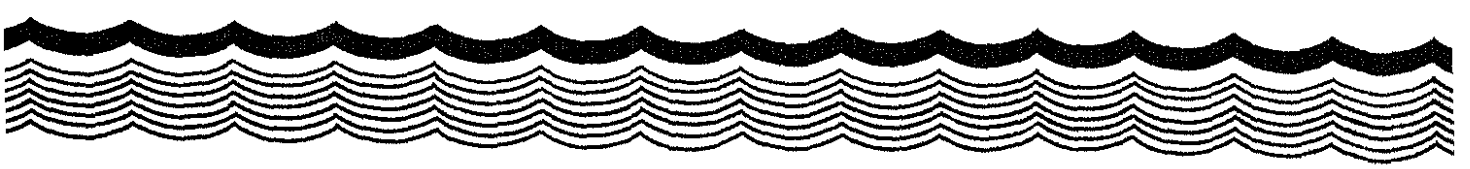
For Clean Water—"One River, One Plan"

Upper Mississippi
DRAINAGE BASIN

A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION



FEDERAL SECURITY AGENCY

Public Health Service

SUMMARY REPORT ON WATER POLLUTION

Upper Mississippi Drainage Basin

Prepared by

FEDERAL SECURITY AGENCY
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Division of Water Pollution Control
Upper Mississippi and Great Lakes Drainage Basins Office

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In cooperation with:

Illinois Sanitary Water Board
Indiana Stream Pollution Control Board
Iowa State Department of Health
Minnesota Department of Health
Missouri Department of Public Health and Welfare
North Dakota State Department of Health
South Dakota Committee on Water Pollution
Wisconsin Committee on Water Pollution

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Part II - SUB-BASIN REPORTS (Continued)

INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June of 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters.

In developing these programs, due regard must be given to improvements necessary to conserve the Nation's waters for public water supplies, propagation of fish and aquatic life, recreational purposes, agricultural, industrial, and other legitimate uses.

Recognizing the fact that full technical information was not available to permit the development of such comprehensive programs immediately for most of the Nation's waters, the Public Health Service envisioned the development of these programs in two general phases. The first phase contemplated the development of a series of reports, consistent with presently available data, which would: provide a reference point for measuring progress; provide a guide to needed additional data; provide a basis for the logical development of comprehensive programs; provide a basis for approval of loans to States, interstate agencies and municipalities at such time as the Congress made available funds for this purpose; and serve to inform the public on the problem of water pollution and set forth suggestions for pollution control.

The collection of available data as of July 1, 1950, has been completed under the first phase of the program. Such data have been assembled with the cooperation of State and interstate water pollution control agencies. Through these agencies additional data have been obtained from other State officials, county and city officials and representatives of industry. Federal agencies also have been of great assistance. In order to make this information available at the earliest possible moment, these data are being presented in 15 summary-type reports covering the United States by major drainage basins. This report on the Upper Mississippi River Basin is one of that series.

These summary reports present information about the ways our water resources are used, the pollution going into our water resources and the resulting damages, the benefits which may result from pollution prevention and abatement, the pollution prevention measures now in effect, and those required.

They are prepared in two parts. Part one considers the water pollution problems of the basin as a whole. Part two presents briefly the data for each of the several sub-basins of the major basin, including a tabulation of pollution abatement projects now known to be needed for water pollution control.

Since the summary reports are based on data which are now readily available, these reports do not discuss or evaluate the most advantageous water uses as they are related to pollution control. Such considerations will be included as a part of the comprehensive water pollution control programs.

The deficiencies in data and the gaps in information indicated in these summary reports are as significant as the presentation of available facts and statistics. They indicate the work which still needs to be accomplished by water pollution control authorities for the preparation of comprehensive programs.

Data and knowledge now available are sufficient, however, to permit the immediate solution of certain of the pollution problems within the Upper Mississippi Basin without awaiting the results of additional surveys and studies. The tabulations of pollution abatement projects which are included in Part Two of this summary report represent presently known needs. However, future studies and evaluations may result in some changes in the estimations of requirements.

A sincere effort has been made by all who contributed to this report to present a fair picture of the complex water pollution problems in the Upper Mississippi Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive pollution control program, will help in safeguarding the water resources of the Upper Mississippi Basin.

Leonard A. Scheele

Surgeon General

ACKNOWLEDGMENTS

The Public Health Service wishes to acknowledge the full cooperation received from the following State agencies in this basin in the preparation and review of the report: Illinois Sanitary Water Board, Indiana Stream Pollution Control Board, Iowa State Department of Health, Minnesota Department of Health, Missouri Department of Public Health and Welfare, North Dakota State Department of Health, South Dakota Committee on Water Pollution, and Wisconsin Committee on Water Pollution.

Acknowledgement is also made of the assistance of the Sanitary District of Chicago in furnishing data relative to that District.

Federal agencies from whose reports many data were obtained include: Bureau of the Census, Department of Commerce; Corps of Engineers, Department of the Army; Fish and Wildlife Service and Geological Survey, Department of the Interior; Department of Agriculture; National Resources Committee, and National Resources Board.

Finally, there is acknowledged the assistance of other Federal and State agencies and individuals interested in water resources development and conservation, that have contributed information through many sources.

SUMMARY

The Upper Mississippi River Basin as considered in this report comprises all drainage to the Mississippi above the mouth of the Ohio River except the Missouri and its tributaries. The Red River of the North and the Rainy River, both of which are tributary to Hudson Bay, are also included for administrative reasons The Upper Mississippi River Basin has a total area of 225,000 square miles and contains portions of the States of Wisconsin, Minnesota, North and South Dakota, Iowa, Illinois, Indiana, and Missouri. The 1950 population for the basin was 16,500,000 persons, varying from a density of 2,420 persons per square mile in the Chicago area to seven persons per square mile in the Rainy River Sub-Basin.

Also included in this basin are the Chicago River and those parts of the Grand Calumet and Little Calumet Rivers which are tributary to the Chicago Sanitary and Ship Canal. These streams and the Chicago Sanitary District are topographically located in the Great Lakes Drainage Basin but actually discharge to the Mississippi through the Des Plaines-Illinois system.

The basin generally is rich in its water resources except in some areas where the ground water table has receded. The increasing shortage of ground water in some of these areas has highlighted the significance of pollution in surface waters which, in these cases, must frequently be used to augment dwindling ground water supplies. Damages to the water resources have been serious in some areas; however, the water resources still afford excellent opportunities for development.

The principal water uses in the Upper Mississippi Basin are municipal and industrial water supply, recreation, commercial fishing, stockwatering, and navigation. While the predominant type of pollution may vary from one area to another, yet in general probably the most significant sources of pollution in this basin stem from municipalities. From a pollutional standpoint, no one area can be singled out as that being the most critical, for the pollution problems are scattered and their effects are more or less localized. The basin contains numerous interstate problems, some of the streams affected being the Red River of the North, St. Croix, Mississippi, and Rock Rivers. The problems of the Red River of the North are also international in scope and as such have been brought to the attention of the International Joint Commission.

The extent and seriousness of silt pollution throughout most of the basin still remain to be determined. Future investigations should evaluate the significance of silt in the entire drainage basin.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table 1, since additional field investigations will undoubtedly produce additional information which will necessitate altering these tables.

There are 1,432 sewered municipalities in the basin serving about 10,400,000 people. Of this number 1,010 municipalities have treatment facilities which serve approximately 8,390,000 people.

Six hundred and seventy-nine known industrial sources of pollution are located in the basin, 345 of which produce organic wastes. Wastes from 94 of the industries on which the population equivalent has been determined were found to have a total population equivalent of 2,260,000. Of the municipal sources of pollution considered in this report 376 had 1940 populations of 2,500 or more, 376 had populations between 1,000 and 2,500, 335 had populations between 500 and 1,000, and 345 had populations less than 500. For many communities the exact number of persons served by sewers is unknown and in a number of cases the discharge to streams has not caused any serious problems. Similarly, a large number of the listed industries have relatively small pollution loads.

Table E shows that many sewage treatment plants do not have adequate capacity. Furthermore, tables D and E show that 214 out of 679 industrial establishments have provided waste treatment facilities although many such treatment works need additional capacity. One hundred and ninety-eight municipal and 31 industrial waste treatment plants produce unsatisfactory effluents due to poor operation. Of the 495 municipalities not included with those reported as having satisfactory treatment, 116 had 1940 populations of 2,500 or over, 131 had populations between 1,000 and 2,500, 124 had populations between 500 and 1,000, and 124 had populations under 500.

Table F indicates progress in pollution abatement achieved in the Upper Mississippi River Drainage Basin measured in terms of

construction of waste treatment plants. During the period 1946 to 1949 inclusive, the various State agencies made considerable progress despite the difficulties encountered in construction and financing and 83 municipal and 47 industrial waste treatment plants were completed. The municipal plants were designed to serve a population of about 2,980,000, while the industrial waste treatment works were designed to treat wastes with a population equivalent of about 857,000.

Water pollution control laws in many of the States in the basin have been strengthened in recent years, and State funds allotted for water pollution abatement activities have in general been increased.

The State water pollution control agencies in this basin have been very active for many years and deserve credit for the progress made. It is evident, however, as shown in table G, that there is a backlog of needed work if existing pollution is to be abated. Three hundred and twenty-nine municipalities and 143 industries require new waste treatment facilities. The existing waste treatment works for 225 municipalities and 46 industrial establishments require enlargement or additions, while 151 municipal and 27 industrial waste treatment plants are obsolete and must be replaced. At this time 579 municipal and 126 industrial sources of pollution require no project for pollution abatement.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500.....	83	36	41	43
500 to 1,000...	95	49	36	28
1,000 to 2,500...	84	58	55	18
Over 2,500...	67	82	19	25
Total.....	329	225	151	114

Another measure of pollution abatement activity within the basin is reflected in table H, which is current to July 1, 1950. The table reveals that 34 municipal and 16 industrial waste treatment works were under construction as of that date. Thirty-seven municipal plants had construction awaiting financing, while 117 municipal and six industrial waste treatment works were in the "final plans approved" stage. Plans were under preparation for 106 municipal and 33 industrial waste treatment works projects and State water pollution control authorities had issued abatement orders to 30 municipalities and ten industries. The number of abatement orders issued, however, does not reflect a fully accurate picture of State activities, since it is the policy of some States to avoid formal orders in favor of an informal approach to the problem.

It has been extremely difficult to estimate the cost of needed waste treatment facilities. On the basis of the data available, it is estimated that the necessary municipal waste treatment facilities will cost about $80,000,000, while the cost of needed industrial waste treatment facilities is expected to equal or exceed this amount. These figures are rough estimates and do not include appraisals for any of the 114 municipalities and 337 industries whose needs were undetermined at the time this report was written. It must be understood that the estimated costs were based on needed treatment works alone and do not include estimates for interceptors, appurtenances and other necessary construction. This unknown cost when added to that for the undetermined group will result in a considerable higher overall cost for required construction.

Recognizing that these expenditures will take place over a number of years, the estimated costs will be increased due to added factors. These include additional annual obsolescence and rehabilitation requirements, needs of communities installing new sewer systems, and normal population increases and industrial expansion.

The effectiveness of water pollution control legislation in the States of the basin varies widely. Some States have good workable laws and it is not anticipated that they will require additional enforcement legislation in the near future. However, other States are in need of effective comprehensive legislation. While progress in pollution abatement has been made in these States, adequate comprehensive legislation is essential if pollution abatement is to be accomplished within a reasonable period of time.

Tables A, B, D, G, and H show a large number of undetermined items. While this is an indication of the work yet to be done it should be appreciated that detailed studies of stream loadings, etc. are not always essential to the operation of a pollution abatement program. The staffs of the water pollution control agencies have been small forcing the agencies to concentrate on the more pressing problems. There is a need to expand the activities of these agencies, however, if the programs are to keep pace with public demand. This will require increased budgets which will permit an expansion of technical staffs. All State agencies within the basin now

have excellent experienced cadres on which to build.

Financing of the needed pollution abatement facilities generally is a serious problem within the basin because of high construction costs. Municipal officials, often aware of the pollution caused by their community and expressing a desire to correct this, generally are hesitant to proceed with the financing of the needed construction because of the high cost involved. In spite of this, however, experience has shown that municipalities with the exception of very small towns have been successful in completing projects with reasonable service charges or tax levies.

In recent years, public interest in water pollution abatement has been increasing, yet there is still an urgent need for additional public support for State pollution abatement programs. It is believed that support obtained by acquainting the citizen with the need for pollution abatement, what is being done, and what can be done by the State water pollution control agency will result in the ultimate solution of many of the present problems, such as financing

The fact that public opinion can be a dynamic force is illustrated by the public support for improved pollution abatement laws, which has been in evidence in recent years. That the pressure is also being felt at the local level is indicated by the relatively large amount of activity in planning of pollution abatement facilities by municipalities and industries. While it is appreciated that "blueprints will not treat sewage" the interest is nevertheless encouraging, since it indicates a change in public thinking which now evaluates streams as natural resources rather than as public sewers.

CONCLUSIONS

From a review of the data it is concluded that:

1. The waters of the basin are widely used for public and industrial water supplies, agriculture, recreation, transportation, and commercial fishing. These waters are of great value to the area and have been responsible to a great extent for its economic growth. While they are abundant these resources are not unlimited and must be conserved.

2. Pollution exists in certain localized areas and in these areas varying degrees of damage have occurred.

3. Although silt pollution has not been completely evaluated as a problem in the basin, it is known to be important in certain critical areas.

4. Pollution problems, particularly in the more critical areas, often are interstate in nature and one is even international in extent. Cooperation rendered by the various governmental agencies concerned with these problems has been excellent.

5. New waste treatment facilities are required for a large number of both municipal and industrial sources of pollution. In addition, many existing waste treatment facilities are in need of replacement, additions, or alterations.

6. Operation of existing waste treatment plants is generally good, but in some cases the plants are not being utilized in the best manner to accomplish the objective for which they were designed and constructed.

7. State legislation on water pollution control varies throughout the basin, a few States do not have adequate water pollution control laws. These States need effective comprehensive legislation, supplementing or replacing present statutes.

8. The States in this basin have had active water pollution control programs for many years and have accomplished a great deal with very small staffs. In recent years the work loads have increased greatly but the staffs have not been expanded to meet this increased load. If pollution abatement programs are to be accelerated, budgets will need to be increased to permit expansion of these staffs. State Civil Service regulations setting up unrealistic maximum salary limits have also prevented some State agencies from attracting additional experienced personnel.

9. Financing of still needed pollution abatement facilities for many smaller towns and municipalities is a serious problem, and it appears that legislation to improve the ability of these to finance needed facilities is desirable.

10. A broad information and education program is urgently needed to advise the people of the essentiality of pollution prevention and abatement and the benefits to be derived from such action.

RECOMMENDATIONS

It is recommended:

1. That all municipalities and industries not now providing adequate treatment provide sufficient treatment of their wastes to prevent damage to any legitimate water use.

2. That all sewage and industrial waste treatment plants be operated and maintained so as to obtain required efficiency.

3. That State water pollution control legislation be revised and supplemented where indicated.

4. That surveys and studies by the State water pollution control agencies be continued in order to obtain complete data on important pollution sources regarding:

   a. The location of significant sources of pollution and the wastes discharged by them to the streams.
   b. The extent to which the legitimate water uses have been damaged.
   c. The pollution control facilities required to obtain the quality of water necessary for the legitimate water uses.

5. That programs of the State water pollution control agencies include expansion of existing information and education programs in order to stimulate public support for pollution abatement activities.

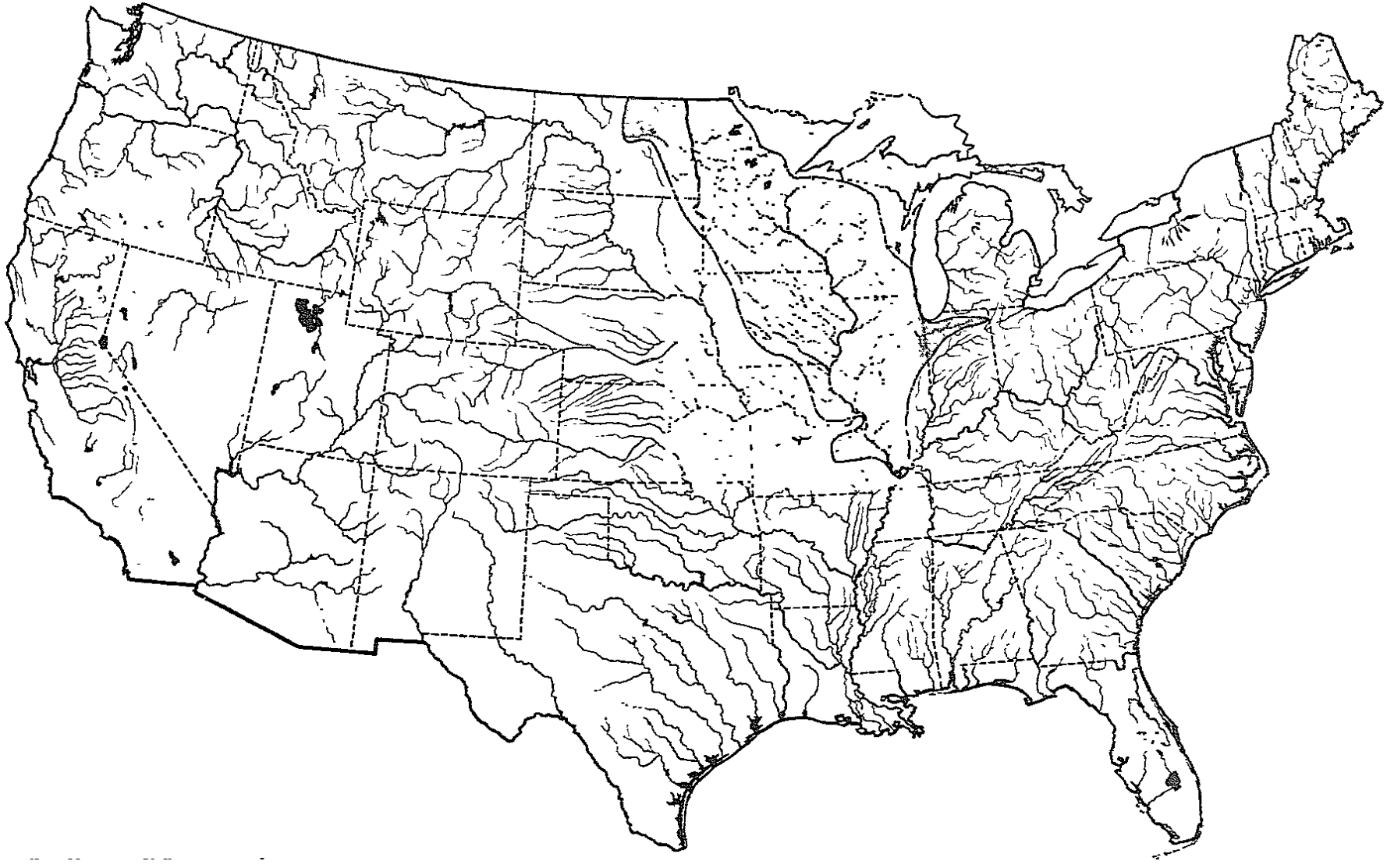
6. That in the development of comprehensive programs the significance of silt pollution be fully evaluated.

7. That the State governments within the basin actively support the State water pollution abatement programs by providing sufficient funds to permit the official agency to acquire the staff and equipment necessary. Where regulations on salary limitations interfere with the employment of experienced personnel, modification of such regulations should be sought.

8. That State legislation be sought to improve the ability of municipalities to finance needed facilities. Specific recommendations on this matter require further study in view of the various constitutions, existing legislation, and policies of the States within the basin.

LOCATION MAP

Upper Mississippi Drainage Basin



GENERAL DESCRIPTION

Historical Background

It is generally conceded that Joliet and Marquette were the first men from the Old World to penetrate the Upper Mississippi country.

According to records, Jean Tolon, a French official in Canada, returned to France in 1670 with plans for exploration of the interior country. For the exploration of the Mississippi he chose Louis Joliet and Jacques Marquette, a Jesuit missionary then stationed at the Mission of St. Ignace on Lake Michigan. On May 17, 1673, the party set out from what is now St. Ignace, Mich., paddled across Lake Michigan into Green Bay and up the Fox River, crossed the portage and started down the Wisconsin River. On June 17, 1763, after their first glimpse of the Mississippi, they turned downstream and paddled for a thousand miles southward. At the mouth of the Arkansas River they turned back not wishing to risk an encounter with the Spanish in the lower reaches of the river.

On the upstream voyage they left the Mississippi and paddled up the Illinois and the Des Plaines to a point near the present Chicago suburb of Riverside. Here they portaged to the Chicago River which carried them to Lake Michigan which they followed northward to Green Bay.

In 1766 Jonathan Carver was engaged by Major Robert Rogers, commander of the post at Michilimackinac, (present site of Mackinac City, Mich.,) to accompany an expedition to the west and to make maps of the area. In the fall of 1766 he mapped the Mississippi as far north as the falls of St. Anthony near Minneapolis, Minn., and then spent the winter in the area awaiting further orders. Failure of Major Rogers to obtain approval of his exploration and mapping project resulted in his inability to furnish supplies and the project was abandoned.

Following the purchase of the Louisiana Territory in 1803, President Jefferson ordered Lewis and Clark to find the headwaters of the Missouri River and to seek streams, beyond the Continental Divide, which would lead to the Pacific. As part of the general program of exploration, Lt. Z. M. Pike was authorized to lead an expedition to the headwaters of the Mississippi. In January 1806 Pike pushed to Leech Lake on his mission. Although this was more than 100 miles from the actual headwaters, he abandoned the search and returned to St. Louis, arriving there in April 1806.

The headwaters were not discovered until July 13, 1832, when H. R. Schoolcraft on a mission of discovery and peacemaking between the Chippewas and the Sioux Indians, came upon a headwater lake and named it Itasca Lake. (Technically the headwaters are a few miles beyond in Lake Hernando de Soto.)

When Lt. Pike visited the Upper Mississippi, he recognized the potential influence which the area now known as the Minneapolis-St. Paul metropolitan area would exert over trade and communication. It was this foresight that prompted the acquisition of the site of Ft. Snelling from the Indians. However, the area was still isolated when Ft. Snelling was established in 1819.

Although there was a flood of commerce on the lower Mississippi, in the 1820's, there was very little on the upper Mississippi above the mouth of the Ohio. In May 1823 the stern wheeler "Virginia" made the first trip up the Mississippi to the head of navigation at Ft. Snelling. By 1832 steam boats were arriving with regularity and the area began to be settled rapidly.

In 1811 the Earl of Selkirk acquired a vast tract of land south and west of Lake Winnipeg and established a colony of poverty-stricken peasants from Scotland in the Red River of the North area. Some of the colonists were disappointed in this cold and difficult land and moved to the Mississippi valley but those who stayed found a livelihood hunting the wild game in which this remote country abounded.

Ft. Snelling became the trading post for the peoples of the Red River valley, since it was easier to travel to this point than to Hudson Bay. For three decades the Red River trail to Ft. Snelling and the Red River ox cart caravans were famous in the north country.

St. Louis was established as a trading post by Laclede Liguest in 1764. The founder named the new town after his king, Louis XV of France, unaware that the territory had been transferred to Spain two years previously. In 1800, Spain retroceded the area to France and in 1803 it was sold to the United States.

