A STUDY OF THE EFFECTS OF THE ARKANSAS NAVIGATION PROJECT ON THE WATER QUALITY OF THE ARKANSAS RIVER AND SELECTED TRIBUTARIES

By

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CHAPTER I

INTRODUCTION

A. General

When in 1970, the U. S. Army Corps of Engineers completes the Arkansas River Navigation System to Catoosa, Eastern Oklahoma will began to enter into a highly industuralized state. This industry will bring more opportunities and wealth to this part of Oklahoma than even the most optimistic supporter of this project could foresee. But it will also bring a problem that will be totally new to this part of the country--Water Pollution.

Today along the Arkansas River there is little, if any, problem with water pollution. Oklahoma's water quality standards for its streams and rivers is one of the best, if not the best, in the United States. But will they remain in this condition in the industrial future? The governor of this state works for industrial development, and every candidate for governor promises to try harder. Promoting new industry is a principal occupation of chambers of commerce. This state has an industrial commission to run advertisements and organize conferences to inform business leaders of this state's advantages.

Water for use, and water to carry off wastes are powerful inducements to locating an industry. The state with a river to pollute has a powerful argument for the location of new industry. The one with water restrictions is not encouraging industry.

B. Justification of this Research

Because of the extensive problems that other cities and states have encountered with water pollution along navigation systems, it was felt that research into water pollution in the Arkansas River Basin was justified.

C. Objectives

The primary objective of this study was to determine if the Arkansas River Basin is polluted now, the effect of industry on pollution in the future, and the methods and procedures of pollution control agencies.

It is hoped that the information thus obtained will be of use in the future to aid the people of Oklahoma in insuring that the Arkansas River will be a clean and unpolluted body of water.

CHAPTER II

LITERATURE SURVEY

A. Types of Pollutants

McKee and Wolf (1) stated that any substance that may enter or be contained in ground or surface waters is deemed to be a "potential" pollutant. Potential in the sense that, if concentrated sufficiently, it can adversely and unreasonable affect such waters for one or more beneficial uses; and yet, if diluted adequately, it will be harmless to all beneficial uses. In view of this definition, every known substance is a potential pollutant. These pollutants that enter the waterway, as a result of man's domestic, industrial, and agricultural activities, have been grouped into the following cases (2):

1. Domestic Sewage and Other Oxygen-Demanding Wastes

   These are the organic substances that come from humans and from industries such as food processing; in pure waters, they are reduced by bacteria.

2. Infectious Agents

   These are organisms that cause typhiod fever,

virus infections, and intestinal disorders. They come from cities, tanneries, and slaughter houses.

3. Plant Nutrients, such as Nitrates and Phosphates

Algae and water plants feed on minerals in solution. Although they occur naturally in streams, when introduced in large quantities, they stimulate excessive growth of the algae and water plants and set up a complex water-destroying cycle.

4. Organic Chemical Exotics

These are new chemical substances such as detergents, weed killers, and pesticides.

5. Other Minerals and Chemicals

Of these, salts and acids are the most common; they include many metals, metal compounds, and manufactured chemicals.

6. Radioactive Substances

Radioactivity of water may be increased by atmospheric nuclear detonations and the resulting fallout products. The major source is the direct action of the atomic-energy industry in mining and separating uranium, in the manufacture of atomic weapons, and in the production of radio-isotopes in piles and reactors.

7. Heat

Temperature changes in bodies of water may result from natural climatic phenomena or from the introduction of industrial wastes, such as distillery effluents or discharges of cooling waters used by many industries.

B. Methods of Treatment

1. General

Concern with water quality, as a factor in public health, goes back more than a century, to the bacteriological researches of Louis Pasteur (3). Prior to the acceptance of Pasteur's theories about water-borne disease, little attempt was made to improve the make-up of water delivered through public supply systems. The Public Health Service Act of 1912 established the agency of that name and authorized investigations of water pollution impairments of man.

In general, the quality of water bodies can be improved either by treating entering wastes or by increasing dilution. As long as dilution water can be made available and the focus is upon maintenance of quality during low-flow periods, treatment and dilution are technical substitutes.

2. Treatment of Waste Water

Oklahoma requires the equivalent of secondary

treatment, which usually reduces BOD by about 75 to 85 per cent. This should be sufficient, for the present, along the Arkansas River Basin, providing, 100 per cent of the sources of pollution provide secondary treatment. At the present time, however, the city of Tulsa is discharging over 13 MGD of waste water with only primary treatment. (4)

Secondary treatment along the Arkansas River Basin, in the near future, may prove to be inadequate. The wastes may require tertiary treatment. Lake Tahoe (5) in 1950, was considered one of the world's three purest lakes. Before 1956, it was a drowsy summer resort for a few thousand residents. Between 1956 and 1964, Tahoe was attracting 6 million visitors a year. The lovely blue waters of Tahoe had become infected with an ugly growth of algae, which fed on the nutrients carried by the waste water. The South Tahoe Public Utility District (6) recently completed construction of a new waste treatment facility that will provide a water of drinkable quality. This water is being piped 27 miles over a mountain to be used for irrigation.

Tertiary treatment is considered by pollution authorities, as the only means of further reducing pollution and cleaning up the heavily polluted bodies of water (7).

3. Dilution

The only sources of dilution, along the Arkansas

River Basin, beyond that provided by natural flow are the reservoirs located on it. None of these reservoirs, at the present time, provide water storage for water quality control. If and when Wister Reservoir (8), on the Poteau River, is modified; it will provide 53 MGD for water quality control for the Poteau River below it. The proposed Skiatook Reservoir on Hominy Creek (9) will include water quality control storage. The Corps of Engineers (10), at the present time, are conducting studies on dilution below Keystone Reservoir. They are investigating the possibility of storing power releases behind the reregulation dam below Keystone for release at times when dilution is needed.

Dilution by flow augmentation is feasible for streams but not for lakes. Flow augmentation could actually increase pollution in lakes by carrying greater quantities of partially assimilated wastes into these water bodies.

Water, for deeper parts of reservoirs, is often virtually devoid of oxygen, owing to the combined effect of biochemical oxygen demand and reservoir stratification. These deeper waters are, for the most part, in an anaerobic condition and noxious hydrogen sulfide and other gases are produced. Hydrogen sulfide can bring about catastrophic kills of fish, both in the lake and when discharged into a stream of water (11). This condition has already been experienced at Keystone Reservoir during releases from the deeper depths.

An alternative method of utilizing the dilution potentitalities of streamflow is to withhold wastes in small impoundments and releasing them during periods of high streamflow. FWPCA (4) recommended that a facility for withholding approximately 2,400 acre-feet annually of adequately treated city of Tulsa wastes for Bird Creek for up to 30 days should be provided at the earliest possible date. To this date, this still has not been done by the city of Tulsa.

C. Case Histories

Water pollution control, all over the world, is a constant game of "catchup." Water pollution control agencies require secondary treatment, only to find that this is not adequate, and tertiary treatment is required. The West German Government (2) has started a 10-year, $2.5 billion program to purify the Rhine River, which is in danger of becoming the world's biggest open-sewer system. FWPCA reported that it would cost $1.3 billion to clean up Lake Eric (12). A team of engineering firms reported to the California State Water Resources Control Board (13) that it will take $2 billion to clean up future water pollution in the San Francisco Bay area. The Italian Pollution Control Agency (14) announced recently that the entire 970,000 square mile Mediterranean Sea is polluted. There is fear that the ecological deterioration of the Mediterranean has gone so far that it is

irreversible. The Curahoge River emptying into Lake Erie, at Cleveland, Ohio, is so oily it has been declared a fire hazard. During the week of July 10, 1969, this river caught fire and before firemen could extinguish it, a large section of the river began to burn. The fire spread to two railroad bridges spanning the river and caused $50,000 in damage. This fire was less than a mile from the center of Cleveland, Ohio (15). The Houston Ship Channel is considered by many as the filthiest, worst-polluted body of water today.

Some river basins are making excellent progress in pollution control. Two very good examples are the Ohio River Basin and the Ruhr River Basin in West Germany.

1. Ruhr River Basin

The small streams of the Ruhr not only support a tremendous industrial development and a massive population, but they do so while providing a generally high level of amenities and recreational opportunity. The water resources associations of the Ruhr area are the only organizations in the world that have designed, built, and operated regional systems for waste disposal and water supply (2). They have developed comparatively sophisticated methods of distributing the cost of their operations by levying charges on the effluents discharged in their respective regions. Members of the associations are principally, the municipal and rural administrative

districts, coal mines, and industrial enterprises, and membership is compulsory.

