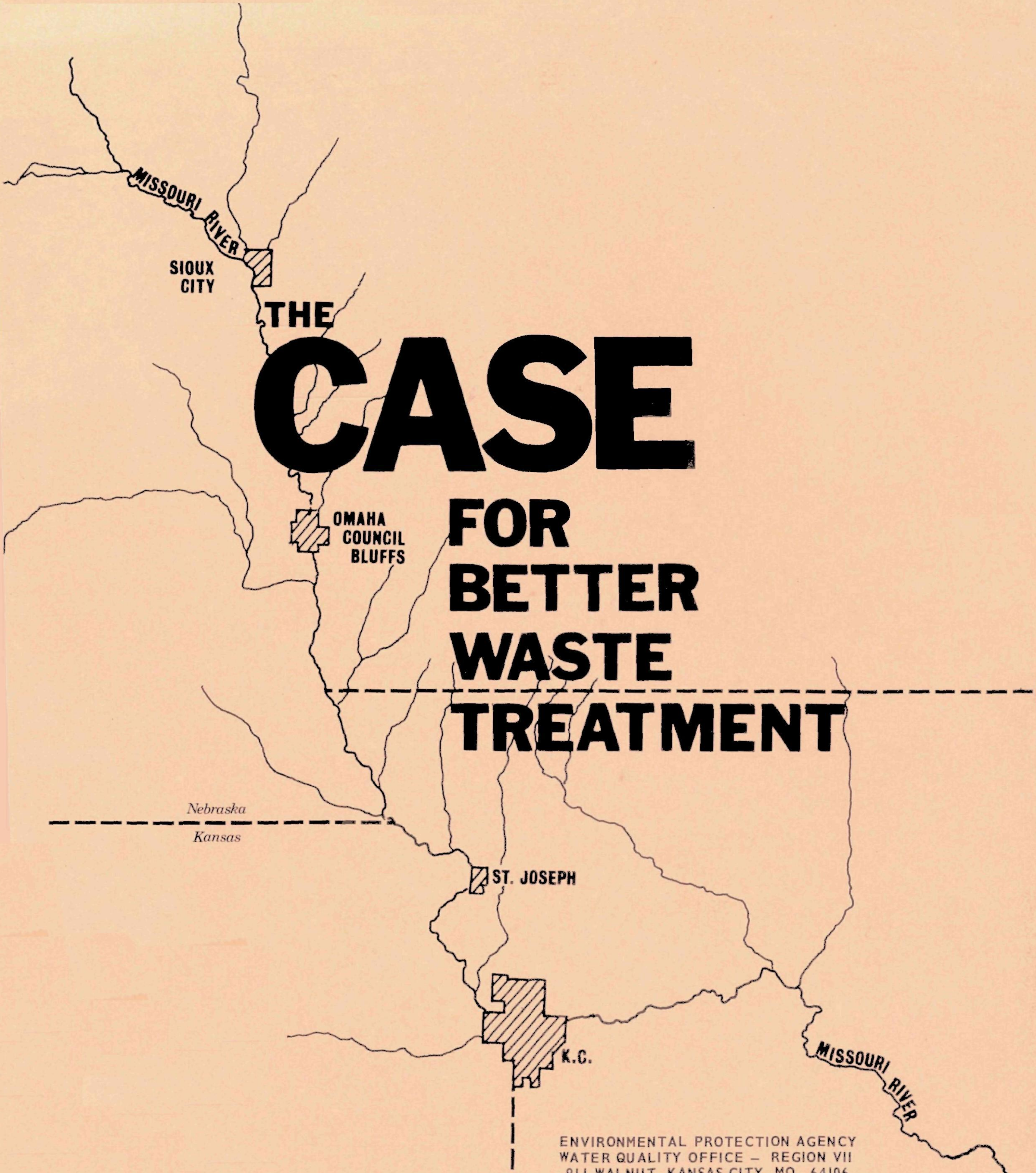
THE CASE FOR BETTER WASTE TREATMENT



ENVIRONMENTAL PROTECTION AGENCY
WATER QUALITY OFFICE – REGION VII
911 WALNUT, KANSAS CITY, MO. 64106

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THE CASE FOR BETTER WASTEWATER TREATMENT

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INTRODUCTION

Following the passage of the Water Quality Act of 1965, the question of the Federal position for mandatory minimum of secondary treatment or its equivalent has been a dominant issue in many parts of this country. A specific challenge was issued by the State of Iowa to the Secretary of the Interior on the setting of secondary treatment plus disinfection requirements as part of the water quality standards for that State's cities, towns and industries on the Missouri and Mississippi Rivers. Essentially the issue was the Federal government's prevention and enhancement policy as contrasted with the generally followed policy of certain states which required a demonstration of proof of damage, either existing or potential, before treatment would be required. The challenge centered on the application of the Federal policy to the muddy Lower Missouri River, in particular, and all interstate streams in general.