The years following the Louisiana Purchase saw a veritable flood of immigration into the Mississippi and Missouri valleys, and St. Louis grew as the result of its favorable location at the junction of the two waterways. Because of the relative difficulty of navigation on the upper Mississippi at this time St. Louis was considered by many as the head of navigation. However, this was soon changed due

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to the large volume of trade to the north and the boldness of the river pilots.

The economic history of this basin has been well recorded. For example, volumes have been written about the growth and development of river navigation, lead mining and the lumber industry.

Physical Description

The Mississippi River rises in a high, densely timbered country in Minnesota. The headwaters of this great stream are near the headwaters of two other great drainage basins--the Great Lakes (St Lawrence) and Hudson Bay. The area of the Upper Mississippi River basin is 225,000 square miles.

Lake Itasca, which is commonly considered as the headwaters of the Mississippi, is 1,461 feet above sea level. The course of the river for the first 60 miles is northward toward Hudson Bay and due to its winding path the river flows over one-fourth of its entire length before it leaves the State of its origin --Minnesota. The total distance from Lake Itasca to the mouth of the Ohio River is approximately 1,400 miles.

Above Minneapolis-St. Paul the river is flanked by forests and the area has gained recognition as a vacation land. From St. Paul to the Ohio River, however, it drains a different country--a fertile prairie busy and populous with large and small cities spaced along the bluffs.

During the glacial period Lake Agassiz was formed covering the area now known as the Red River valley. This lake was a part of the Mississippi system since it drained through the Minnesota River to the Mississippi. As the ice receded the lake found an outlet to the north and became part of the Hudson Bay drainage system.

Owing to its midcontinental location the upper Mississippi River basin has a continental type of climate. In the north near its headwaters there are wide variations in temperature, scanty winter rainfall, normally imple summer rainfall and a general tendency o extremes in all climatic features. In the outhern part of the basin the extremes of eat and cold, draught and moisture are not so pronounced as in the more northerly areas.

The average January temperature near the headwaters and the Red River valley is about 4°F. whereas the average July temperature is about 67°F. The corresponding temperatures near the mouth of the Ohio River are 36°F. in January and 80°F. in July.

The average annual precipitation varies from approximately 26 inches at the headwaters of the Mississippi to 45 inches near the mouth of the Ohio. Forty-five percent to 55 percent of the annual rainfall occurs during the growing season which varies from 100 days at the headwaters to 210 days at Cairo, Ill. Snowfall, which is heavy at the headwaters in Minnesota, is very light at Cairo. The precipitation in the Red River valley varies from 20 inches to 22 inches with approximately 16 inches being received during the warm season. The growing season is from 110 days to 120 days.

The topography of the area is typical of a glaciated country; over most of the area gently rolling hills interspersed with many lakes and marshes are found. In the vicinity of the headwaters in Minnesota and in northern Wisconsin the area has a forest covering. In the Iowa-Illinois section of the basin the land originally was covered with grass except for occasional patches of wood.

The soils of the Upper Mississippi River basin are derived from glacial drift and are mixtures of clay, sand, gravel and loams. The soils vary in fertility, the best from an agricultural standpoint being generally in the Iowa-Illinois section.

Erosion and the result--high stream turbidity, are serious in several areas, particularly those areas where a large percentage of the land is used for field crops. The seriousness of this has been considered by many conservation authorities and an example of the damage which can occur to a stream use is considered under damages to water resources.

The surface soils of the Red River valley are of alluvial origin. The tributaries of Lake Agassiz carried considerable silt. The deposition of the finer particles over the lake bottom formed the excellent agricultural land that is found in the valley today.

A wide variety of minerals is found in the Mississippi River basin. A few of the more important are iron ore, coal, lead, granite, limestone, and fire clay.

Lakes, of more or less importance, abound in the northern part of the basin in the States of Minnesota and Wisconsin. Many of these serve as natural reservoirs for water storage and exercise a beneficial effect on stream flow below.

The streams of the basin depend in varying degrees on ground water, lake storage and run-off for their total flow. For this reason, any "average" for the basin would be misleading. While the major streams have some flow during the entire year, the smaller tributaries become dry in late summer and early fall, particularly in dry years.

Flood damage is a problem in certain sections of the main stem as well as on many of the tributaries. While the reasons for these conditions are as numerous and varied as the problems, two general factors stand out as significant; first, the fertility of the flood plain and the value of river commerce has caused municipalities and farms to be established in the normal flood plain; and,

second, the high state of development of agriculture has increased the rate of runoff

A study of the flow records of the Mississippi itself reveals that the average at St. Paul from 1892 to 1947 was about 9,400 cubic feet per second, which increased to 166,700 c.f.s. at St. Louis immediately below its confluence with the Missouri River During the period 1933-1947 the maximum flow recorded at St Louis was 844,000 c.f.s., measured in April 1944, and the minimum flow of 27,600 c.f.s. was recorded in December 1937.

Ground water is generally highly mineralized over much of the basin although there are notable exceptions to this general statement. The ground water is often high in calcium and fluorine and in some areas this has resulted in a trend to the use of surface waters as a public and industrial source of water. The high rate of use of ground water particularly in highly industrialized areas has caused the ground water table to decline forcing users to consider the use of surface waters as a source of supply.

Economic Development

The total population of the Upper Mississippi River basin was approximately 16,500,000 in 1950. About half of this total was concentrated in the large cities, six of which are over 100,000 and 45 in the range 25,000 to 100,000. These cities are fairly well scattered over the area. An idea of the general population density can be obtained by the following:

Sub-basin number	Sub-basin name	Approximate density in persons per square mile
1	Red River of the North....	14
2	Rainy River.....	7
3	Mississippi River and Tributaries--Headwaters to St. Paul.....	53
4	Mississippi River and Tributaries--St. Paul to Below Wisconsin River...	35
5	Mississippi River and Tributaries--Wisconsin River to Below Rock River.....	70
6	Mississippi River and Tributaries--Rock River to Illinois River.....	49
7	Illinois River and Tributaries.....	74
8	Chicago Area-Illinois River Drainage.....	2,420
9	Metropolitan St. Louis-Meramec River.....	245
10	Mississippi River and Tributaries--Meramec River to Ohio River.....	59

Agriculture undoubtedly dominates the economy of the basin, which, however, is well balanced with industry such as the development and processing of the natural resources, recreation, manufacturing, transportation, etc.

In the areas drained by the Red, Minnesota, Root, Wapsipinicon, Cedar, Iowa, Des Moines, Rock, Illinois, and Kaskaskia, the economic background is predominantly agricultural although the products vary widely. Wheat, corn, miscellaneous small grains, sugar beets, forage, fruit and vegetables are the principal crops. Dairying, livestock and poultry raising are important in the areas where the soil is less fertile.

The accompanying industries such as milling, brewing, canning, sugar beet refining, milk products processing, and meat packing are found in both the rural areas and in the urban centers.

Summer homes, cottages, resorts, clubs and camps, furnish the basis for a highly profitable industry in several localities especially in the northern country. In these areas the abundance of rivers, lakes, forests and game is the framework upon which the recreational industry has been built. In many cases the recreational industry has been the economic salvation of agriculturally sub-marginal land areas.

In the larger metropolitan areas the industries are highly diversified and not entirely dependent upon the resources of the region. These municipalities are important transportation centers which have played an important role in the development of the area. The need to transport the resources and products of the basin to markets has resulted in an extensive network of water routes, railroads, air lines, and highways.

In the southern part of the basin rich deposits of coal are found. The Kaskaskia and Big Muddy basins are in the heart of the eastern interior coal fields and contain rich veins. Approximately seven percent of the total United States bituminous production is obtained from this highly developed mining industry.

While coal is one of the most important resources found in the basin there are many others of economic significance. Some of

these resources are iron ore, granite, limestone, fire clay, shale, oil and natural gas.

Lumber production, which at one time was a major industry in the northern part of the basin, has declined appreciably due to the destruction of many of the forests. Pulp and paper manufacture in Wisconsin and Minnesota continues, however, as an important industry.

Except for certain localized areas the per capita income for the basin is slightly above the national average. According to a reliable source, the 1949 net effect buying income of families was above the national average in all basin States except Indiana, Minnesota, and Missouri.

In general, it can be said that the economic level of the area is adequate to support the needed abatement facilities. It is true, of course, that there are deviations from the average and in some cases financial assistance may be required if the facilities are to be provided. It is interesting to note, however, that the monetary value of the 1949 retail sales per family in every State but one in this basin was above the national average, indicating that the majority of the people have adequate incomes and spend their money but need to be educated to the fact that stream pollution abatement is essential to the maintenance of their high standard of living and therefore is deserving of a part of their expenditures.

USES OF WATER RESOURCES

Surface waters in the basin are in many cases used as sources of municipal water supplies. Large cities such as St. Paul, Minneapolis, Rock Island, Davenport, Quincy, St. Louis, and Cairo on the Mississippi, and Decatur and Springfield on the Sangamon all obtain their public water supplies from surface sources. Other large cities like Des Moines have relied on ground water to provide their needs. However, during the prolonged and severe draught of the thirties, some of these latter communities were faced with a serious water shortage. Many of them have already turned to surface supplies to augment or replace existing ground water supplies and probably more will do so in the future. This trend emphasizes the need for reasonably clean, safe sources of surface water for such communities.

Industrial use of surface water is common in the basin. As in the case of municipalities, some industries, because of receding ground water tables, may be forced to turn to surface supplies to augment dwindling well supplies. Cooling, process water and fire protection are some of the uses which industry has for surface waters.

Irrigation is practiced to a very limited extent in a few areas of the basin. The most important venture of this kind exists in the Red River of the North drainage area where 4,370 acres are irrigated with river water.

One of the most important uses of the water resources of the basin is navigation. Fleets of barges often carrying several trainloads of freight make their way on the Mississippi River as far north as Minneapolis. Other fleets ply their way on the Illinois River system from Grafton to Chicago, where they enter the Great Lakes. In 1946, 1,200 towboats and 4,800 barges passed Hamburg, Ill., on the Mississippi River. River traffic on the Illinois River has risen steadily during the period 1936-49. In 1949 the total tonnage moved approximated 12,900,000 tons. The principal commodities carried on the Illinois waterway are coal, sand, stone, cement, petroleum products, grain, sulphur, iron, and steel.

Recreational use of the water resources is well developed in this basin. Out-of-state tourist business is the second largest industry in Minnesota, while in Wisconsin it is a 300 million-dollar-a-year business and ranks as the fourth largest industry in terms of dollars. While excellent bathing and boating waters abound in the northern part of the basin, yet the waters of the south and mid-sections of the basin probably are more widely used for these activities. This is due to the northern waters being utilized largely during vacation periods, while the southern waters, being much closer to large population concentrations, are used on weekends and holidays during a large part of the year.

POLLUTION CONTRIBUTED TO WATER RESOURCES

The known sources of pollution discharged to the water resources are shown in tables A and B. All municipalities, as defined in the footnote to table A, having sewer systems, have been shown as sources of pollution whether treatment has been provided or not. Existing waste treatment works are indicated in tables C and D, while adequacy of such works is shown in table E.

Table A indicates that there are 1,432 municipal sewer systems serving 10,400,000 people. The pollution load discharged to the watercourse has not been established for 658 of the 1,432 municipalities.

Of the 658 municipalities where the pollution load discharged to watercourses has not been established, 138 had 1940 populations of 2,500 or over, 147 had populations between 1,000 and 2,500, 183 had populations between 500 and 1,000, and 190 had populations under 500. Similarly, a large number of the listed industries (see below) had relatively small pollution loads.

Table B discloses that there are 679 industries which are not connected to municipal sewers but which have separate outlets. The table shows that of 345 industries producing organic wastes the population equivalent has been determined for 94 and has been found to be 2,260,340. Eleven of these 94 industries also produce inorganic wastes.

The pollution load discharged within the Upper Mississippi River Drainage Basin results in a number of individual and local pollution problems. While many of these problems cause particularly serious local pollution, yet, considering the basin as a whole, no single pollution problem stands out by itself as being the most critical. Many of the streams in the Chicago area, such as the Chicago, Des Plaines, and Little Calumet Rivers, receive considerable pollution. The Illinois River receives localized pollution at various points along its length. Industrial wastes have brought serious pollutional conditions into the Chippewa River Basin as well as the Wisconsin River Basin.

Interstate pollution problems exist at several points on the Upper Mississippi River, the Red River of the North, and the St. Croix River. While other interstate pollutional problems exist, these probably are the most significant. Pollution problems of an international character are found on the Red River of the North and have been given consideration by the International Joint Commission.

Inorganic wastes are produced by 327 industries. Such wastes include mine drainage, oil, brine, acids, and other inorganic substances deleterious to aquatic stream life. While they do not have an oxygen demand and cannot be compared to other wastes which do exert such a demand, nevertheless inorganic wastes cause serious stream damage in numerous areas in the basin.

Table A. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	774	8,654,999	5,261,144
Having population data available (Data on pollution load to watercourse incomplete or not available)	658	1,766,206	Not applicable
Total	1,432	10,421,205	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	94**	2,260,340
Producing organic wastes	251	Undetermined
Producing inorganic wastes	327	Not applicable
Producing waates of undetermined type	18	Undetermined
Total	679***	--

*Industries having separate outlets and discharging wastes directly to watercourse.

**Includes 11 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Many of the damages to water resources resulting from pollution cannot be accurately measured. The effects of some of these damages often can be indicated only in an indirect way. For example, what value should be assigned to a human life lost because of an epidemic caused by a polluted water supply? Similarly, damages to aesthetic and intangible assets can be discussed but cannot be truly evaluated.

On the other hand, certain damages have been determined only in a general way since accurate estimates cannot be made. It has been impossible to obtain any single figure which would indicate, on a monetary basis, the overall economic damage suffered for the entire basin. This report, therefore, will submit a few of the more widely recognized examples of pollution damage which exist in the basin.

The Mississippi River from St. Paul to LaCrosse has in the past been very seriously polluted. At one time property damage in the area affected was estimated at $4,000,000, while sport and commercial fishing damage was estimated to be $110,000 annually. In spite of the fact that numerous corrective works to treat wastes have been built and the stream is greatly improved, considerable pollutional material is still being discharged into the Mississippi River and its tributaries in this area.

Commercial fishing and the button manufacturing industry (dependent upon fresh water mussel shells) were once important enterprises on the Upper Mississippi River. However, due to the detrimental effects of pollution on fish and mussels, these industries experienced a decline in the late twenties. At present pollution abatement has enabled the river to recover to such an extent that the commercial fish catch is 80 percent of the peak of 25 years ago. The commercial fish catch in Lake Pepin was nearly 3,600,000 pounds in 1922, but five years later the catch fell to only 900,000 pounds. The catch has increased greatly since then, and in 1948 almost 3,000,000 pounds were taken.

For many years the Red River of the North has had its own special and peculiar pollution problem. Low flows in the stream have aggrated pollution conditions in spite of municipal waste treatment, where it has been provided. As a result the stream, which is the source of numerous municipal and industrial water supplies, has become seriously polluted, fish and other aquatic life have been killed, and livestock have been reported lost. Large industrial waste concentrations have added to the problem in certain areas and some concern has been expressed as to the suitability of the water for irrigation purposes. Boating and bathing, as well as other recreational water uses, have also been damaged.

One city on the Red River of the North has been the defendant in two damage suits to the extent of $18,000 each, brought by downstream farmers and property owners who alleged to have been damaged by the municipality's wastes. In another case, one city in an effort to obtain a satisfactory and pollution-free source of water has expended over $50,000 in a search for a ground water supply.

The lower Minnesota River from Mankato to its mouth receives considerable untreated municipal sewage in addition to cannery and sugar refinery wastes. Game fishing, stockwatering, bathing, and wildlife water uses all have been harmed in this area.

The Des Moines River at Ottumwa receives meat packing plant wastes having an oxygen requirement comparable to that of the raw wastes from about 350,000 people. Untreated municipal sewage also enters the stream here and adds another 35,000 to the population equivalent of the wastes received by the stream. Resulting nuisance conditions with accompanying foul offensive odors have interfered with the usefulness of the stream in this area for recreation, wildlife, and stockwatering.

The St. Croix River Sub-Basin has been noted as a recreational area for many years. Raw and partially treated municipal sewage and some industrial wastes have harmed four of the 12 bathing beaches on the river as well as other recreational water uses. High concentrations of coliform organisms have been found in the river at the St. Croix River Boy Scout Camp. This undoubtedly is due to pollution discharged into the St. Croix River from the Apple River. Virtual absence of current below Stillwater has permitted settling of putrescible organic solids. Masses of partially decomposed sludge are reported to rise occasionally to the water surface of the St. Croix in the area between Stillwater and Bayport. Game fishing has been damaged here and even dead carp have been found.

Industrial and municipal wastes discharged to the Flambeau and Chippewa Rivers have a population equivalent of nearly 400,000, most of which comes from the Eau Claire locality. These wastes have caused fish kills, oil coverage of the stream surface, tastes and odors in fish, and damage to bathing waters.

Deposition of silt in Lake Decatur has caused

serious economic loss to the City of Decatur, Ill., by decreasing the capacity of the water storage reservoir by about 26 percent in slightly over 24 years. It has been estimated that this represented a loss of over $47,000 annually. If the damage is permitted to continue to a point where 80 percent of the lake is filled, it is estimated that the resulting damage will be over $4,000,000 for property values of sites adjacent to the lake and $40,000 annually from loss of recreational facilities

The examples given are but a few of the cases of water resource damage by pollution which have occurred in the basin. By depriving the citizen of his right to the legitimate use of the stream, pollution has exacted a multifold price. This price will increase until corrective works permit the rightful use of the stream.

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From the foregoing, we can see some of the ways in which the streams of the Upper Mississippi River Basin are damaged. It is obvious, of course, that damages avoided as the result of pollution prevention can be considered as benefits of the stream improvement program.

There is probably no one benefit of stream pollution abatement which is outstanding since there is such a variety of water uses in the basin. Of course, the use of the streams as sources of public water supplies has a high priority. While there is not an extensive utilization of the surface waters of the Upper Mississippi Basin proper for this use due to the abundance of ground water in most areas, it nevertheless is vital because of the need of the larger, and key, cities to use the streams for this purpose. There is also indication in certain areas that additional communities may need to turn to surface sources in future years. In the Red River of the North Sub-Basin this is a primary water use, and the pollution of this source of supply has been a matter of serious concern to Federal, State, and municipal officials.

The benefits of pollution prevention and abatement to agriculture through improved livestock watering sources may be underestimated unless one takes into consideration the value of meat and dairy production to the region. It is true that livestock can be watered by utilization of the ground water over most of the area, but the advantages of surface water are apparent when one considers the cost of obtaining ground water in contrast to the utilization of readily available surface waters.

The recreation industry of the basin is dependent on water that is satisfactory for bathing, boating and fish and wildlife propagation. The impairment of this resource would soon lead to the elimination of this important industry as an economic factor. Further, the value of water front property would be greatly enhanced through the prevention or abatement of pollution.

At one time commercial fisheries were quite prominent on the Mississippi and some of its major tributaries. Pollution of the waterways reduced this industry to a fraction of its former size although in recent years recovery has been noted. It is reported that downstream conditions have improved materially since the installation of sewage treatment by Minneapolis-St. Paul, and it is envisioned that similar improvement will be noted in other areas as existing pollution is abated.

Many of the benefits which would accrue as the result of pollution abatement are intangible. Protection of public health is one of these intangible benefits. This protection is obtained through the improvement of waters used as a source of municipal water supply as mentioned above and elimination of nuisances which interfere with the healthful recreational uses of the stream.

The Upper Mississippi River Drainage Basin has about 10,400,000 persons, located in 1,432 communities, who are served by municipal sewerage systems. Eighty-one percent of the sewered population is provided with treatment works, however, one fourth of the population whose wastes are treated is served by plants which have inadequate capacity.

The basin has 985 municipal sewage treatment plants, which are divided into 310 primary treatment plants serving 1,757,000 people and 675 secondary treatment plants serving 6,634,000 people. About 20 percent of the municipal plants is reported to be unsatisfactorily operated.

The greatest known organic industrial pollution in the basin originates in two of the major type industries, food and kindred products, and paper and allied products. In the first group, 43 percent provides some treatment for its wastes while in the second type, 72 percent provides some degree of waste treatment. Of the 679 industrial establishments in the basin discharging wastes directly to streams, 214 are known to provide some type of treatment. The importance of mine drainage waste in the basin is still largely undetermined, and at present, only 11 of 284 such sources are known to provide waste treatment. There are 94 industrial establishments in the basin which discharge wastes for which the population equivalent has been determined. It is significant to note that five such establishments produce about 73 percent of the organic industrial pollution reaching the waters for which the population equivalent has been determined.

Table F reveals that construction of waste treatment facilities was very slow immediately following World War II but then began to accelerate rapidly. This was due principally to the very difficult construction conditions which followed the war and the delayed effect of the interruption of pollution abatement programs during the war. During 1946 and 1947 only three municipal plants and 16 industrial waste treatment plants were completed but the State agencies were very active during the period. The results of their efforts began to show in 1948 and 1949 when 80 municipal plants, designed to serve 2,975,000 people, and 31 industrial waste treatment plants, designed for wastes with a population equivalent of 4,374,000, were completed. (Battery C of the West-Southwest Plant of the Sanitary District of Chicago, which was completed in 1949, is included here because of its importance even though it is only part of a larger plant.) At the time this report was written it was apparent that much of the inertia had been overcome and that the tangible evidence of the work of the State agencies would become apparent through the construction of treatment facilities at an increasing rate.

Table H indicates that abatement orders were issued for 30 municipalities and ten industries The number of abatement orders issued, however, does not reflect a fully accurate picture of State activities, since it is the policy of some States to avoid formal orders in favor of an informal approach to the problem. Plans were under preparation for 106 municipal and 33 industrial waste treatment plant projects. As of July 1, 1950, plans had been approved for 117 municipal and six industrial waste treatment plant projects, 34 municipal projects had their construction awaiting financing, and 35 municipal and 16 industrial waste treatment plant projects were under construction.

Two formal interstate agencies which are in existence in the basin have authority to act in matters pertaining to pollution. The Tri-State Water Commission [1] (Minnesota, North Dakota, and South Dakota) was formed to coordinate efforts to improve conditions on the Red River of the North. The States have since adopted minimum effluent standards for the Red River of the North and its tributaries. Although the Bi-State Development Agency (Illinois and Missouri) was formed primarily as a planning agency for the Metropolitan St. Louis-East St. Louis area, one of its earliest actions was to sponsor a joint pollution survey of the Mississippi River which was started late in 1950.

The Upper Mississippi Board of Engineers is an informal group of State sanitary engineers of the basin which meets at intervals to consider various problems. This group has developed agreements concerning minimum waste treatment standards and although these standards have no legal basis they have proved effective in promoting uniform corrective action, particularly in inter-state waters. The group has, however, been very influential over a period of years in matters pertaining to waste treatment and stream pollution abatement. In 1948, this board joined with the Great Lakes Board of Engineers to sponsor a

[1] This commission became inactive in 1940; however, its pollution abatement activities have been carried on since 1943 by the Inter-State Sanitation Committee.

study of uniform design standards for sewage treatment works. This activity, which is partially supported by funds under the provisions of Public Law 845 (80th Congress), was expanded to include industrial waste treatment works in 1950.

