.

4. Some industrial wastes contain material which is toxic to the fish, livestock, and humans.

Dissolved Oxygen and Biochemical Demand:

All unpolluted stream water contains free oxygen in a dissolved form. This oxygen is essential to the maintenance of aquatic life, is drawn upon to support biochemical oxidation of organic wastes during natural purification of streams, and is replaced by absorption from the atmosphere and the photosynthetic action of some water plants, including algae. The dissolved oxygen in the water is available to bacteria which oxidize the organic material present in the pollution entering the stream. These bacteria are dependent upon the presence of dissolved oxygen. If there is a sufficient quantity of oxygen present in the water, this bacterial action will result in the complete oxidation of the organic material present without creating any objectionable odor nuisance or destruction of aquatic life. If there is not a sufficient amount of oxygen present, anaerobic bacterial action takes place and the organic material present in the water undergoes putrefaction with accompanying foul odors and the black, inky appearance of water which is familiar in a polluted stream.

In order to support aquatic life and prevent nuisances, there must always be present in the water a sufficiency of dissolved oxygen. It is generally agreed that if fish life is to be properly maintained, there must always be from four to five parts per million of oxygen in the water at all times. There is some evidence that some of the soft fish are more tolerant to a lower oxygen content than this level. In addition to the direct effect on fish of pollution, there is evidence that fish will leave areas of deficient oxygen if they can find means of escape.

Submerged vegetation promotes the propagation of fish life by furnishing shelter and nourishment to many forms of life which are necessary in the diet of the common game fish. These organisms and plants are all dependent upon oxygen and sunlight for existence and cannot grow under water made turbid and depleted of oxygen by sewage or wastes. Thus a low oxygen content not only kills or excludes the fish life at the time the deficiency occurs, but also kills a major portion of the food organisms. In general it is the worst conditions of pollution which occur occasionally, rather than the average conditions, which determine whether fish can be successfully propagated in certain streams.

It is possible in the laboratory by means of biochemical oxygen demand (B.O.D.) determinations to measure the organic content in the sewage to determine if an orderly oxidizing process will take place. The B.O.D. indicates the amount of dissolved oxygen which may be expected to be absorbed from the stream water to support the biochemical oxygen oxidation of the organic material carried by the stream at the point of sampling.

In an area of the stream above a riffle or an artificial dam where the water velocity has been reduced, there is a tendency on the part of the heavier solids to settle, forming banks of so-called sludge. The sludge in the stream beds then undergoes bacterial putrefaction with accompanying foul odors, and large masses of sludge rise to the surface rendering the water black in color and odorous. These sludge deposits interfere seriously with propagation of fish life. The accumulation of sludge is most serious during the extended periods of low stream flow and if there is a considerable accumulation of sludge in the stream, a sudden rise in the stream will stir up these deposits carrying them in suspension with the result that the oxygen of the stream waters is depleted and aquatic life in the stream is destroyed.

V SAMPLING STATIONS:

Sampling stations are usually referred to by number in all tables and charts used in this report. A map showing the location of all river sampling stations is shown on the following page. A more detailed map of Cedar Rapids is also shown to locate the major sources of pollution from the industries in Cedar Rapids. Table I, following these maps, is a description of the various sampling stations.

VI SOURCES OF POLLUTION AND PHYSICAL CONDITIONS AT OUTLETS:

The following sources of pollution are listed in order downstream through the City of Cedar Rapids. On each trip, the investigator made notes as to the physical condition of the wastes being discharged and the effect on the river.

1. Rock Island Shops.

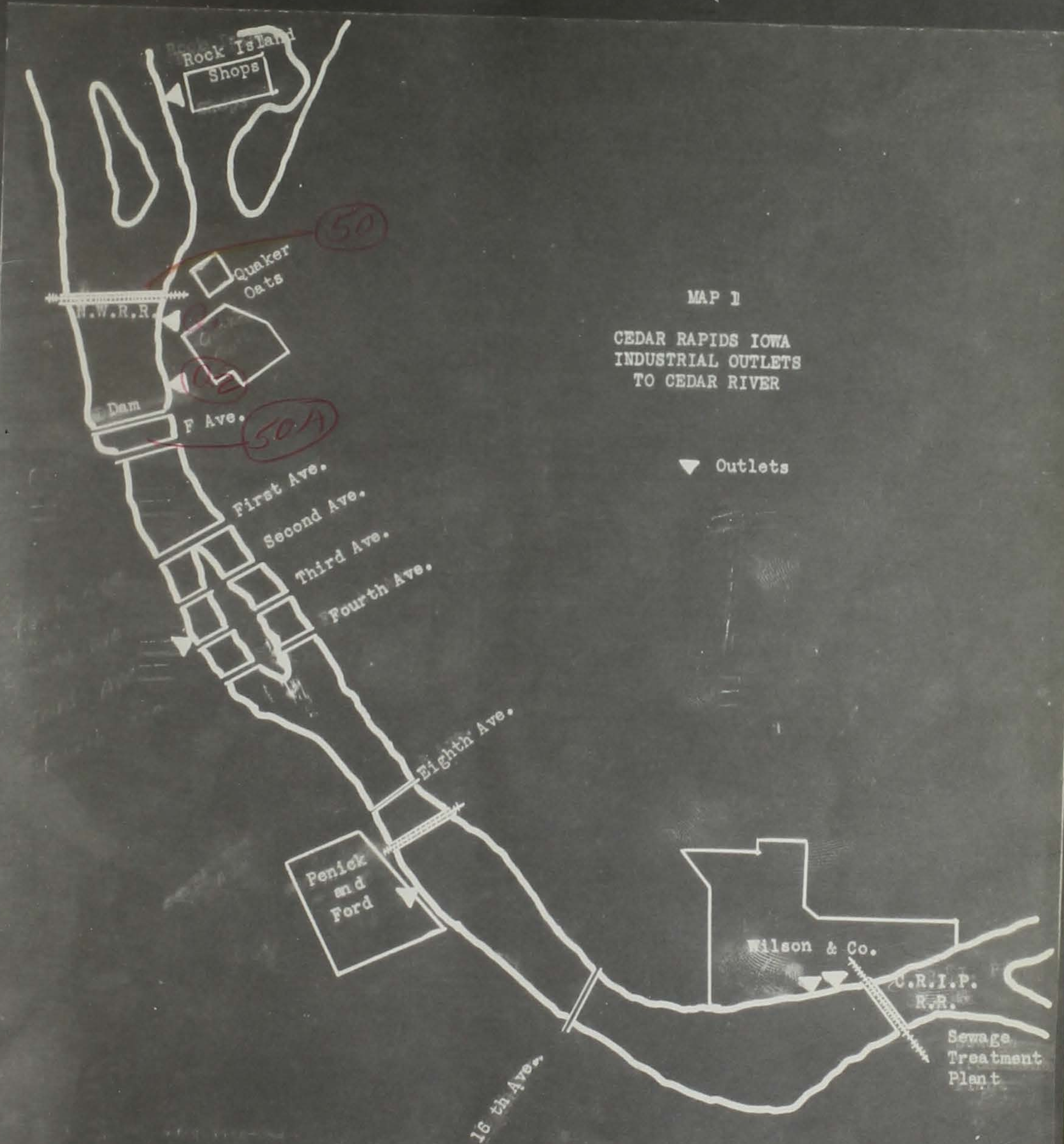
An outlet to the Cedar River located directly west of the Rock Island shops discharges some oil waste to the river which creates an oil slick at times.