The point generally made by the proponents of this philosophy was that no dissolved oxygen problems exist in the Missouri River except during periods of high runoff when tremendous organic and bacterial loads were washed from the agricultural and metropolitan landscapes into the feeder streams. During these periods, low D.O's were in fact measured in substantial stretches of the main stem between Kansas City and St. Louis. Credit for the consistently high bacterial loads at all water supply intakes was also given to these sources by State and local officials. The fact that no detailed investigation had been made on the Lower Missouri River since 1951-52 to confirm these contentions did not appear to be an important consideration for the supporters of these views. And complicating the question further is the fact that these early surveys were done prior to the closure of Gavins Point Dam at Yankton, South Dakota in August, 1955 at which time the Lower Missouri became essentially an hydrologically controlled system.

Faced with a dearth of information on the actual water quality character of the Lower Missouri and with the definite evidence of consistently high bacterial densities at water intakes which were in violation of all generally accepted standards for this parameter, 1/ the Federal Water Quality Administration Missouri Basin Regional Office instituted field investigations of the Lower Missouri in 1968 to develop a solid technical base from which to make reasonable judgments.

The standard parameters of water quality were measured in the stream during this initial effort, which covered eight days of dry weather flows and two days of wet weather flows during the fall of 1968 and on seven days of steady state flow during January, 1969. The evaluation of these collected data demonstrated general degradation of the River downstream from all metropolitan and major industrial sources. On the basis of a mass analysis of bacteria, the argument for secondary treatment, plus bacterial control on the river was supported.

1/ Missouri River Public Water Supplies Association-Records-Surveillance Network

The preliminary report, its findings, conclusions and recommendations formed the basic part of the Federal position at the Water Quality Standards Setting Conference held in Council Bluffs, Iowa on April 15 and 16, 1969.2/

It is important to note that the dissolved oxygen level as a significant concern was clearly demonstrated to be unimportant during dry weather flow conditions in the river.

What the investigations and the Conference did show was the need for further specific investigations into the bacterial and dissolved organic content of the River and the sources of the contributory loads. To this end Commissioner D. D. Dominick in August, 1969 directed these necessary investigations to be made through the combined efforts of the Missouri Basin Regional Office and the National Field Investigations Center and Advanced Waste Treatment Laboratory in Cincinnati, Ohio.

Uniqueness of Approach

From the outset, the field investigations were unique, not only for the type and variety of parameters measured and evaluated but also for the first time in a reach of river 500 miles long, field sampling for such pollution indicators as virus, salmonella and coprostanols (fecal sterols) were made routinely.

Major problems in logistics were faced and overcome. Viral samples were large (up to 100 gallons--850 pounds each) and had to be transported overnight to Dr. Gerald Berg in the Advanced Waste Treatment Laboratory in

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2/ Proceedings, Conference to Consider Establishment of Water Quality Standards for the Missouri River Basin Interstate Waters-State of Iowa-April 15-16, 1969 Council Bluffs, Iowa.

Cincinnati, Ohio. Both air and truck transport were used. Similarly, samples for coprostanol were shipped to Dr. Robert Bunch, also at the Advanced Waste Treatment Laboratory under equally rigid time constraints. Field crews from the National Field Investigations Center and the Regional technical support group and laboratory at Kansas City, Missouri, collected and measured the total coliform, fecal coliform, fecal streptococci, and Salmonella in the field. Also, the biologists set out periphyton slides and evaluated the communities of attached organisms of the river below each metropolitan area. Regrowth studies were also performed in the laboratory using river water to estimate the influence of nutrients discharged from primary treated waste sources on the bacterial character of the River.

Fish tainting investigations were made with caged live catfish placed downstream from all significant metropolitan, industrial and tributary waste sources. An expert taste panel at Oregon State University was used to analyze these fish samples.

Another significant factor evaluated was the coprostanol level in the River, from the waste sources and at water supply intakes. This biodegradable indicator of fecal contributions from man and higher animals appears to have unparalleled significance as it relates to the whole host of other, though unmeasured, dissolved biodegradable organics which are discharged from untreated or partially treated municipal and industrial waste sources. It also confirms the importance of fecal coliform as a key index to municipal and certain industrial waste sources during steady state flow conditions.

The final report on these investigations including the 1969-70 surveys is currently being prepared and should be available soon. A summary statement of findings, conclusions, and recommendations on the water quality investigations was made to the State of Nebraska water quality hearing held in Lincoln, Nebraska, on August 28, 1970. What follows is a distillation of that statement.