Analysis of State Water Pollution Control Legislation

The following analysis offers briefly the principal features regarding water pollution control legislation of the various States in the Upper Mississippi River Basin. It is based on previous analyses of State legislation which were reviewed by the various States and used in the preparation of a suggested State water pollution control act which was subsequently endorsed by the Council of State Governments and recommended to the States for favorable consideration

All the basin States except Iowa, North Dakota, and Missouri have established boards or commissions which have general water pollution abatement, prevention and control powers and duties. In Iowa and Missouri, the State Health Department has the responsibility for State water pollution control activities, although in Missouri and North Dakota no specific water pollution control act exists. In North Dakota jurisdiction over water pollution is shared by the Water Conservation Commission, the State Department of Health, local boards of health under the supervision of the State Department, the Industrial Commission, and water conservation districts. Certain authority regarding water pollution has also been vested in the State Department of Health in South Dakota; in the State Board of Health and the Conservation Commission in Wisconsin; and in the Department of Mines and Minerals and Department of Conservation in Illinois.

Minnesota together with South Dakota and North Dakota comprise the Tri-State Water Commission which is a corporate body created for several purposes, among which were the study of pollution of water supplies in the interstate drainage basin area of the member States and recommendation of uniform legislation to the States involved for the control of such pollution. The Commission is authorized to review and approve plans for all waste disposal works on certain specified waters in the interstate drainage basin area. While the Tri-State Water Commission became inactive in 1940, the program has been carried forward by the Inter-State Sanitation Committee, an informal body representing the same three States, which was organized in 1943.

South Dakota and Wisconsin have Water Pollution Committee personnel who are ex-officio members of the State government, while Illinois and Indiana have the mixed type of agency representing various branches of State governments as well as affected interests.

Indiana, Minnesota, and South Dakota have authority to adopt water quality standards. In addition Minnesota has the statutory power to classify waters. The authority to formulate water quality standards in South Dakota consists of placing waters into one of two categories, "Class A" - for public water supply, plant or fish life, and "Class B" - for carriage of wastes, provided such wastes are not detrimental to the public health.

Permits for construction of new sewer systems and treatment works or extensions thereof are issued in Illinois, Iowa, Minnesota, North Dakota, and South Dakota. The State Health Agency issues the permits in Iowa, while the State Water Pollution Control Agency reviews the plans and issues the permits in Illinois and South Dakota. The State Department of Health reviews plans in Minnesota, but the official Water Pollution Control Agency issues permits. In North Dakota, approval by both the Water Conservation Commission and the State Department of Health is required prior to construction. In South Dakota the Committee on Water Pollution issues permits governing discharge of wastes into "Class A" waters only. Although Indiana does not issue permits, plan approval by both the State Board of Health and the Water Pollution Control Board is required. In Wisconsin the Committee on Water Pollution Control has authority to require submission of plans for approval by the State Board of Health.

Rules and regulations relating to water pollution control are issued by the State Water Pollution Control Board or Commission in Illinois, Indiana, Minnesota, South Dakota, and Wisconsin where these boards or commissions are separate entities, but in Iowa, such authority has been granted to the State Health Department which also is recognized as the official State Water Pollution Control Agency. In North Dakota rules and regulations are formulated by the Water Conservation Commission.

In Illinois, Indiana, Iowa, Minnesota, South Dakota and Wisconsin, the Water Pollution Control Agencies have authority to issue orders following hearings. In Wisconsin the Water Pollution Control Agency can act jointly with the State Board of Health and may issue orders without a preliminary hearing; however, any person affected by such order may secure a review upon petition thereof. Such review includes a public hearing. In Minnesota the State Board of Health issues orders in cases where pollution affects water supplies for domestic use. The Water Conservation Commission in North Dakota has authority to hold hearings and issue orders.

Exemptions from the requirements of the State water pollution control legislation appear in Illinois statutes. The Sanitary District of Chicago is specifically exempt from the Illinois Sanitary Water Board Act. Hickory Creek in Illinois is also exempt from the Illinois Sanitary Water Board Act, according to an attorney general's opinion.

In Iowa, the water pollution control act did not apply to the lower 5,000 feet of any stream tributary to any river which forms part of the boundary line of the State until after July 4, 1951.

Table C. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	300	310	1,757,385
Secondary	710	675	6,634,357
No treatment	422	--	2,029,463

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	271	117	134	20
Textile mill products.....	4	0	4	0
Lumber and wood products...	1	1	0	0
Paper and allied products..	32	23	9	0
Chemical and allied products.....	20**	9	9**	2
Products of petroleum and coal.....	14	11	1	2
Rubber products.....	1	1	0	0
Leather and leather products.....	1	1	0	0
Primary metal industries...	9	6	2	1
Fabricated metal products..	10	6	4	0
Miscellaneous.....	31	26	5	0
Mine drainage.....	284	11	29	244
Other mining industries....	2	2	0	0
Totals.....	679	214	196	269

*Industries having separate outlets and discharging wastes directly to watercourse.
**Includes 1 industry also listed under "Food and kindred products."

Table E. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	985	552	384	49	694	198	93
Industrial	214	107	74	33	150	31	33

Table F. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Planta completed	Amount of waste treated (in terms of equivalent number of people)
1946	2	1,000	6	141,950
1947	1	1,500	10	277,552
1948	26*	95,344	14	351,936
1949	54**	2,879,624	17	85,525***

*Includes one community which provided sewers to plant of adjoining community.

**Includes Battery C of West-Southwest plant of Sanitary District of Chicago. This plant serves a population of 2,615,455 (PE 5,845,000).

***In 1949 a population equivalent of 450,000 was still being discharged to the watercourse in the Sanitary District of Chicago. Steps were being taken to eliminate most of this by the end of 1950.

New sewage treatment plants are required for 329 municipalities having a population of nearly 834,000. Enlargements or additions are required for 225 existing municipal waste treatment plants serving 1,520,000 people, and 151 existing obsolete works must be replaced. The requirements for 114 plants serving 1,212,000 people are as yet undetermined.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500....	83	36	41	43
500 to 1,000..	95	49	36	28
1,000 to 2,500..	84	58	55	18
Over 2,500..	67	82	19	25
Total....	329	225	151	114

On the basis of available information the estimated cost of the facilities presently known to be needed by municipalities will be approximately $80,000,000. This estimate was obtained by using reports where available and adjusting the estimated cost of a 1950 base. Where reports were not available rough cost estimates were made based on the method advanced by Professor C. J. Velz in the October 14, 1948, issue of "Engineering News-Record". A cost index of 246 for July 1950 was used and all estimates were based on 1940 population.

Recognizing that these expenditures will take place over a number of years, the estimated costs will be increased due to added factors. These include additional annual obsolescence and rehabilitation requirements, needs of communities installing new sewer systems, normal population increases and industrial expansion as well as allowance for presently undetermined needs.

One hundred and forty-three industrial establishments which now discharge untreated wastes to the watercourses require new waste treatment plants, while 46 additional industries possess waste treatment plants which require enlargement or additions. Twenty-seven treatment plants are obsolete and must be replaced. The treatment requirements for 337 industrial establishments are as yet undetermined and when known will undoubtedly increase the estimate cost of needed waste treatment works.

An additional pollution problem arises from the fact that even though treatment facilities are provided there are 198 municipal and 31 industrial waste treatment plants that produce a poor effluent because of unsatisfactory operation.

The cost of needed industrial waste treatment facilities is estimated to be equal to or greater than the cost of the needed municipal facilities, although it should be recognized that the estimation of industrial cost is very difficult because of the number of unknown factors.

Seven municipalities, which are included among those listed as requiring new municipal waste treatment plants, probably will be connected to nearby municipal sewers. Similarly, at least six industries listed as requiring new waste treatment works probably will discharge their wastes into nearby municipal sewers.

The stream pollution control legislation of many of the States of the basin has been strengthened in recent years, and as a result a good legislative framework for pollution abatement exists in those States. However, adequate comprehensive legislation is essential if pollution abatement is to be accomplished within a reasonable period of time.

It is believed that in addition to the technical activities all State water pollution control agencies need to develop broad information and education programs designed to acquaint the public with the serious need for pollution abatement and what is being done to accomplish this objective. Aggressive action of this nature may be of material assistance in obtaining stronger public support for these programs.

Table G. Requirements for municipal and industrial waste treatment plants*

Requirements**	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	329[1]	833,668	143
Enlargement or additions to existing plant	225[2]	1,519,794	46
Replace existing plant	151[3]	263,180	27
No project[4] required	579	6,592,270	126
Undetermined[5]	114	1,212,293	337

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For individual project needs refer to table I contained in each of the sub-basin discussions which follow Part 1 of this report.

[1]Includes two cases where two municipalities without treatment are to build one plant as a joint project.

[2]Includes one municipality with three plants. wo plants (capacity undetermined) are to be onnected to the third which is to be enlarged.

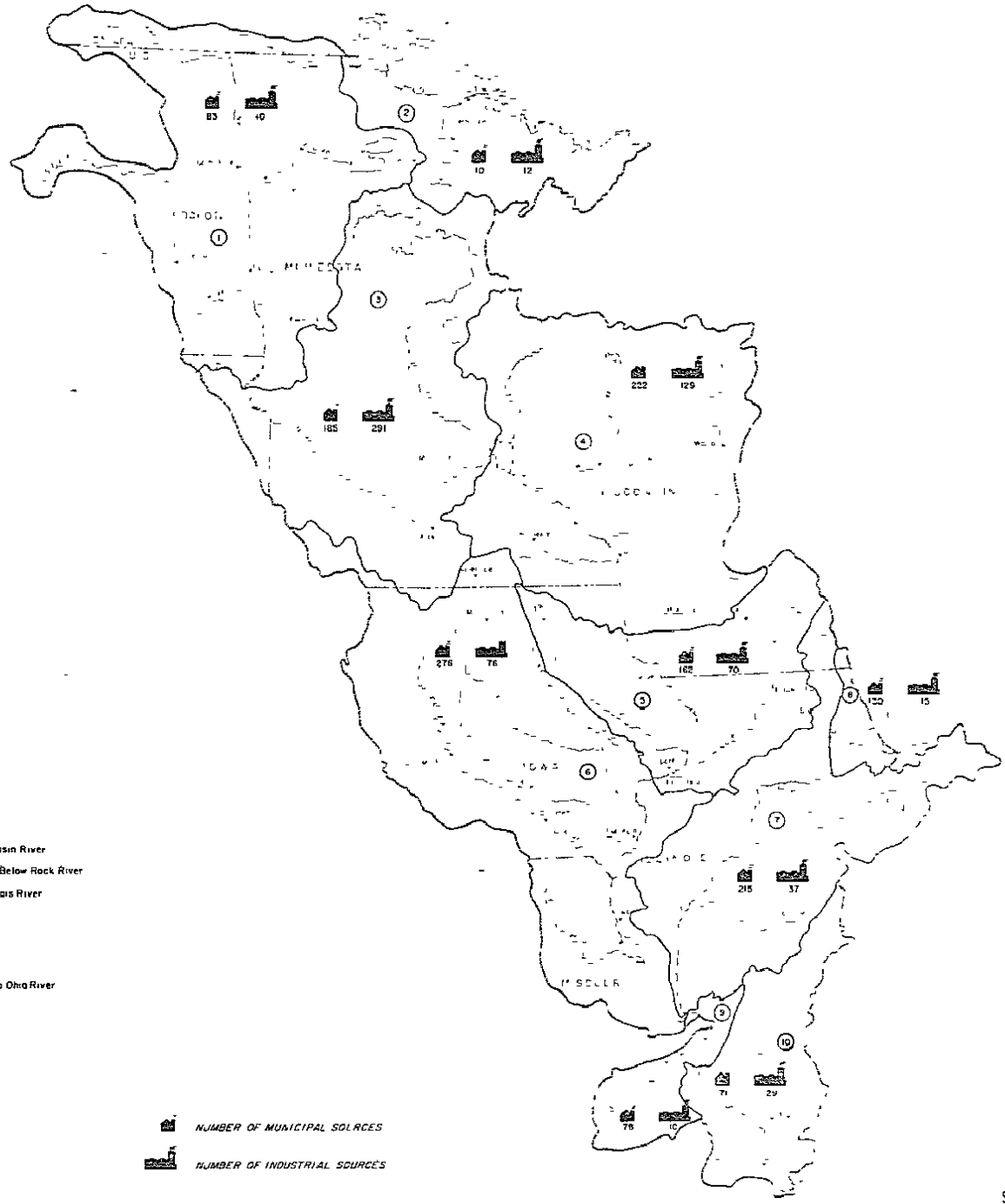
[3]Includes three cases where a municipality has two plants to be replaced by one plant, and one case where a municipality has three plants to be replaced by one plant.

[4]Includes 27 municipal and 19 industrial minor sources of pollution not included in table E for which existing disposal methods are considered satisfactory for present stream conditions.

[5]Includes 64 municipalities and 34 industries which are known not to provide treatment, but stream requirements are undetermined. Also includes three municipalities and one industry which are known to provide treatment, but treatment plant requirements are undetermined although plant capacities are known to be unsatisfactory.

Table H. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	196	72
Abatement ordered	30	10
Plans under preparation	106	33
Final plans approved	117	6
Construction awaiting financing	37	0
Under construction	34	16
Status undetermined	329	426



SUB-BASIN INDEX

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2. Rainy River Basin
3. Mississippi River & Tributaries Basin-Headwaters To St Paul
4. Mississippi River & Tributaries Basin-St Paul To Below Wisconsin River
5. Mississippi River & Tributaries Basin-From Wisconsin River To Below Rock River
6. Mississippi River & Tributaries Basin-From Rock River To Illinois River
7. Illinois River & Tributaries Basin
8. Chicago Area-Illinois River Drainage Basin
9. Metropolitan St Louis-Meramec River Basin
10. Mississippi River & Tributaries Basin-From Meramec River To Ohio River

NUMBER OF MUNICIPAL SOURCES

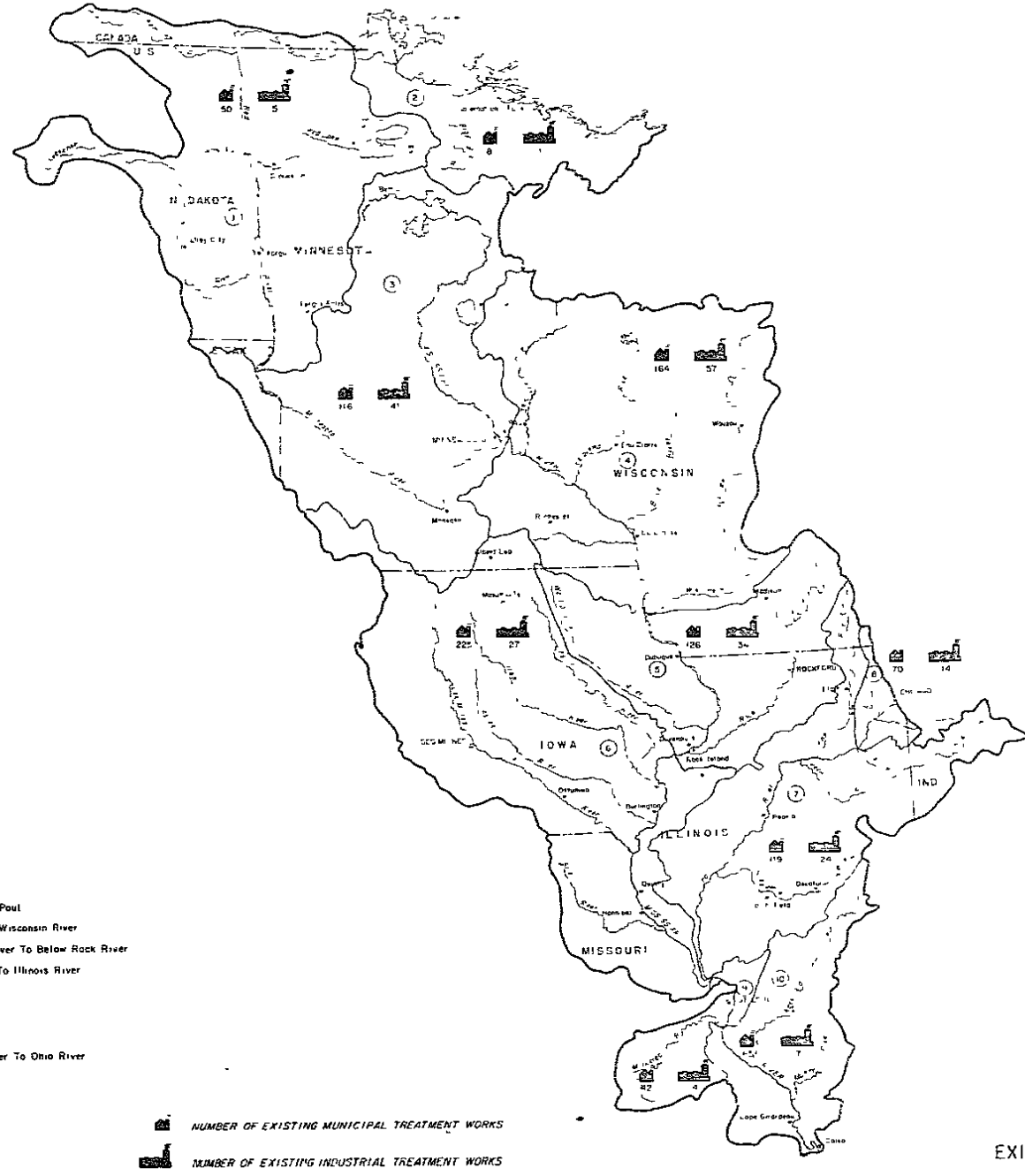
NUMBER OF INDUSTRIAL SOURCES

SCALE OF MILES

40 20 0 40 80 120 160

UPPER MISSISSIPPI RIVER DRAINAGE BASIN SOURCES OF POLLUTION

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 1



SUB-BASIN INDEX

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6. Mississippi River & Tributaries Basin-From Rock River To Illinois River
7. Illinois River & Tributaries Basin
8. Chicago Area Illinois River Drainage Basin
9. Metropolitan St Louis-Meramec River Basin
10. Mississippi River & Tributaries Basin-From Meramec River To Ohio River

NUMBER OF EXISTING MUNICIPAL TREATMENT WORKS

NUMBER OF EXISTING INDUSTRIAL TREATMENT WORKS

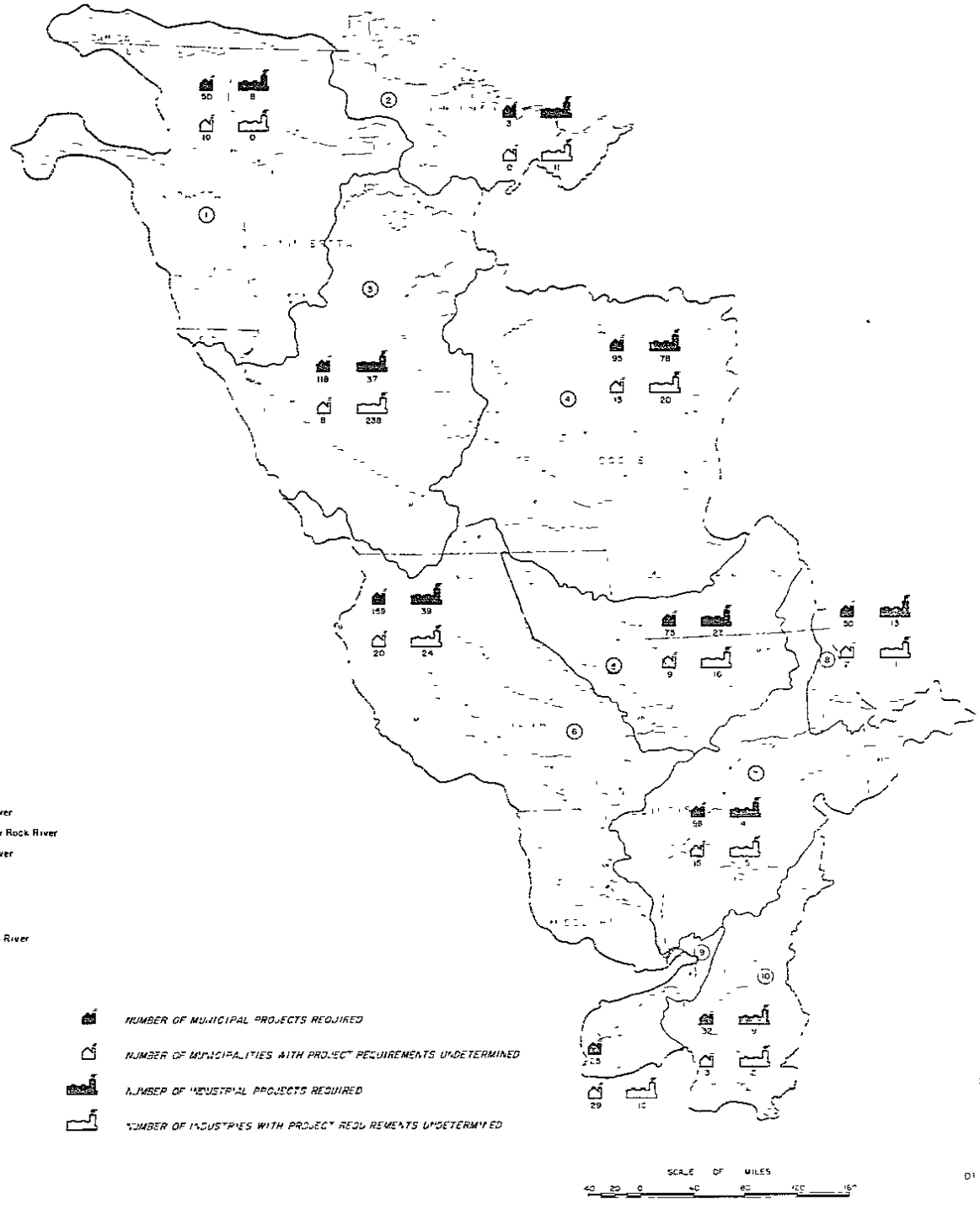
SCALE OF MILES

40 20 0 40 80 120 160

UPPER MISSISSIPPI RIVER
DRAINAGE BASIN

EXISTING TREATMENT WORKS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL



UPPER MISSISSIPPI RIVER
DRAINAGE BASIN
PROJECTS REQUIRED

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 3

UPPER MISSISSIPPI RIVER
DRAINAGE BASIN
EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL
MAP No 4

RED RIVER OF THE NORTH SUB-BASIN

The portion of the Red River of the North Sub-Basin in the United States includes an area of 34,260 square miles, of which 17,060 are in North Dakota, 16,400 in Minnesota, and 800 are in South Dakota. This portion of the sub-basin is 245 miles long to the international boundary and 300 miles wide at its widest point. Drainage is into Hudson Bay, this river being one of the few major streams in the United States which flows northward. Its broad plains have gentle slopes to the main stem of the river. The highest point in the drainage sub-basin occurs in North Dakota and has an elevation of 2,150 feet, but most of the area is under 1,200 feet. The elevation of the river at the international boundary is 789 feet.

There are a large number of lakes in the outer portion of the sub-basin in Minnesota but the Red River sub-basin is largely a flat alluvial plain to the west of which lies an expansive prairie. The alluvial deposits were formed at the bottom of a great glacial lake called Lake Agassiz. It has been estimated that this glacial lake was 700 miles long and 250 miles wide at the international boundary. Lake Agassiz was formed as the glacier retreated northward and cut off drainage to the north. At one time, Lake Agassiz drained southward into the Minnesota River by way of Lake Traverse and Big Stone Lake. Before this lake eventually found drainage to the north, sediment was laid down in its bottom to a depth of 20 feet to 50 feet. The eventual drainage of the area did not occur suddenly, but in steps as more rapid means of drainage were found by the River. Red Lake in Minnesota and Lake Winnipeg are remnants of this glacial lake.