The Ruhr River Basin is comprised of five small rivers, these are the Ruhr, Lippe, Wupper, Emscher, and the Niers. The Emscher, is fully lined with concrete and serves one purpose only--effluent discharge. The only quality objective is the avoidance of aesthetic nuisance, and this is achieved by primary treatments of effluents entering the stream. Also, by the use of plantings, gentle curves of the canalized stream, and attractive design of bridges, care is taken to give the Emscher as pleasing an appearance as circumstances permit.

Near the mouth of the Emscher River the entire flow is treated mechanically to remove most of the suspended matter. The water resources association is now planning for biological treatment of the Emscher River. A test plant is achieving 90 per cent degradation of phenols (13).

The general objective of the other four rivers is to maintain water quality suitable for water supply and recreation. Some wastes enter these streams but not enough to lower quality below that suitable for water supply and recreation. All other wastes are pumped into the Emscher River.

2. Ohio River Basin

The most extensive river-basin antipollution operation in the United States is the Ohio River Valley Water

Sanitation Commission (2). It was established in 1948 by interstate compact and, as required for such compacts, approved by Congress. The area covers some 150,000 square miles, and includes parts of Illinois, Indiana, Kentucky, New York, Pennsylvania, Virginia, and West Virginia. Industries and communities are not members but are governed by the applicable laws of the states.

A centrol monitoring system in Cincinnati inquires once every hour about the condition of the Ohio River. Its signal goes out over long-distance telephone lines to 13 robot monitors submerged along the river system. These monitors test the quality of the water flowing through their sensing units. The main unit in Cincinnati records the answers on an automatic typewriter and tape. This system enables the commission to alert affected cities or industries at once if pollution on the river becomes hazardous. Inspections are also made from the air and from boats.

The commission has attacked and partially solved a staggering problem. By 1948, the Ohio had reached the point where it was a health hazard to millions of Americans and could not continue to serve the needs of industry. Since then, more than $1 billion has been invested in sewage disposal (5). The Ohio River, though still polluted, is cleaner now than it has been at any time during the past 21 years because of the activities of this commission (13).

CHAPTER III

METHODS OF STUDY

In order to evaluate the effect of the Arkansas River Navigation Project on the water quality of the Arkansas River and selected tributaries, this study was conducted in two phases. Phase one consisted of bringing together all available documents, engineering reports, and other publications regarding the development of the Arkansas River Navigation Project and the development of industries within the area. This data was then analyzed to obtain an overall projection of the water quality of the Arkansas River Basin. Phase two consisted of personal interviews with responsible officials of various agencies involved in the development of navigation and the development of industry. These agencies were the U. S. Army Corps of Engineers, City of Tulsa-Rogers County Port Authority, and the Arkansas River Development Association.

During phase two, no formal questionnaire was used in the interviews. During these interviews, the main objectives were to determine if there were any individual or coordinated plans for pollution control and to evaluate each agency's opinions on the development of industry along the Arkansas River Navigation Project.

CHAPTER IV

RESULTS

A. History of Navigation Project

The Arkansas River Navigation Project was authorized by the River and Harbor Act of July 24, 1946. It will provide navigation from the Mississippi River, through Arkansas, to Catoosa, Oklahoma.

The history of the navigation project has been reported by the U. S. Army Corps of Engineers (16). The project starts on the Mississippi River, goes 10 miles up the White River, then 10 miles across the manmade Arkansas Post Canal, where it joins the Arkansas River. The system continues up the Arkansas River to Muskogee, Oklahoma, where the navigation route turns up the Verdigris River for the last 50 miles before reaching the head of navigation at the Port of Catoosa. Minimum channel depth will be nine feet throughout, the minimum channel width will be 250 feet on the Arkansas and 150 feet on the Verdigris.

A series of 17 locks and dams along the 440 mile navigation route raises the water 420 feet, with the steps being between 14 and 54 feet. There are 12 locks and dams in Arkansas and five in Oklahoma. All of the locks in the entire stretch of the navigation system are the same

size. They are 110 feet wide and 600 feet long.

Three upstream reservoirs in the system are Eufaula Dam, on the Canadian River, Oologah Dam, on the Verdigris River, and Keystone Dam, on the Arkansas River. These multiple-purpose dams will contribute to streamflow regulation and retain a large part of the river's tremendous sediment load.

Construction of the navigation system is of such magnitude that it dwarfs the Panama Canal project, both in engineering obstacles and in monetary costs. The ultimate cost of the project will be $1.2 billion (four times the cost of the Panama Canal).

The navigation system was designed by the U. S. Army Corps of Engineers with district offices in Tulsa, Oklahoma and Little Rock, Arkansas. The construction was performed by private contractors under the supervision of the Corps of Engineers.

Figure 1 shows a map of the project which in turn shows the route of the project and the locks and dams involved.

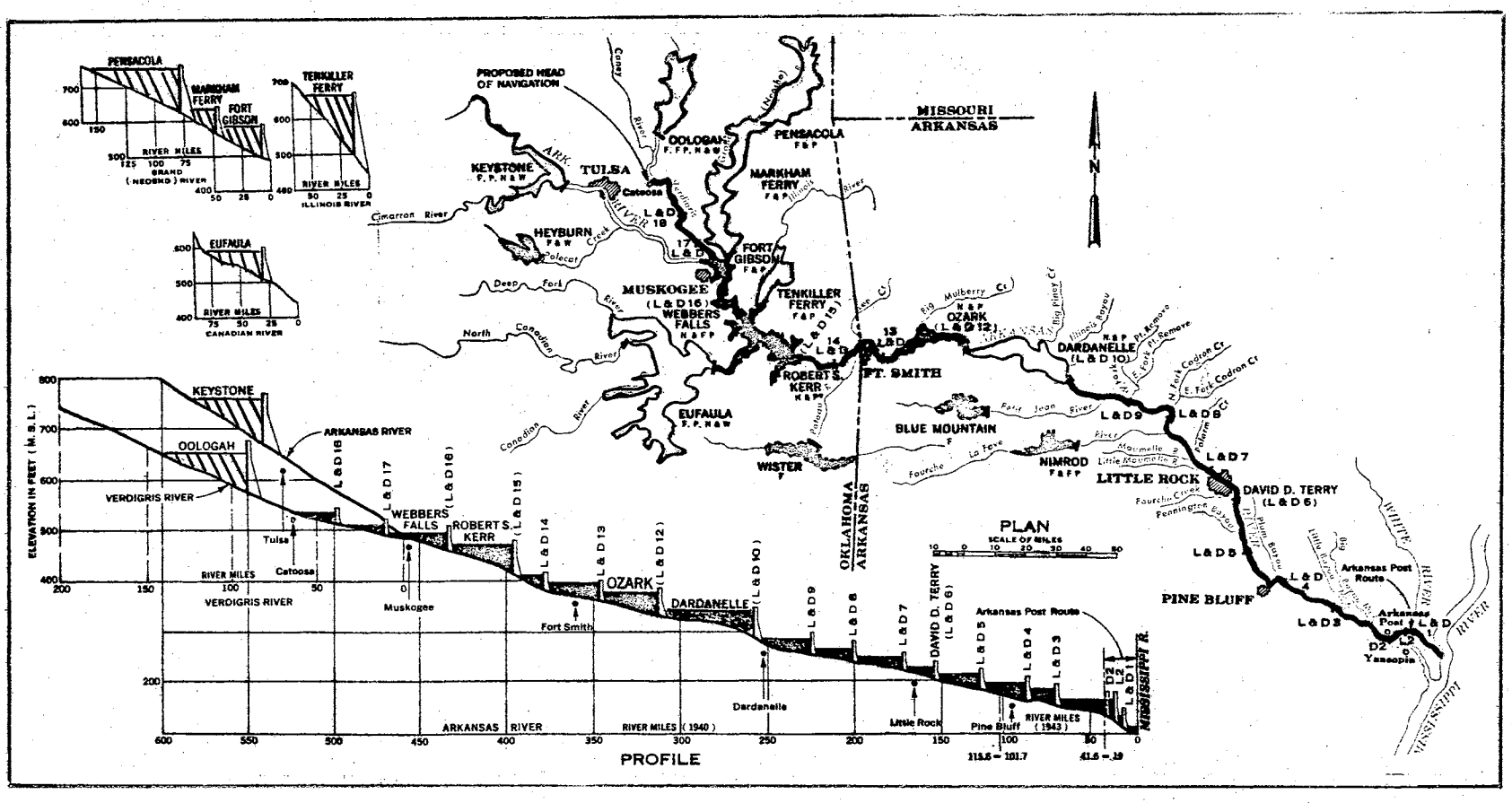

Figure -1-

MAP OF NAVIGATION SYSTEM

B. History of the Port of Catoosa and Industrial Park

The Port of Catoosa is located about 16 miles northeast of downtown Tulsa, and about nine miles southwest of Claremore. The port terminal (17) is planned to be developed in stages as required by increasing commerce. The master plan of ultimate development is shown in figure 2, the first phase of port development is shown in figure 3, and the plan for the industrial park is shown in figure 4. The port terminal area is 513 acres and the industrial park area is 1,240 acres.