STATEMENT

The material presented is based on the detailed analysis of the data collected during investigations made of the Missouri River and its tributaries by the FWQA over the past two years and represents new approaches to pollution evaluation. The specific topics discussed include (1) bacterial investigation; (2) fecal sterol investigations; (3) pathogen isolations; (4) biological investigations including the periphyton and fish flesh tainting studies; and, (5) goals to be achieved by secondary treatment.

Table I summarizes the fecal coliform and fecal streptococci data. The data for the River are presented graphically in Figure 1 to demonstrate the observed profile of fecal coliform densities. It is significant to note that all the observed river mean densities, except the control station above Sioux City, are in excess of the 2,000 organisms per 100 ml limit recognized by the FWQA and the State of Nebraska as the maximum criteria for domestic water supply use.

The fecal streptococci data provide insight to the predominant origin of wastes in the outfalls. The ratios between fecal coliform and fecal streptococci suggest whether the wastes are of human or animal origin and the fecal streptococci typing confirmed these findings. Origin data are shown in Table I.

It must be emphasized that these Fall 1969 studies were conducted during dry periods when there was no significant rainfall runoff. The river flows at that time were between 50 and 100 percent above normal due to the abnormally high releases from the main stem reservoirs. Even with this large volume of uncontaminated dilution water the measured fecal coliform densities were in excess of the recognized FWQA criteria.

Fecal coliform organisms are not harmful in themselves and do not pose a significant health hazard. They do, however, indicate the presence of relatively recent fecal contamination, with a high probability of pathogens being present. Under non-polluted conditions, the natural die-off will result in a reduction of approximately 99 percent within two days in the summer and 80 percent to 90 percent in winter. When inadequately treated wastes are present in the receiving water, there is a source of basic food material (organic carbon and nitrogen) which will result in persistence, less than 50 percent die-off in 24 hours, or regrowth, a ten-fold increase in 24 hours. Table II shows the results of bacterial survival tests on selected waste effluents. These data show clearly the availability of nutrients to support bacterial growth.

Table III shows the bacterial quality of the Missouri River at the major water intakes and serves to emphasize the existence of a potential hazard.

Conclusive evidence of the presence of recent fecal pollution at the major municipal water intakes was obtained through the isolation of fecal sterols. In general, sterols are a group of solid cyclic alcohols found in plant and animal tissues. Certain sterols such as coprostanol are unique in that they are found only in the feces of man and higher animals. The isolation of coprostanol in water provides positive proof of the presence of excreta.

Table IV shows the field data for the coprostanol studies and the fecal coliform densities isolated from the same samples. These data are shown graphically in Figure 2. The important factors are (1) there is an increase in coprostanol concentrations below each major metropolitan area with waste discharges; (2) the coprostanol which is readily biodegradable persists in the river at all water treatment plant intakes showing conclusively the presence of recent fecal pollution; (3) the presence of fecal sterols combined with the observed densities of fecal coliforms leave no doubt as to the water supply hazard that exists, and (4) the contributions from sources other than municipal and industrial were minor. The tributaries -- the Boyer, Platte, Kansas -- had little effect during steady state flow conditions. Also, the graphic similarity of the coprostanol and fecal coliform curves provides an excellent correlation as to common source.

Figure 3 more vividly shows the increase in coprostanol concentration. The diameter of the circles is proportional to mean concentration, graphically portraying the accumulation of fecal pollution in the Missouri River.

The validity of the fecal coliform and fecal sterol data was confirmed by the actual isolation of pathogens. Waste effluent samples and river samples were analyzed for enteric virus and Salmonella. Table III shows the Salmonella in serotypes isolated at the water intakes. These organisms were also isolated in the waste effluents and the survival studies indicated the availability of nutrients for these organisms to persist or regrow.

Even more important, enteric virus were isolated from waste outfalls and in the river. The virus data are shown in Table V and are graphically pictured in Figure 4. The presence of virus and Salmonella in an area, demonstrated by other means to have been subjected to recent fecal pollution, confirms the existence of a significant hazard to those using the water as a source of municipal supply. The dedication of a few underpaid men and a tremendous amount of good luck have prevented the occurrence of water borne epidemics. How critical this might be was pointed out by Mr. Walter Lyons, Director, Bureau of Sanitary Engineering, Pennsylvania Department of Health, Harrisburg, Pennsylvania, in a recent paper in which he cited an authority on the possibility that half of the 40,000 annual cases of infectious hepatitis might be due to water borne viruses which have passed present disinfection procedures.3/

Specialized biological investigations, in addition to the virus and bacteriological studies, were conducted. The purpose of these investigations was to determine the effects of waste discharges on the composition and abundance of attached growth (periphyton) and on the flavor and palatability of fish flesh.