The main stem of the river has its origin at Wahpeton, N. Dak., at the junction of Bois des Sioux and the Otter Tail River. Between Wahpeton and the international boundary, an airline distance of 190 miles, the actual stream length is 394 miles. The winding course of the river has presented great problems in flood control and water conservation. The main stem is characterized by a low gradient which diminishes toward the north, the average being about 0.5 feet per mile. In the distance between Wahpeton and the international boundary, the river drops a distance of 198 feet.

The principal tributaries of the Red River in Minnesota are the Pelican, Buffalo, Wild Rice, Red Lake, Tamarac, and Two Rivers. The Roseau River rises on the Minnesota side but enters the Red River north of the international boundary. The principal North Dakota tributaries to the Red River are the Wild Rice, Sheyenne, Goose, Snake, Park, and Pembina Rivers. Like the Roseau River, the Souris River also drains a considerable part of the Red River sub-basin, but enters the Red River north of the Canadian border.

Flood control is of great importance and has been considered in comprehensive plans for this river. The Baldhill Reservoir, being constructed for flood control and increasing low flows, will to some extent aid in pollution abatement of the Red and Sheyenne Rivers. The Homme Reservoir on the Park River, now under construction, and the authorized Orwell Reservoir, on the Otter Tail River, should augment low flows. The proposed Missouri River diversion into the Sheyenne River would also increase low flows.

These plans will have an important bearing on pollution abatement, since the communities in the valley must obtain water supplies directly from the river and also use the streams as a means of sewage disposal. Ground waters in the area are generally unsuited for water supply. During drought periods some of the smaller tributaries and even the main stem of the Red River itself have been known to dry up. Water conservation, therefore, is a major problem requiring coordinated consideration by the States and by the various agencies of the Federal government and industries and individuals concerned. The problems in the Red River Valley are being considered by the International Joint Commission.

The climate in the area is temperate with cold winters and warm summers. The average temperature for January is 4.9°F. above zero, and for July 69.0°F. The range in extremes of temperature extends from -50°F to +110°F. The length of the growing season is 103 to 139 days. The average annual precipitation is 20.1 inches. It is heaviest over the higher lands in the Otter Tail, Wild Rice, Buffalo, and the Red Lake Rivers in Minnesota. Half of the rainfall occurs during the growing season, and the average run-off varies from one inch in eastern North Dakota to three inches in western Minnesota. There are times when the Red River freezes to the bottom during the dry winters. Use of polluted ice in the lower reaches of the river above the international boundary constitutes a health hazard.

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There are extensive swamp lands in the Red Lake, Two Rivers and Roseau basins. The deep, heavy, finely divided, well compacted mixtures of clay, loam, with small proportions of very fine sand, are very fertile when properly drained and support extensive agriculture. The 1950 population of the sub-basin was approximately 492,000, of which 231,210 lived in North Dakota; 251,102 in Minnesota, and 10,105 in South Dakota. About 77 percent of these people resided on farms or in small towns with a population of less than 2,500 persons. The principal cities along the main stem of the Red River are Moorhead, Fargo, and Grand Forks. Other larger cities are Valley City on the Sheyenne River and Crookston and Thief River Falls on the Red Lake River.

Approximately 72 percent of the area is comprised of agricultural lands, about 77 percent of which is improved for cropping. The great fields which once supported herds of bison are now a rich farming country, and wheat is the principal small grain crop. Corn, fodder crop, potatoes, sugar beets, livestock, dairy products, and poultry are other important agricultural products of the area. Processing of agricultural products is one of the major industries of the valley. Approximately 4,000 acres in Minnesota and North Dakota are irrigated lands.

The eastern portion of the sub-basin in the lake-studded area supports an abundant fish and waterfowl population, and as a result is popular as a recreational area.

The production of hydroelectric power in the sub-basin is a modest industry in which there are 11 private developments.

All of the large cities in the Red River Valley except Moorhead, Minn., take their water supplies directly from the streams. In the main stem the stream flow has been largely sewage during periods of low flow, and as a result municipal water supplies have been seriously endangered. The relatively low rainfall and high annual rate of evaporation (36 inches from water surfaces) aggravates pollution particularly during low flow or drought periods and during periods of ice coverage.

Channel improvement, storage reservoirs, and diversions have been considered by government agencies for increasing flows which would improve the water supply for the major cities in the sub-basin.

Tables A and B show that there are 93 sources of pollution in the area, including 83 municipalities and ten industries. These tables also indicate that the pollution load to the stream has been determined for 80 sources. Of the ten sources of industrial pollution, five discharge wastes with a population equivalent of 250,800. Two of these are beet sugar plants, one located at Moorhead, Minn., and the other at East Grand Forks, Minn., contributing a population equivalent of 220,000 in organic waste discharges to the Red River. A packing plant at Grand Forks, N. Dak., contributes organic wastes to the Red River with a population equivalent of 21,700.

Of the 93 known sources of pollution, 51 municipalities and five industries have provided treatment but 21 municipal and three industrial waste treatment plants lack adequate capacity. Seven municipal and one industrial waste treatment plants are producing poor effluents because of unsatisfactory operation.

Thirty-one new sewage treatment plants are required while 15 existing municipal plants require enlargement or additions. Four existing municipal waste treatment plants are obsolete and must be replaced. The waste treatment requirements of ten municipalities are undetermined.

Five new industrial waste treatment plants are required and three existing plants require enlargement or additions.

During the four-year period 1946-1949 four municipal waste treatment plants and three industrial waste treatment works were completed.

Table H_1 reveals that on July 1, 1950, plans were being prepared for six municipal waste treatment projects while final plans had been approved for seven municipal treatment works. Three municipal projects had construction awaiting financing and two municipal and one industrial waste treatment projects were under construction. The status of eleven municipal and four industrial waste treatment projects was undetermined.

In July 1935, the Tri-State Water Commission was formed to synchronize efforts for the alleviation of pollution and for the coordination of efforts to obtain flood control and the maximum recreational use of the area. This Commission became inactive in 1940, but in 1943 the Inter-State Sanitation Committee was organized to carry on the program of pollution abatement. The Corps of Engineers and Bureau of Reclamation have plans for increasing low flows in the Red River and its tributaries. It is not anticipated that all of these improvements will be brought about immediately, but several of them will be effective in relieving critical conditions and improving the water supply.

The summarized data on sources of pollution, treatment facilities, needs, etc. are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables

B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative length of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_1. Source of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	75	226,775	140,472
Having population data available (Data on pollution load to watercourse incomplete or not available)	8	4,285	Not applicable
Total	83	231,060	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_1. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	5	250,800
Producing organic wastes	4	Undetermined
Producing inorganic wastes	0	Not applicable
Producing wastes of undetermined type	1	Undetermined
Total	10	--

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_1. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	21	22	52,315
Secondary	30	28	139,505
No treatment	32	--	39,240

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_1. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	9	4	5	0
Miscellaneous.....	1	1	0	0
Total.....	10	5	5	0

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_1. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	50	21	21	8	27	7	16
Industrial	5	2	3	0	3	1	1

Table F_1. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	None	--	2	500
1947	1	1,500	None	--
1948	None	--	1	126,000
1949	3	5,565	None	--

Table G_1. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	31	39,165	5
Enlargement or additions to existing plant	15	95,625	3
Replace existing plant	4**	4,240	0
No project required	21	88,455	2
Undetermined***	10	3,575	0

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes one municipality with two plants which are to be replaced by one plant.

***Includes one municipality which lagoons its wastes and the stream loading is undetermined. Also includes one municipality which is known not to provide treatment, but stream requirements are undetermined.

Table H_1. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	31	3
Abatement ordered	--	--
Plans under preparation	6	--
Final plans approved	7	--
Construction awaiting financing	3	--
Under construction	2	1
Status undetermined	11	4

Table I_1. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
MINNESOTA			
Ada	1,700	Replacement	Plans approved
Argyle	900	New plant	Planning initiated
Blackduck	900	Replacement	Plans approved
Breckenridge	2,480	New plant	Planning initiated
Climax	100	New plant	--
Crookston	6,450	New plant	Awaiting financing
Donnelly	345	New plant	--
East Grand Forks	3,150	New plant	Awaiting financing
Elbow Lake	1,000	Enlargement	--
Fergus Falls	9,800	Enlargement	Planning initiated
Fertile	820	New plant	--
Frazee	1,050	Enlargement	--
Frazee Creamery Co	PEU***	New plant	--
Hawley	1,000	New plant	--
Halstad	570	New plant	--
Herman	640	New plant	--
Kennedy	300	New plant	Plans approved
Mahnomen	1,400	New plant	Plans approved
Moorhead	8,500	Enlargement	Under construction
New York Mills	700	Enlargement	--
Northome	140	Replacement	--
Pelican Rapids:			
Farmers Co-op Creamery Co	PEU***	New plant	--
Red Lake Falls	1,380	Enlargement	Plans approved
Twin Valley	760	New plant	--
Underwood:			
Underwood Co-op Creamery	PEU***	Enlargement	--
Warren	1,500	Replacement	Planning initiated
NORTH DAKOTA			
Anamoose	500	New plant	--
Casselton	1,700	New plant	--
Cavalier	1,200	New plant	--
Cooperstown	1,200	New plant	--
Drayton	700	New plant	Plans approved
Enderlin	1,700	New plant	--
Fairmount	700	New plant	--
Fargo	40,000	Enlargement	Planning initiated
Forman	700	New plant	--
Grand Forks	25,000	Enlargement	--
Armour Packing Co	21,700	New plant	--
North Dakota State Mill	3,800	New plant	--
Roger Bros. Food Processing	4,300	New plant	--
Hankinson	1,800	New plant	--
Harvey	2,000	New plant	--
Hillsboro	1,300	New plant	--
Lidgerwood	1,300	New plant	--
Maddock	750	New plant	Awaiting financing
Mayville	1,200	Enlargement	--
McVille	600	New plant	--
Park River	2,000	New plant	--
Walhalla	1,000	New plant	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

RAINY RIVER SUB-BASIN

The Rainy River Sub-Basin lies in the north central part of Minnesota and includes part of the Lake of the Woods. The river forms a portion of the boundary between Canada and Minnesota. The drainage area extends about 220 miles along an east-west line and measures 70 miles in a north-south direction.

The sub-basin, as considered in this report, lies entirely in the State of Minnesota and has an area of about 11,100 square miles. The highest point in the sub-basin is about 1,900 feet above sea level and from this point the sub-basin slopes generally to the northwest at an average of about 12 feet to 15 feet per mile. The total fall through the chain of border lakes above Rainy Lake is 444 feet in a distance of 160 miles.

The major American tributaries to the Rainy-Lake of the Woods system are the Vermilion, Littlefork, Big Fork, Rat Root, Kawishiwi, and the Warroad. There are numerous lakes in the area varying in size from very small to over 30 miles in width. The average discharge of the Rainy River during 1934-46 was 12,340 second feet, with a maximum of 65,400 on May 8, 1938 and a minimum of 2,200 on January 18, 1941. Mean flows of the major streams range from 66 cubic feet per second to 910 cubic feet per second, with only one major stream flow being less than 299 cubic feet per second. Minimum flows have been important on some of the streams, in some cases these flows being zero or very near it. Only one water power development of importance exists in the area and is located at International Falls.

The topography of the sub-basin is divided into two distinct areas, the first, which is rough and hilly, lies south and east of Rainy Lake, while the second, which is west of Rainy Lake, is a flat area with a few small hills. The first area, southeast of Rainy Lake, is a high undulating plateau, thickly dotted with lakes which lie in rock-bound basins. The second area, which is deeply covered with glacial drift and has only a few lakes, is generally swampy and heavily forested. Large portions of this swamp land were drained between 1911 and 1916 at great cost but the reclaimed land proved unsuitable for cultivation. Considerable areas of the sub-basin are roadless and are contained in the Superior National Forest.

The climate is characterized by wide variations in temperature, scanty winter precipitation, and normally ample summer rainfall. The average annual precipitation varies from 21 inches to 29 inches. The average January temperature is about 6°F. while the average July temperature is about 63°F. The growing season is only about 110 days long, yet the small amount of agriculture practiced is successful. This is due to the fact that evaporation is less rapid in this area than in areas farther south and consequently the annual rainfall here is more effective in crop-producing power than equal or greater amounts in warmer climates.

The sub-basin population is distributed rather unevenly throughout the sub-basin. St. Louis County has the highest concentration which is less than 30 persons per square mile, while Lake of the Woods County has the smallest concentration of about five persons per square mile. The area has only two important cities, Ely and International Falls, each with populations between 6,000 and 7,000. The estimated 1950 population for the sub-basin was 84,020.

Principal industries of the region include iron ore mining, lumbering, and tourist trade. Probably the most important industry of the sub-basin is the tourist trade, which is attracted by the beautiful forests and excellent hunting and fishing found in the area. Much of the sub-basin is wild and rugged yet offers splendid sites for fine recreational activities. About 43,000,000 people live within a radius of 750 miles of this wilderness and thousands are attracted to it each year. Some commercial fishing is carried on in the Lake of the Woods.

Reference to tables A_2 and B_2 indicates that there are 22 sources of pollution in the sub-basin, ten municipal and 12 industrial. The tables show all municipalities and industries as "sources" of pollution even though many of these have provided satisfactory treatment.

Tables C_2, D_2, and E_2 reveal the fact that of 22 sources of pollution, nine of the municipalities and one industry have provided treatment. However, two municipal and one industrial waste treatment plants do not have adequate capacity, while one municipal plant produces an unsatisfactory effluent due to poor operation. A new sewage treatment plant is required by one municipality while one existing municipal plant requires additions. Another existing municipal waste treatment plant is obsolete and must be replaced.

Requirements for industrial waste treatment works in the sub-basin are minor. No new plants are known to be needed and only one existing plant requires enlargement or

additions. However, the requirements for 11 mines have not yet been established.

Progress in construction of municipal waste treatment facilities in the sub-basin is shown in table F_2. The data in this table indicate that four municipal treatment works were built in the 1946-49 period and that these treatment works were designed to serve a population of 4,112. While no industrial waste treatment works projects were completed in this four-year period, it is significant to note that one such project is now under construction and is intended to treat wastes, now being discharged, which have a population equivalent of over 600,000. Plans are being prepared for one municipal waste treatment project while final plans have been approved for one additional municipal project. Another municipal waste treatment project has construction awaiting financing while the status of waste treatment works at eleven mines is undetermined.

The important water uses of the sub-basin are municipal and industrial water supply and recreational. Paper mill wastes with a population equivalent of over 600,000 and untreated municipal sewage are being discharged to the Rainy River at International Falls. The important uses affected by pollution include municipal and industrial water supply and wildlife, while other uses harmed are livestock watering and commercial and game fishing. Untreated municipal wastes have harmed recreational use as well as livestock watering in the Little Fork River at Little Fork. Damage to recreational use and commercial fishing has occurred in the Warroad River at Warroad due to inadequately treated municipal wastes.

In all probability the most serious pollution problem in the sub-basin exists at International Falls and is due to inadequately treated paper mill wastes. However, additional treatment facilities now being provided should relieve this condition. Other pollutional conditions in the sub-basin are of minor significance.

The summarized data on sources of pollution, treatment facilities, needs, etc. are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_2. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	0	--	--
Having population data available (Data on pollution load to watercourse incomplete or not available)	10	16,970	Not applicable
Total	10	16,970	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_2. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercoursa (in terma of equivalent number of people)
Producing organic wastes	1	600,000
Producing organic waatea	0	Undetermined
Producing inorganic wastes	11	Not applicable
Producing wastes of undetermined type	0	Undetermined
Total	12	--

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_2. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	8	7	11,180
Secondary	1	1	790
No treatment	1	--	5,000

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_2. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Paper and allied products..	1	1	0	0
Mine drainage.....	11	--	--	11
Total.....	12	1	--	11

*Industries having separate outleta and discharging wastes directly to watercourse.

Table E_2. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	8	6	2	0	2	1	5
Industrial	1	0	1	0	1	0	0

Table F_2. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	0	--
1948	2*	2,600	0	--
1949	2	1,512	0	--

*Includes one community sewerage system which was connected to treatment plant of adjoining community.

Table G_2. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	1	5,000	--
Enlargement or additions to existing plant	1	6,000	1
Replace existing plant	1	1,190	0
No project required	6	4,780	--
Undetermined	0	0	11

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

Table H_2. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	0	--
Abatement ordered	0	--
Plans under preparation	1	--
Final plans approved	1	--
Construction awaiting financing	1	--
Under construction	0	1
Status undetermined	0	11

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Table I_2. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
MINNESOTA			
Ely	6,000	Enlargement	Awaiting financing
International Falls	5,000	New plant	Plans approved
Minnesota and Ontario Paper Co.	600,000	Enlargement	Under construction
Warroad	1,190	Replacement	Planning initiated

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

MISSISSIPPI RIVER AND TRIBUTARIES SUB-BASIN
(Headwaters to St. Paul, Minn.)

This sub-basin contains two major streams --the Mississippi River from its headwaters in Lake Itasca to St. Paul and the Minnesota River from its headwaters on the eastern slopes of the Dakota foothills to its confluence with the Mississippi at St Paul.

The sub-basin is roughly rectangular in area, having a maximum north-south length of approximately 300 miles and maximum east-west width of approximately 210 miles. A total area of about 36,300 square miles is contained within the sub-basin boundaries. Of this total 34,000 square miles, or 94 percent, are in the State of Minnesota while the remaining 2,100 square miles are almost entirely within the State of South Dakota, with only a small part of the sub-basin lying in Iowa.

The principal tributaries to the Mississippi in this area are Leech Lake, Willow, Pine, Crow Wing, Sauk, Crow, Prairie, Elk, and Rum Rivers. The principal tributaries to the Minnesota are the Whetstone, Yellow Bank, Lac Qui Parle, Yellow Medicine, Redwood, Cottonwood, Pomme de Terre, Chippewa, and Blue Earth Rivers. Many of the smaller tributaries are completely dry during the summer months except for storm water run-off.

Reservoirs on the headwaters of the Mississippi, while intended primarily for navigation and flood control, have been of some aid to pollution abatement by augmenting low flows at times.

The topography in the sub-basin is gently undulating, having long, low swells and hollows in the north and smooth outwash plains in the southwest. The area of the sub-basin is generally covered with blue till, a confused mixture of sand, clay, and gravel of glacial origin. The maximum elevation of the sub-basin is found near the headwaters of the Mississippi and has been determined to be about 1,200 feet above sea level.

The sub-basin is characterized by relatively cold winters and fairly short but productive growing seasons. The average January temperature will range from 4°F. in the north to 14°F. in the south. The corresponding average July temperature ranges from 68°F. to 72°F. The average annual precipitation in the sub-basin varies from 22 inches in the north to 29 inches in the south. The majority of this precipitation occurs during the growing season.

The population of the sub-basin in 1950 was estimated to be 1,930,520. Population concentration in 1940 ranged from over 1,900 persons per square mile in Ramsey County to about ten persons per square mile in Aitkin County. The area is fundamentally rural in nature, the large cities being Minneapolis, St Paul, and St. Cloud. While Minneapolis and St. Paul are physically within this sub-basin they are located at the south edge of the sub-basin, and as a result the wastes from these cities are actually discharged in the "St. Paul to Below Wisconsin River" sub-basin.

Agriculture is probably the most important industry of the sub-basin. Major products include dairy products, corns, peas, and miscellaneous small grains. Other important industries are iron ore mining in the famous Cuyuna and Mesabi ranges, granite quarries, grain milling, beet sugar refining, food canning, and recreation.

One hundred and eighty-five sewered municipalities serving 275,800 people are located in this sub-basin. Of this number 61 municipalities provide secondary treatment serving 120,500 people and 55 municipalities provide primary treatment serving 62,100. Of the 69 municipalities, with a total population of 93,200, which do not provide treatment 24 have populations less than 500, 21 have populations between 500 and 1,000, 14 have populations between 1,000 and 2,500, and 10 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 291 industries, 41 of which have provided treatment for their wastes.

Table E_3 is an analysis of the adequacy of existing treatment facilities. This table indicates that 52 of the municipal and 19 of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 36 municipal and five industrial waste treatment plants

The requirements for municipal and industrial waste treatment plants are shown in table G_3. This shows that 67 new municipal plants are needed and that 35 existing plants need enlargement or additions. Sixteen plants are reported to need replacement. It is also noted that 18 new industrial waste treatment plants are needed while 14 are in need of enlargement or additions. Five

existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500....	24	4	2	4
500 to 1,000..	21	10	4	1
1,000 to 2,500..	13	11	9	2
Over 2,500..	9	10	1	1
Total....	67	35	16	8

Table F_3 reveals there were 12 municipal treatment plants completed in 1948 and 1949, and seven industrial treatment works were constructed from 1947 through 1949. One municipal and five industrial treatment plants were under construction on July 1, 1950, and construction of four municipal works was awaiting financing. Final plans had been approved for 29 municipal and one industrial treatment plants, while planning had been initiated on 21 municipal and six industrial treatment works. These figures show definite progress in spite of difficult financing, material shortage, and other problems encountered during this period

Because of the economic importance of agriculture to the area, stockwatering is perhaps the most important use of surface water, with certain exceptions. However, the northern part of the sub-basin has achieved prominence as a recreational area, so that recreational uses, including game fishing and wildlife propagation, are increasing in economic importance. The abundance of ground water in the sub-basin which is suitable for domestic and industrial water supply has made it possible to use this source rather than surface waters, although the surface waters are used for water supplies in several places, notably at Minneapolis and St. Paul.

The pollution picture in this sub-basin consists of a number of localized problems that vary in the degree of seriousness. Many of the streams have irregular run-off characteristics, some being dry in the summer and early fall except for storm water run-off. This, combined with inadequate or no treatment of wastes, has created serious pollution in certain areas during the period when the desire and need to use the stream is the greatest. In the northern part of the sub-basin ice coverage which interferes with the reaeration of the stream also creates some problems.

Stockwatering and game fishing have been damaged in various localities throughout the sub-basin. In most instances, the pollution is due to small municipalities generally with populations of less than 1,000, however, food and kindred products, manufacture and mine drainage have contributed much of this pollution. The outstanding organic pollution load, in terms of population equivalent, is on the Minnesota River between the mouths of the Blue Earth River and Le Seur Creek. Four municipalities, one hospital and one food and kindred products industry discharge wastes with a population equivalent of 106,000 to the river in this stretch.

In several instances small industries and municipalities discharge their wastes to lakes polluting the water that is used for ice harvests in the wintertime. Municipal and industrial water supply is being damaged on the Mississippi by raw wastes from municipalities, food and kindred products manufacturers, and paper and allied products plants.

The summarized data on sources of pollution, treatment facilities, needs, etc. are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_3. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	23	62,097	74,927
Having population data available (Data on pollution load to watercourse incomplete or not available)	162	213,697	Not applicable
Total	185	275,794	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_3. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	12**	136,940
Producing organic wastes	40	Undetermined
Producing inorganic wastes	240	Not applicable
Producing wastes of undetermined type	0	Undetermined
Total	291***	--

*Industries having separate outlets and discharging wastes directly to watercourse.

**Includes one plant also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table C_3. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	55	55	62,131
Secondary	61	61	120,486
No treatment	69	--	93,177

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_3. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	37	19	16	2
Paper and allied products..	2	0	2	0
Chemical and allied products.....	1**	0	1**	0
Miscellaneous.....	13	13	0	0
Mine drainage (silt pollution only).....	239	9	10	220
Total.....	291	41	28	222

*Industries having separate outlets and discharging wastes directly to watercourse.
**Includes one industry which is also listed under "Food and kindred products".