The port will contain a service center which will provide fire and police protection. For personnel services it may include a restaurant, grocery store, service station and garage, barber shop, laundry and cleaners, bank, truck and rail reciprocal switching service, and recreational clubs.

All necessary utility services will be made available to users of the terminal and industrial park. Water and sewage utilities will be provided by the Port Authority. Electric power, natural gas, and telephone service will be supplied by companies specilizing in these services.

The approved plans provide for a water supply and distribution system with a capacity of at least 2.0 MGD of potable water. The City of Tulsa and the Tulsa Metropolitan Water Authority has applied to the Oklahoma Water Resources Board for the right to take 85 MGD from the Verdigris River for industrial use, and has requested

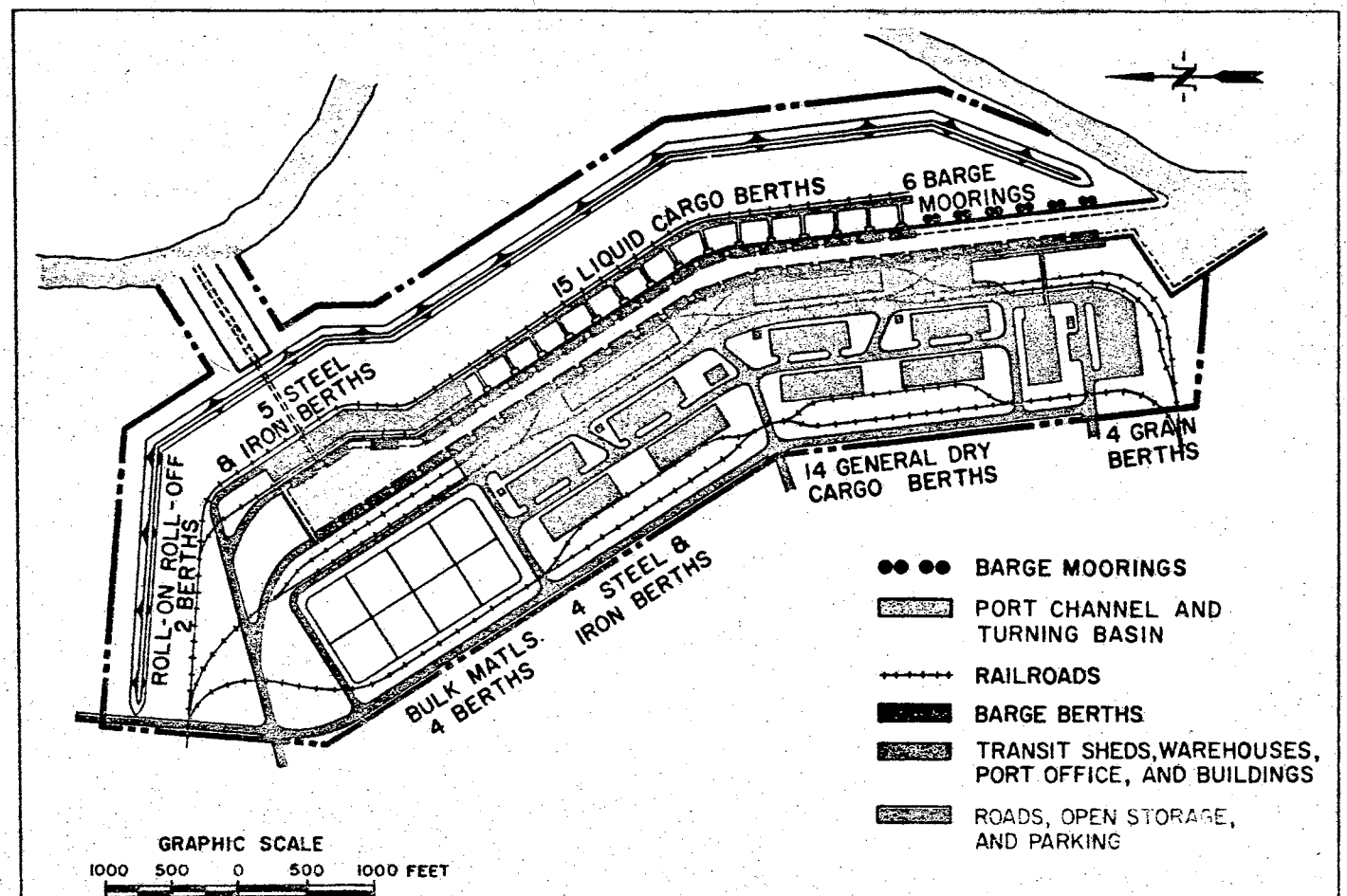

Figure -2-

ULTIMATE PORT DEVELOPMENT

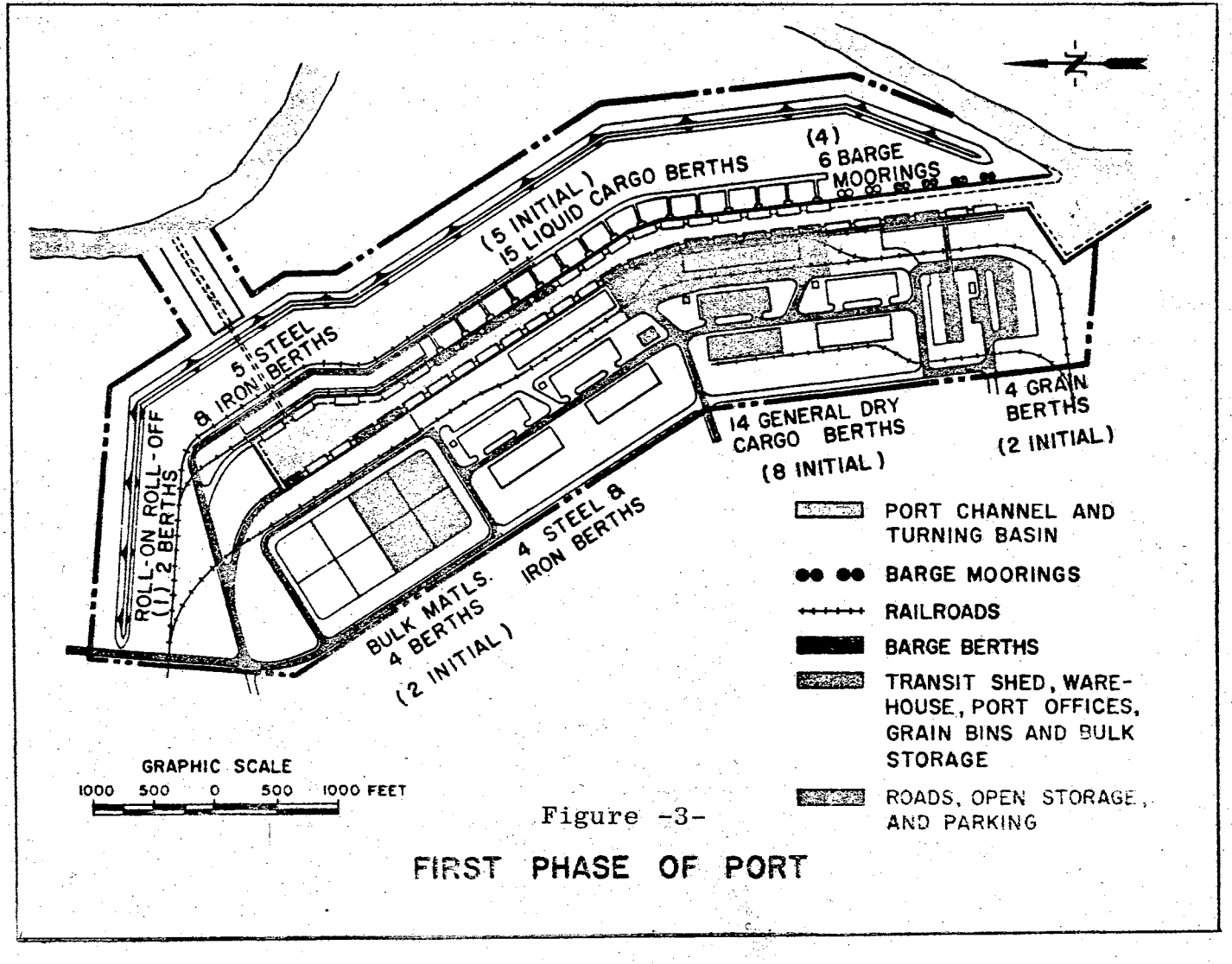

Figure -3-

FIRST PHASE OF PORT

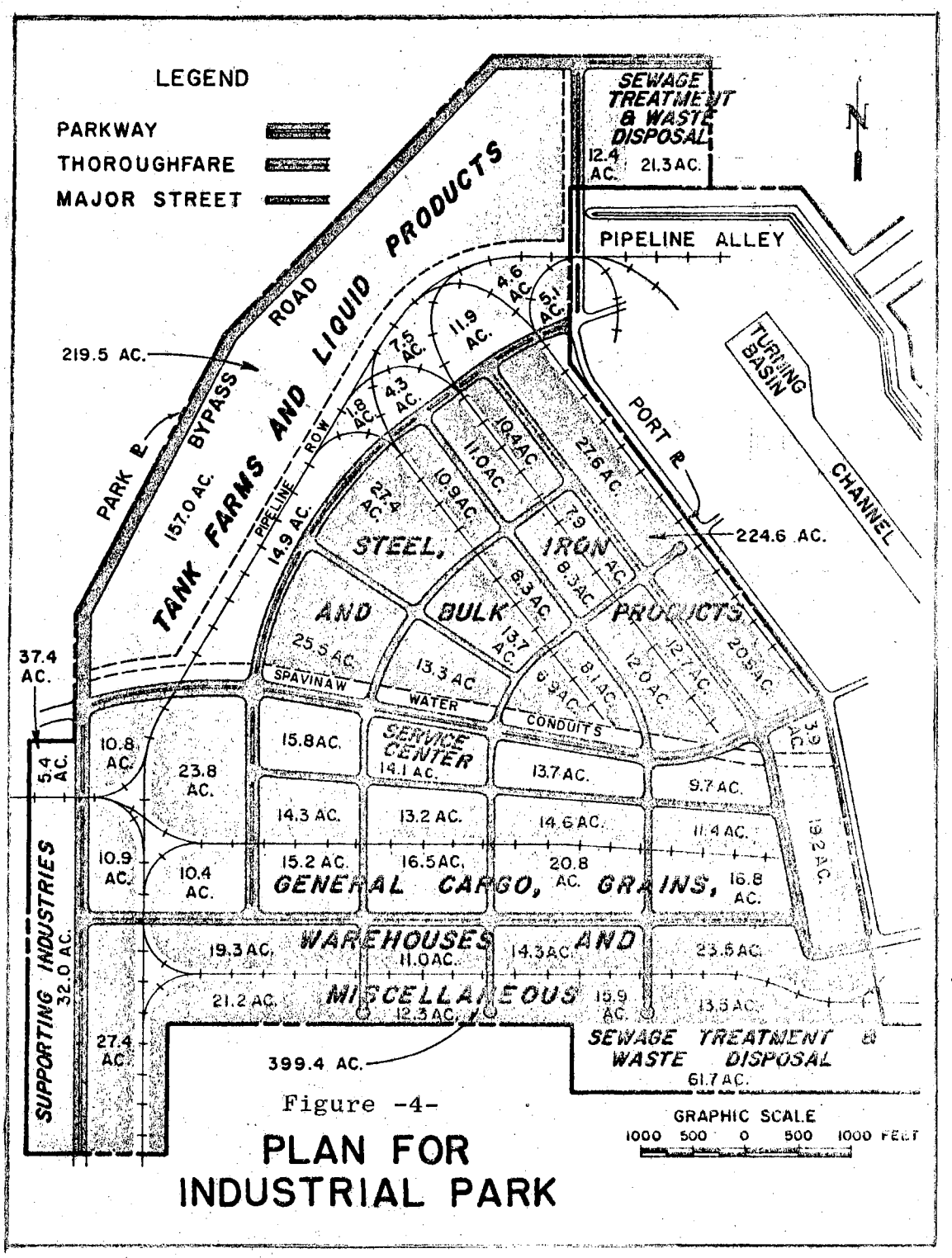

Figure -4-

PLAN FOR INDUSTRIAL PARK

the U. S. Army Corps of Engineers, to reserve storage space in the Oologah Reservoir for this amount. Use of this industrial water supply is to began in 1970. This water will not be treated. It will be used for cooling, washing, and other industrial use.

The sewage treatment will be handled by two oxidation ponds with a surface area of 95.4 acres. The effluent will be discharged into the Verdigris River. If wastes from processes using industrial water do not contain harmful chemical or organic material, they may be discharged into the storm sewer system. But, if the industrial use adds harmful or obnoxious chemical or organic matter, the owner of the plant producing such wastes shall provide separate treatment facilities at its own expense to render the wastes harmless and suitable for discharge into public water-courses under the regulations of the Oklahoma State Department of Health.

The planners of the port considered that rainfall runoff into the port channel would not provide satisfactory flushing in the artificial harbor. So, provisions will be made to flush out the harbor with water from the Verdigris River.

C. Sources of Pollution

1. Municipal

Municipal wastes are the major sources of pollution in the Arkansas River Basin at the present time. Oklahoma's

laws require that all wastes discharged to the waters of the state receive the equivalent of secondary treatment prior to being discharged. In December, 1966 there were some 29 cities and towns along the Arkansas River Basin that were not in compliance with these laws (4). It should be pointed out, that most of these towns and cities have or plan to comply with these laws, but it depends on one very important item--local bond issues. Kneese (5) stated it very well when he said, "A society that allows waste dischargers to neglect the offsite costs of waste disposal will, not only devote too few resources to treatment of waste, but will also produce too must waste in view of the damge it causes."