The attached organisms are the primary producers in flowing waters. The composition of the communities of these organisms is primarily determined by the rate of flow, the temperature, the turbidity, the amounts of organic materials, toxic materials and inorganic nutrients present in the water. When other conditions are favorable, flowing waters that receive inorganic nutrients support large numbers of attached algae. If water conditions restrict the populations of green algae and diatoms, the pollution tolerant blue-green algae increase in number. When organic materials are discharged to a stream in abundance, consumer organisms such as protozoa and bacterial slimes become the predominant attached organisms. Farther downstream the organic materials decompose and release inorganic nutrients that become available for increased algal

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3/ "Water and Health - Are We Concerned Enough?", Walter A. Lyons, Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, October, 1970.

growths.

In general, the periphyton investigation substantiated the impact of waste effluents on the river despite the generally inhospitable swift currents and heavy abrasive silt load. Immediately downstream from each major metropolitan area there was a change in community composition either to pollution tolerant or to reduced number of organisms. The field crews observed chunks of meat, fat and clumps of blood in the river and odor of sewage was present. The specific findings were:

1. Sioux City, Iowa (River Mile (R.M.) 732.1 Missouri River 1.9 miles downstream from Big Sioux River confluence, Iowa side of river.) Attached organisms were reduced in number by waste-waters possibly of a toxic nature.
2. Council Bluffs, Iowa (R.M. 613.5 Missouri River 0.5 mile downstream from Council Bluffs sewage treatment plant effluent, Iowa side of river.) Water at this station was polluted by inadequately treated organic wastes that were discharged to the river. These wastes supported the growth of bacterial slimes in this area of the river.
3. Downstream from Omaha and Council Bluffs. Water was polluted for approximately 30 miles (R.M. 608 to R.M. 580) by inadequately treated organic wastes as indicated by the presence of bacterial slimes as far downstream as R.M. 580.
4. In the vicinity of Kansas City, Missouri, water was polluted for about 15 miles (R.M. 362 to R.M. 347) by wastes toxic to some attached growths.
5. The Kansas River and Blue River contained waters polluted by organic and toxic materials.

The fish flesh tainting studies were conducted by exposing caged channel catfish to the waters of the Missouri and Kansas Rivers upstream and downstream from all known significant waste discharges. These catfish were obtained from commercial rearing ponds for this test. After four days exposure time, the fish were removed, dressed, quick frozen and submitted to a food-flavor test panel. The results of this investigation were:

1. Fish held in the Missouri River in a one mile reach downstream from slaughterhouses and industrial waste discharges at Sioux City, Iowa, had an unacceptable flavor. Pieces of meat scraps and fat littered the water surface and collected on the baskets containing the fish.
2. Downstream from the Council Bluffs and Twin Cities sewage discharges, caged fish acquired unacceptable flavor.
3. Downstream from the Omaha sewage treatment plant discharge, fish acquired the most unacceptable flavor of any tested in the study. Wastes from the Omaha sewage treatment plant caused an unacceptable off-flavor in fish for 2.5 miles of river along the Nebraska shore. The discharge of inadequately treated wastes from the Omaha sewage treatment plant produced slimes in the river that collected on the cages, another indication of the severity of pollution in this area.
4. Test fish placed in the Missouri River downstream from the confluence of the Platte River to Kansas City, Kansas, had acceptable flavors.
5. Wastes in runoff from the Fairfax dump at Kansas City, Kansas,

caused fish to have an unacceptable flavor.

6. Fish placed in the Kansas River acquired an unacceptable flavor.
7. Wastes in the Kansas River and from the Kansas City, Kansas, and Kansas City, Missouri, sewage treatment plants discharge combined to cause an unacceptable off-flavor in caged fish for 2.5 miles along the south shore of the Missouri River.
8. Slime growths stimulated by wastes from Corn Products Company plant covered baskets placed 1000 feet downstream from the outfall and suffocated the test fish.
9. Fish placed along the north shore of the river downstream from the North Kansas City, Missouri sewage treatment plant (Rock Creek) acquired an unacceptable flavor.
10. Fish placed in the Big Blue River and immediately downstream from its confluence with the Missouri River died within 24 hours indicating that these waters were toxic. Fish placed farther downstream in the Missouri River (one-half mile) possessed an unacceptable flavor.
11. The Old Blue River and Sugar Creek waters were toxic to fish. Caustic wastes in Sugar Creek dissolved the meat leaving only skin and bones in the basket. Fish in the Missouri River downstream from Sugar Creek acquired even more of an unacceptable flavor than fish at the next upstream station.
12. Wastes discharged to the Missouri River and its tributaries from the Kansas City area not only caused an unacceptable flavor in test fish for 22 miles, but were toxic to fish.
13. Of the 440 mile reach of the Missouri River studied, flavors

were found in fish flesh placed at locations bracketing a total of 26 miles of river, all of which were confined to metropolitan areas.