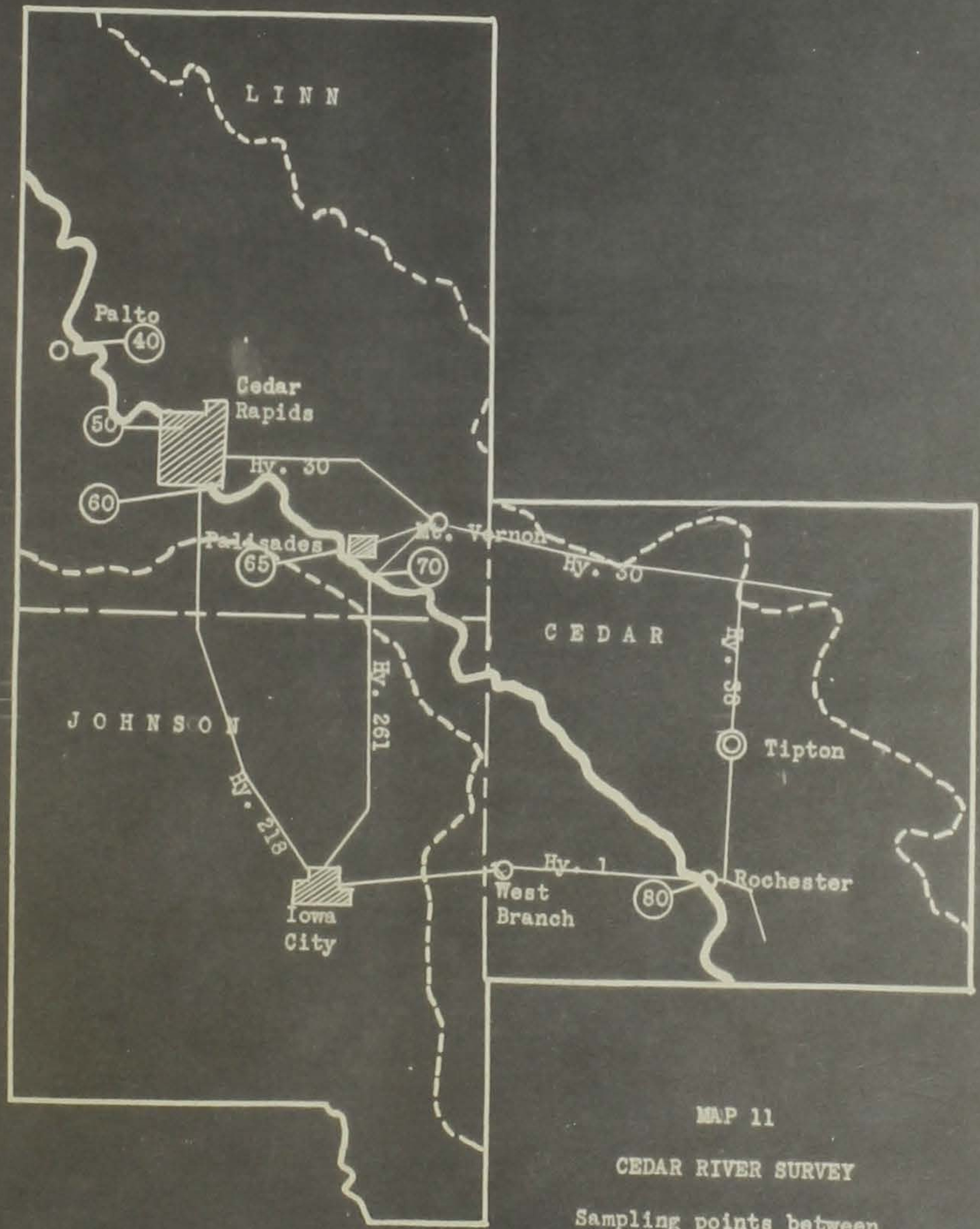
2. Quaker Oats Company

The principal source of waste from the Quaker Oats Company is from the furfural plant. The liquid chemical furfural is found useful in the refining of oils, in synthetic resins, insecticides, pharmaceuticals and other furan compounds.

In the process employed in the production of furfural, ground oat hulls or corn cobs and dilute sulfuric acid are charged to a rotary digestor. Steam is introduced to bring the charge to a selected conversion temperature and carry off the furfural as soon as it is formed in the form of a steam distillate. The mixture of steam and volatile reaction products is separated in a rectifying column into three fractions, one mainly water with traces of organic acids, one containing low boiling materials including acetaldehyde, and one consisting of 98 to 99 percent furfural.

The first two fractions apparently are discharged to the river with the cooling water. The high organic content of this waste creates a high pollutional load on the stream. The digester residue which consists of about 70 percent of the original weight is largely utilized as fuel for boilers at the nearby power plant.


MAP 1
CEDAR RAPIDS IOWA
INDUSTRIAL OUTLETS
TO CEDAR RIVER
Outlets
Rock Island
Shops
Quaker
Oats
50
N.W.R.R.
102
Dam
F Ave.
50A
First Ave.
Second Ave.
Third Ave.
Fourth Ave.
Eighth Ave.
Penick
and
Ford
Wilson & Co.
C.R.I.P.
R.R.
Sewage
Treatment
Plant
16 th Ave.



MAP 11

CEDAR RIVER SURVEY

Sampling points between
Palo and Rochester

(60) Numeral refer to sampling station

Scale, 1' = 8 miles

Cedar Rapids, Iowa
CEDAR RIVER POLLUTION SURVEY
October 13, 1949 to February 3, 1950

SAMPLING STATIONS

TABLE I

Station Designation	Station Description
40	County road bridge between Palo and Cedar Rapids (this is above all Cedar Rapids pollution.)
50	Northwestern Railroad bridge in Cedar Rapids (this is above the Quaker Oats outlets.)
Q_1	Quaker Oats (bank or upper outlet)
Q_2	Quaker Oats (submerged or lower outlet)
50 AR	Right bank at F Avenue N.W. bridge in Cedar Rapids (below Quaker Oats)
50AL	Left bank at F Avenue N.W. bridge
T	Third Avenue storm sewer outlet on right bank of river
P_1	Penick and Ford outlets (P_1 is upstream, P_2 down stream)
P_2	Penick and Ford outlet
W_1	Wilson and Company (upstream outlet)
W_2	Wilson and Company (down stream outlet)
C	City sewage treatment plant outlet
60	North Western Railroad bridge below city treatment plant outlet and below all Cedar Rapids pollution.
65	Palisades Park
70	Bridge on Highway No. 261 southeast of Mt. Vernon
80	Rochester bridge on Highway No. 1 20 miles east of Iowa City

A total of four outlets to the river are available for the discharge of wastes at the Quaker Oats Company Plant. One outlet located north of the grain elevator is reported to be a storm water drain carrying roof drainage only and no flow was observed during any inspection of this outlet. A second outlet is a 24 inch line located at the end of Avenue B which is reported by the plant engineering department to carry cooling water from compressors, water from small plant truck washing, and possibly plant roof washings used to remove accumulation of grain dusts. This tile line at times has appeared to be quite heavily contaminated with grain and other organic material.

Two outlets discharge the furfural into the river approximately 200 feet above the river dam. Both of these lines terminate in a common manhole in the plant into which the wastes from the furfural process are discharged. The 16 inch tile is partially submerged during normal flows and normally carries the greater portion of the furfural water due to a lower elevation at the plant manhole. The plant management estimates that approximately 400 - 500 gallons per minute of furfural wastes are discharged from the outlets. The waste is a clear, brown colored liquid with a characteristic sweet smelling odor. Small particles of digested corn cob have been observed in the waste. The temperature of the waste was found to be in the range of 118°F.

Sludge banks were being formed below these outlets since gas bubbles were observed rising at this point. Profuse growths of the sewage fungus Sphaerotilis natans were being formed on the gates of the hydroelectric plant mill race and along the channel walls of the mill race.

3. Avenue E., N. W. Storm Sewers.

A nearby milk plant which is reported to have connected newly installed equipment to this storm sewer during early 1950 apparently is the creator of a nuisance condition at this outlet.

4. Third Avenue, S. W., box storm sewer.

The Third Avenue storm sewer outlet contains the wastes of the Cargill Soybean Company plant and possibly the Cedar Rapids Cooperative Creamery and Troy Laundry.