Table E_3. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	116	57	52	7	64	36	16
Industrial	41	13	19	9	26	5	10

Table F_3. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	1	750
1948	7	22,028	2	132,000
1949	5	12,972	4	37,500

Table G_3. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	67[1]	93,177	18
Enlargement or additions to existing plant	35	63,880	14
Replace existing plant	16	23,800	5
No project required[2]	57	88,030	16
Undetermined[3]	8	6,907	238

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes two cases where two municipalities without treatment are to build one plant as a joint project.

[2]Includes three industrial minor sources of pollution not included in table E_3 for which existing disposal methods are considered satisfactory for present stream conditions.

[3]Includes seven industries which are known not to provide treatment, but stream requirements are undetermined. Also includes one municipality which is known to provide treatment, but treatment plant requirements are undetermined although plant capacity is known to be unsatisfactory.

Table H_3. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	27	8
Abatement ordered	0	0
Plans under preparation	21	6
Final plans approved	29	1
Construction awaiting financing	4	0
Under construction	1	5
Status undetermined	44	255

Table I_3. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served **	Project requirements	Remarks
MINNESOTA			
Aitkin	2,300	New plant	Plans approved
Anoka	5,800	Replacement	Planning initiated
Anoka State Hospital	1,400	Replacement	for joint project
Arlington:			
Big Stone Cannery Co.	PEU***	Enlargement	--
Barrett:			
Barrett Co-op. Locker Assn.	PEU***	Enlargement	--
Belle Plaine	1,834	New plant	--
Minnesota Valley Co-op Creamery	2,150	New plant	Planning initiated
Bird Island	1,100	New plant	Planning initiated
Blue Earth	3,300	New plant	Plans approved
Bricelyn:			
Bricelyn Co-op Cannery Assn	PEU***	Enlargement	--
Brownton	650	New plant	--
Browns Valley	960	Enlargement	Plans approved
Buffalo Lake	570	New plant	--
Cambridge	1,400	New plant	
Cambridge Colony for Epileptics	1,200	New plant	Planning initiated for joint project
Canby	1,900	Replacement	Plans approved
Cass Lake	1,700	New plant	Plans approved
Chaska	6,150	New plant	--
American Crystal Sugar Co.	64,700	New plant	--
Cold Springs	1,275	New plant	--
Cooley	120	New plant	--
Carver:			
Minnesota Cove Cheese Co.	153	New plant	--
Cuyuna	150	New plant	--
Deer River	880	New plant	Plans approved
DeGraff	260	New plant	Plans approved
Easton	300	New plant	--
Elk River	1,100	New plant	Plans approved
Elmore	840	New plant	--
Fairmont	6,000	Enlargement	Planning initiated
Fairmont Cannery Co.	PEU***	Enlargement	Planning initiated
Franklin	450	New plant	Plans approved
Gaylord	1,200	Replacement	Planning initiated
Gibbon:			
Gibbon Co-op Creamery	PEU***	New plant	--
Glencoe	2,100	Enlargement	--
Good Thunder	410	New plant	--
Granada	50	New plant	Planning initiated
Grand Rapids	4,400	New plant	Plans approved
Blandin Paper Co.	PEU***	New plant	Planning initiated
Hanley Falls	300	New plant	--
Hector	960	New plant	--
Henderson	272	New plant	Plans approved
Holdingford	460	New plant	Plans approved
Ivanhoe	540	New plant	Plans approved
Janesville	1,200	Replacement	Plans approved for
Janesville Creamery Assn.	400	New plant	joint project
Lafayette	360	New plant	--
Lake Crystal	1,100	Replacement	Planning initiated

See footnotes at end of table.

Table I$_3$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
MINNESOTA--Continued			
Lamberton	800	New plant	Planning initiated
LeCenter	730	Replacement	Plans approved
LeSuer	2,962	New plant	--
Minnesota Valley Canning Co.	67,000	Enlargement	--
Lewisville	270	New plant	Plans approved
Little Falls	5,800	New plant	--
Lowry	245	New plant	--
Manganese	60	New plant	--
Madelia	1,200	New plant	Planning initiated
Mankato	22,296	New plant	Planning initiated
Blue Cross Rendering Co.	750	Enlargement	Planning initiated
Maple Lake	570	Enlargement	Planning initiated
Marshall	4,000	Enlargement	Planning initiated
Melrose	1,800	New plant	Planning initiated
Milaca	1,500	New plant	Awaiting financing
Minnesota Lake	470	New plant	Under construction
Minnesota Masonic Home	215	New plant	--
Montevideo:			
Montevideo Co-op Cannery Assn.	PEU***	New plant	--
Monticello	1,000	New plant	Plans approved
Montrose	240	New plant	--
Mountain Lake	1,500	Enlargement	Plans approved
Mudbaden Sanitarium	60	New plant	--
Mudcure Sanitarium	80	New plant	--
Nashwauk	2,000	New plant	--
New Brighton:			
Harry Menglecock Co.	PEU***	Replacement	--
Minnesplis Hide & Tallow Co.	PEU***	Replacement	--
Minnesota Rendering Co.	PEU***	Replacement	--
Van Hoven Co., Inc.	PEU***	Replacement	--
New Prague:			
National Milling Co.	PEU***	New plant	--
New Ulm:			
John Hauenstein Brewery	1,200	New plant	--
August Schell Brewing Co.	1,940	New plant	--
North Mankato	5,000	New plant	--
Olivia	1,600	Replacement	Plans approved
Ortonville	2,200	Enlargement	Planning initiated
Osakis	1,300	Enlargement	--
Park Rapids	2,400	Enlargement	--
Pine River	520	New plant	Plans approved
Princeton:			
Princeton Rendering Co.	PEU***	Enlargement	Construction authorized
Benville	1,140	Enlargement	Plans approved
Richmond	570	New plant	--
Russell	400	New plant	--
Sanborn	520	New plant	--
Sartell	470	New plant	Planning initiated
St. Regis Paper Co.	PEU***	New plant	Planning initiated
Shakopee	9,160	New plant	--
Reformatory for Women	75	New plant	--
Rahr Malting Co.	7,550	New plant	--

See footnotes at end of table.

Table I$_3$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served **	Project requirements	Remarks
MINNESOTA--Continued			
St. Cloud	2,100	New plant	Planning initiated
St. Cloud Canning Assn.	PEU***	New plant	Planning initiated
St. Cloud Rendering Co.	PEU***	Enlargement	Construction authorized
Stewart	570	New plant	--
St. Joseph	900	New plant	Plans approved
St. Michael	350	New plant	Plans approved
Starbuck	870	Replacement	Planning initiated
St. Peter	5,592	New plant	Planning initiated
St. Peter Hospital	2,893	New plant	for joint project
Swift Falls Co-op Creamery Assn.	PEU***	New plant	--
Trommald	150	New plant	--
Truman	900	New plant	Plans approved
Tyler	950	New plant	Plans approved
Waconia	1,200	Enlargement	Awaiting financing
Walnut Grove	670	Replacement	Plans approved
Waseca	3,900	New plant	Awaiting financing
Watertown	660	Enlargement	--
Welcome	550	New plant	--
Wells:			
California Packing Co.	PEU***	Enlargement	--
Winnebago	1,700	New plant	Planning initiated
Winthrop	1,000	New plant	Plans approved
Minnesota Valley Canning Co.	PEU***	Enlargement	--
SOUTH DAKOTA			
Sisseton	2,000	Replacement	Awaiting financing

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

MISSISSIPPI RIVER AND TRIBUTARIES SUB-BASIN
(St. Paul, Minn. to Below Wisconsin River)

The area included in this sub-basin comprises 39,613 square miles in Wisconsin, Minnesota, Iowa, and Michigan. The sub-basin measures about 170 miles across on a east-west line and about 250 miles on a north-south line. One of the highest points in the drainage area is found near the headwaters of the Wisconsin River, which is 1,600 feet above sea level.

The largest stream in the sub-basin is of course the Mississippi. It has many tributaries within the boundaries of this sub-basin but the principal ones are the St. Croix, Chippewa, and Wisconsin. Other tributaries which are much smaller in size but which have pollutional importance are the Zumbro, Black, Upper Iowa, Cannon, Root, Trempeleau, and LaCrosse. Some of these streams are very long, the Wisconsin being 407 miles in length, while others are much shorter.

The sub-basin topography is a typical glacial formation except for an area in the south part of the sub-basin, which was untouched by the glaciers. Numerous lakes and many rolling hills are found in the northern part of the region. Much of the northern area is covered with second growth timber but to the south a flat, sub-marginal area is found. Portions of the terrain are ideally suited for agriculture and here the rich glacial till supports a substantial number of farms. Along the Mississippi steep rocky bluffs rise 300 feet to 400 feet above the river bed. The dells of the Wisconsin River are famous for the perpendicular cliffs formed by the passage of the river through the rock formations in that section.

The sub-basin has a continental type of climate, the average January temperature being about 13°F. and average July temperature being about 72°F. Extreme temperatures range between -52°F. and 110°F. Average annual precipitation varies from 27 inches in the northern part to about 32 inches in the south. The growing season ranges from 110 days in the north to 160 days in the south.

The estimated 1950 population in the drainage area was about 1,400,000 with a large portion of the populace concentrated in the Minneapolis-St. Paul metropolitan area. Population in the sub-basin outside this metropolitan area is well distributed in small villages and towns. The Wisconsin River valley, for example, averages only about six inhabitants per square mile compared with the average of about 35 per square mile for the sub-basin as a whole. Principal cities of the sub-basin are Rochester, LaCrosse, Eau Claire, Wausau, and Winona.

The important industries of the drainage area are recreation, production of various wood products, such as pulp and paper, navigation, food processing plants, and hydroelectric power development. Wisconsin has a national reputation as a vacation land. Its fine lakes and streams, forests and parks have attracted thousands of fishermen, hunters, and others seeking recreation. Income from various recreational commerce has brought this enterprise the position of fourth among all the State's industries. Pulp and paper products together with related wood products manufacture are important industries in the upper Wisconsin and Chippewa drainage area. Dairying is carried on extensively in the lower area of the sub-basin while farming is found generally in the Minnesota and Iowa portions of the sub-basin. Navigation on the Mississippi is of considerable importance, as this stream is the principal waterway linking the Minneapolis - St. Paul area with the south and central sections of the United States. The St. Croix is also navigable for a short distance above its mouth. Hydroelectric power development is especially important on the Wisconsin River where 50 water power installations exist on the main stem. However, other power developments have been built on various streams including the Chippewa, St. Croix, Zumbro, and Cannon Rivers. Scattered throughout the sub-basin are canneries, cheese factories, meat packing plants, and a few breweries.

Two hundred and twenty-two sewered municipalities serving 1,323,500 people are located in this sub-basin. Of this number 96 municipalities provide secondary treatment serving 189,540 people and 69 municipalities provide primary treatment serving 1,021,300. Of the 57 municipalities, with a population of 112,700, which do not provide treatment 12 have populations less than 500, 17 have populations between 500 and 1,000, 16 have populations between 1,000 and 2,500, and 12 have populations over 2,500.

St. Paul and Minneapolis, which lie at the head of navigation on the Mississippi River, are at the edge of this sub-basin. Although they are located in the Mississippi River and Tributaries Sub-Basin (Headwaters to St. Paul, Minn.), the effluent from the primary treatment plant for the Twin Cities discharges into that part of the Mississippi River in this sub-basin.

Industrial wastes are discharged to the streams through separate outlets by 129 industries, 57 of which have provided treatment for their wastes.

Table E_4 is an analysis of the adequacy of existing treatment facilities This table indicates that 45 of the municipal and 21 of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 24 municipal and eight industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_4. This shows that 54 new municipal plants are needed and that 26 existing plants need enlargement or additions. Fifteen plants are reported to need replacement. It is also noted that 58 new industrial waste treatment plants are needed while 12 are in need of enlargement or additions Eight existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500....	10	2	5	8
500 to 1,000..	17	9	2	3
1,000 to 2,500..	15	7	5	2
Over 2,500..	12	8	3	0
Total....	54	26	15	13

Twenty-six municipal treatment plants and 12 industrial plants were constructed in the period 1946 through 1949. Five municipal and five industrial treatment plants were under construction on July 1, 1950, and four municipal works were awaiting financing on that date. Final plans had been approved for 17 municipal and two industrial treatment plants, and plans were under preparation for 27 municipal and 15 industrial treatment facilities. Fourteen municipalities and six industries were under order to abate pollution.

The Minneapolis and St. Paul area contributes a pollutional load of treated sewage having a population equivalent of 915,000 to the section of the Mississippi River between St. Paul and Hastings. Most of the load comes from the Minneapolis-St. Paul Sanitary District, which produces an effluent with a population equivalent of about 750,000. The sanitary district plant provides primary treatment consisting of plain sedimentation, and has facilities for chemical precipitation and chlorination for use during periods of low river flow. Other significant contributors include the South St. Paul plant, whose effluent has a population equivalent of approximately 150,000 and the Cudahy Packing Company Plant at Newport, which produces an effluent having a population equivalent of about 15,000. Both of these installations, which are high rate trickling plants, provide secondary treatment during all river flow conditions. Game fishing and other recreational uses have not been affected in this portion of the river to an extent which has been considered sufficient to justify requiring the installation of additional treatment facilities. Other municipalities along the river cause local health hazards and nuisances through the discharge of their untreated wastes into the Mississippi River. On the St. Croix River recreation and commercial fishing have been affected below communities where no treatment is provided.

Pulp and paper companies located at Park Falls on the north fork of the Flambeau River and at Eau Claire are the most serious offenders in the Chippewa River Basin. On the Wisconsin River serious pollution enters from pulp and paper companies at Rhinelander, Tomahawk, Brokaw, Wisconsin Rapids, and Port Edwards. In general the water uses which have received the greatest damage are recreation and stockwatering.

The summarized data on sources of pollution, treatment facilities, needs, etc. are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not he readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_4. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	50	928,215	1,723,064
Having population data available (Data on pollution load to watercourse incomplete or not available)	172	395,356	Not applicable
Total	222	1,323,571	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_4. Sources of pollution, industrial

Industries	Sources of pollution (in number of plants)*	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	30**	625,947
Producing organic wastes	78	Undetermined
Producing inorganic wastes	26	Not applicable
Producing wastes of undetermined type	1	Undetermined
Total	129***	--

*Industries having separate outlets and discharging wastes directly to watercourse.

**Includes six plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table C_4. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	69	71	1,021,359
Secondary	96	93	189,541
No treatment	57	--	112,671

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_4. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	85	28	50	7
Textile mill products.....	2	0	2	0
Lumber and wood products...	1	1	0	0
Paper and allied products..	27	22	5	0
Chemical and allied products.....	1	0	1	0
Rubber products.....	1	1	0	0
Fabricated metal products..	1	0	1	0
Miscellaneous.....	5	4	1	0
Mine drainage.....	6	1	0	5
Total.....	129	57	60	12

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_4. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	164	110	45	9	122	24	18
Industrial	57	30	21	6	46	8	3

Table F_4. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	1	Undetermined
1947	0	--	4	151,140
1948	8	48,890	4	32,886
1949	18	73,270	3	5,950

Table G_4. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	54	112,062	58
Enlargement or additions to existing plant	26	145,180	12
Replace existing plant[1]	15	42,468	8
No project required[2]	110	1,016,358	31
Undetermined[3]	13	7,503	20

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes one municipality with two plants which are to be replaced by one plant, and one municipality with three plants to be replaced by one plant.

[2]Includes one industrial minor source of pollution not included in table E_4 for which existing disposal methods are considered satisfactory for present stream conditions.

[3]Includes three municipalities and one industry which are known not to provide treatment, but stream requirements are undetermined. Also includes one municipality and one industry which are known to provide treatment, but treatment plant requirements are undetermined although plant capacities are known to be unsatisfactory.

Table H_4. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	8	19
Abatement ordered	14	6
Plans under preparation	27	15
Final plans approved	17	2
Construction awaiting financing	4	--
Under construction	5	5
Status undetermined	47	57

Name	served**	requirements	
IOWA			
Calmar	903	Replacement	--
Cresco	2,150	Enlargement	--
Cresco Rendering plant	PEU***	Enlargement	--
Decorah	4,600	Enlargement	--
Lansing	1,100	New plant	--
Marquette	600	New plant	--
McGregor	1,000	New plant	--
Monona	350	Replacement	--
Postville	850	Replacement	Construction authorized
Postville Co-op Creamery Co.	380	New plant	--
Waukon	2,500	Replacement	--
MINNESOTA			
Barnum	290	New plant	--
Cannon Falls	1,400	New plant	Plans approved
Faribault	13,000	Replacement	Plans approved
Harmony	500	Replacement	Plans approved
Hastings	5,000	New plant	Planning initiated
Hinckley	600	New plant	Planning initiated
Lakeland:			
Stokely Bros. Cannery	PEU***	Replacement	Planning initiated
LeRoy	670	New plant	--
Mazeppa	500	New plant	--
North Branch	680	New plant	Plans approved
Northfield	4,700	New plant	Planning initiated
North St. Paul	2,800	Enlargement	Plans approved
Ogilvie:			
Farmers Co-op Creamery Asen.	240	New plant	--
Orono Township:			
Mather Cheese Co	PEU***	New plant	--
Pine City	1,540	Enlargement	Plans approved for joint project
Pine City Co-op Creamery Assn	600	New plant	
Pine Island	900	New plant	Planning initiated
Preston	1,300	New plant	Plans approved
Red Wing	9,000	New plant	--
Rochester	25,000	Replacement	Awaiting financing
Sandstone	1,400	New plant	Plans approved
St. Charles	1,400	Replacement	Plans approved
State School for Boys	350	New plant	--
Stillwater	6,400	New plant	--
Vermillion:			
Empire Rendering Co	PEU***	Enlargement	Planning initiated
Wanamingo	430	New plant	--
Zumbrota	1,300	New plant	--
Zumbrota By-Products Co	PEU***	Enlargement	--
WISCONSIN			
Alma:			
Alma Dairy Products	PEU***	New plant	Part of wastes go to city sewer
Altoona	1,000	Enlargement	--
Antigo	9,000	Enlargement	Planning initiated
Shawano Canning Co	PEU***	New plant	Planning initiated
Arcadia	1,200	Enlargement	Not in operation
Augusta	1,200	Replacement	Under order, planning initiated

See footnotes at end of table.

Table T4. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN--Continued			
Augusta Canned Foods	PEU***	Replacement	--
Baraboo:			
Creamery	PEU***	New plant	--
Herfort Canning Co.	PEU***	New plant	--
Woolen Mill	PEU***	New plant	--
Barron	2,060	Replacement	Planning initiated
Inderrieden Canning Co.	PEU***	New plant	--
Biron	470	New plant	--
Blair	856	New plant	Planning initiated
Blair Packing Co.	PEU***	New plant	Planning initiated
Boscobel	2,000	Enlargement	--
Brokaw	477	New plant	Construction authorized
Wausau Paper Co. (Pulp)	119,000	New plant	--
Cadott	400	New plant	Under order; construction authorized
Cambria:			
Columbia Canning Co.	PEU***	Replacement	Construction authorized
Cambria Canning Corp.	PEU***	Replacement	Construction authorized
Cassville:			
Klindt-Geiger Canning Co.	3,990	New plant	3,900 during pea packing season
Chippewa Falls	10,370	New plant	Under order; planning initiated; additional PE of 28,000 from industry
Peter, Fox & Sons (slaughter house)	4,200	New plant	Under order; planning initiated
Leinenkugel Brewery	3,115	New plant	Under order; planning initiated
Colfax	800	New plant	Under order; planning initiated
Cornell	1,300	New plant	Under order; planning initiated
Cornell Wood Products	5,617	Enlargement	Planning initiated
Cumberland	1,200	Enlargement	Plans approved
Durand	1,400	New plant	Under order, planning initiated
Hercules Powder Co. (Dairy Division)	1,170	New plant	Under order; planning initiated; to connect to city sewer in lieu of new plant
Edgar:			
Cheese Industry	PEU***	New plant	--
Ellsworth:			
East Plant	650	Replacement	Single plant required; planning initiated
North Plant	100	Replacement	
West Plant	350	Replacement	
Co-op Creamery	2,600	Enlargement	Planning initiated
Eau Claire	47,000	Enlargement	Under order; planning initiated
Sterling Pulp & Paper Co.	252,000	New plant	--

See footnotes at end of table

Table I4. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN--Continued			
Libby, McNeill & Libby.....	604	New plant	Under order; planning initiated
U. S. Rubber Co.....	PEU***	New plant	Part to city sewer
Fountain City.....	985	New plant	--
Fountain City Brewing Co....	924	New plant	Will connect to city sewer in lieu of new plant
Frederick:			
Stokely Foods, Inc.....	PEU***	New plant	--
Gleason:			
Butter-Cheese.....	PEU***	New plant	--
Grantsburg:			
Wood River Cooperative Creamery.....	126	New plant	--
Hawkins.....	300	Replacement	--
Hayward.....	1,700	New plant	Under order; awaiting financing
Federal Indian Hospital.....	260	Replacement	Under order
Holmen:			
Holmen Cooperative Creamery Assn.....	660	New plant	--
Holmen Canning Co.....	6,000	New plant	--
Hudson.....	2,987	New plant	Planning initiated
Humbird:			
Humbird Canning Co.....	PEU***	New plant	--
Independence.....	100	Replacement	Single plant required; plans approved
Independence.....	600		
LaCrosse.....	46,000	Enlargement	Planning initiated
LaCrosse Asylum.....	300	New plant	--
LaFarge.....	700	New plant	Plans approved
Lodi:			
Lodi Canning Co.....	PEU***	Enlargement	Only part of wastes treated
Loyal:			
Loyal Canning Co.....	PEU***	New plant	--
Marathon:			
Condensery.....	PEU***	New plant	--
Mauston.....	2,100	New plant	--
Milk industry.....	PEU***	New plant	--
Medford.....	2,000	Enlargement	--
Medford Co-op Creamery.....	PEU***	New plant	--
Menominee:			
Parker Pen Co.....	PEU***	New plant	--
Merrill.....	6,200	New plant	Planning initiated
Creamery.....	PEU***	New plant	Planning initiated
Condensery.....	PEU***	New plant	Planning initiated; will connect to city sewer in lieu of new plant
Dairy.....	PEU***	New plant	Planning initiated; will connect to city sewer in lieu of new plant
Paper plant.....	4,400	New plant	Planning initiated
Merillan.....	500	New plant	--
Milltown:			
Stokely Foods, Inc.....	PEU***	New plant	--
Mondovi.....	1,500	New plant	Plans approved
Mondovi Canning Corp.....	PEU***	New plant	--
Mosinee.....	1,100	New plant	Planning initiated
Pulp mill.....	31,506	Enlargement	--

See footnotes at end of table.