The presence of unacceptable flavors in fish flesh from caged fish bracketing 26 miles of river, all confined to metropolitan areas, is a significant indication of the existence of a problem and of the presence of taste and odor-producing compounds in the water.

In summary, we believe the data collected during our field surveys of the Missouri River demonstrate conditions of pollution. Wastes discharged by the major communities using only minimal treatment, i.e., primary, cause measurable increases in bacterial indicator organisms, virus and fecal sterols. These wastes also cause water quality degradation as reflected by the structure of the periphyton communities and the tainting of fish flesh. Each measured pollutional characteristic or observed effect is attributable to constituents that can be removed from the waste waters by properly operated secondary treatment facilities with bacterial control.

Concentrations of the primary nutrients--carbon, nitrogen and phosphorus--can be reduced 90 percent, 50 percent and 30 percent, respectively, by secondary treatment.4/ Over 90 percent of the coliform indicator organisms can be physically removed along with a high percentage of the virus. Secondary treatment plant effluent can be disinfected more

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4/ Statement of Dr. David G. Stephan, Acting Assistant Commissioner, Research and Development, Federal Water Pollution Control Agency, U.S. Department of Interior, Washington, D.C. Volume I - Proceedings from the Conference in the matter of pollution of the interstate waters of the Potomac River (Washington, D.C.)--District of Columbia--Maryland--Virginia. Page 487, Conference date April 2-4, 1969.

effectively and economically. The fecal sterols are biodegradable and would be reduced substantially by secondary treatment as would the other dissolved organics known or suspected to be part of the waste load though not specifically measured. In addition, certain phenols that affect drinking water and other industrial chemicals that are picked up and accumulated in the tissues of fish are normally removed in secondary treatment.

Secondary treatment with bacterial control is necessary to comply with established water quality standards for the Missouri River and to safequard the water supply for some 3,000,000 people using it as a drinking water source.

TABLE-I

SUMMARY OF BACTERIOLOGICAL DATA

Date of Survey	Mo. R RM	Station Description	Station No.	MEAN FECAL COLIFORM NO. /100ML	MEAN FECAL STREP. NO. /100ML	FC/FS	Character-istic of Probable Source Type	Eff.
9/08-12	736.0	Mo. R. above B. Sioux	M-52	85	160	0.5		
9/08-12	734.0	Big Sioux River	BS-51	120	48	2.5		
9/08-12	731.2	Floyd River	F-50.5	3,700	2,200	1.7		
9/08-12	729.0	Sioux City STP	SC-49	$32X10^6$	$5X10^6$	6.4	Domestic	X
9/08-12	717.4	Iowa Beef Processors	IBP-48.5	$2X10^6$	$4X10^6$	0.5	Animal	X
9/08-12	669.2	Mo. R. below S.C. STP	M-48	6,900	3,800	1.8		
9/08-12	664.0	Soldier River	S-45	2,100	790	2.7		
9/08-12	635.1	Boyer River	B-43	5,500	2,900	1.9		
9/08-12	626.2	Omaha WW Intake	M-42	3,500	700	5.0		
11/03-07	626.2	Omaha WW Intake	M-42	1,950	2,500	0.8		
11/03-07	615.2	Quaker Oats Eff.	M-212	2,400	2,400	1.0		X
11/03-07	615.1	Pacific Fruit	M-211	2,400	1,200	2.0		X
11/03-07	614.0	Council Bluffs STP	CB-40B	$12X10^6$	$1X10^6$	12.0	Domestic	X
11/03-07	613.6	Twin Cities Plaza STP	TC-210	$3X10^6$	$.13X10^6$	23.1	Domestic	X
11/03-07	611.5	Omaha Primary Eff.	OM-40A	$6X10^6$	$8X10^6$	0.8	Mix	X
11/03-07	611.2	Monroe St. Sewer	OM-208	$3X10^6$	$10X10^6$	0.3	Animal	X
11/03-07	601.5	Bellvue STP	M-206	$4X10^6$	$.78X10^6$	5.1	Domestic	X
11/03-07	601.3	M. R. at Bellvue	M-38	15,000	10,000	1.5		
11/03-07	596.5	Big Papillion Cr.	PA-213	$2X10^6$	$.73X10^6$	2.7		
11/03-07	594.8	Platte River	P-37	645	721	0.9		
11/03-07	591.2	Plattsmouth STP	M-201	$5X10^6$	$.59X10^6$	8.5	Domestic	X
11/03-07	562.3	Nebraska City STP	M-200	$7X10^6$	$6X10^6$	1.2		X
11/03-07	559.7	Below Nebraska City	M-34	18,200	12,200	1.5		
11/03-07	542.0	Nishnabotna River	N-199	700	840	0.85		
11/03-07	462.4	Nodaway River	N-196	1,840	3,250	0.57		