The soybean plant is of the solvent extraction type, employing hexane as the solvent. A number of years ago, an explosion occurred at the screen house of the municipal treatment plant and the city believed that a spill of hexane solvent, which is a hydrocarbon somewhat similar to gasoline, may have been responsible for the accident. As a result of the explosion, the soybean plant was requested to disconnect from the sanitary sewer and connect to the storm sewer which outlets at Third Avenue. During the process of the extraction of the oil from the soybeans, a small percentage of fine bean meal dust is lost with the cooling water which is discharged to the city storm sewer.

Quantities and flows from the Cedar Rapids Cooperative Creamery are not known. An investigation is being conducted by the city to determine definitely if this plant is connected to the storm sewer.

5. Penick and Ford.

Due to the extensive and varied processes used in the manufacture of corn products, a complete plant survey was not made to discover all possible sources of pollution. However, the main source of pollution is believed to be the many vacuum evaporators used to concentrate various liquors. During the evaporation, solids or organic vapors may be entrained with the steam as the water boils off and the large quantities of cooling water to condense these vapors may contain this organic material when discharged to the river. Sanitary wastes and some industrial waste in the plant are discharged to the city sanitary sewers. There have been reports that large quantities of a starch like material have been discharged to the river at times. Discharge of these wastes to the sanitary sewers have also caused occasional operating difficulties at the treatment plant due to interference with gas production by the CO_2 producing starch products.

6. Wilson and Company

A large proportion of the wastes of the Wilson and Company meat packing plant is treated in the municipal sewage treatment plant. However, two waste outlets were observed discharging directly to the stream. A survey was made to determine the methods of waste disposal in the plant. The plant employs pretreatment of the wastes produced by the use of grease skimming tanks and fine screens.

The downstream outlet from the packing plant contained a large amount of solids, such as grease and meat scraps, and a large amount of hair and solids had been deposited along the stream bank near this outlet. It was determined during the plant survey that this line is a bypass line connected to the city and packing plant sewer which apparently was open slightly to relieve the overloaded hydraulic condition at the city sewage treatment plant during a high infiltration period and had not been closed. The bypass was closed to eliminate this discharge to the river.

The upstream outlet was observed to discharge a very strong waste apparently containing considerable paunch manure with a flow estimated at approximately 50 gallons per minute. Considerable solids were observed to have been deposited along the stream bank at the outlet. This outlet is reported to drain the surface water from the stockyards area. An attempt was made at the packing plant to separate the paunch manure screen from this line but investigation indicates that the screen drain was directed to another line. For this reason, a program of locating and mapping all waste lines on the Wilson property was begun during June, 1950, and was expected to take several months.

7. Municipal Sewage Treatment Plant.

Increased population and greatly increased industrial expansion during the war years has contributed to an overloaded condition of the municipal sewage treatment plant, both from an organic and hydraulic loading standpoint. Therefore, even though the plant is being operated in an excellent manner and is affording efficient treatment, a substantial load is being added to the stream by remaining organic material in the treated sewage.

VII PHYSICAL CONDITIONS OF STREAM

On all sampling trips, the physical condition of the stream at each station was noted. The stream was sampled during the late fall under low flow conditions and during the winter under ice cover conditions.

Station 40 is located between Palo and Cedar Rapids above all sources of pollution and the river was in very good condition at this point. The stream water was usually clear but contained some algae growth during the summer months.

Station 50 is located at the Northwestern Railroad bridge in Cedar Rapids just above the Quaker Oats outlets. The river at this point appeared to be in good condition at all times, although it contained algae growth during the warmer months. Some light oil film was noted on most occasions coming from the Rock Island shops outlet. Grain dust covered the surface of the river near the elevator on a number of occasions.

As described previously, the various industrial outlets in the city in some cases created nuisance conditions in the reach of the stream within the city. The sewage fungus Sphaerotilis, which is an indication of pollution and is stimulated in growth by carbohydrate wastes, became quite abundant below the Sixteenth Avenue bridge in Cedar Rapids and long gray festoons of it were often seen attached to sticks and stones in the water.

Algae growth was usually very heavy in the pool formed by the Palisades-Kepler State Park dam and sometimes imparted a green or brown color to the water at this point. At the time of the September 21, 1950, survey, the algae growth was very heavy and apparently these organisms were causing an obnoxious "fishy" odor in the water. This odor was very noticeable at the dam where aeration during the flow over the dam released these odors.

The physical condition of the river at the Mount Vernon bridge and Rochester bridge appeared to be satisfactory except for a heavy algae growth at times.

VIII INTERPRETATION OF CHEMICAL AND BACTERIOLOGICAL DATA

River sampling surveys were made under both warm water conditions and under cold water conditions with ice cover to determine the effect of the wastes on the stream under different conditions. Samples were also collected from the various industrial waste outlets to determine the approximate strength of these wastes.

INDUSTRIAL WASTES.

1. Rock Island Shops

No samples were collected from this outlet and it is not believed to contribute significant pollution with the possible exception of oil wastes.

2. Quaker Oats Company

In Tables II, III, and IV, are tabulated the results of the chemical determinations made on grab samples of the furfural wastes. The waste was found to be strongly acid with a pH of 4.2 due to the sulfuric acid digestion of the process. The nitrogen content of the furfural waste is low as may be expected from the low protein content of the raw material.

Table IV indicates that the B.O.D. of the waste is uniformly high with laboratory determinations ranging from 560 to 1000 parts per million.

A very high organic load is thus contributed to the Cedar River since, based on a flow of 500 gallons per minute, the furfural waste is equivalent to a population of 22,000 to 36,000 persons.

Samples were not collected from the Avenue D outlet from the Quaker Oats Company due to the sporadic nature of the flow, but it is believed to contain much less organic material than the furfural waste outlet.

3. Avenue E, N.W. Storm Sewer

No samples were collected since this is a new discharge apparently from a nearby milk plant which began sometime during the spring of 1950 and is under investigation by the city.

4. Third Avenue, S.W. Storm Sewer.

Results of chemical determinations made on two samples collected from the Third Avenue storm sewer outlet are tabulated in Tables II and III. The high organic nitrogen content as shown in Table III indicates the high protein content of the sample which may originate from the soybean plant.

The 5-day B.O.D. of the samples collected was 85 and 45 parts per million. Based on an estimated flow of 100 gallons per minute and using the higher B.O.D. value of 85 parts per million, a population equivalent of 600 people is obtained. This organic loading is not high in comparison with the other industries, but because of the location and suspended material carried in the waste, an odor nuisance and unsightly condition is created at the outlet.

As the result of a petition concerning this condition received by the city council during June, 1950, and a second received in August, a series of samples has been collected by the city at various places in the storm sewer to trace the industry or industries responsible for the discharge and eliminate the sources if possible. The soybean plant has discharged waste to this sewer for approximately 10 years but the condition is reported to have grown much worse in the past several years.

5. Penick and Ford.

Results of the chemical determinations made on samples collected from the Penick and Ford outlets are tabulated in Table III with an additional B.O.D. determination shown in Table II. Nitrogen determinations are not significant due to the low protein content of much of the raw material.

The major portion of the solids is in a dissolved form with a high percentage of volatile solids or solids of an organic nature.

The B.O.D. of the waste is relatively low but very large quantities of the waste are produced by the condenser waters creating a heavy pollutional load on the stream. The 5-day B.O.D. results are in the magnitude of 35 to 50 parts per million, and based on an average of only two results, the wastes have a population equivalent of 11,000 persons.

The Penick and Ford laboratory runs daily B.O.D. determinations on composite samples of these wastes. These samples are incubated one day only giving a one-day B.O.D. determination rather than the customary 5-day B.O.D. result and is ordinarily considered to be approximately 30 per cent of the 5-day B.O.D. These one-day B.O.D. determinations are made available to the City Engineer's office. A study of these results indicates a considerable day-to-day variation in the organic load going to the river and also that the average B.O.D. may be somewhat higher than that determined by this Department on a small number of samples.