Table 14. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN--Continued			
Neillsville	2,560	New plant	--
Nekoosa:			
Pulp mill	35,000	Enlargement	--
New Lisbon	1,100	New plant	Plans approved
New Richmond	2,700	Enlargement	Under order
Friday Canning Co.	15,000	Replacement	Under order
North Freedom:			
St. Mary's Cannery Co.	PEU***	Replacement	--
North Hudson			
Milwaukee, St. Paul, Minn. & Omaha RR Shops	PEU***	New plant	Oil wastes, and domestic wastes from 50 employees
Norwalk:			
Dairy	PEU***	New plant	--
Osceola	650	New plant	Plans approved
Maple Island Dairy	68	New plant	Plans approved
Osseo	900	Enlargement	Planning initiated
Osseo Canning Co.	PEU***	New plant	--
Owen	900	New plant	Awaiting financing
Owen Canning Corp.	PEU***	New plant	Construction authorized
Park Falls:			
Flambeau Paper Co.(Pulp mill)	360,000	Enlargement	--
Phillips	1,600	Enlargement	Planning initiated
Pittsville:			
Pittsville Canning Co.	PEU***	New plant	--
Plover	150	New plant	--
Portage:			
Brewery	PEU***	New plant	--
Hosiery mill	PEU***	New plant	--
Port Edwards:			
Pulp mill	362,000	New plant	--
Prairie du Chien	5,000	New plant	Industrial wastes 400 PE; only 50 percent of population connected to sewers
Oscar Mayer Packing Co.	864	Enlargement	--
Wisconsin Co-op Farm Plant Foods, Inc.	30	New plant	No industrial wastes; 30 employees to stream. Will connect to city plant when completed
Rhinelander:			
Pulp	168,000	Enlargement	Construction authorized
Rib Lake	1,042	New plant	Planning initiated
Dairy	PEU***	New plant	--
Rice Lake	5,200	New plant	Under order; planning initiated
River Falls	3,000	Enlargement	--
Rothschild	750	New plant	Planning initiated
St. Croix Falls	850	New plant	Construction authorized
Sauk City:			
Sauk City Canning Co.	PEU***	New plant	Construction authorized
Shell Lake	900	Enlargement	--
Spooner	2,900	Replacement	Under order; planning initiated
Stanley	1,600	New plant	Under order; planning initiated

See footnotes at end of table.

Table I4. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN--Continued			
Thorp	900	Enlargement	Under order; plans approved
Tomahawk	2,800	New plant	Planning initiated
Pulp and paper company	120,000	Enlargement	--
Pulp mill	1,500	New plant	--
Viola	650	New plant	--
Creamery	PEU***	New plant	--
Dairy	PEU***	New plant	--
Warrens:			
Cheese plant	PEU***	Replacement	--
West Salem	9,328	New plant	PE 128 from creamery and 9,200 from cannery during season
West Salem Packing Co	PEU***	New plant	--
Whitehall	700	New plant	Planning initiated
Whiting:			
Whiting-Plover Paper Co:			
(Pulp)	4,000	New plant	--
(Paper)	2,400	New plant	--
Wisconsin Rapids:			
Consolidated Water Power & Paper Co. (Pulp)	516,000	New plant	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

MISSISSIPPI RIVER AND TRIBUTARIES SUB-BASIN
(Wisconsin River to Below Rock River)

This sub-basin consists of the area drained by the Mississippi River from the Wisconsin River to below the Rock River. With a total area of 20,333 square miles, 35 percent of the sub-basin lies in Iowa, 33 percent in Wisconsin, and 32 percent in Illinois.

The sub-basin is somewhat wider than it is long with the eastern and western ends extending northward like horns. The maximum southeast-northwest length is 211 miles and the maximum distance along a north-south axis is 188 miles.

The principal tributaries to the Mississippi in this sub-basin are the Wapsipinicon, Turkey, Maquoketa, and Rock Rivers. The Rock receives discharges from such tributary streams as the Sugar, Pecatonica, Kishwaukee, and Green Rivers; and the Buffalo drains into the Wapsipinicon.

The upper parts of the drainage sub-basin are characterized by fertile soils of a sandy or gravelly nature and by rolling to hilly topography. Near the Mississippi the terrain becomes rugged and the streams have fairly steep slopes, and as a result flash floods occur which cause serious damage to property and farmlands. The soils in the lower sub-basin are a rich prairie loam.

The average annual precipitation varies from 32 inches in the north to 36 inches in the south end of the sub-basin. Average January temperature ranges from 14°F. to 18°F., while average July temperatures vary from 72°F. to 74°F. The growing season ranges from 170 days in portions of the Rock River basin to 150 days in parts of the Turkey River basin in Iowa. Precipitation during the growing season is normally abundant and at times becomes so excessive that flooding results.

The 1950 population of the sub-basin was 1,421,301; concentration of this population varies over a wide range. Rural areas throughout the entire sub-basin have from 30 to 40 persons per square mile while the Tri-city area--Davenport, Iowa; Rock Island and Moline, Ill.--has 270 persons per square mile. Other densely populated urban centers are Dubuque, Clinton, Freeport, Rockford, Belvidere, Beloit, Janesville, Monroe, and Madison.

While part of the sub-basin lies in the corn belt and is important in grain and stock producing, including dairying, there are numerous manufacturing industries located in some of the cities. Manufacture of tools and equipment for farm use, meat packing plants, vegetable canneries, and various enterprises associated with dairying, such as creameries, condenseries, and cheese plants, are important industries in the sub-basin. The Mississippi River is an important waterway used to convey thousands of tons of freight annually. A number of dams on this river have created pools that assure a nine-foot navigational channel at all times.

One hundred and sixty-two sewered municipalities serving 778,700 people are located in this sub-basin. Of this number, 92 municipalities provide secondary treatment serving 253,000 people and 40 municipalities provide primary treatment serving 344,000 people. Of the 30 municipalities, with a population of 181,300, which do not provide treatment, six have populations less than 500, seven have populations between 500 and 1,000, six have populations between 1,000 and 2,500 and 11 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 70 industries, 34 of which have provided treatment for their wastes.

Table E_5 is an analysis of the adequacy of existing treatment facilities. This table indicates that 45 of the municipal and six of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 20 municipal and two industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_5. This shows that 30 new municipal plants are needed and that 17 existing plants need enlargement or additions. Twenty-eight plants are reported to need replacement. It is also noted that 21 new industrial waste treatment plants are needed, while four are in need of enlargement or additions. Two existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500....	6	1	11	1
500 to 1,000..	7	1	10	4
1,000 to 2,500..	6	5	5	4
Over 2,500..	11	10	2	0
Total. ...	30	17	28	9

According to table F_5 eight municipal treatment plants and 16 industrial plants were constructed from 1946 to 1949 The wastes treated by the 16 waste treatment works had a combined population equivalent of more than 317,000 On July 1, 1950, seven municipal and two industrial waste treatment works were under construction while construction was awaiting financing on three municipal plants Final plans were approved for five municipal and one industrial waste treatment plant and planning was initiated for 17 municipal and three industrial treatment works. Two municipalities and four industries were under order to abate pollution.

Many of the legitimate water uses are present in this sub-basin, but the more common are stockwatering and fishing. Some municipal water supplies are drawn from surface sources, especially along the Mississippi River main stem, but a large percentage of municipal and industrial water supply comes from ground water. Recreational water uses other than fishing are found occasionally throughout the sub-basin, and navigation is important on the Mississippi. There is considerable commercial fishing on the Mississippi in this sub-basin. In 1949 over 949,000 pounds of fish were caught by commercial fishermen compared to 660,000 pounds in 1948 and 720,000 pounds in 1947.

Pollution in this sub-basin is characterized by a number of localized problems which interfere with the use of the streams in these particular areas. Generally speaking the pollutional loads are small but often the streams receiving these discharges are also small and conditions become critical during periods of low flow.

Enabling legislation has been passed by State legislatures in both Illinois and Wisconsin to allow Beloit, Wis., and South Beloit, Ill., to construct an interstate sewage project to treat wastes from these two municipalities At present, there is no treatment provided for either of these two municipalities, however, North Beloit has constructed an interceptor sewer that brings its sewage to a point near the State line.

There is an odor nuisance problem in several lakes in the Madison area. This odor is attributed to the decomposition of algae, which are said to grow profusely as a result of the nitrogenous and phosphorous material in the effluent from Madison's secondary sewage treatment plant. This condition also impairs fish life. Laws that require Madison to construct an outfall that will by-pass the concerned lakes have been passed by the legislature, and an abatement order issued by the State Committee on Water Pollution has been appealed to the Circuit Court. The exact solution is not known at present, but research is in progress to find a practical means of providing a third state of treatment for removal of the nutrient materials.

The Maquoketa River in Iowa is receiving gross pollution from several municipalities, creameries, and poultry dressing plants in the vicinity of Strawberry Point, Langworthy, and Manchester, which harms stockwatering and fishing.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and 1, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and 1), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_5. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	43	167,430	299,580
Having population data available (Data on pollution load to watercourse incomplete or not available)	119	611,284	Not applicable
Total	162	778,714	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_5. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	6	2,700
Producing organic wastes	53	Undetermined
Producing inorganic wastes	8	Not applicable
Producing wastes of undetermined type	3	Undetermined
Total	70	--

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_5. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	40	41	344,313
Secondary	92	85	253,076
No treatment	30	--	181,325

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_5. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	55	25	27	3
Textile mill products.....	1	0	1	0
Paper and allied products..	1	0	1	0
Chemical and allied products.....	2	0	2	0
Primary metal industries...	5	5	0	0
Fabricated metal products..	2	1	1	0
Miscellaneous.....	2	1	1	0
Other mining industries....	2	2	0	0
Total.....	70	34	33	3

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_5. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satis-factory	Unsatis-factory	Unde-termined	Satis-factory	Unsatis-factory	Unde-termined
Municipal	126	72	45	9	95	20	11
Industrial	34	26	6	2	31	2	1

Table F_5. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	2	135,450
1947	0	--	4	124,662
1948	2	8,400	4	51,050
1949	6	9,300	6	6,400

Table G_5. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	30	181,325	21
Enlargement or additions to existing plant	17	246,773	4
Replace existing plant	28	30,510	2
No project required[1]	72	310,306	27
Undetermined[2]	9	9,800	16

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes one industrial minor source of pollution not included in table E_5 for which existing disposal methods are considered satisfactory for present stream conditions.

[2]Includes 11 industries which are known not to provide treatment, but stream requirements are undetermined.

Table H_5. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	13	17
Abatement ordered	2	4
Plans under preparation	17	3
Final plans approved	5	1
Construction awaiting financing	3	--
Under construction	7	2
Status undetermined	39	20

Table I_5. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
ILLINOIS			
Cambridge	1,312	Replacement	Awaiting financing
East Dubuque	1,475	New plant	Planning initiated
East Moline	12,359	New plant	Planning initiated
Fulton	2,585	New plant	--
Galena	4,126	New plant	Planning initiated
Geneseo	3,824	Replacement	--
Genoa	1,290	Replacement	Planning initiated
Hanover	899	New plant	--
Milledgeville	808	Replacement	--
Moline	34,608	New plant	Awaiting financing
Mt. Carroll	1,845	New plant	--
Orangeville	407	New plant	--
Port Byron	861	New plant	--
Silvis	2,990	New plant	Planning initiated
South Beloit	2,825	New plant	--
Food end kindred products (2 plants)	PEU***	2 new plants	Construction authorized
IOWA			
Alpha:			
Alpha Rendering plant	PEU***	New plant	--
Alta Vista:			
Alta Vista Creamery	600	New plant	--
Bellevue	1,300	New plant	--
Calmar	450	Replacement	Plans approved
Camanche	640	New plant	--
Castelia:			
Carnation Milk Station	200	Enlargement	--
Central City	300	Replacement	--
Clinton	25,000	New plant	--
Davenport	60,000	Enlargement	--
Dubuque	50,000	New plant	Plans approved, PE discharged - 200,000
Dunkerton	300	New plant	--
Elgin	638	New plant	Plans approved
Creamery	PEU***	New plant	--
Elkrader	1,200	New plant	--
Farley	500	Replacement	--
Fayette	1,000	Replacement	--
Fredericksburg	500	Replacement	Planning initiated
Fredericksburg Creamery	400	New plant	--
Grand Mound	350	Replacement	--
Guttenburg	1,500	New plant	--
Hawkeye	400	Replacement	--
Hazelton:			
Hazelton Cheese Factory	400	New plant	--
Independence State Hospital	2,000	Enlargement	--
LeClaire	881	New plant	Plans approved
Langworthy:			
Langworthy Creamery	PEU***	New plant	--
Manchester	3,200	New plant	Awaiting financing
Maquoketa	3,200	New plant	--
Monona (South Plant)	550	Replacement	--
New Hampton	2,000	Enlargement	--
Oelwein	6,600	Enlargement	Construction authorized
Railroad yard	PEU***	New plant	--
Olin	430	New plant	--
Oasian	410	Replacement	Construction authorize

See footnotes at end of table.

Table I_5. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
IOWA--Continued			
Oxford Junction	300	New plant	--
Preston	540	Replacement	--
Riceville	1,000	Replacement	--
Riceville Creamery	100	New plant	--
Strawberry Point:			
(North Plant)	340	Replacement	Planning initiated
(South Plant)	765	Replacement	Planning initiated
Tripoli	810	Replacement	--
WISCONSIN			
Astico:			
Stokeley Foods, Inc	PEU***	Replacement	--
Beloit	25,370	New plant	Planning initiated
Fairbanks-Morse Foundry Co.	PEU***	Enlargement	Planning initiated
Blanchardville	550	New plant	--
Cassville:			
Cassville Canning Co	PEU***	New plant	--
Clinton	800	Replacement	--
Clyman:			
Clyman Canning Co	PEU***	Enlargement	--
Darlington	1,700	New plant	Planning initiated
Fall River:			
Fall River Canning Co	PEU***	Replacement	--
Horicon	2,000	New plant	Planning initiated
Hustisford	100	New plant	Planning initiated
Home Cheese Factory	PEU***	New plant	Under order
Cannery	PEU***	New plant	Under order
Kekoskee	175	Replacement	--
Janesville	23,000	Enlargement	Construction authorized
Jefferson	4,000	Enlargement	--
Johnson Creek	450	Replacement	--
Louisburg:			
Creamery	PEU***	New plant	--
Mayville	2,600	Enlargement	Under order
Mineral Point:			
Mineral Point Foods, Inc	PEU***	New plant	--
New Glarus	1,000	Replacement	--
Patch Grove:			
Dairy	PEU***	New plant	--
Plattville	4,500	Enlargement	Planning initiated
Potosi:			
Brewery	PEU***	New plant	--
Randolph	1,000	Replacement	--
Reeseville:			
Reeseville Canning Co	PEU***	New plant	--
Shullsburg:			
Calumet-Hecla Mining Co	PEU***	Enlargement	--
Statesan	250	Replacement	Planning initiated
Theresa:			
C. Weber Brewing Co	PEU***	New plant	Planning initiated; under order
Riverside Cheese Factory	PEU***	New plant	Planning initiated; under order
Verona:			
Dane County Asylum	450	Enlargement	--
Waterloo	1,200	Replacement	Planning initiated
Watertown	11,300	Enlargement	--

See footnotes at end of table.

Table I5. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN--Continued			
Waunakee.....	600	Enlargement	Secondary facilities should be replaced
Waupun.....	6,500	Replacement	Construction authorized
Whitewater:			
Whitewater Canning Co.....	PEU***	New plant	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

MISSISSIPPI RIVER AND TRIBUTARIES SUB-BASIN
(Rock River to Illinois River)

This sub-basin is comprised of portions of Iowa, Missouri, Minnesota, and Illinois. The sub-basin is 464 miles long on a northwest-southeast axis and 153 miles wide. The drainage extends over an area of 40,748 square miles with 66 percent in Iowa, 19 percent in Missouri, nine percent in Illinois, and six percent in Minnesota.

There are five important streams within this sub-basin, all discharging directly to the Mississippi, including the Iowa-Cedar, Skunk, Des Moines, North Fabius, and Salt. Flooding is a problem on the Des Moines, Skunk, and Iowa-Cedar Rivers, and flows in these streams vary over a wide range.

The major part of this sub-basin is a typical glaciated country, with rounded, gently rolling hills interspersed with many lakes and marshes. However, a smaller portion consists of a comparatively flat, moderately elevated plain. The soil is a glacial drift and is generally considered excellent for agriculture.

The average annual precipitation in the sub-basin varies from 30 inches in the northwest to 36 inches in the southeast near the Mississippi River. About 75 percent of the precipitation occurs from April through September. The growing season varies from 150 days at the Iowa-Minnesota State line to 180 days at the mouth of the Salt River. Average January temperatures at these localities vary from 14°F. to 30°F., while average July temperatures at the same points range from 72°F. to 78°F.

The 1950 population for the sub-basin was 2,018,400, with the population concentration varying from 330 persons per square mile in Polk County, Iowa, to as low as 17 persons per square mile in the northeastern part of Missouri. Important cities in the sub-basin are Des Moines, Cedar Rapids, and Waterloo, and some of the smaller industrial centers are Muscatine, Ottumwa, Keokuk, Quincy, Burlington, Austin, and Albert Lea.

The economic background of the sub-basin is predominantly agricultural, with 90 percent of the total area being farmland. Most of these farms lie in the heart of the corn belt, and the corn production has led to an appreciable amount of stock raising. A large portion of the industry of this area is concerned with the processing of farm products and the manufacture of farm implements. Mining, mineral products, and the manufacture of machinery and other consumer goods are also economically significant in the area.

Two hundred and seventy-six sewered municipalities serving about 1,000,000 people are located in this sub-basin. Of this number, 178 municipalities provide secondary treatment serving over 745,000 people and 30 municipalities provide primary treatment serving about 100,000. Of the 68 municipalities which do not provide treatment, 25 have populations less than 500, 22 have populations between 500 and 1,000, 14 have populations between 1,000 and 2,500 and seven have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 76 industries, 27 of which have provided treatment for their wastes.

No information on industrial sources of pollution was reported by the State of Missouri so the above mentioned figures, as they pertain to industry, are incomplete. At the time this report was prepared, the water pollution control agency in Missouri was in the process of surveying its industrial sources of pollution. When the results of this survey are published, a revision of these figures probably will be necessary.

Table E_6 is an analysis of the adequacy of existing treatment facilities. This table indicates that 115 of the municipal and ten of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 55 municipal and eight industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_6. This shows that 45 new municipal plants are needed and that 63 existing plants need enlargement or additions. Fifty-one plants are reported to need replacement. It is also noted that 29 new industrial waste treatment plants are needed, while two are in need of enlargement or additions. Eight existing industrial waste treatment plants, it is reported, need to be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500....	18	10	16	6
500 to 1,000..	11	18	16	12
1,000 to 2,500..	9	16	15	0
Over 2,500..	7	19	4	2
Total....	45	63	51	20

Water is put to nearly all legitimate uses in this sub-basin, but the outstanding use is stockwatering. Other important uses are recreational activities, primarily fishing, but including some boating and swimming. Navigation is important on the Mississippi River. Most municipalities within the sub-basin obtain their water supply from ground water, but these sources often have impaired quality because of hardness.

The pollution problem in this sub-basin consists of a series of localized highly polluted areas where a stream receives gross pollution in one locality and gradually recovers only to be polluted again. For example, the Cedar River in Iowa and several of its tributaries, such as Blackhawk Creek and Wapsi Creek, are receiving untreated or poorly treated wastes from a number of municipalities, food products processing industries, and machinery manufacturers. This pollution renders the stream unfit for stockwatering and fishing in the concerned areas. Serious pollution of the Iowa River at Tama, due primarily to industrial wastes has caused several instances of fish loss in the river.

Packing house wastes having a population equivalent of about 350,000 plus untreated municipal wastes from a population of 35,000 are being discharged into the Des Moines River at Ottumwa, Iowa. This pollution makes the river unfit for stockwatering and all recreational purposes. The Raccoon River in Iowa and one of its tributaries, Butterick Creek, are being polluted in certain localities by municipalities and industries associated with agriculture. Stockwatering and fishing are harmed by pollution in this stream.

In Missouri portions of the Salt River and its tributaries are receiving localized pollution from a group of small municipalities and as a result stockwatering and recreation are affected by this pollution.

These examples are only some of the more important pollution problems that are causing nuisance conditions. There are many more cases where pollution has rendered the streams unfit for their legitimate water uses.

Although there is an appreciable amount of pollution within the sub-basin, the situation is improving as shown by the fact that 16 municipal and eight industrial waste treatment plants were constructed during the period 1946 to 1949, inclusive. This rate of construction will probably continue as shown by the fact that six municipal and one industrial plant were under construction on July 1, 1950, and seven municipal treatment works are awaiting financing. Twenty-eight municipal and one industrial treatment facility are in the approved plan stage, while planning has been initiated on 17 municipal and eight industrial treatment works. One municipality is under orders to abate pollution.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_6. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	236	920,989	643,973
Having population data available (Data on pollution load to watercourse incomplete or not available)	40	86,871	Not applicable
Total	276	1,007,860	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_6. Sources of pollution, industrial

Industries	Sources of pollution (in number of plants)*	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	26**	625,300
Producing organic wastes	40	Undetermined
Producing inorganic wastes	12	Not applicable
Producing wastes of undetermined type	1	Undetermined
Total	76***	--

*Industries having separate outlets and discharging wastes directly to watercourse.

**Includes 3 plants also producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table C_6. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	30	33	99,466
Secondary	178	192	747,036
No treatment	68	--	161,358

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_6. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products	50	17	30	3
Chemical and allied products	12	6	4	2
Products of petroleum and coal	1	--	--	1
Miscellaneous	4	3	1	0
Mine drainage	9	1	--	8
Total	76	27	35	14

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_6. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	225	105	115	5	162	55	8
Industrial	27	13	10	4	15	8	4

Table F_6. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	2	1,000	1	6,000
1947	0	--	1	1,000
1948	1	3,500	3	10,000
1949	13	128,010	3	35,000

Table G_6. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	45	144,642	29
Enlargement or additions to existing plant	63[1]	455,269	2
Replace existing plant	51[2]	83,290	8
No project required[3]	111	309,265	13
Undetermined[4]	20	15,394	24

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes one municipality with three plants. Two plants (capacity undetermined) are to be connected to the third which is to be enlarged.

[2]One municipality with two plants which are to be replaced by one plant.

[3]Includes six municipal minor sources of pollution not included in table E_6 for which existing disposal methods are considered satisfactory for present stream conditions.

[4]Includes 17 municipalities and six industries which are known not to provide treatment but the stream requirements are undetermined.

Table H_6. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	15	6
Abatement ordered	1	--
Plans under preparation	17	8
Final plans approved	28	1
Construction awaiting financing	7	--
Under construction	6	1
Status undetermined	106	47

Table I_6. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
IOWA			
Ackley	1,200	Enlargement	--
Adel	1,200	New plant	Planning initiated
Albert City	2,000	New plant	Plans approved
Albia (North Plant)	2,000	Enlargement	--
Rendering Plant	PEU***	Replacement	--
Algona	5,000	New plant	Planning initiated
Ames	25,000	Replacement	Under construction
Armstrong	600	New plant	--
Bagley	160	Replacement	--
Bancroft	700	Enlargement	--
Baxter	350	Replacement	--
Belmond	1,150	Replacement	Planning initiated
Blairstown	400	Replacement	--
Bode	400	Enlargement	--
Bonaparte	400	New plant	--
Boone	13,700	Enlargement	Plans approved
Brighton	600	Enlargement	--
Britt:			
Britt Rendering Co.	PEU***	New plant	--
Burlington	25,000	New plant	--
Burt	350	Enlargement	--
Bussey	350	New plant	--
Cedar Falls	10,000	Enlargement	Planning initiated
Cedar Rapids	60,000	Enlargement	--
Centerpoint:			
Centerpoint Cannery	PEU***	New plant	--
Chariton:			
N. W. Plant	1,200	Replacement	Plans approved
N. E. Plant	700	Replacement	Plans approved
S. E. Plant	1,200	Replacement	Plans approved
Churdan	400	Replacement	--
Clarksville	850	Replacement	--
Clear Lake	15,000	Enlargement	Planning initiated
Colfax	1,600	New plant	--
Columbus Junction	600	New plant	--
Corwith	360	Enlargement	--
Dayton	800	Replacement	--
Denver	500	Replacement	--
Dike	408	New plant	--
Donnelson Creamery	1,000	New plant	--
Dows	760	Replacement	--
Dysart	800	Enlargement	--
Eagle Grove	3,000	New plant	Planning initiated
Eldon	800	New plant	--
Ellsworth	444	New plant	--
Estherville:			
Rendering Plant	PEU***	Replacement	--
Farmington	300	New plant	--
Fonda	700	Replacement	--
Forest City	3,500	Enlargement	--
Fort Dodge	25,000	Enlargement	Plans approved
Fort Madison	14,000	New plant	--
Fort Madison State Penitentiary	1,100	New plant	--
Garwin	300	Replacement	--
Gladbrook	580	New plant	Plans approved
Glidden	700	Replacement	Awaiting financing

See footnotes at end of table.