During the summer of 1965 the Federal Water Pollution Control Administration (4) ran a study on the Arkansas River and tributaries from Tulsa to Muskogee. Their findings were that a serious pollution condition existed in Bird Creek during the time of the study. That, even though, the three City of Tulsa water pollution control plants provided secondary treatment, the stream will be unable to assimilate this quantity of effluent during low streamflows without excessive degradation. The head of navigation at Catoosa will be materially affected by the quality of Bird Creek and navigation channel modifications will result in slowing the recovery from degradation. They also found that there may be an increased algae production

in Keystone and Oologah reservoirs due to nitrates and phosphates.

2. Industrial

Little, if any, information on industrial pollution along the Arkansas River Basin was known until the Federal Water Pollution Control Administration ran its study in 1965. Table I shows their findings pertaining to industrial wastes and treatment in the Arkansas River Basin. When Oklahoma's Water Quality Standards (21) were submitted to the Federal Water Pollution Control Administration for approval, it stated that on or before January 1, 1969, a list would be furnished to FWPCA on all industrial wastes discharged into the Arkansas River Basin. At the time of this study this list has not been prepared. This is not surprising, the fear of losing an industry because of rigid pollution laws is felt from California to Maine. In Ohio, the State Pollution Control Board has been prohibited by state law from disclosing the sources and nature of industrial pollution without the expressed consent of the industries affected. Industrial pollution accounts for two-thirds of the total water pollution in the United States (2).

D. Potential Industrial Development

Water navigation is available at almost all large industrial centers. Growth along waterways is simply a matter of economics. To move a ton mile of heavy bulk

Table I

PARTIAL LIST OF INDUSTRIAL WASTES PRODUCTION AND TREATMENT DATE AS OF 1965 (4)

City	Industry	Product	Water Use MGD	Type Waste	Treated	Q. Waste MGD	Discharged to
Barnsdall	Petrolite Corp., Bareco Div.	Wax	.720	Cooling Water	No	.144	Bird Creek
Bartlesville	National Zinc Co.	Zinc Sulphuric Acid	.543	Cooling Water	Yes	.373	Caney River
	Phillips 66	Research Lab's	.533	Cooling Water	Yes	.144	Caney River
Muskogee	Corning Glass Co.	Glassware	.295	Process Water	No	.295	Arkansas River
	Ransteel Metal-urgical Corp.	Refractory Metals	.355	Slightly Acid	Yes	.355	Arkansas River
Tulsa	Albert & Harlow Caterpillar, Inc.	Repair Tractors	.011	Soap, Oil, Grease, Kerosene	No	.011	City Sanitary Sewers
	American Airlines	Repair Airplane	.685	Indus-trial Sanitary	Yes No	.323 .323	Subsurface Well City Sanitary Sewers
	Automation Industries, Inc.	Aircraft & Missle Parts	.003	Casutic Soda	No	.003	City Sanitary Sewers

Table I (Continued)

City	Industry	Product	Water Use MGD	Type Waste	Treated	Q. Waste MGD	Discharged to
Tulsa	Banfield Packing Company	Beef, Pork	.0033	Blood	No	.0033	City Sanitary Sewers
	Dewey Portland Cement Company	Cement	.516	Cooling Water	Yes	.516	Mingo Creek
	Douglas Aircraft	Repair Airplanes	.840	Toxic Metals	Yes	.083	Mingo Creek
				Sanitary	No	.575	City Sanitary Sewers
	Joe S. Brown & Son Packing Company	Beef	.0048	Blood	No	.0048	City Sanitary Sewers
	Nipak, Inc.	Fertilizer	.518	Calcium, Phosphate	Yes	.040	Arkansas River
	Johnson-Fagg Engineering Co.	Oilfield Products	.008	Grease, Oil	Yes	.008	Mingo Creek
	Pure Milk	Dairy Products	.705	Dairy Waste	No	.705	City Sanitary Sewers
	Ozark-Mahoning Company	Sulphuric Acid	.030	Process Cooling	Yes	.015	Arkansas River