6. Wilson and Company.

In Tables II and III, are tabulated the results of chemical determinations made on samples collected from the two outlets of the Wilson and Company discharging to the Cedar River. Two samples were collected on different dates from the two outlets for nitrogen and solids determinations, but only the results in Table IV are given since the second set of results are quite similar. The high nitrogen content of the packing house waste is indicative of a high protein waste as compared with the carbohydrate waste from the Quaker Oats Company. A population equivalent of approximately 2000 persons is calculated for the waste from the upstream outlet. The downstream outlet, which was a bypass line, has been eliminated by the closing of the bypass valve.

7. Cedar Rapids Sewage Treatment Plant.

The municipal sewage treatment plant receives all of the domestic sewage including that of most of the industries, with the exception of the wastes discharged directly to the stream as previously discussed. The bulk of the packing house waste is handled by the sewage treatment plant.

The treatment plant is of the separate sludge digestion type with secondary treatment provided by trickling filters. The plant which was completed in 1935 is now overloaded from both an organic and hydraulic loading

Cedar Rapids, Iowa
Cedar Rapids Industrial Outlets
SUMMARY OF CHEMICAL DETERMINATIONS
October 13, 1949 to September 21, 1950

TABLE II

Outlet	Temp. °C	pH	Dissolved Oxygen p.p.m.	B.O.D. p.p.m.
		October 13, 1949		
Quaker Oats - Bank		4.2	2.2	700+
Quaker Oats - Sub.	48	4.2	2.2	700+
Third Avenue	24	7.4	3.0	85
Penick & Ford - Up	28	7.6	5.1	50
Penick & Ford - Down	25	7.2	5.0	35
Wilson - Up	24	7.6	0	540
Wilson - Down	43	8.2	2.7	100
City		7.0	1.4	80
		November 17, 1949		
Quaker Oats - Bank	26	.		650
Quaker Oats - Sub.	28	4.2		600
Wilson - Up	22	7.3		600
Wilson - Down	38	7.8		320
		December 29, 1949		
Quaker Oats - Sub.		4.2		1000
		January 18, 1950		
Quaker Oats - Sub.				560
		July 12, 1950		
Quaker Oats - Sub.				720
Third Avenue				45
Penick and Ford				35
Wilson - Up				270
		September 21, 1950		
Quaker Oats - Bank	47	4.2		940

100,000

Cedar Rapids, Iowa
Cedar Rapids Industrial Outlets
CHEMICAL DETERMINATIONS
(in parts per million)
October 13, 1949

TABLE III

Determination	Quaker Oats Bank	Quaker Oats Submerged	3rd Ave. Outlet	Penick & Ford North	Penick & Ford South	Wilson North	Wilson(4) South
Organic Nitrogen	2.70	4.00	12.3	3.6	2.8	69.7	43.9
Ammonia Nitrogen	6.27	5.73	1.2	.014	.985	42.4	6.08
Nitrite Nitrogen	0	0	0	0	0	0	.44
Nitrate Nitrogen	0	0	0	0	0	0	0
Total Nitrogen	8.97	9.73	13.5	3.614	3.785	112.1	50.42
Total Solids	552	698	-	604	372	2860	1346
Total Volatile Solids	272	420	-	286	124	1210	438
Total Fixed Solids	280	278	-	318	248	1650	908
Suspended Solids	116	250	-	82	84	1230	296
Susp. Volatile Solids	84	214	-	54	48	810	266
Susp. Fixed Solids	32	36	-	28	36	420	30
Dissolved Solids	436	448	-	522	288	1630	1050
Dis. Volatile Solids	188	206	-	232	76	400	172
Dis. Fixed Solids	248	242	-	290	212	1230	878
Dissolved Oxygen	2.2	2.2	3.0	5.1	5.0	0	2.7
5 day B.O.D.-20°C.	800+	700+	85	50	35	540	100
Estimated flow - g.p.m.	50	500	100	3500		50	200
Population equivalent (1) (0.167 lbs. BOD/capita)	2800	27,000(2)	600	11,000(3)		2000	

(1) Table of population equivalents indicates approximate relative amounts of pollution contributed to river.
(2) Based on average of 6 samples over period of several months.
(3) Figure based on average of BOD results May be low based on one-day BOD results routinely run by company.
(4) Nitrogen solids determinations made on sample collected November 17, 1949, are quite similar to these results.

16,000#

16,000#
Half to river
96,000 PE

45,000# to plant
Est ½ Now due to changes in plant

Cedar Rapids, Iowa
Quaker Oats Outlets
CHEMICAL DETERMINATIONS
(in parts per million)
October 13, November 17, 1949

TABLE IV

Determination	Oct. 13, 1949 Q_1(1)	Q_2	Nov.17 1949 Q_2	Dec.29 1949 Q_2	Jan.18 1950 Q_2	Feb.3 1950 Q_2	July 12 1950 Q_2
Organic Nitrogen	2.70	4.00	17.10				
Ammonia Nitrogen	6.27	5.73	3.08				
Nitrite Nitrogen	0	0	0				
Nitrate Nitrogen	0	0	0				
Total Nitrogen	8.97	9.73	20.18				
Total Solids	552	698	754				
Total Volatile Solids	272	420	462				
Total Fixed Solids	280	278	292				
Suspended Solids	116	250	220				
Susp. Volatile Solids	84	214	204				
Susp. Fixed Solids	32	36	16				
Dissolved Solids	436	448	534				
Dissolved Volatile Solids	188	206	258				
Dissolved Fixed Solids	248	242	276				
Dissolved Oxygen	2.2	2.2					
5 Day B.O.D. - 20°C	700+	700+	600		1000	560	720
pH	4.25	4.25	4.25		4.2	4.2	
Population equivalent (2) (0.167 lbs B.O.D./capita)	25,000	25,000	22,000		36,000	21,000	26,000

All samples are grab samples.

(1) Samples collected from 16" and 21" outlets approximately 100 feet above gates on river dam.

(2) Based on estimated flow of 500 gallons per minute.

standpoint due to population and industrial increases. At the time the plant was designed in 1934, there was little to serve as a guide in the design of settling tanks to handle the wastes and the plans were approved with the understanding that additional tanks would be provided if settling capacity proved inadequate. Based on present average dry weather flows, less than half the necessary settling capacity is provided. Likewise, the present filter loadings are approximately three times the usual recommended loadings as a result of poor primary settling and industrial expansion.

RIVER STUDY

OXYGEN FINDINGS:

In Table V is tabulated the summary of the dissolved oxygen and B.O.D. determinations made on the river samples. These values are also plotted on Charts I and II accompanying the report. A river survey conducted August 31, 1947, by Dr. F. W. Mohlman, Consulting Chemist for the Quaker Oats Company, is also included in the tabulation and chart for comparison purposes.

Two river surveys were made under warm water conditions and three under winter conditions. It will be noted that the sample collected October 13, 1949, under warm water conditions shows an increase in both dissolved oxygen and B.O.D. from the station at Palo to Station 50 at the Northwestern Railroad bridge in Cedar Rapids. The increase in dissolved oxygen from 7.2 to 18.4 parts per million which is 189 per cent saturation is undoubtedly due to photosynthesis by heavy algae growth in the dam pool. These samples were collected during daylight hours and during this period the chlorophyll bearing algae give off oxygen as a result of photosynthesis. During the night, this process ceases and the algae growth consumes oxygen during the process of respiration and thus considerable variation may occur in the dissolved oxygen content.

The survey of September 21, 1950, under warm weather conditions, was made under cloudy conditions when there was little opportunity for photosynthesis and the dissolved oxygen content of the stream at Stations 40 and 50 remained below saturation. These samples were collected on a rising river stage and the organic material introduced by surface runoff may also have been a factor in lowering the dissolved oxygen content of the stream.