Table I6. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
IOWA--Continued			
Gilman:			
Gilman Cannery	PEU***	New plant	--
Gilmore City	700	Enlargement	Planning initiated
Gowrie	800	New plant	--
Creamery	3,000	New plant	--
Grinnell	5,000	Enlargement	Construction authorized
Grundy Center	1,350	Replacement	Plans approved
Canning Factory	8,000	Replacement	--
Hampton	3,500	Enlargement	--
Hudson	300	Replacement	Planning initiated
Hudson Creamery	2,700	New plant	--
Indianola:			
(North Plant)	1,800	Replacement	Awaiting financing
(South Plant)	800	Replacement	Awaiting financing
Jewell	500	Replacement	--
Kanawaha	500	Enlargement	--
Creamery	300	New plant	--
Keokuk	15,000	New plant	--
Keosaugua	500	New plant	--
Klemme:			
Co-op Creamery	PEU***	New plant	--
Lake City:			
(North Plant)	1,200	Replacement	--
Rendering Plant	200	Replacement	--
Lake Mills:			
Cool Springs Cannery	8,000	New plant	--
Laurens	600	Replacement	Plans approved
Lehigh	400	New plant	--
Lohrville	650	Replacement	Planning initiated
Lytton:			
Creamery	PEU***	New plant	Plans approved
Madrid	1,700	Enlargement	--
Manson	1,100	Enlargement	--
Marengo	1,800	New plant	Plans approved
Mason City	25,600	Enlargement	--
Rendering Plant	PEU***	New plant	--
Mediapolis	400	New plant	--
Montezuma	1,000	Enlargement	--
Morning Sun:			
Rendering Plant	PEU***	New plant	--
Moulton	540	Enlargement	--
Mt. Pleasant	3,000	Enlargement	--
Mt. Pleasant State Hospital	1,750	Enlargement	--
Mt. Vernon	1,300	Enlargement	Awaiting financing
Muscatine	18,000	New plant	Planning initiated
Nevada	3,000	Enlargement	--
Newell	730	Enlargement	--
Creamery	300	New plant	--
New Sharon	800	Replacement	--
Newton:			
(Northwest)	1,150	Enlargement	--
(East)	2,800	Enlargement	--
Nora Springs	900	New plant	--
North English	700	Replacement	--
Creamery	1,000	New plant	--
Northwood	1,400	Replacement	--
Creamery	200	New plant	

See footnotes at end of table.

Table I$_6$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
IOWA--Continued			
Osage	2,500	Replacement	Planning initiated
Rendering plant	PEU***	New plant	--
Oskaloosa:			
(North Plant)	6,500	Enlargement	--
(South Plant)	6,500	Enlargement	--
Ottumwa	35,000	New plant	Planning initiated
Morrell Packing Co	350,000	New plant	Planning initiated
Panora	700	New plant	--
Perry	5,000	Enlargement	--
Pocahontas	650	Enlargement	Planning initiated
Pomeroy	450	Replacement	Planning initiated
Redfield	600	New plant	--
Soybean processing plant	400	New plant	--
Reinbeck	1,200	Replacement	--
Cannery	PEU***	New plant	Planning initiated
Rippey	300	New plant	--
Riverside	500	New plant	--
Rockwell City	1,600	Enlargement	--
Roland	500	Enlargement	--
Rolfe	700	Enlargement	--
Sac City:			
Cannery	5,000	New plant	--
Sheffield	900	Replacement	Plans approved
Shellrock	800	New plant	--
Shellsburg	400	New plant	--
Sigourney:			
(South Plant)	555	Replacement	--
Slater:			
Creamery	3,000	New plant	--
Stanhope	200	Replacement	--
Storm Lake	5,000	Enlargement	Construction authorizsd
Kingan Packing Co	35,000	--	Construction authorized for joint project
Stratford	500	Enlargement	--
Stuart	1,200	Replacement	Planning initiated
Swea City	550	Replacement	Plans approved
Tama:			
Tama Paper Mill	PEU***	New plant	Planning initiated
Toledo:			
Toledo Canning Factory	PEU***	Replacement	--
Union	380	Replacement	--
University Park	350	Replacement	--
Ventura	275	New plant	--
Vinton	2,500	Enlargement	--
Wallingford:			
Creamery	400	New plant	--
Wapello	1,290	New plant	--
Cannery	PEU***	New plant	--
Walcott	390	Replacement	--
Waterloo	50,000	Enlargement	Planning initiated
John Deere Farm Machinery Plant	PEU***	Replacement	--
Waverly:			
Carnation Milk Plant	PEU***	New plant	--
Wellsburg	800	Enlargement	--
West Branch	600	Replacement	--

See footnotes at end of table.

Table 16. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
IOWA--Continued			
West Liberty	1,140	Enlargement	--
Williams	250	Replacement	--
Williamsburg	1,100	Replacement	--
Wilton Junction	700	Replacement	--
Winfield	500	Replacement	--
Winterset	1,500	Enlargement	--
MINNESOTA			
Adams	610	New plant	--
Albert Lea	11,000	Replacement	Awaiting financing for joint project
Wilson & Co. Packing Plant	38,000	New plant	Awaiting financing for joint project
Currie	460	New plant	--
Heron Lake Village	760	New plant	--
Jackson	2,500	New plant	--
Lake Wilson	380	New plant	--
Lyle	465	New plant	--
Wilmont	320	New plant	--
Windom	2,500	New plant	Planning initiated
MISSOURI			
Bowling Green	650	Enlargement	--
Centralia	1,500	Enlargement	--
Edina:			
(North Plant)	750	Enlargement	--
(South Plant)	750	Enlargement	--
Kahoka	375	Enlargement	Plans approved
Macon	4,000	Replacement	--
Moberly:			
(East Plant)	5,490	Enlargement	--
Monroe City	1,800	Replacement	--
Palmyra	1,300	Enlargement	Plans approved
Paris	1,200	New plant	--
Shelbina	320	New plant	--
(South Plant)	730	Replacement	Construction authorized
Troy	1,000	Enlargement	--
Warrenton	1,060	Enlargement	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

ILLINOIS RIVER AND TRIBUTARIES SUB-BASIN

The Illinois River and its tributaries drain a large irregularly shaped area that lies between Lake Michigan and St. Louis. The total area of the sub-basin is 26,797 square miles with 85 percent in Illinois, 12 percent in Indiana, and three percent in Wisconsin.

The principal tributaries to the Illinois River, which joins the Mississippi River at Grafton, Ill , are the Des Plaines, Kankakee, Fox, Vermilion, Mackinaw, Sangamon, and Spoon Rivers. Numerous smaller rivers and creeks are also tributary to the Illinois along its 273-mile length

An outstanding feature of this sub-basin is the low gradient of the Illinois River which falls 75 feet throughout its entire length. All of the principal stream valleys are flat-bottomed and average from 130 feet to 250 feet below the general prairie plains level. All of the sub-basin has been glaciated, and the terrain is characterized by a series of glacial moraines and intervening plains. The southwest corner is a relatively flat plain with deeply incised valleys. The soils in most of the area are excellent for agriculture and are classified as glacial till, but much of the Kankakee Basin and an extensive area at the junction of the Illinois and Sangamon Rivers has sandy soils whose productiveness is limited. Soil erosion is a problem in 60 percent of the sub-basin.

The average annual precipitation varies from 32 inches in the north to 38 inches in the southern part of the sub-basin, with 60 percent of the moisture falling during the growing season which is from 160 days to 190 days long. Average January temperatures range from 20° F. to 30° F., and average July temperatures are 72° F. to 78° F.

While much of the sub-hasin is devoted to farming and consequently has a rural type population, there are numerous heavily populated cities such as Peoria, Pekin, Springfield, Aurora, Kankakee, Bloomington, Decatur, Lincoln, Ottawa, La Salle, and Peru. The population concentration varies from 250 persons per square mile in Peoria County to as low as 30 persons per square mile in the rural areas of the southern part of the sub-basin. The total population for the sub-basin for 1950 is estimated at 1,980,000.

Navigation has been an important factor in the economic development of this region. The Illinois River has become a link in the Great Lakes-Gulf of Mexico waterway. This was made possible by a nine-foot channel which was a result of the construction of a series of dams, locks, and levees. In 1949, approximately 13,000,000 tons were transported on the Illinois River. This water transportation has aided in the development of such mineral resources as coal, sand, limestone, petroleum, and sulphur.

Agriculture, an important industry of the sub-basin, furnishes the raw materials for a number of industries, such as meat packing, distilleries, and corn starch manufacturing.

Two hundred and fifteen sewered municipalities serving 932,000 people are located in this sub-basin. Of this number, 86 municipalities provide secondary treatment serving 647,000 people and 31 municipalities provide primary treatment serving 105,000 people. Of the 98 municipalities with a population of 180,200 which do not provide treatment, 34 have populations less than 500, 24 have populations between 500 and 1,000, 24 have populations between 1,000, and 2,500 and 16 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 37 industries, 24 of which have provided treatment for their wastes.

Table E_7 is an analysis of the adequacy of existing treatment facilities. This table indicates that 29 of the municipal and two of the industrial waste treatment plants have unsatisfactory capacity and that the operation should be improved at 17 municipal and one industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_7 . This shows that 69 new municipal plants are needed and that 20 existing plants need enlargement or additions. Nine plants are reported to need replacement. It is also noted that two new industrial waste treatment plants are needed and two are in need of enlargement or additions.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500...	9	2	--	8
500 to 1,000.	22	3	2	3
1,000 to 2,500.	23	5	5	2
Over 2,500.	15	10	2	2
Total..	69	20	9	15

According to table F_7 there were no waste treatment facilities constructed in this sub-basin during 1946 and 1947, but in 1948 and 1949 twelve municipal plants were completed. Construction progress has been slow in view of the large number of new waste treatment plants needed in this sub-basin. Table H_7 indicates that seven municipal and one industrial waste treatment works were under construction on July 1, 1950, and five municipal works were awaiting financing. Final plans for 17 municipal treatment plants have been approved, while plans for ten municipal and one industrial treatment works are under preparation. Six municipalities are under order to abate pollution.

Table I_7 is a listing of projects which are known to be needed. This should not be considered a complete list, since it is reasonable to expect that investigative and survey work in this sub-basin will reveal additional sources of pollution that will require corrective action.

A constantly receding water table in the northern and central part of the sub-basin has made it necessary to consider the development of surface water for both municipal and industrial water supply. Stockwatering is probably the most common use, followed by fishing and other recreational activities. Navigation is important along the Illinois River itself.

The Kankakee River which is a relatively clean stream receives pollution from several small cities, such as West Kankakee and Bradley, Ill., which discharge raw sewage to the watercourse from a total 1940 population of about 7,600. These discharges together with certain minor industrial wastes cause some localized damage to the stream during periods of low flow.

The Illinois River sub-basin is highly industrialized and this factor must be considered in all pollutional abatement activities The significance of industrial wastes in the basin is illustrated by an examination of two of the most important industrial areas in this sub-basin.

Peoria, a municipality with a population of 111,342, is in an area having wastes with a total population equivalent potential of 2,690,972. This has been reduced to 495,000, however, prior to discharge to the river through the cooperation of industry and the operation of an efficient secondary treatment plant by the Peoria Sanitary District.

Pekin, a municipality of 19,407, a few miles downstream is also highly industrialized. The total population equivalent potential of the wastes in this area is 1,127,407, which is reduced to 183,500 prior to discharge through the operation of industrial and municipal treatment facilities.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table 1, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A7. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	90	555,076	514,710
Having population data available (Data on pollution load to watercourse incomplete or not available)	125	376,669	Not applicable
Total	215	931,745	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B7. Sources of pollution, industrial

Industries	Sources of pollution (in number of plants)*	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	4**	2,553
Producing organic wastes	19	Undetermined
Producing inorganic wastes	6	Not applicable
Producing wastes of undetermined type	9	Undetermined
Total	37***	--

*Industries having separate outlets and discharging wastes directly to watercourse.

**Includes one plant producing inorganic wastes.

***Total adjusted to correct for duplication noted in footnote marked thus,**.

Table C7. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	31	31	104,592
Secondary	86	88	646,952
No treatment	98	--	180,201

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D7. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	25	17	3	5
Textile mill products.....	1	0	1	0
Products of petroleum and coal.....	3	2	1	0
Primary metal industries...	2	1	--	1
Fabricated metal products..	6	4	2	0
Total.....	37	24	7	6

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_7. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	119	86	29	4	90	17	12
Industrial	24	16	2	6	15	1	8

Table F_7. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	0	--
1948	6	12,500	0	--
1949	6	19,350	0	--

Table G_7. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	69	164,411	2
Enlargement or additions to existing plant	20	222,947	2
Replace existing plant	9	17,215	--
No project required[1]	104	508,228	18
Undetermined[2]	15	18,944	15

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes 18 municipal and two industrial minor sources of pollution not included in table E_7 for which existing disposal methods are considered satisfactory for present stream conditions.

[2]Includes 11 municipalities and three industries which are known not to provide treatment, but stream requirements are undetermined.

Table H_7. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	34	2
Abatement ordered	6	--
Plans under preparation	10	1
Final plans approved	17	--
Construction awaiting financing	5	--
Under construction	7	1
Status undetermined	40	15

Table I$_7$. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
ILLINOIS			
Assumption	1,561	New plant	--
Atlanta	1,290	Replacement	Plans approved
Bourbonnais	771	New plant	--
Bradley	3,689	New plant	Plans approved
Bristol	464	New plant	--
Bushnell	2,906	Replacement	Construction authorized
Carrollton	2,285	Replacement	--
Crystal Lake	3,917	Enlargement	--
East Dundee	1,306	New plant	Plans approved
Eureka	1,714	New plant	Construction authorized
Gibson	2,401	New plant	Under order; awaiting financing
Lake Villa	438	New plant	Plans approved
Lake Zurich	421	Enlargement	--
Lewiston	2,355	Replacement	Awaiting financing
Macomb	8,764	Enlargement	Awaiting financing
Manteno	1,537	Enlargement	--
Mason City	1,984	New plant	--
Milford	1,628	New plant	Plans approved
Morton	2,241	New plant	Planning initiated
Onarga	1,413	New plant	--
Ottawa	16,005	New plant	Planning initiated
Peotone	1,146	Enlargement	--
Petersburg	2,586	New plant	Planning initiated
Rankin	781	Enlargement	--
Shabbona	593	New plant	Planning initiated
Sheldon	1,036	New plant	--
St. Anne	1,131	New plant	Plans approved
St. Charles	5,870	Enlargement	Planning initiated
Toluca	1,433	Enlargement	Plans approved
Washington	2,456	New plant	Awaiting financing
Watseka	3,744	New plant	--
West Kankakee	4,000	New plant	--
Wenona	967	Replacement	Plans approved
Yorkville	562	New plant	--
Mining (one plant)	Inorganic waste	New plant	Construction authorized
INDIANA			
Ambia	603	New plant	Individual septic tanks to storm sewers
Argos	1,190	New plant	Individual septic tanks to storm sewers
Bremen	2,179	New plant	--
Brook	888	New plant	--
Earl Park	507	New plant	Individual septic tanks to sewer system
Fowler	2,800	New plant	Plans approved, under order
Goodland	1,097	New plant	Individual septic tanks to sewer system
Hamlet	519	New plant	No community sewer system, plan approved
Hebron	949	New plant	Individual septic tanks to storm sewers
Kentland	1,608	New plant	Individual septic tanks to storm sewers
Kouts	732	New plant	Individual septic tanks to storm sewers

See footnotes at end of table.

Table I7. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
INDIANA--Continued			
Lakeville	567	New plant	Individual septic tanks to sewer system, plans approved
LaPorte	16,180	Enlargement	--
Lowell	1,448	New plant	Individual septic tanks to sewer system
Morocco	1,151	New plant	--
North Judson	1,408	New plant	Individual septic tanks to storm sewers
North Liberty	978	New plant	--
Plymouth	5,713	New plant	Plans approved, under order
Remington	869	New plant	Individual septic tanks to sewer system
Rensselaer	3,214	New plant	--
Walkerton	1,178	New plant	--
Westville	523	New plant	No community sewer syatem, plans approved
WISCONSIN			
East Troy:			
Milk plant	PEU***	New plant	--
Mukwonago	700	Replacement	--
Pewaukee	3,800	Replacement	Plans approved
Westchester	300	Enlargement	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

The area of this sub-basin is comparatively small, having only 2,024 square miles--1,786 square miles in Illinois, 133 square miles in Wisconsin, and 105 square miles in Indiana. The north-south length of the region is 92 miles, and the east-west width is 44 miles The Sanitary District of Chicago, which includes the City of Chicago and 71 adjacent communities as well as a large number of industries, comprises 23 percent of the total area.

The principal rivers in the sub-basin are the Chicago, Des Plaines, Grand Calumet, and Little Calumet The Chicago River, which at one time discharged to Lake Michigan, is now connected to the Des Plaines River by the Chicago Sanitary and Ship Canal which joins the Des Plaines at Lockport. While the Calumet River opens to Lake Michigan, its drainage is generally away from the lake into the Calumet-Sag Channel except for periods of heavy local rainfall which sometimes causes this stream to reverse its direction of flow and to discharge into Lake Michigan. Much of this sub-basin originally drained into the lake, but by means of drainage channels, locks, dams, and controlling works, this drainage has been brought into the Illinois-Mississippi system. Pollution of Lake Michigan is discussed in the "Summary Report on Water Pollution--Western Great Lakes Drainage Basin"

The topography of the sub-basin is gently rolling to flat. The soils of the area are classified as a glacial drift, but because of the high concentration of population and industry, very little farming is practiced in this sub-basin Flooding has been a problem on the Little Calumet River and its tributaries. This flooding presents a public health problem because of the polluted condition of the river.

The average annual precipitation is about 32 inches with approximately 60 percent falling during the summer months. The average January temperature is 22°F., while the average July temperature is 72°F. The close proximity of Lake Michigan has a moderating effect on the weather, tending to temper the severe cold waves, and cool the summers.

This sub-basin has a very high population concentration as it includes Chicago, which is the second largest city in the United States. The estimated 1950 population was about 4,900,000 for the sub-basin. The Sanitary District of Chicago waste treatment facilities serve about 4,255,000 people. The population concentration within the Sanitary District is about 9,170 persons per square mile.

Tables A_8 and B_8 show that there are 130 sewered municipalities serving about 4,361,000 people and 15 industries with separate outlets in the sub-basin. The total number of municipalities include 71 municipalities that are served by the Sanitary District of Chicago. In addition to the industrial figure shown, there are an estimated 10,240 industries in the Sanitary District. The wastes of these industries have a population equivalent of approximately 3,450,000 and for the most part, are being treated by the facilities of the Sanitary District, but wastes with a population equivalent of about 450,000 are finding their way to the streams untreated. Steps were taken to eliminate most of this by the end of 1950. The organic pollution load to the watercourse has been determined for 98 percent of the municipal sources and 60 percent of the industrial sources.

Inspection of the table discloses the fact that 110 municipalities with a total population of over 4,280,000 are served by 70 treatment plants, but 32 of these plants have inadequate capacity, and 22 are discharging poor effluents due to improper operation.

Of the 20 municipalities discharging untreated wastes to the stream with a population of 79,364, 10 have populations less than 500, two have populations between 500 and 1,000, two have populations between 1,000 and 2,500, and six have populations over 2,500.

Eighteen new municipal treatment plants are required and 19 treatment works are in need of enlargement or additions, while 13 plants are obsolete and should be replaced.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500...	9	6	4	4
500 to 1,000.	1	2	--	2
1,000 to 2,500.	2	2	7	0
Over 2,500.	6	9	2	1
Total	18	19	13	7

Of the 15 reported industrial sources, 14 have provided some kind of treatment, but 12 of these plants have unsatisfactory capacity and four plants are reported to be improperly operated. One new industrial waste treatment plant is required, but eight plants are in need of enlargement or additions and four are obsolete and should be replaced.

No new treatment facilities were constructed in this sub-basin from 1946 through 1948, but in 1949 one municipal plant was built, and Battery C of the West-Southwest Plant of the Sanitary District of Chicago was completed. There were four municipal treatment plants under construction on July 1, 1950. While construction on ten municipal treatment works was awaiting financing, three municipal and one industrial treatment work were in the "approved plan" stage, and plans for six municipal plants were being prepared. Five municipalities were under order to abate pollution.

The Illinois waterway has been an important reason for the growth of industry in the Chicago area. Nearly 2,900,000 tons of freight were moved through Calumet-Sag Channel alone in 1949. There is a large amount of water used in the Chicago area for industrial water supply, especially for cooling water. The City of Chicago, which obtains its municipal water supply from Lake Michigan, delivers water to 3,600,000 consumers in Chicago as well as to 490,000 consumers located in 49 suburban communities which are also served by the Chicago system. Nearly all of the remaining communities in this sub-basin obtain their municipal water supplies from wells. Stockwatering is of some importance because of the dairying that is carried on in the upper reaches of the Du Page and Des Plaines Rivers.

Although there is some dairying in the region, agriculture is relatively unimportant because the area is so highly industrialized. In 1940, there were about 10,000 manufacturing establishments in the Chicago metropolitan area employing a total of nearly 500,000 persons. The value added to products by manufacture in the area in 1939 was nearly $2,000,000,000. Some of the more important industries are: iron and steel production and related industries; food and kindred products, meat packing the most outstanding; transportation, including land, water, and air; machinery and industrial apparatus manufacturing; textile manufacturing; petroleum refining; non-ferrous metal works; paper products; paints and varnishes, motor vehicles and parts; electronics; and chemical products.

The Du Page River, a tributary to the Des Plaines River, is receiving localized pollution in certain areas. Joliet, discharging wastes with a population equivalent of 87,000 to the Des Plaines River, is also actively planning treatment facilities.

The Chicago Sanitary District discharges effluent from its four major sewage treatment plants into the North Branch of the Chicago River, Chicago Sanitary and Ship Canal, and Calumet-Sag Channel.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as a approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_8. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	127	4,356,552	638,295
Having population data available (Data on pollution load to watercourse incomplete or not available)	3	4,473	Not applicable
Total	130	4,361,025	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_8. Sources of pollution, industrial

Industries	Sources of pollution (in number of plants)*	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	9	14,900
Producing organic wastes	3	Undetermined
Producing inorganic wastes	3	Not applicable
Producing wastes of undetermined type	0	Undetermined
Total	15	---

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_8. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	21	23	18,373
Secondary	89	47	4,263,288
No treatment	20	--	79,364

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_8. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	4	4	0	0
Chemical and allied products.....	2	2	0	0
Products of petroleum and coal.....	4	4	0	0
Fabricated metal products..	1	1	0	0
Miscellaneous.....	4	3	1	0
Total.....	15	14	1	0

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_8. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	70	31	32	7	41	22	7
Industrial	14	1	12	1	9	4	1

Table F_8. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	0	--
1948	0	--	0	--
1949	2*	2,619,955	0	(**)

*Includes Battery C of West-Southwest plant of Sanitary District of Chicago. This plant serves a population of 2,165,455 (PE-5,845,000).