Table I (Continued)

City	Industry	Product	Water Use MGD	Type Waste	Treated	Q. Waste MGD	Discharged to
	Sargent Company	Aircraft Components	.003	Cooling Water	No	.003	Mingo Creek
	Sinclair Refining Company	Demulsifying Plant	.200	Cooling Water, Oil Grease	Yes	.180 .020	Arkansas River
	Sunray-DX Oil Co.	Refined Petroleum	7.50	Phenols and Cooling	Yes	4.032	Arkansas River
	Texaco, Inc.	Refined Petroleum	3.53	Phenols Cooling Water	Yes Yes	1.3 .611	Arkansas River
	United Plating Works	Aircraft Plating	.008	Chromic Acid	No	.008	City Sanitary Sewers
Sand Springs	Pedrick Laboratories	Pet Food	.008	Process	No	.008	Arkansas River

commodities by truck costs 6.5¢; by rail, 1.4¢; and by water, 0.4¢. All but two of the 25 largest cities in the United States are served by water transportation. Industries along the Ohio spent $25 billion on capital expenditures between 1950 and 1966. Barge traffic in 1965 on the Ohio River and its tributaries was approximately 90 million tons. The largest users of the waterway were petroleum, wheat, and chemical and coal products--all of which are in abundance in Oklahoma (18).

To visualize the potential of the Arkansas Basin, observe what has happened along other waterways. The significance of water transportation can be best demonstrated by comparing the growth in population of Houston and Dallas, Texas over the past 50 years. In 1920, the Houston Inland Water Channel was opened, and, at that time, they had approximately the same population. Since that time, Houston's population has surpassed Dallas by about 300,000 people. The answer to this is obvious--water transportation.

The Federal Government is providing the total cost of development of the waterway. Normally, all costs of terminal facilities are born by private industry, local groups, municipalities and authorities to make it possible to utilize the waterway.

Development of public ports is essential. Realizing this, cities, towns, and private groups all along the waterway are in the process of financing and developing these

facilities. Industrial districts are planned along the channel. All the port areas have land set aside for industry. Muskogee has purchased land and obtained financing ($2.5 million) for a port and industrial park. This project is under construction. At Catoosa, the head of navigation, 2,000 acres has been purchased and set aside for a port and industrial complex. To finance the project, $20 million has been voted by the people of Tulsa County to build the major facility. Included in the 2,000 acres is a 1,500 acre, fully developed industrial park, featuring sites ranging from 20 to 150 acres with all utilities, paved roads and rail service. Construction is underway on this project.

In addition to the public port areas, there are several large private industrial areas being planned at this time. These include the Verdigris Industrial Park containing some 4,650 acres, Port 33 development, and the Merkel Industrial Property containing 1,100 acres. The location of these areas is shown in figure 5.

Private industry is rapidly taking advantage of benefits offered by the river system, including low cost transportation of bulk commodities, ample supplies of water for industrial processing and cooling, and hydroelectric power at reasonable rates. The number of industries that are planning to build along or near the waterway is being increased almost daily. Table II shows the industrial, commerical, and other businesses that have built, announced

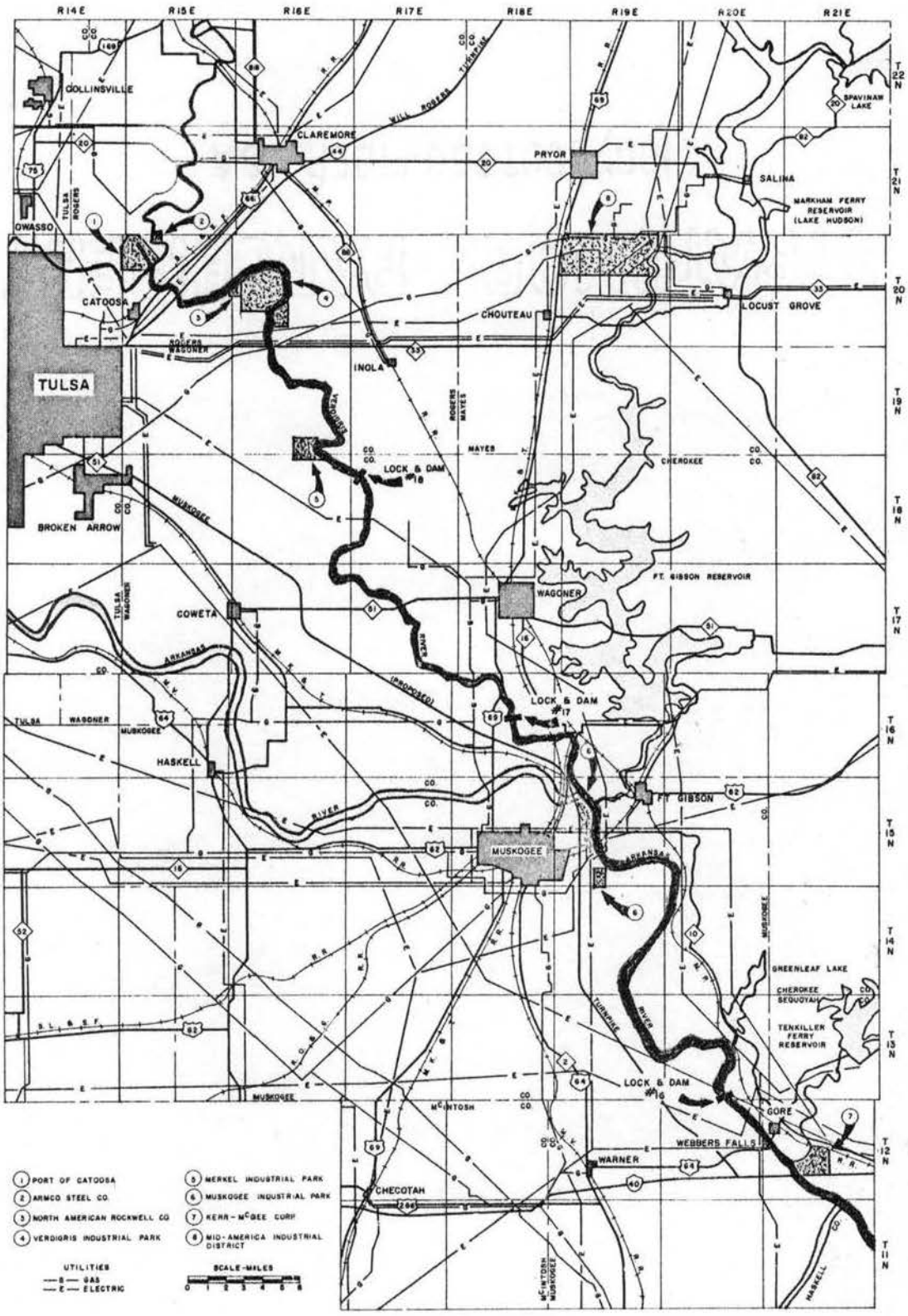

Figure -5-

MAP OF INDUSTRIAL SITES

Table II

FUTURE INDUSTRY IN ARKANSAS BASIN IN OKLAHOMA (19)

Firm	Location	Type of Industry	Cost (million)
Camelot Inn	Tulsa	New Facility	Unspecified
Cities Service Oil Company	Tulsa	New Office Building	Unspecified
Dewey Portland Cement Co.	Tulsa	Facility Expansion	$18
Howe Coal Co.	Stigler	Coal Mine	$10
Kerr-McGee Industries	Stigler	Coal & Coking Plant	$20
Mid-America Industrial District	Pryor	Miscellaneous Businesses	$31
Public Service Co. of Oklahoma	Tulsa	Planned Addition	$35
University Towers	Tulsa	Apartment House	Unspecified

intentions, or are building in the Arkansas River Basin in Oklahoma.

In addition to industry locating along the waterway, Oklahoma is experiencing a tremendous growth in industry in towns and cities away from the waterway that have ample supplies of water for industrial processing. A good example of this is Congoleum Industries Inc., which produces resilient vinyl floors and carpets. This industry has started construction in Wilburton, Oklahoma on a 72 acre tract involving over $10 million.

The valley of the Arkansas is a great storehouse of energy fuels--oil, natural gas, coal, and uranium. It has almost all of this nation's supply of aluminum ore and large, undeveloped reserves of other metals.