High B.O.D. values occurred at Station 50, which is supposedly above all sources of pollution, during both the survey on October 13, 1949, and the survey of Dr. Mohlman in 1947, but did not occur during the winter

Cedar Rapids, Iowa
Cedar River Pollution Survey
October 13, 1949, to February 3, 1950
CHEMICAL AND BACTERIOLOGICAL DATA

TABLE V

Sta.	Temp. °C	pH	Dissolved Oxygen p.p.m.	Saturation per cent	B.O.D. p.p.m.	Oxygen Balance	M.P.N. per 100 ml.	River Flow c.f.s.
October 13, 1949								
40	17	8.4	7.2	74	3	4.2		575
50	17	8.4	18.4	189	15	3.4	230	
60	17	7.8	16.2	166	20	-3.8	110,000	
70			6.2 *Mt Vernon*		4.4	1.8		
December 29, 1949								
40	0		15.1		6	9.1		825
50	0		15.0		7	8.0		
60	0		14.7		15	-0.3		
January 18, 1950								
40	0	7.5	11.0	75	6	5.0	16,000	450
50	0		8.9	61	7	2.9	5,400	
50AR	0		11.4	78	10	1.4		
50AL	0		11.7	80	7	4.7		
60	0	8.6	10.6	72	17	-6.4	920,000	
65	0	7.7	8.6 *-Palisades*	59	10	-1.4	33,000	
70	0	7.4	9.9	68	8	1.9	54,000	
80	0		9.8	67	8	1.8	7,900	
February 3, 1950								
40	0	7.4	6.0	41	1	5.0	5,400	456
50	0		4.9	34	1	3.9	2,400	
60	1	7.4	6.5	44	12	-5.5	240,000	
65	0	7.5	4.7 *Palisades*	32	7	-2.3	70,000	
70	0		8.1	55	6	2.1	54,000	
80	0	7.7	6.2	42	2	4.2	3,300	

TABLE V

(Continued)

Sta.	Temp. °C	pH	Dissolved Oxygen p.p.m.	Saturation per cent	B.O.D. p.p.m.	Oxygen Balance	M.P.N. per 100 ml.	River Flow c.f.s.
				September 21, 1950				
40	20	7.8	5.9	65	6	-0.1	24,000	Not available
50	20	7.9	6.7	73	7	-0.3	18,000	Rising stage
CRI&P RR	21	8.0	6.0	66	14	-8.0	5,400	
60	22	7.8	2.0 NW	22	11	-9.0	54,000	
65	22	7.8	1.0 Palisades	11	5	-4.0	350,000	
70	22	7.6	5.3 Mt Vernon	60	7	-1.7	92,000	
80	20	7.8	7.9	86	8	-0.1	1,400	
				F. W. Mohlman Survey August 31, 1947				
50	24		10.9		10.5			
16thA	25		10.1		9.9			1470
CRI&P	24		10.5		10.2			
60	24		10.3		10.3+			
65	23		5.5 Palisades		9.3			
70	25		10.3		10.3+			

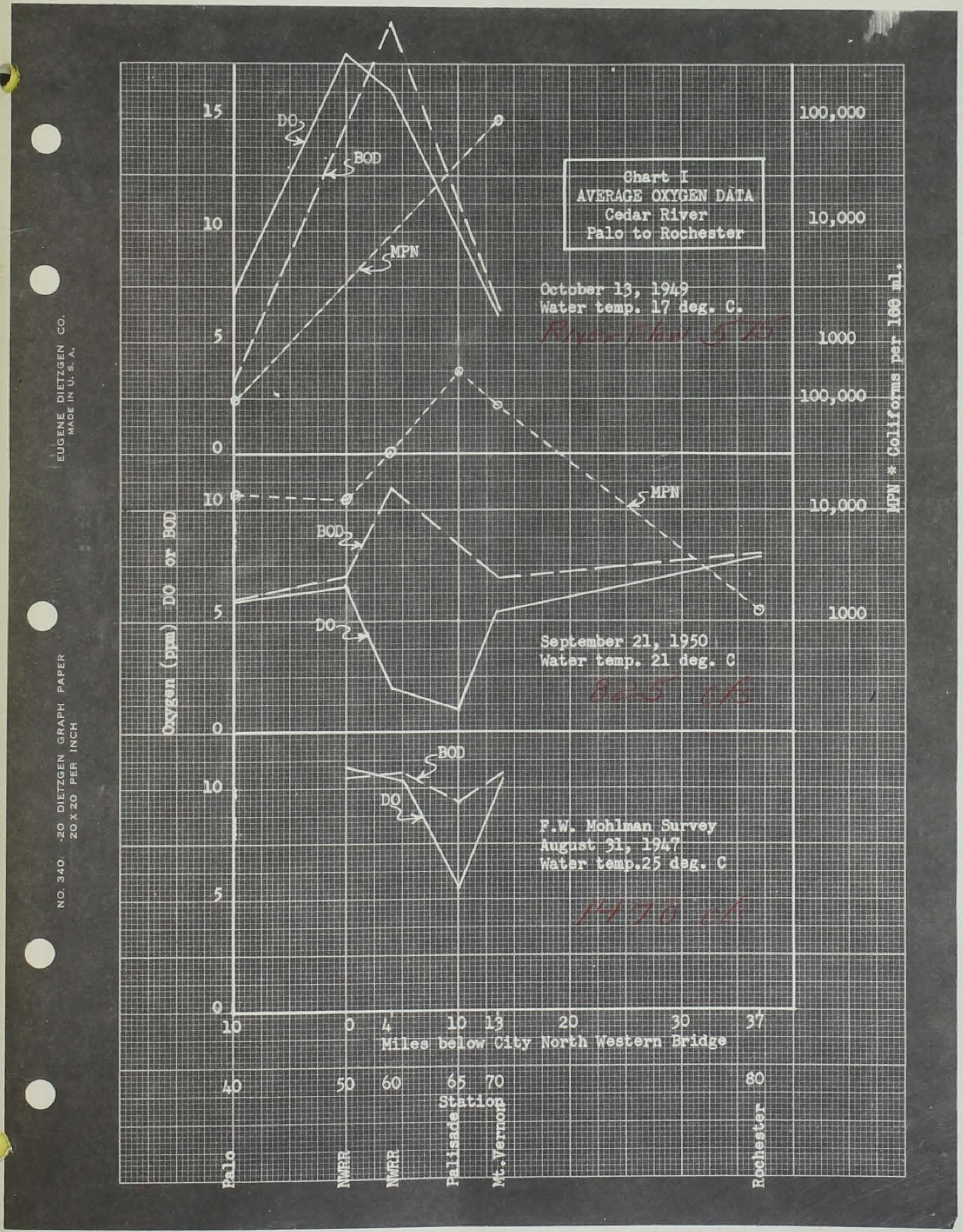


Chart I
AVERAGE OXYGEN DATA
Cedar River
Palo to Rochester
October 13, 1949
Water temp. 17 deg. C.
September 21, 1950
Water temp. 21 deg. C
825 cfs
F.W. Mohlman Survey
August 31, 1947
Water temp.25 deg. C
1470 cfs
DO
BOD
MPN
Oxygen (ppm) DO or BOD
MPN * Coliforms per 100 ml.
Miles below City North Western Bridge
Station
Palo
NWRR
NWRR
Palisade
Mt.Vernon
Rochester
NO. 340. -20 DIETZGEN GRAPH PAPER 20 X 20 PER INCH
EUGENE DIETZGEN CO. MADE IN U. S. A.