TABLE-I (Continued)

SUMMARY OF BACTERIOLOGICAL DATA

Date of Survey	Mo. R. RM	Station Description	Station No.	MEAN FECAL COLIFORM NO./100ML	MEAN FECAL STREP. NO./100ML	FC/FS	Characteristic of Probable Source Type	Eff.
11/03-07	452.3	St. Joseph WW Intake	M-28	6,500	3,200	2.0		
9/18-22	452.3	St. Joseph WW Intake	M-28	4,300	4,300	1.0		
9/18-22	452.3	Black Snake Creek	SJ-3	$2X10^6$	$.96X10^6$	2.1		
9/18-22	452.3	Charles St. Sewer	SJ-5	$3X10^6$	$1X10^6$	3.0	Domestic	
9/18-22	452.3	Mitchell St. Sewer	SJ-9	$2X10^6$	$.79X10^6$	2.5	Mix	
9/18-22	446.4	St. Joseph STP	SJ-15	$4X10^6$	$2X10^6$	2.0	Mix	X
9/18-22	446.4	Brown's Ditch	SJ-17	170,000	52,000	3.3		
9/18-22	445.6	St. Joseph Ind. STP	SJ-18	$7X10^6$	$37X10^6$	0.2	Animal	X
9/18-22	440.3	Missouri River	M-27	7,800	8,800	0.9		
9/18-22	421.2	Atchison STP	A-25.5	$2X10^6$	$.25X10^6$	8.0	Domestic	X
9/18-22	395.6	Leavenworth STP	L-24.5	$4X10^6$	$.27X10^6$	14.8	Domestic	X
9/18-22	391.2	Platte River	P-23.5	420	550	0.8		
9/18-22	372.2	Line Creek	M-101	10,300	2,800	3.6		
9/18-22	370.5	K.C., Mo. WW Intake	M-23	3,800	2,400	1.6		
9/25-29	370.5	K.C., Mo. WW Intake	M-23	3,800	4,600	0.8		
9/25-29	367.19	K.C., Mo. WS STP	K-19-B	$1X10^6$	$1X10^6$	1.0	Mix	
9/25-29	365.0	Corn Prod. Intl. Eff.	M-105A	1,700	17,000	0.1	Animal	X
9/25-29	370.5	Howell St. Sewer	M-105B	2,600	30,000	0.09	Animal	
9/25-29	362.7	N.K.C. STP Eff.	M-106	$.3X10^6$	$15.7X10^6$	0.2	Animal	X
9/25-29	358.1	Big Blue River	BR-1	$.99X10^6$	$.16X10^6$	6.2	Domestic	
9/25-29	356.9	Independence, Mo. STP	M-108	$2X10^6$	$1X10^6$	2.0	Mix	X
9/25-29	356.9	Blue River STP	M-19	$3X10^6$	$.58X10^6$	5.2	Domestic	X
9/25-29	345.5	Mo. R., Missouri City	M-18	9,000	54,000	0.2		
9/25-29	339.5	Little Blue River	M-109	4,200	2,900	1.5		
9/25-29	293.4	Mo. R., Waverly, Mo.	M-15	8,700	12,000	0.7		