The Bureau of Mines reports there are 65 commercially producible minerals in the Arkansas, White, and Red River Basin areas, all within reach of the navigation system. It has been estimated that recoverable oil reserves exceed five billion barrels, gas reserves approximately 75 billion tons. Coal can move by barge to the Gulf coast, then to Europe at several dollars per ton less than the current price in Europe and it is of a higher quality than European coal.

At the present time this country is importing high grade iron ore from South America, some of which moves up the Mississippi and Ohio Rivers to steel producing mills. River mileage from New Orleans to Tulsa will be 940 miles.

This cuts the distance almost in half, and makes it possible for this ore to move a much shorter distance to Tulsa--a site highly favorable to the production of steel with an abundance of limestone and the finest coking coal in the world located in this area.

Economists predict the Arkansas River Basin, given the benefit of low-cost transportation, will have a capability for industrial development equal to that which has been witnessed in the Ruhr and Ohio Valley (20).

E. Control of Pollution

1. State Agencies

Water pollution control in Oklahoma is in the control of five different state agencies. These agencies are the Oklahoma State Department of Health, the Oklahoma State Water Resources Board, the Oklahoma State Corporation Commission, the Oklahoma State Department of Wildlife Conservation, and the Oklahoma State Department of Agriculture. These agencies' powers and duties are listed below (21):

(a) Oklahoma State Department of Health

This agency has primary responsibility for protecting the municipal and domestic water supplies from pollution. In addition, the Department has the authority to control pollution resulting from municipal or domestic sewage or any pollution affecting municipal, domestic and/or recreational waters.

(b) Oklahoma Water Resources Board

This agency coordinates the activites of the other pollution control agencies in the state and is responsible for industrial waste discharges. It is also responsible for adopting and promulgating standards of quality of the waters of the state.

(c) The Oklahoma State Corporation Commission

This agency has the responsibility for controlling pollution resulting from oil and gas production and/or processing.

(d) The Oklahoma State Department of Wildlife Conservation

This agency is responsible for maintaining water quality at levels suitable for substaining and propagating fish and wildlife.

(e) Oklahoma State Department of Agriculture

This agency has the responsibility for controlling pollution resulting from use of pesticides.

2. Federal Agencies

The U. S. Army Corps of Engineers, until recently, only maintained and operated a navigation system. But, this year they entered the water pollution control business. They filed charges against two Chicago industries for polluting the Chicago Sanitary and Ship Canal and the

Little Calumet River. These firms are the Interlake Steel Corporation and the Trumbull Asphalt Company. The charges were made under the Federal Rivers and Harbors Act of 1899, which forbids discharging refuse into a stream making it unnavigable. The fines under the 1899 law are small: From $500 to $2,500 per incident. But, if the Corps of Engineers wins the suit, they will be in the water pollution control business (22).

3. Water Quality Criteria

Oklahoma's water quality criteria for the Arkansas River Basin is considered one of the best to control pollution. The statement that, "The proposed criteria shall serve as guidelines to control pollution and to maintain the best quality which will result in an equitable balance of social and economic benefits to the state. It is realized that the criteria cannot be considered as permanently fixed. Future changes in cultural activites, the development of additional quality data, enhancement of existing quality by further removals of dissolved solids, and improvements in waste treatment technology may necessitate revisions of the criteria," is one of the best indications that the state in looking to the future. The water uses of the Arkansas River Basin, as designated by the Water Quality Coordinating Committee (21), is listed in table III. A summary of the water quality criteria that this committee submitted to FWPCA and that

Table III

PRESENT AND POTENTIAL WATER USES FOR ARKANSAS RIVER BASIN (21)

Stream	Beneficial Uses										
	Public & Private Water Supplies	Emergency Water Supplies	Fish & Wildlife Propagation	Agriculture	Hydro-electric Power	Cooling Water	Receiving Treated Wastes	Recreation	Navigation	Aesthetics	Trout Fishing (Put & Take)
Arkansas River		x	x	x	x	x	x	x	x	x	
Bird Creek	NOT CLASSIFIED										
Canadian River	x		x	x	x	x	x	x		x	
Caney River	x		x	x		x	x	x		x	
Hominy Creek	NOT CLASSIFIED										
Poteau River	x		x	x		x	x	x	x	x	
Verdigris River	x		x	x	x	x	x	x	x	x	
Below Fort Gibson Dam	x		x	x	x	x	x	x		x	
Below Tenkiller Dam	x		x	x	x	x	x	x		x	x

was approved is listed below:

(a) General Criteria

All tributary streams and all waste effluents shall be in such condition that when discharged to the Arkansas River and Interstate Tributaries, they shall not create conditions which will adversely affect public health, or use of the water for beneficial purposes.

(b) Specific Criteria

(1) Mineral Quality

It is recognized that the present quality of the Arkansas River and Interstate Tributaries, particularly the Salt Fork, Arkansas, and Cimarron River, is less than desirable with significant contributions of minerals from natural as well as man-made sources. These criteria have the objective of enhancement of water quality by preventing further degradation at this time with the intent of improving the quality as the plans for removing the major natural salt sources are inplemented and man-made pollution is further controlled. Quality management objectives, insofar as is practical, will be directed toward securing a water of higher quality.

(2) Bacteria

In evaluating biological quality of waters and the use and value of such water for beneficial purposes, consideration will be given by the appropriate regulatory authority to the results of a sanitary survey covering the drainage areas and stream reaches that may affect such biological quality. Waste discharges into waters used or capable of being used for domestic water supplies or body contact aquatic sports including skiing and swimming, shall receive disinfection or equivalent treatment as necessary for compliance with the following requirements:

1. At the point of intake for treatment of waters used as public water supplies bacteria of the coliform group shall not exceed 5,000/100 ml as a monthly average value (either MPN or MF count); nor exceed this number in more than 20% of the samples examined during any month; nor exceed 20,000/100 ml in more than 5% of such samples.

2. In all areas designed as recreational areas for body contact aquatic sports including swimming and skiing, bacteria of the coliform group shall not exceed 2,400/100 ml (MPN or MF count) on any day except during periods of storm water runoff. Provided, however, that the fecal coliform shall not exceed a geometric mean of

200/100 ml, nor shall more than 10% of total samples during any 30-day period exceed 400/100 ml.

3. Bacterial concentration, of other than natural origin, will be maintained below levels detrimental to beneficial uses.

(3) Oil and Grease

Essentially free of floating or emulsified oil or grease.

(4) Solids

Free of floating debris, bottom deposits, scum, foam, and other materials of a persistent nature from other than natural sources.

(5) Turbidity

Turbidity of other than natural origin shall not cause a substantial visible contrast with the natural appearance of the water or be detrimental to beneficial uses.

(6) Color

Color producing substances of a persistent nature from other than natural sources shall be limited to concentrations which will not be detrimental to beneficial uses.

(7) Temperature

Differential changes in temperature from other than natural sources shall be limited to a maximum of 5°F provided the maximum temperature due to man-made causes shall not exceed 70°F in trout streams, 75°F in small-mouth bass streams, or 93°F in warm water streams.

(8) Taste and Order Producing Substances

Taste and odor producing substances shall be limited to concentrations that will not interfere with the production of potable water by modern treatment methods or impart off color or unpalatable flavor to the flesh of fish, or result in offensive odors in the vicinity of the water, or otherwise interfere with beneficial uses.

(9) Dissolved Oxygen

The dissolved oxygen concentration shall not be less than 4 mg/l except that this limitation of 4 mg/l will not be applicable in the immediate vicinity of the point of waste discharge when the stream flow is less than 200% of the waste flow. In addition, the relationship of dissolved oxygen, biochemical oxygen demand, and chemical oxygen demand of waste releases, and the flow characteristics of the stream shall not create conditions down-stream that are detrimental to beneficial uses.

(10) Toxic Substances

Toxic substances shall not be present in such quantities as to cause the waters to be toxic to human, animal, plant, or aquatic life. For aquatic life, using bioassay techniques, the toxic limit shall not exceed one-tenth of the 40-hour median tolarance limit, except that other limiting concentrations may be used in specific cases, when justified on the basis of available evidence and approved by the regulatory authority.

(11) Radioactivity

The average concentration of the radionuclide (or radionuclides) in water at points of release from the control of the user shall not exceed the limits prescribed for such releases in the applicable portion of the current set of Radiation Protection Regulations, as promulgated by the Oklahoma State Board of Health or subsequent revisions thereof. A reasonable effort shall be made to identify each radionuclide, and to determine its concentrations, which is present in the effluent.

(12) pH

The pH shall be between 6.5 and 8.5. pH values below 6.5 and above 8.5 must not be due to waste discharge.

(13) Other Substances

The control of other substances, not heretofore mentioned, will be guided by the U. S. Public Health Service Drinking Water Standards of 1962, or latest revision thereof, and accumulated scientific data on limits above which injury to use occurs. Pollutional substances will be maintained below maximum permissible concentrations for public water supplies, recreation requirements, agricultural needs, and other beneficial uses.