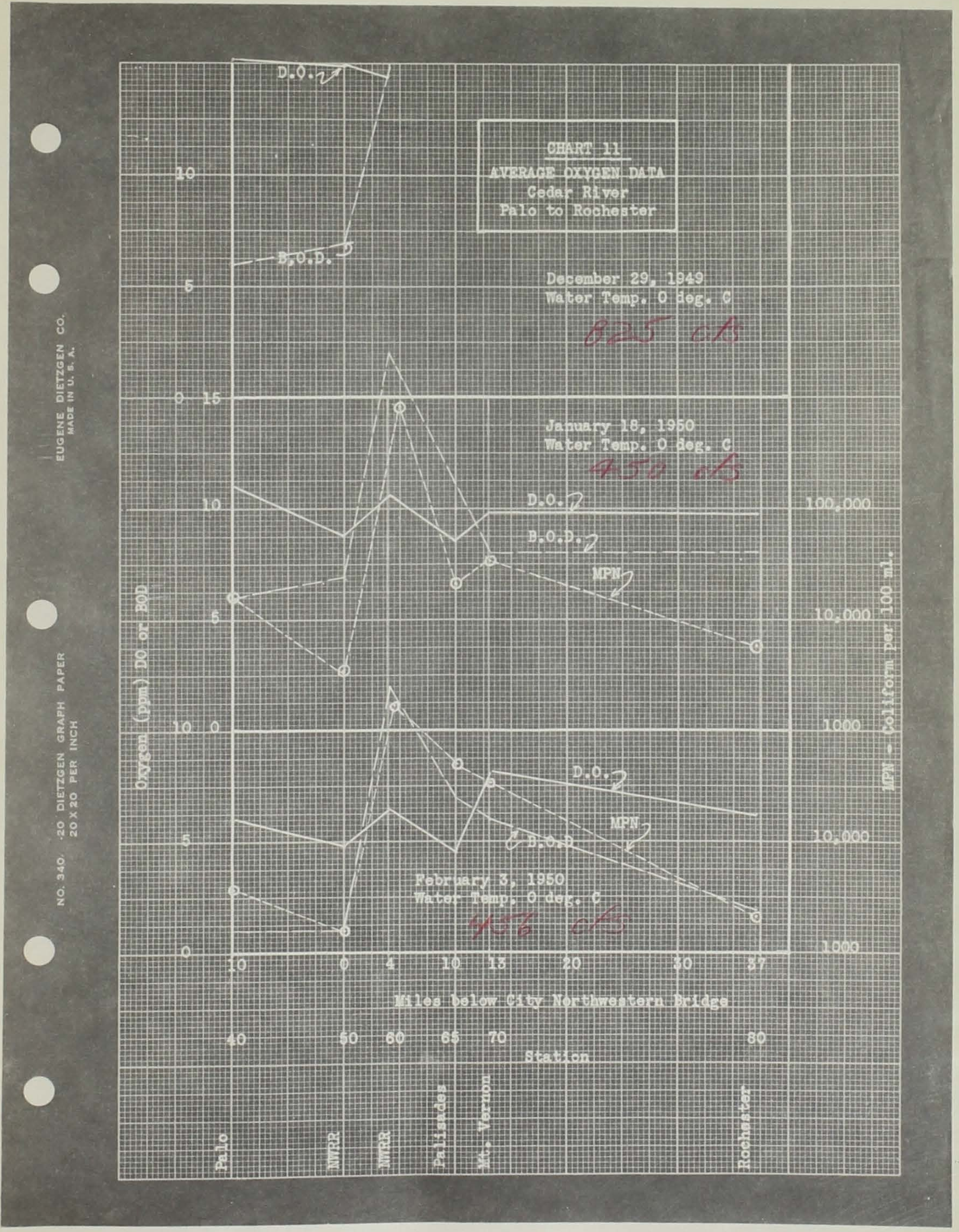


CHART 11
AVERAGE OXYGEN DATA
Cedar River
Palo to Rochester
December 29, 1949
Water Temp. 0 deg. C
825 cfs
January 18, 1950
Water Temp. 0 deg. C
450 cfs
February 3, 1950
Water Temp. 0 deg. C
456 cfs
D.O.
B.O.D.
MPN
Oxygen (ppm) DO or BOD
MPN - Coliform per 100 ml.
100,000
10,000
1000
Miles below City Northwestern Bridge
Station
Palo
NWRR
NWRR
Palisades
Mt. Vernon
Rochester

sampling. This apparent discrepancy showing high B.O.D. values may be due to sampling or possibly to some source of pollution above this station. It was reported that the lagoons which receive the ash from furfural digester residue from the power plant eventually discharge to the river but such outlet could not be discovered to determine if the high B.O.D. may have come from this source.

The survey of October 13, 1949, indicated the B.O.D. increased at Station 60 (Northwestern Railroad bridge) which is below all sources of pollution, to a high of 20 parts per million. The influence of this organic demand decreased the dissolved oxygen at this station and to a low value of 6.2 parts per million at Station 70 approximately 10 miles below the Cedar Rapids treatment plant. The natural purification of the stream decreased the B.O.D. from a high of 20 to 4.4 parts per million in this section of stream.

The survey of September 21, 1950, showed a serious oxygen deficiency at the Northwestern Railroad bridge and at Palisades-Kepler State Park below Cedar Rapids as the oxygen content of the Cedar River decreased to 2.0 parts per million and 1.0 parts per million respectively at these points. This oxygen content is usually insufficient to support fish life especially at elevated temperatures. This oxygen deficiency may possibly be attributed to a combination of factors such as the absence of photosynthesis under cloudy conditions, to organic demand contributed by surface runoff, and to scouring of the stream bed during the rising river stage which picked up partially digested sludge deposited from the various organic wastes. In addition reaeration is slowed by the stilling effect of the pool formed by the Palisades dam.

The survey by Dr. Mohlman made under warm water conditions showed B.O.D. and dissolved oxygen values of approximately 10 parts per million in the river between the two Northwestern Railroad bridges. His survey showed a marked drop in dissolved oxygen to 5.5 parts per million at Palisades State Park pool with an increase at Station 70 but little or no reduction in the B.O.D. in this reach of stream.

The surveys made under winter conditions were not under complete ice cover due to the relatively mild winter prevailing until the latter part of January, 1950. The first winter survey as shown by Chart II showed a high dissolved oxygen and low B.O.D. at Palo and at the Northern Railroad bridge in Cedar Rapids, but a sharp increase in B.O.D. and a drop in the dissolved oxygen at Station 60 below the sources of pollution. The survey on January 18, 1950, showed similar results at these stations with an increase noted in dissolved oxygen below the dam. The dissolved oxygen decreased at the Palisades dam due to the oxygen demand of the organic waste. The B.O.D. also showed a considerable decrease in this reach of the stream.

The dissolved oxygen content of the stream entering Cedar Rapids during the February 3 survey was low, apparently due to the organic load upstream and the lessened opportunity for reaeration during this period. The dissolved oxygen content remained low during the entire reach of the stream from the effect of the organic load and decreased opportunity for reaeration.

CHEMICAL AND BACTERIOLOGICAL FINDINGS

Results of the nitrogen and MPN determinations of the river samples are given in Table V and VI accompanying the report. The nitrogen values found during October 13th survey showed no significant changes, whereas those during the February 3d survey showed a substantial increase following the pollutional load.

The MPN (most probably number) expressed as coliform bacteria per 100 ml showed a great increase following the pollutional load at Cedar Rapids and a rapid decrease with river distance.

IX RIVER DISCHARGE

The total water yield of the Cedar River is larger per square mile of drainage than are most of the streams in Iowa and likewise the river has a much better low water yield than the Iowa, Skunk, and Des Moines. There is a considerable seasonal variation in stream flow, yet the sustained dry weather flows, coupled with the freedom of silt, as compared with other Iowa rivers, makes the Cedar River one of the finest rivers for water supply purposes, for recreational purposes, and for fish culture.

Stream flows during the period of river sampling were among lower flows of record. Flows prevailing at the time of sampling are included in Table V and vary from 450 to 825 cfs. The minimum low flow of record is 236 cfs during 1934. Periods of sustained low flows have occurred as follows during the summer of 1934 and winter of 1940.

Period of Low Flow	Average Discharge cfs	Period
1 day	236	July, 1934
15 days	315 or less	June, July, 1934
1 month	350 or less	June, 1934
54 days	400 or less	January, February, 1940

Charts I and II showing the dissolved oxygen curve downstream indicate that the critical oxygen level is being approached both under summer and winter conditions. Low flows occur with the greatest frequency during the early fall and during the extremely cold winter weather.