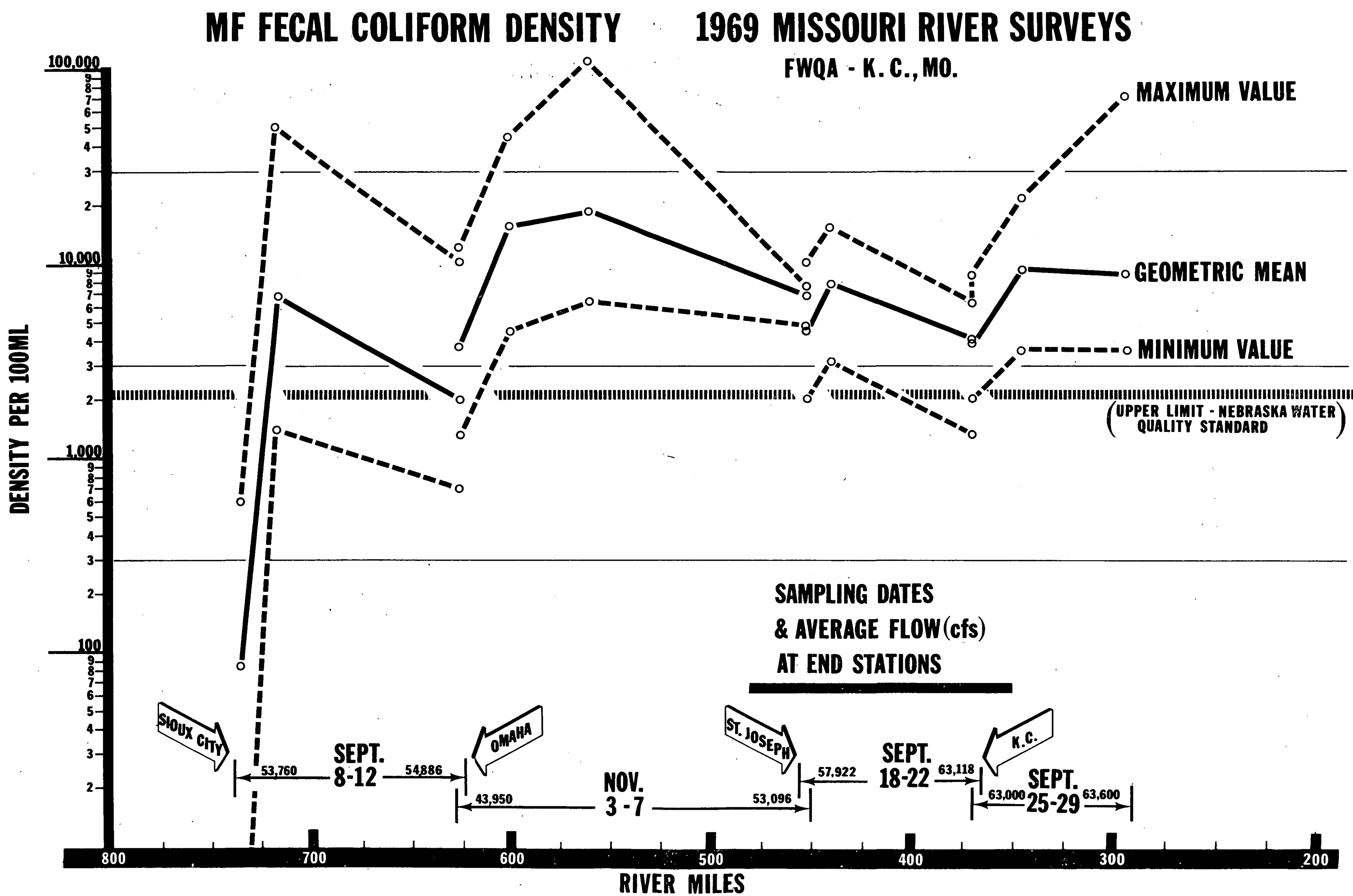

MF FECAL COLIFORM DENSITY 1969 MISSOURI RIVER SURVEYS
FWQA - K.C., MO.
MAXIMUM VALUE
GEOMETRIC MEAN
MINIMUM VALUE
(UPPER LIMIT - NEBRASKA WATER QUALITY STANDARD)
DENSITY PER 100ML
100,000
10,000
1,000
100
SAMPLING DATES
& AVERAGE FLOW (cfs)
AT END STATIONS
SIOUX CITY
OMAHA
ST. JOSEPH
K.C.
53,760
SEPT. 8-12
54886
43,950
NOV. 3-7
53,096
57,922
SEPT. 18-22
63,118
63,000
SEPT. 25-29
63,600
800
700
600
500
400
300
200
RIVER MILES

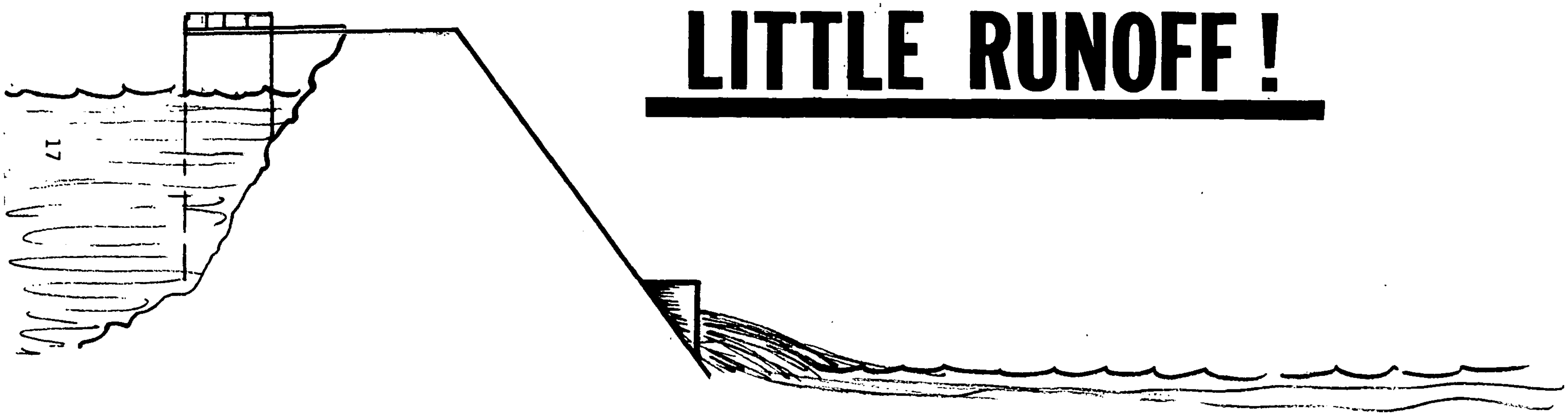
FIG. 1

NOTE !