**In 1949 a population equivalent of 450,000 was still being discharged to the watercourse in the Sanitary District. Steps are being taken to eliminate most of this by the end of 1950.

Table G_8. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	18	62,961	1
Enlargement or additions to existing plant	19	169,296	8
Replace existing plant	13	28,415	4
No project** required	33	4,095,130	1
Undetermined	7	5,223	1

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**Includes two municipal minor sources of pollution not included in table E_8 for which existing disposal methods are considered satisfactory for present stream conditions.

Table H_8. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	28	8
Abatement ordered	5	--
Plans under preparation	6	--
Final plans approved	3	1
Construction awaiting financing	10	--
Under construction	3	--
Status undetermined	7	5

Table 1g. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served**	Project requirements	Remarks
ILLINOIS			
Arlington Heights	4,800	Enlargement	Planning initiated
Bensenville (Part)	130	New plant	--
Bensenville	1,870	Replacement	Awaiting financing
Bloom Township Sanitary District	25,000	Enlargement	Awaiting financing
Crete	1,400	Enlargement	--
Deerfield (Part)	500	Replacement	Under orders
Deerfield	1,500	Replacement	Under orders
Downer's Grove Sanitary District	15,000	Replacement	--
East Hazelcrest	100	New plant	--
Grayslake	1,200	Replacement	Construction authorized
Gurnee	120	New plant	--
Hazelcrest	900	Enlargement	--
Highland Park: (Clavey Road)	120	Replacement	--
Highland Park: (Deerfield Ave.)	1,310	Replacement	--
Joliet (North)	10,000	New plant	Awaiting financing
Joliet (South)	62,000	New plant	Awaiting financing
Joliet	15,000	New plant	Awaiting financing
Lansing	5,000	Enlargement	--
Lemont	2,557	New plant	Planning initiated
Libertyville	3,500	Enlargement	Awaiting financing
Libertyville (Part)	1,200	Enlargement	Awaiting financing
Lockport	2,600	New plant	Planning initiated
Olympia Fields	100	Replacement	--
South Chicago Heights	700	New plant	Being connected to Bloom Township Sanitary District in lieu of new plant
Stateville Prison	2,715	Replacement	Plans approved
Tinley Park	1,200	New plant	Awaiting financing
Villa Venice Club	250	Replacement	--
Wheaton Sanitary District	8,000	Enlargement	Financing completed
Wheeling	500	Replacement	Under orders
Yorkfield	200	New plant	--
Chemical and allied products (one plant)	--	Enlargement	Inorganic waste
Oil production industries (four plants)	2,000	Four enlargements	--
Food and kindred products: (Two plants)	1,000	Two replacements	--
(One plant)	1,000	Enlargement	--
INDIANA			
Griffith	2,116	New plant	--
Hammond: Lever Brothers	10,800	Enlargement	Engineer preparing plans
Highland	2,723	New plant	Under order
Munster	4,500	--	Under order, plans approved for connection to Hammond Sanitary District plant

See footnotes at end of table.

Table Ig. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950--Continued

Name	Population served**	Project requirements	Remarks
WISCONSIN			
Union Grove:			
Union Grove Canning Co.....	PEU***	Enlargement	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**For industries the organic waste load is expressed as population equivalent as measured by B.O.D.

***PEU is abbreviation for Population Equivalent Undetermined.

METROPOLITAN ST. LOUIS-MERAMEC RIVER SUB-BASIN

The Meramec River Basin and metropolitan St Louis form this sub-basin. The total area is 5,937 square miles with 4,104 square miles in Missouri and 1,833 square miles in Illinois. The maximum width of the sub-basin is about 70 miles and the length is about 160 miles.

The principal tributary to the Mississippi in this sub-basin is the Meramec River. Its headwaters rise in the Ozark plateau at an elevation of from 1,250 to 1,700 feet above sea level, and the stream enters the Mississippi about 20 miles below St. Louis at an elevation of 400 feet. Major tributaries to the Meramec are the Bourbeuse and Big Rivers, and Huzzah and Curtois Creeks. The Wood River, Piasa Creek, and Cahokia Creek enter the Mississippi from the Illinois side. Many small rivers and creeks enter the Mississippi from both the east and west sides.

The terrain is generally classified as rugged to rolling plains. Steep bluffs have been formed by the rivers and creeks as they cut deep troughs through the surface, especially along the Meramec River and the Mississippi River in the southern part of the sub-basin. In the northern part, the Mississippi flood plain in Illinois expands to a width of about ten miles to form what is called the "American Bottoms."

The Ozark soils are generally thin, rocky, and poor. The flood plains have some good soils, but commonly they are too sandy or gravelly. The loessial soils of the uplands and the alluvial soils in the American Bottoms are excellent and are the basis of intensive truck and dairy farming. A large part of the Meramec basin has a cover of hardwood forests.

The average annual precipitation for the sub-basin is about 39 inches with over 50 percent of the moisture falling in the growing season. The area enjoys a relatively long growing season that extends from 190 days to 200 days. The average January temperature is about 31°F., while the July average is 78°F. Winters are comparatively mild; and since a large portion of the sub-basin is in the Ozark plateau region, the summer heat is not so intense.

Although the population concentration for the sparsely settled rural regions in the southern part of the sub-basin runs as low as 16 persons per square mile, the concentration is almost 1,000 persons per square mile in the metropolitan St. Louis area. The estimated 1950 total population for the sub-basin was about 1,450,000.

St. Louis is one of the major transportation centers of the United States, since it is the focus of numerous highways, railways, airways, and waterways. Most of the barite produced in this country is mined in the vicinity of Old Mines and Potosi, and 41 percent of the domestic lead output is mined in the Bonne Terre vicinity. Other important mining in this area includes coal, fire clays, shale, granite and some iron. Extensive sand and gravel deposits in the Meramec River yield thousands of tons of these building materials each year.

Although agriculture is relatively minor in this area, there is some truck farming and dairy farming in the American Bottoms. In St. Louis and East St. Louis, there are a number of consumer goods manufacturers, some automobile assembling plants, and some iron and steel works. The Meramec basin has economically important recreational facilities including hunting lodges, fishing clubs, resorts, and hotels.

Municipal and industrial wastes are discharged into the Mississippi River from both sides in the St. Louis area, and in addition much of the city's garbage is ground and emptied into the stream through city sewers.

Seventy-eight sewered municipalities serving 1,200,000 people are located in this sub-basin. Of this number, 27 municipalities with population of 1,132,106, provide secondary treatment serving 57,000 people and 13 municipalities provide primary treatment serving 13,000. Of the 38 municipalities which do not provide treatment, six have populations less than 500, six have populations between 500 and 1,000, nine have populations between 1,000 and 2,500 and 17 have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by ten industries, four of which have provided treatment for their wastes.

No information on industrial sources of pollution was reported by the State of Missouri; consequently the data given above on industrial sources of pollution apply to Illinois industries only. At the time this report was being prepared the water pollution control agency in Missouri was engaged in surveying its industrial sources of pollution. When the results of this survey are published a revision of this section of the report will be necessary.

Table E_9 is an analysis of the adequacy of existing treatment facilities. This table indicates that 17 of the municipal waste treatment plants have unsatisfactory capacity and that the operation should be improved at three municipal waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_9. This shows that eight new municipal plants are required and that 11 existing plants need enlargement or additions. Six plants are reported to need replacement.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500...	2	7	2	4
500 to 1,000.	3	--	--	3
1,000 to 2,500.	2	2	3	6
Over 2,500.	1	2	1	16
Total.	8	11	6	29

Two municipal treatment plants were constructed in 1949, and two more municipal works were under construction on July 1, 1950, while final plans have been approved for six municipal treatment plants. One municipality has plans under preparation for a waste treatment plant.

Nearly all legitimate water uses exist in this area. That there is an extensive use of surface water for public water supply is indicated by the fact that 77 of a total of 103 municipal water supplies in the Meramec basin are drawn from surface sources. In addition, there is considerable use of surface water for industrial water supply. Due to the heavy population concentration in the St. Louis area, all water available for recreational use is utilized to its present capacity. It is estimated that over 1,600,000 person-days are devoted to the recreational facilities in the Meramec basin annually.

Nearly all of the municipalities along the Mississippi in the St. Louis area are discharging raw sewage into the stream. The municipal sewage load alone, from the cities of St. Louis, East St. Louis, Alton, and Granite City, is estimated to have a population equivalent of about 1,000,000. The tributaries to the Mississippi in this area are also carrying a large pollution load. According to a report of the Technical Committee for Fisheries of the Upper Mississippi River Conservation Committee, fish taken by commercial fishermen from the Mississippi River between St. Louis and the mouth of the Kaskaskia River at times have a gassy flavor which makes them almost worthless for the market. In the area from Jefferson through Cape Girardeau Counties on the Missouri side, the number of licensed commercial fishermen decreased 42 percent from 1948 to 1949 and licensed tackle decreased in proportion. The take in this area alone decreased from 76,133 pounds in 1947 to 38,280 pounds in 1949. Recent surveys of the damages to the fisheries on the Illinois side of the river probably will show similar or even greater losses.

A definite pollution problem has occurred within the sub-basin as a result of the various types of mine drainage. Numerous fish kills have been called to the attention of and investigated by the Missouri State Conservation Commission.

The information on industrial waste disposal in this sub-basin is very incomplete. A survey to assemble this very pertinent data is planned for the very near future.

In December 1942, the Field Committee for the Meramec Cooperative Investigation was organized by five Federal agencies--the Departments of Agriculture, Interior, and War, the Federal Power Commission, and the Public Health Service,--under the encouragement of the Water Committee of the National Resources Planning Board. The object of this investigation was to determine whether cooperative development of plans for water control and use by interested State and Federal agencies was feasible and to prepare a comprehensive plan for the Meramec basin. A report by this Committee was completed and approved in August 1949.

The following quotations were taken from Appendix No. 5 of a report, entitled "A Program for the Meramec River Basin," 1949. Appendix No. 5 is entitled "A Public Health Program for the Meramec River Basin," 1949 and was prepared by the Missouri Division of Health.

Major Objectives of a Public Health Program for Basin

> Page 21--"All municipalities using the Meramec River or its tributaries for the disposal of sewage wastes should provide complete treatment."
>
> Page 21--"Detailed studies should be made of the sewage disposal facilities of all cabins, camps, and bathing beaches adjacent to the Meramec or its tributaries, and the owners required to provide satisfactory treatment of water-borne sewage including chlorination of all wastes reaching the stream."

Recommendations

No. 6, page 27--"That a workable, practical, and comprehensive State stream pollution law be promoted and a long range program established on a State-wide basis for adequately maintaining satisfactory stream cleanliness and safety."

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_9. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	70	1,199,831	1,146,457
Having population data available (Data on pollution load to watercourse incomplete or not available)	8	2,000	Not applicable
Total	78	1,201,831	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_9. Sources of pollution, industrial

Industries	Sources of pollution* (in number of plants)	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	1	1,200
Producing organic wastes	5	Undetermined
Producing inorganic wastes	4	Not applicable
Producing wastes of undetermined type	0	Undetermined
Total	10	--

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_9. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	13	13	12,981
Secondary	27	29	56,744
No treatment	38	--	1,132,106

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_9. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industrial plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	1	0	1	0
Paper and allied products.....	1	0	1	0
Chemical and allied products.....	1	0	1	0
Products of petroleum and coal.....	3	3	0	0
Leather and leather products.....	1	1	0	0
Primary metal industries...	2	0	2	0
Miscellaneous.....	1	0	1	0
Totals.....	10	4	6	0

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_9. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	42	25	17	0	39	3	0
Industrial	4	--	--	4	--	--	4

Table F_9. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	0	--
1948	0	--	0	--
1949	2	3,050	0	--

Table G_9. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	8	10,304	--
Enlargement or additions to existing plant	11	14,426	--
Replace existing plant	6	10,974	--
No project required[1]	26	45,580	--
Undetermined[2]	29	1,120,547	10

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes one municipal minor source of pollution not included in table E_9 for which existing disposal methods are considered satisfactory for present stream conditions.

[2]Includes 29 municipalities and six industries which are known not to provide treatment, but stream requirements are undetermined.

Table H_9. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	15	--
Abatement ordered	0	--
Plans under preparation	1	--
Final plans approved	6	--
Construction awaiting financing	0	--
Under construction	2	--
Status undetermined	30	10

Table I_9. Project list - municipalities requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served	Project requirements	Remarks
MISSOURI			
Afton Sanitary District	2,000	Enlargement	Plans approved
Bells Villa Sanitary District	800	New plant	--
Cardinal Hills	64	Enlargement	--
Carsonville Sanitary District	3,000	New plant	--
Coburg Lands	300	Enlargement	--
Crescent Acres	--	Enlargement	--
Cuba	500	Enlargement	--
Ferguson Sanitary District	4,200	Enlargement	--
Flat River	2,500	Enlargement	--
Green Park Hills	200	Enlargement	--
Kirkwood: (Leffingwell)	4,800	Replacement	Under construction
Kirkwood	1,400	Replacement	Construction authorized
LeMay Gardens	450	Enlargement	--
Normandy	1,000	New plant	Plans approved
Northdale	144	Replacement	--
Point Breeze Subdivision	--	Enlargement	--
Potosi	630	Replacement	Plans approved
Rose Gardens	160	New plant	--
Union	1,900	New plant	Plans approved
Valley Park	1,000	New plant	Plans approved

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

The 12,615 square miles in this sub-basin are distributed with about 46 percent in the Kaskaskia River Valley, 19 percent in the Big Muddy River Valley, and 35 percent in the remaining drainage area of the smaller tributaries. The length of the sub-basin is about 240 miles along a northeast-southwest line and the width is about 75 miles on a northwest-southeast line.

Most of the area lies in the State of Illinois with the smaller portion being in the State of Missouri. The highest land in the drainage area has an elevation of approximately 1,000 feet above sea level although most of the area is much lower. The area includes the western part of the southernmost portion of the State of Illinois.

In addition to the Kaskaskia and Big Muddy, the tributaries to the Mississippi include the Cache and Whitewater Rivers. The Kaskaskia is the largest of these, having a length of about 300 miles while the Cache with a length of about 70 miles, is the shortest.

The Mississippi River in this section is a broad deep stream with steep bluffs bordering a rather narrow flood plain valley. Levees along the stream bank prevent encroachment of flood waters upon this flood plain. Some of the sub-basin was covered during the glacier period and was blanketed with a fine till. This till has been supplemented by rich soils deposited by numerous floods which covered portions of the sub-basin in the past. As a result the ground is very fertile and productive.

The average annual precipitation in the drainage area is about 43 inches, with about 50 percent falling in the warm season. The growing season is about 200 days, being one of the longest for the entire State of Illinois. The average January temperature is 34°F., while the average July temperature is about 78°F. The favorable growing climate has brought enormous crop yields, especially in the bottom lands.

The estimated 1950 population for the sub-basin was nearly 750,000. Population concentrations range from about 20 persons per square mile in Bollinger County, Missouri, to over 250 persons per square mile in St. Clair County, Illinois. Major cities in the sub-basin are Belleville, Centralia, Cape Girardeau, West Frankfort, and Mt. Vernon

The economy of the sub-basin is supported mainly by the coal mining industry and by agriculture. The region contains one of the leading coal mining areas in the country. Other valuable mineral deposits include limestone, oil, silica, sand, gravel, shale, and clay. Sand for glass manufacturing is mined, and stone is quarried in the St. Peter sandstone at the base of the Crystal City escarpment. The area is well covered by railway and highway transportation as well as the very important Mississippi River waterway. The region is important agriculturally but manufacturing is of minor significance.

Seventy-one sewered municipalities serving 293,000 people are located in this sub-basin. Of this number, 50 municipalities provide secondary treatment serving 217,000 people and 12 municipalities provide primary treatment serving 30,700 people. Of the nine municipalities with 4,500 population, which do not provide treatment, one has a population of less than 500. Two have populations between 1,000 and 2,500, and six have populations over 2,500.

Industrial wastes are discharged to the streams through separate outlets by 29 industries, seven of which have provided treatment for their wastes.

Table E_{10} is an analysis of the adequacy of existing treatment facilities. This table indicates that 26 of the municipal waste treatment plants have unsatisfactory capacity and that the operation should be improved at 13 municipal and two industrial waste treatment plants.

The requirements for municipal and industrial waste treatment plants are shown in table G_{10}. This shows that six new municipal plants are needed and that 18 existing plants need enlargements or additions. Eight plants are reported to need replacement. It is also noted that nine new industrial waste treatment plants are needed.

An analysis of the municipal waste treatment requirements by population groups shows the following distribution:

Population group	New plant	Enlargement or additions to existing plant	Replace existing plant	Undetermined
Less than 500...	1	2	0	0
500 to 1,000.	0	1	1	0
1,000 to 2,500.	2	6	3	0
Over 2,500.	3	9	4	3
Total..	6	18	8	3

No information on industrial sources of pollution has been reported by the State of Missouri. All data on industrial pollutional sources mentioned in this sub-basin section are concerned with Illinois industries. At the time this report was being prepared the water pollution control agency in Missouri was engaged in surveying its industrial sources of pollution. When the results of this survey are published a revision of this section of the report will be necessary.

In the Illinois part of the sub-basin seven out of 29 industrial establishments have treatment for their wastes. These treatment plants all have adequate capacity, but two plants are being improperly operated. Nine new Illinois industrial waste treatment plants are needed and requirements for two industries are undetermined.

Three municipal treatment plants and one industrial plant were constructed in 1949. One municipal treatment plant was under construction on July 1, 1950, and plans for four municipal treatment works had been approved. Two municipalities were under order to abate pollution.

Coal mine wastes have damaged municipal water supplies and stockwatering in portions of the Big Muddy drainage system. Municipal wastes have caused local nuisance in several short stretches of stream in the Kaskaskia drainage basin. Soil erosion has caused high turbidities in the Mississippi as well as in the Big Muddy and other tributaries, and as a result municipal water supplies and recreational water uses are impaired.

The summarized data on sources of pollution, treatment facilities, needs, etc., are presented in the tables which follow. Attention is invited to the fact that in many cases the number of persons served by a particular sewer system could not be readily determined. The information included in the "population served" column of tables A, C, G, and I, therefore, is the best estimate possible. Often the 1940 population was used as an approximation, even though it is realized that probably in no case are all persons connected to the municipal sewer system. In the case of industry (Tables B and I), the population equivalent of the waste was used when known.

The tables contained in this report have been developed from basic data drawn from the files of the various cooperating State water pollution control agencies and represent material readily available. Since some of the information is preliminary in nature and time has not permitted field checking by these cooperating agencies, it does not necessarily represent their final judgment on treatment requirements. Accordingly, no conclusions may be drawn from the relative lengths of table I, since further field investigations will undoubtedly produce additional information which will necessitate altering these tables.

Table A_{10}. Sources of pollution, municipal

Municipalities*	Sources of pollution (in number of municipalities)	Population served by sewerage system	Amount of pollution discharged to watercourse (in terms of equivalent number of people)**
Having data on pollution load discharged to watercourse	60	238,034	79,666
Having population data available (Data on pollution load to watercourse incomplete or not available)	11	54,601	Not applicable
Total	71	292,635	--

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

**Includes industrial wastes discharged into municipal sewerage systems.

Table B_{10}. Sources of pollution, industrial

Industries	Sources of pollution (in number of plants)*	Amount of pollution discharged to watercourse (in terms of equivalent number of people)
Producing organic wastes	0	--
Producing organic wastes	9	Undetermined
Producing inorganic wastes	17	Not applicable
Producing wastes of undetermined type	3	Undetermined
Total	29	--

*Industries having separate outlets and discharging wastes directly to watercourse.

Table C_{10}. Existing treatment facilities, municipal

Degree of treatment provided	Number		Population served
	Municipalities*	Plants	
Primary	12	14	30,675
Secondary	50	51	216,939
No treatment	9	--	45,021

*Includes incorporated or unincorporated municipalities; other legal bodies as sanitary districts, counties, towns; significant institutions, resorts, recreational centers, or other population centers, and industries discharging sanitary sewage wastes directly to watercourse.

Table D_{10}. Existing treatment facilities, industrial*

Type industry	Number of plants	Number of industriel plants having:		
		Treatment facilities	No treatment facilities	Undetermined facilities
Food and kindred products..	5	3	2	0
Chemical and allied products.....	1	1	0	0
Products of petroleum and coal.....	3	2	--	1
Miscellaneous.....	1	1	0	0
Mine drainage.....	19	0	19	0
Total.....	29	7	21	1

*Industries having separate outlets and discharging wastes directly to watercourse.

Table E_{10}. Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to:					
		Capacity			Operation		
		Satisfactory	Unsatisfactory	Undetermined	Satisfactory	Unsatisfactory	Undetermined
Municipal	65	39	26	0	52	13	0
Industrial	7	6	--	1	4	2	1

Table F_{10}. Progress in pollution abatement

Year	Municipal		Industrial	
	Plants completed	Design population	Plants completed	Amount of waste treated (in terms of equivalent number of people)
1946	0	--	0	--
1947	0	--	0	--
1948	0	--	0	--
1949	3	6,640	1	675

Table G_{10}. Requirements for municipal and industrial waste treatment plants*

Requirements	Municipal		Industrial
	Number	Population served by facilities	Number
New plant	6	20,621	9
Enlargement or additions to existing plant	18	100,398	--
Replace existing plant	8	21,078	--
No project required[1]	39	126,138	18
Undetermined[2]	3	24,400	2

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

[1]Includes 12 industrial minor sources of pollution not included in table E_{10} for which existing disposal methods are considered satisfactory for present stream conditions.

[2]Includes three municipalities which are known not to provide treatment, but stream requirements are undetermined.

Table H_{10}. Status of treatment works project to abate pollution, July 1, 1950

Status of project	Number	
	Municipal	Industrial
No formal action	25	9
Abatement ordered	2	--
Plans under preparation	0	--
Final plans approved	4	--
Construction awaiting financing	0	--
Under construction	1	--
Status undetermined	5	2

Table I_{10}. Project list - municipalities and industries requiring improvements for abatement of pollution*, July 1, 1950

Name	Population served	Project requirements	Remarks
ILLINOIS			
Chester	5,110	Replacement	--
Jonesboro:			
(Plant A)	1,070	Enlargement	--
(Plant B)	450	Enlargement	--
Menard Branch:			
Illinois State			
Penitentiary	4,000	New plant	Plans approved
Lebanon	1,867	Enlargement	--
Mt. Vernon	14,724	Enlargement	Under order
Murphysboro	8,976	New plant	--
Nokomis	2,562	Replacement	--
Pana:			
(North outlet)	2,300	Replacement	Plans approved
(South outlet)	3,500	Replacement	Plans approved
Royalton	1,772	Enlargement	--
Sesser	2,117	Enlargement	--
Shelbyville	4,092	New plant	Under order; plans approved
Sparta	3,664	Enlargement	--
Vandalia	5,288	Enlargement	--
Vandalia State Farm	1,300	Enlargement	--
Zeigler	3,006	Replacement	--
Food and kindred products			
(two plants)	PEU**	Two new plants	--
Mining (seven plants)	Inorganic wastes	Seven new plants	--
MISSOURI			
Hereulaneum	500	New plant	--
Jackson:			
(East Plant)	1,000	Replacement	--
(West Plant)	1,600	Replacement	--
St. Genevieve	290	Enlargement	--
St. Genevieve	1,880	New plant	--

*The needs set forth in this table are based on presently available information. However, future studies and evaluations may result in some changes in these needs.

**PEU is abbreviation for Population Equivalent Undetermined.

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