Factors of self-purification must be considered in estimating the effect of an organic load on the stream but it is always possible to evaluate these factors. Settling of solids takes place in quiescent areas such as the Palisades pool but creates sludge banks which exert an oxygen demand. Likewise, during winter months, reaeration is reduced or prevented under conditions of ice cover. The dissolved oxygen content of the water is normally greater under winter conditions, but as indicated by the February 3, 1950, survey, upstream organic load and lack of aeration by ice cover may prevent an increase in oxygen content.

Cedar Rapids, Iowa
Sewage Plant Outlet and River Stations
RESULTS OF CHEMICAL DETERMINATIONS
Nitrogen and Solids Included
(in parts per million)

TABLE VI

October 13, 1949

Determination	Station 40	Station 50	Sewage Plant Outlet	Station 60	Station 70
Organic Nitrogen	2.4	1.8	6.6	2.7	2.0
Ammonia Nitrogen	.04	.053	14.9	.10	.506
Nitrite Nitrogen	0	0	0	.0024	.009
Nitrate Nitrogen	0	0	0	0	0
Total Nitrogen	2.44	1.133	21.5	2.8024	2.515
Total Solids	-	-	1548	-	-
Total Volatile Solids	-	-	228	-	-
Total Fixed Solids	-	-	1320	-	-
Suspended Solids	-	-	140	-	-
Suspended Volatile Solids	-	-	112	-	-
Suspended Fixed Solids	-	-	28	-	-
Dissolved Solids	-	-	1408	-	-
Dissolved Volatile Solids	-	-	116	-	-
Dissolved Fixed Solids	-	-	1292	-	-
Dissolved Oxygen	7.2	18.4	1.4	16.2	6.2
5 day B.O.D. - 20°C	3	15	80	20	4.4
M.P.N. - Coliform	-	230	-	110,000	490,000
Temperature °C	17	17	18	17	17

February 3, 1950

	Station 40	Station 60	Station 65	Station 70	Station 80
Organic Nitrogen	3.26	8.93	6.05	5.86	9.49
Ammonia Nitrogen	1.26	2.21	1.86	2.13	1.91
Nitrite Nitrogen	0.02	0.05	0.06	0.06	0.03
Nitrate Nitrogen	1.1	1.4	0.9	1.2	1.4
Total Nitrogen	5.64	12.59	8.87	9.25	12.83
Dissolved Oxygen	6.0	6.5	4.7	8.1	6.2
5 day B.O.D. 20°C	1.0	12	7	6	2
M.P.N. - Coliform °C	5,400	240,000	70,000	54,000	3,300
Temperature °C	0	1	0	0	0

XI CONCLUSIONS:

1. Serious pollution is being contributed to the Cedar River at Cedar Rapids by the discharge of industrial wastes directly to the river. The effect of the industrial wastes on the river is equivalent to that produced by a population of approximately 40,000 persons, as shown in Table III. The contributors of this pollution in varying degrees include the Quaker Oats Company, various industries discharging wastes to the E. Avenue N.W., and Third Avenue S.W. storm sewers, Penick and Ford and Wilson and Company.

2. While a sewage treatment plant study is not a function of the present stream pollution investigation, it is pointed out that the Cedar Rapids sewage treatment plant is greatly overloaded from an organic loading and hydraulic loading standpoint due to population increase and heavy industrial expansion. Enlargement of municipal treatment facilities to handle the industrial waste appears to be the most logical solution to the elimination of the discharge of these wastes to the river. Industrial plant studies will be necessary to reduce the quantity and strength of these wastes.

3. Observations of the physical condition of the stream indicate considerable pollution below Cedar Rapids as evidenced by undesirable pollutional growths as far downstream as Palisades-Kepler State Park. While actual fish destruction was not noted, it is likely that normal aquatic life is rendered difficult under the pollutional conditions. Oxygen determinations approach the critical level under both winter and summer conditions during low flows and indicate a negative oxygen balance below the sources of pollution.

XII RECOMMENDATIONS:

1. It is recommended that the three major industries, namely, the Quaker Oats Company, Penick and Ford, and Wilson and Company, begin a study of their plant processes and wastes looking toward treatment of their wastes or treatment by the municipal plant in order to minimize the pollutional load on the Cedar River. Wilson and Company is completing or has completed an intensive investigation of all waste lines within their property in order to determine methods to minimize pollution.

2. It is recommended that the City of Cedar Rapids request the industries discharging to the East Avenue N.W. and Third Avenue N.W. storm sewers disconnent from these sewers and connect to the sanitary

sewer. Adequate precautions, satisfactory to the city, must be taken by the Cargill soybean plant to guard against an explosive hazard to the sanitary sewer or treatment plant.

3. It is understood that an engineering firm is making a study of the west side sewers in Cedar Rapids which are inadequate to handle domestic and industrial flows. This engineering study should include an investigation of the quantity and strength of the industrial wastes in this area. It is suggested that an engineering study of the municipal sewage treatment plant requirements be initiated following completion of the sewer system study.

Respectfully submitted,

R. J. Schliekelman
R. J. Schliekelman
Public Health Engineer

RJS:bh

PB-A-6599

IOWA
STATE DEPARTMENT OF HEALTH
DIVISION OF PUBLIC HEALTH ENGINEERING
DES MOINES

Town Cedar Rapids, Iowa Date Oct. 26, 1950 to Nov. 30, 1950

Report on Pollution of the Cedar River from Cedar Rapids to Rochester

By R. J. Schliekelman & A. Dennis Approved Director

Division of Public Health Engineering

I. Introduction:

The following report covers an investigation of the Cedar River from Cedar Rapids to Rochester, Iowa and of the Cedar Rapids industrial outlets during the period Oct. 26, 1950 to Nov. 30, 1950 and is a supplement to the original report covering the period from October 13, 1949 to Sept. 21, 1950. Three additional river surveys are included in this report and the sampling procedures and stations remain the same.

II. Physical Condition of Stream and Industrial Outlets:

The physical condition of the stream was very good at Cedar Rapids above sources of pollution but again generally showed various evidences of pollution through Cedar Rapids and extending to Palisades-Kepler State Park. The physical condition of the river at the Mt. Vernon and Rochester bridges appeared to be generally satisfactory. Gross pollution was noted below the Quaker Oats furfural waste outlet, at the Third Ave. storm sewer due to discharge of soybean wastes and at Wilson and Company where a waste similar to paunch manure screen washings are discharged. The conditions at the Quaker Oats and Third Ave. storm sewer outlets appeared much worse than those observed during the period covered by the previous report.

III. Interpretation of Chemical and Bacteriological Data:

Industrial Outlets

1. Quaker Oats

In Table A are tabulated the results of B.O.D. determinations made on grab samples of furfural waste which indicate no change from the high values found previously. B.O.D. values in the magnitude of 116 to 880 ppm were found in the waste outlet from the Quaker Oats plant at Ave. D. This outlet thus also contributes a considerable pollutional load at times as flow estimated at 200-300 gallons per minute has been observed.

2. Avenue E N.W. Storm Sewer

Pollution entering this sewer appears to have been eliminated.

3. Third Avenue N.W. Storm Sewer

There appears to be no significant change in the strength of this outlet although the appearance of the stream at the outlet is definitely worse.

4. Penick & Ford

An extremely high B.O.D. value of 390 ppm was found at the combined waste outlet from the Penick and Ford Plant. This B.O.D. value is much higher than any previous B.O.D. determination. The influence of this high strength waste was noted approximately one mile downstream at the Rock Island Railroad bridge where a B.O.D. of 22 ppm was noted.

5. Wilson and Company

No samples were collected from the outlet discharging a small amount of wastes from this plant. However, the waste was creating an unsightly condition at the outlet and was noticeable in the river for some distance below the Railroad bridge. The Wilson and Company has completed a study to determine the location of all drains and sewers.

River Study

The B.O.D. and dissolved oxygen determination made on the river samples are tabulated in Table A and plotted on Charts III and IV accompanying the report.