C. Tributaries to the Arkansas River

The quality of tributary streams shall be controlled so that the quality of the Arkansas River and Interstate Tributaries will not be lowered beyond the criteria set forth above. In addition, adequate control shall be maintained to prohibit the development of public health hazards or nuisance conditions in such tributaries and maintain the highest current beneficial use of the waters pending a determination of best usage and the establishment of specific criteria.

CHAPTER V

DISCUSSION

A. General

As water management grows more complex, the need for wise consideration of water supply development in relation to expending surburbs, highways, and industries is only part of the problem. If the environment is to be protected, water pollution must be controlled.

B. Industrial Development

The only measure of success of this item is based on previous experience of similar navigation systems. The Tennessee River Navigation System was completed in 1945. Since that time private industry has invested $1.5 billion and public investment has been $2.5 billion. With its abundance of natural resources the Arkansas River Basin should exceed all expectations.

Oklahoma's tax credit law, which was written to encourage new industry to relocate to Oklahoma and present industry to expand, is one of the major items that will cause industrial growth along the Arkansas River in Oklahoma. This law allows an industry to deduct the cost of waste treatment facilities from state income taxes--after

the tax has been figured. This is a much more liberal handling than usual depreciation allowance.

This law will do more to attract industry to the Arkansas River Basin than any feature. This allows industry to pass on to the people of Oklahoma a part of the costs of producing their product which in turn allows industry to make a greater profit. Profit is the name of the game in industry.

C. Sources of Pollution

1. City of Tulsa

The City of Tulsa, at the present time, is dumping into the Arkansas River 13 to 15 MGD of wastes with only primary treatment. This condition has existed for the last ten years or so with no improvement. Their Northside plants provide secondary treatment and discharge into Bird Creek which at times has no flow in it other than effluent that has been discharged into it. A bond issue to correct this was voted down recently by the residents of Tulsa. This same bond issue is to be presented again to the people this fall, and with the present rate of taxes and high cost of living, the odds of it passing are very small. The growth of Tulsa is such that the problem of waste treatment, if not corrected, will only continue to become more serious and complex. The City of Tulsa further complicates their problems by accepting to their sewer system any and all new industry.

2. Port of Catoosa

The Port Authority, in their planning, appears to have done an exceptionally fine job in all areas except in the treatment of wastes. Oxidation ponds might prove to be satisfactory if the full 95.4 acres were developed into oxidation ponds and only the waste water from the 2 MGD of treated water was emptied into them. But, there is the fact that 85 MGD will be made available to industry to use for cooling and processing. Also, as the port develops, the price of land will become more and more expensive and the thought of valuable land being used for oxidation ponds is not realistic. Past experience has proven that cities have a tendency to allow these ponds to overflow and drain into the nearest stream which, in this case, will be the navigation channel. There is a possibility of algae problems in the navigation channel now, due to the wastes that are being dumped into Bird Creek by the City of Tulsa and this appears to only compound the problem. The oxidation ponds may be adequate for the present needs, but the question is, what about the future needs and will the residents of Tulsa County approve another bond issue to make the necessary improvements if they are needed?

During the interview with the Port Authority officials, they indicated that water pollution was no problem and little, if any, comments were offered on that subject. They were very willing to discuss the potential of industrial development but felt that the problem of pollution

had been solved when the plans for the port were approved.

3. Industry

Industrial pollution at this time does not appear to be much of a problem but, as stated previously, little is known about industrial pollution. The question to be raised at this time is, will the state enforcement agencies enforce the water quality criteria laws in the future? The threat by industry to move to another state, if they are required to comply with water quality laws or any laws, is a very strong incentive for any state to forget or to ignore enforcement. Also, an industry may connect to a city sewer system which puts them outside the jurisdiction of the state agencies and, in most cases, only creates unforeseen problems for the city.

D. Water Quality Control

1. State Enforcement Agencies

These five agencies each have a separate and distinct area in water pollution to enforce. The authority given to each agency is very distinct and does not overlap with another agency.

The methods of enforcement that these agencies have, covers a wide range. The Department of Health may notify the Federal Housing Administration and the Veterans Administration that a city's facilities for municipal sewage treatment are inadequate, and these federal agencies in

turn are generally reluctant to insure loans if they have knowledge that such deficiencies exist. The State Corporation Commission may issue an order to cease taking oil from a lease and the Department of Wildlife Conservation may fine a violator from $100 to $500 per day as long as the violation continues.

The method of enforcement used by the State Corporation Commission appears to be very lax. If an oil drilling company carelessly allows thousands of gallons of polluted water to enter a stream, this act of pollution is not a violation, only the refusal to take corrective action is a violation. For a specific example, if an earthen diked sump fills with salt water, the operator has two choices--spend a few thousand dollars to pump the waste into tank trucks and dispose of it properly, or, he can let it fill to the brim until it washes out into some body of water. To eliminate any danger of prosecution, all he has to do is push the dirt back into place and he has fullfilled the provisions of the law. No other state agency can prosecute because the Corporation Commission has sole jurisdiction over this type of pollution.

The City of Tulsa can be a very good example of what is to be expected in the future in the way of enforcement. No official action has been taken by the Department of Health to cause Tulsa to improve their waste treatment plants, which are dumping 13 to 15 MGD of wastes that have only received primary treatment. A halt to all types of

construction can be an effective way of getting the message to the people of Tulsa of how urgent the approval of the bond issue is to their city. Is this an indication of the type of enforcement by all agencies in the future?

2. Federal Enforcement Agencies

The Corps of Engineers seems to be in the business of water pollution control. With their size, experience, and influence in Congress, this could be the best thing for pollution control. The problem of pollution in some states is so big and expensive that it cannot be handled without federal aid. One thing is sure, if state and local agencies do not control pollution, then the federal agencies will step in and take control. The problem is too large in some states to let state and local politics hinder the process of cleaning up water pollution.

3. Existing Water Quality Criteria

The approved criteria for mineral quality was based upon records from 1947 through 1963, but a study recently completed at Oklahoma State University (23), indicated that chlorides and total dissolved solids in the Arkansas River Basin had improved in the last ten years over that of all years of record. The quality of the water in regard to sulfate concentration and hardness showed no change during the period of record available. It was their opinion that the improvement of the quality of the water in regard to chlorides and total dissolved solids was probably due

to the cleaning up of oil field operation. Due to the high nitrate (130 mg/l) and phosphate (35 mg/l) concentrations found in some streams, they also concluded that there are some serious water quality problems in the Arkansas River Basin and there is a potential for very serious problems in the future. Their findings are shown in figures 6 through 7 . They also found that there was an acute shortage or lack of data on the biochemical quality of the waters in the Arkansas River Basin.

The present criteria that the dissolved oxygen concentration can be less than 4 mg/l, in the immediate vicinity of the point of waste discharge when the stream-flow is less than 200 per cent of waste flow allows a sewage treatment facility to discharge effluent directly into a dry stream bed. A very good example of this is Bird Creek and the City of Tulsa.