All B.O.D. determinations indicate a very substantial increase in pollution through and below Cedar Rapids. All B.O.D. values remain relatively high as far downstream as Rochester.

The dissolved oxygen content of the river water shows a decided drop from the effects of the oxygen demand exerted by the pollutional load. Decreases in dissolved oxygen from 13.3 to 6.7 ppm and 16.5 to 5.9 were noted at Palisades-Kepler State park on two of these surveys. This oxygen sag and low dissolved oxygen values indicate the river is approaching critical conditions and it is entirely likely that critical conditions may occur or have occurred under certain river and weather conditions. In the two surveys commented upon critical conditions would have occurred if the stream water had not been supersaturated.

The MPN (most probable number) expressed as coliform bacteria per 100 ml. showed a considerable increase following the pollutional load at Cedar Rapids.

IV. River Discharge:

River flows prevailing at the time of the surveys are given in Table A and are considerably above minimum flow.

V. Remarks:

The additional river investigations covered by this report confirm the conclusions and recommendations given in the previous report and no additional recommendations are therefore made.

Respectfully submitted,

R. J. Schliekelman

R. J. Schliekelman
Public Health Engineer

RJS:ci

Cedar Rapids, Iowa

Cedar River Pollution Survey

Supplementary Report

October 26, 1950 to Nov. 30, 1950

Chemical & Bacteriological Data

TABLE A

Sta. No.	Temp. °C	pH	Dissolved Oxygen ppm	Saturation %	B.O.D. ppm	Oxygen Balance	M.P.N. per 100 ml.	River Flow c.f.s.
October 26, 1950								
40	11	7.9	13	117	8	5	200	
50	11	8.2	13.3	120	12	1.3	200	900
55	12	7.9	12.1	110	15	-2.9	7,900	
60	12	7.9	10.4	96	30	-20	240,000	
65	11	7.8	6.7 Palisade	60	10	-3.3	240,000+	
70	13	7.9	10.5	99	12	-1.5	180,000+	
80	14	8.0	12.7	120	13	-0.3	16,000	
Quaker*	-	7.5			880			
November 8, 1950 (778 cfs)								
40	6	8.3	11.8	95	9	2.8	5,400	
50	7	8.5	15.6	128	13	1.4	330	778
55	8	8.2	12.4	105	22	-10	92,000	
60	7	7.5	9.5 Palisade	78	15	-5.5	350,000	
65	8	8.5	11.0	92	14	-3.0	170,000	
70	8	8.5	11.7	98	14	-2.3	240,000	
80	7	8.5	11.9	98	19	-7.0	7,900	
Quaker*			4.4		170			
Q_2			0.9		1000			
P_2			2.9		390			
P_1	18	8.0	6.7		120			
November 30, 1950								
40	0	8.1	15	102	3	12	450	
50	1	8.5	16.5	112	1	15.5	490	Not available
55	0	8.1	15.0	102	13	2	23,000	
60	0	8.0	14.4	98	16	-1.6	490,000	
65	0	8.3	5.9 Palisade	40	3	2.9	33,000	
70	0	8.0	14.6	100	10	4.6	20,000	
80	0	8.1	14.5	31	13	1.5	4,900	
Quaker*		8.5	5.2		116			
Quaker			11.6		550			
P_2	15	7.4	13.8		50			
3rd Ave.	20	7.4	3.6		110			

Note - *Indicates Ave. D outlet at Quaker Oats plant

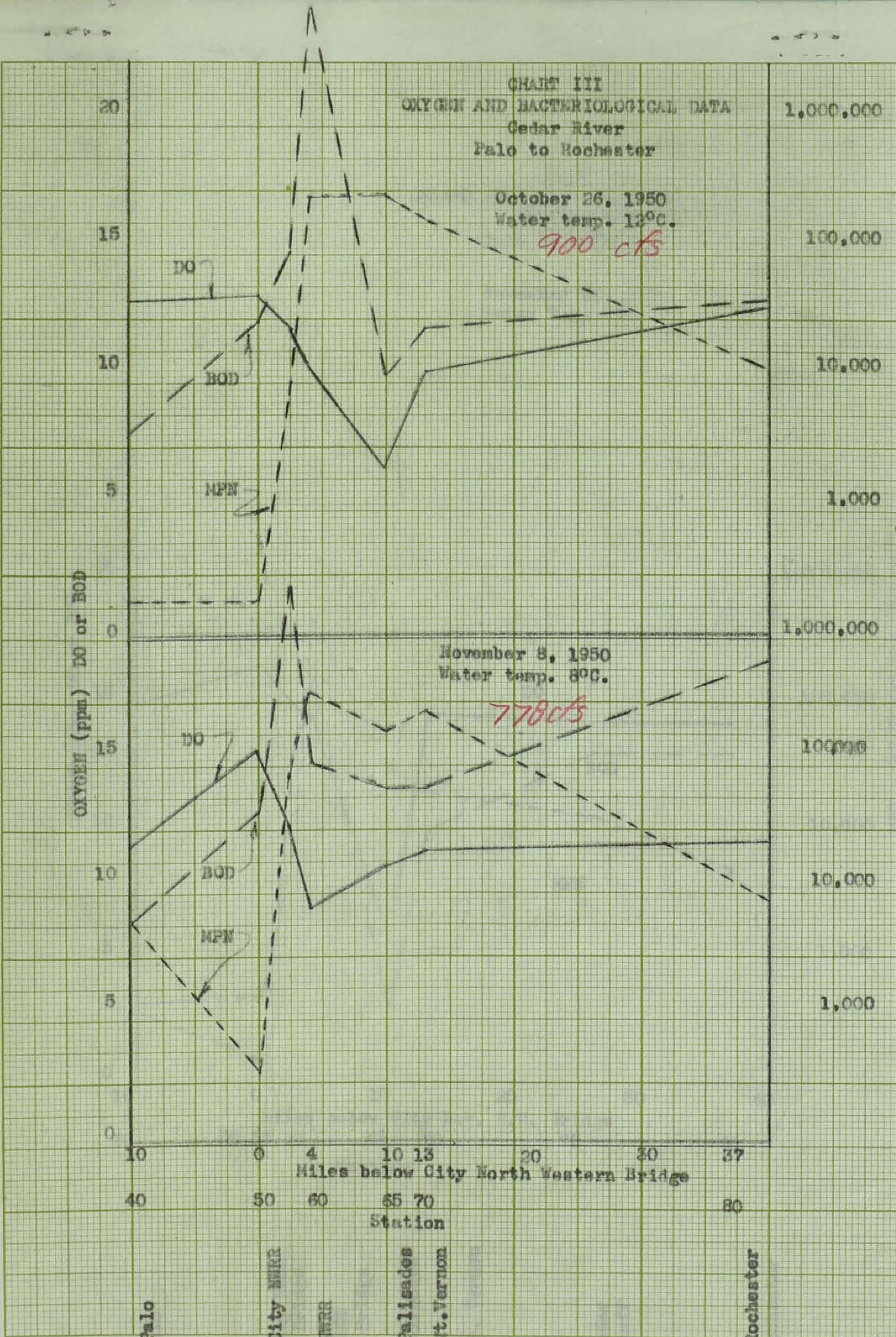


CHART III
OXYGEN AND BACTERIOLOGICAL DATA
Cedar River
Palo to Rochester
October 26, 1950
Water temp. 12°C.
900 cfs
November 8, 1950
Water temp. 8°C.
778cfs
DO
BOD
MPN
OXYGEN (ppm) DO or BOD
MPN - COLIFORMS per 100 ml.
20
15
10
5
0
1,000,000
100,000
10,000
1,000
10
0
4
10 13
20
30
37
Miles below City North Western Bridge
40
50
60
65 70
80
Station
Palo
City NWRR
NWRR
Palisades
Mt.Vernon
Rochester

CHART IV
OXYGEN AND BACTERIOLOGICAL DATA
CEDAR RIVER
Palo to Rochester

November 30, 1950
Water Temp. 0°C