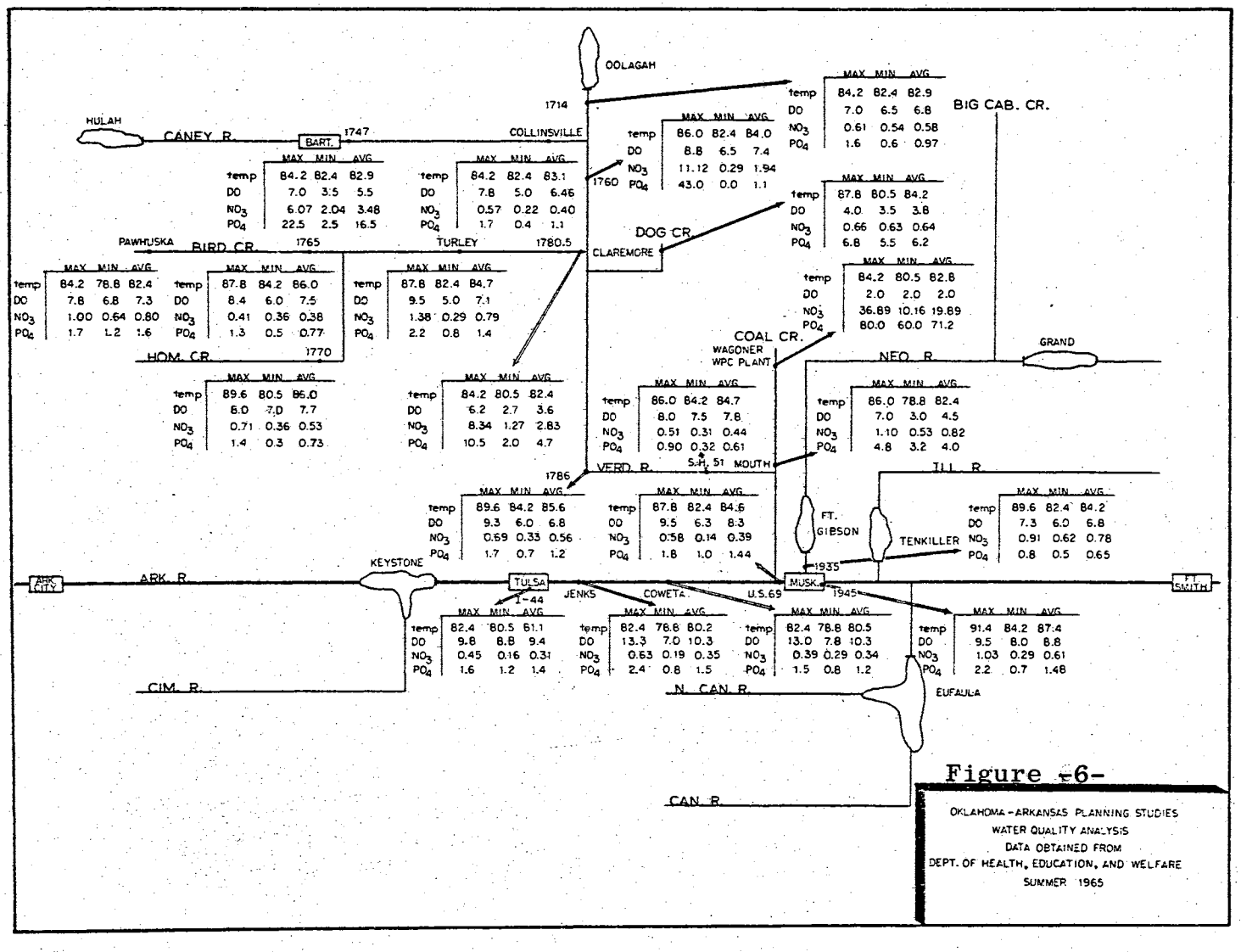

Figure -6-

OKLAHOMA-ARKANSAS PLANNING STUDIES
WATER QUALITY ANALYSIS
DATA OBTAINED FROM
DEPT. OF HEALTH, EDUCATION, AND WELFARE
SUMMER 1965

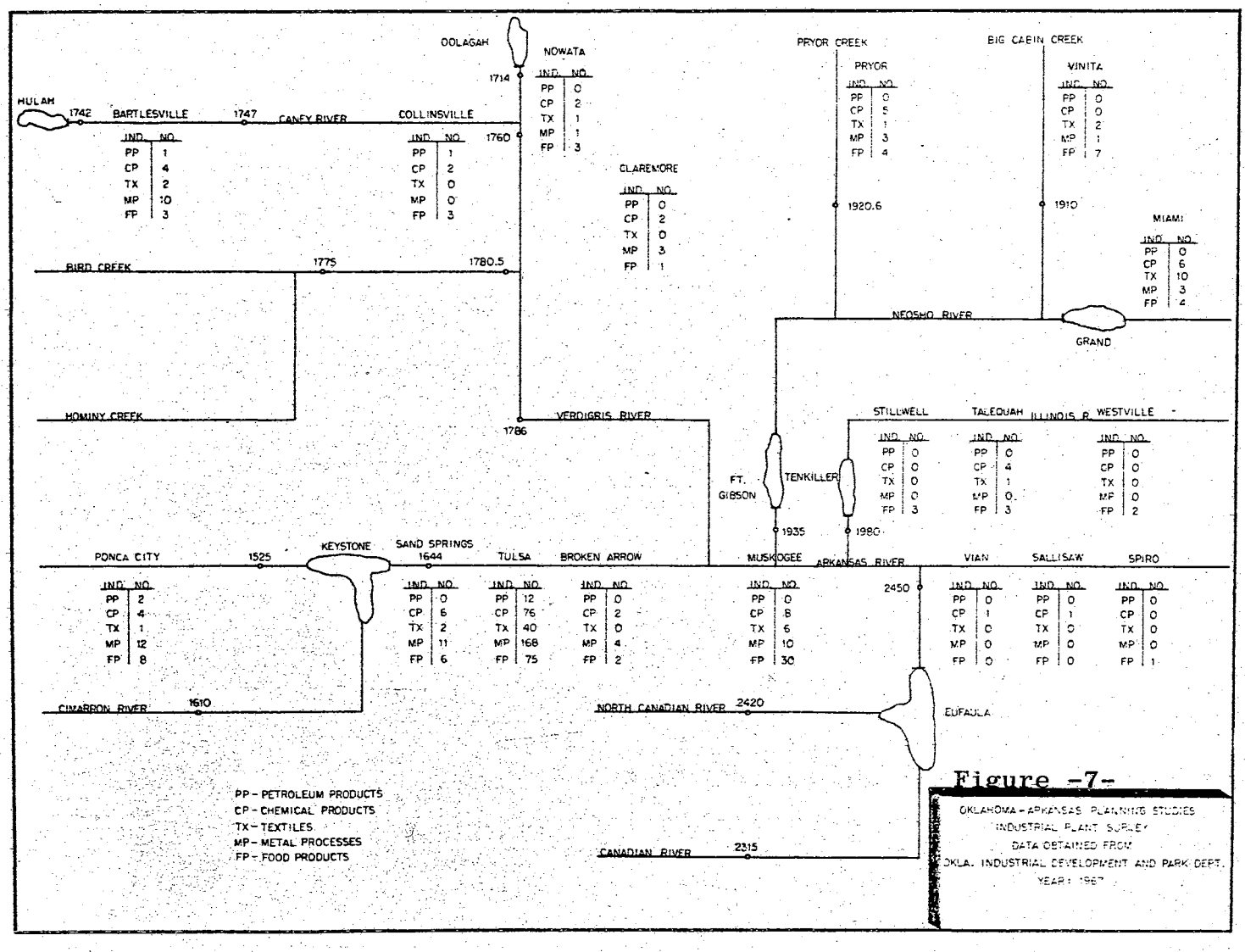

Figure -7-

OKLAHOMA-ARKANSAS PLANNING STUDIES
INDUSTRIAL PLANT SURVEY
DATA OBTAINED FROM
OKLA. INDUSTRIAL DEVELOPMENT AND PARK DEPT.
YEAR: 1967

CHAPTER VI

CONCLUSIONS

Based upon the results and discussion presented in this report, the following conclusions can be drawn:

1. Water pollution in the Arkansas River Basin at the present time is not a major problem. There are some pollution problem areas, but these could be corrected if the present laws were enforced.

2. There is no coordinated plan between federal and state agencies to control water pollution at the present time. But, if the Corps of Engineers wins their suit in Illinois they will definitely step into the pollution picture if the state agencies fail to control pollution.

3. The Arkansas River Basin, in being converted to a navigation system, is undergoing very dramatic changes. Very little, if anything, is known regarding the water quality after the system has been completed. A study should be made similar to the one done by FWPCA in 1965. The period of study should cover at least three years. With the information from this study, criteria could be extablished to insure that the Arkansas River remains as unpolluted in the future as it is now.

4. The City of Tulsa is a major source of pollution

to the Arkansas River. Steps should be taken immediately to insure that the situation is corrected. All of the treatment plants should provide secondary treatment, and the plants that discharge into Bird Creek should provide tertiary treatment, or facilities should be built for storing wastes to be released during high flows. If this treatment is not provided, the reservoirs immediately downstream from Tulsa could experience a serious algae problem in the near future.

5. Oklahoma, not only has a river to pollute, but it has insured that new industry and water pollution control are compatible in the passage of the tax credit law. As stated before, little is known about industrial pollution, but it appears to present only a minor problem at the present time. A deadline for existing industry to comply with the present standards should be set and an all out effort be made to insure that this deadline is met by industry.

6. The administration and enforcement of water pollution control should be under one agency. Water pollution should be its one and only job. The five agencies, as they are now organized cannot do an efficient job of controlling water pollution in the future.

7. Releasing water from upstream reservoirs for dilution in all probability will reduce, not increase, the dissolved oxygen concentration in the Arkansas River. A study should be made in methods to reaerate the water released from these reservoirs.

CHAPTER VII

SUGGESTIONS FOR FUTURE WORK

Based on the results of this study, the following suggestions are made for future research in the area of pollution and the navigation system:

1. A study on the effects of industry and air pollution along the Arkansas River Basin. Very little, if anything, is known about air pollution along the Arkansas River Basin.

2. A study on methods to reaerate the water released from upstream reservoirs to be used for dilution.

3. A study to develop an automatic monitoring system for determining the quality of the water in the Arkansas River Basin.

4. A study to determine the biochemical quality of the waters in the Arkansas River Basin. This study should begin immediately before industry becomes to heavily located along the river.

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