STUDIES WERE CONDUCTED **DURING DRY PERIODS**. . .

THEREFORE . . .

LITTLE RUNOFF !



RIVER FLOW WAS 50% - 100% ABOVE NORMAL DUE TO

RESERVOIR RELEASES

HOWEVER . . . . .EVEN WITH THIS UNCONTAMINATED DILUTION
THE FECAL COLIFORM LEVEL STILL EXCEEDED CRITERIA!

FECAL COLIFORM (INDICATORS OF FECAL CONTAMINATION)

NATURAL DIE-OFF UNDER NON-POLLUTED CONDITIONS → 90% IN 2 DAYS

INADEQUATELY TREATED WASTE WATERS PROVIDE FOOD!

Resulting in

PERSISTENCE

(LESS THAN 50% DIE-OFF IN 24 HRS.)

or

REGROWTH

(10-FOLD REPRODUCTION)

TABLE-II

BACTERIAL NUTRIENTS IN PRIMARY EFFLUENTS

Sewage Treatment Plant	Sample Number	Temperature	Organism Fecal Coliform	Response S. Typhinurium
Sioux City	SC-49A	44.5°C	Persistence	Regrowth
Council Bluffs	CB-40B	15°C	Persistence	Persistence
Omaha	OH-40A	20°C	Regrowth	Regrowth
St. Joseph	SJ-15	20°C	Regrowth	Regrowth
S. St. Joseph Industrial	SJ-18	25°C	Regrowth	Regrowth

Persistence - Population surviving 24 hours is greater than 50%

Regrowth - 10 fold increase in population in 24 hours

Temperature - Incubation temperature related to water temperature

TABLE-III

BACTERIOLOGICAL QUALITY OF MISSOURI RIVER AT WATER INTAKES

Water Intake	Total Coliform	Fecal Coliform	Fecal Streptococcus	Ratio FC/FS	Salmonella *** Isolated
Omaha	32,000	2,700	1,300	2.1	S. Anatum
St. Joseph	88,000	5,300	3,700	1.4	S. Derby S. Montevideo
Kansas City	89,000	3,800	3,300	1.2	S. Newport S. Give S. Infantis S. Poona

Bacteriological Limits for Public Water Supplies*

Total Coliforms**	10,000 per 100 ml (Monthly Arithmetic Avg.)
Fecal Coliforms	2,000 per 100 ml (Monthly Arithmetic Avg.)

* Water Quality Criteria, FWPCA (April 1, 1968)

** Total coliforms may be related if fecal coliforms do not exceed their limit of 2,000 per 100 ml.

*** Serotypes determined by Communicable Disease Center, Atlanta, Georgia

COPROSTANOL (FECAL STEROL)

FOUND ONLY IN FECES

OF

MAN

&

HIGHER ANIMALS

THEREFORE...

ISOLATED COPROSTANOL

PROVES PRESENCE OF EXCRETA

TABLE –IV

OBSERVED COPROSTANOL CONCENTRATIONS AND FECAL COLIFORM DENSITIES

Sampling Area	Station Number	Station Description	River Mile	Mean Coprostanol Conc. µg/l	Mean Fecal Coliform Densities Organisms/100 ml
Sioux City Area	M-52	Mo. R. above Mouth of Big Sioux R.	736.0	6	140
	SC-49	Sioux City STP Effluent	729.0	709	19×10^6
	M-48	Mo. R. Sioux City Mixing Zone	717.4	101	1.3×10^4
(Jan. 20 thru Mar. 24, 1970)	B-43	Boyer R. at I-29 Highway Bridge above Omaha	631.1	62	3,500
	M-42	Mo. R. at Omaha Water-works Intake	626.2	20	770
Omaha Area	M-42	Mo. R. at Omaha Water-works Intake	626.2	21	1,000
	CB-40-B	Council Bluffs STP Eff.	614.0	797	2.9×10^6
(Jun. 27 thru Mar. 31, 1970)	OM-40-A	Omaha-Mo. R. STP Eff.	611.5	312	1.9×10^6
	M-38	Mo. R. at Bellevue-Omaha Area Mixing Station	601.7	72	4,200
	M-205	Papillion Cr. at CRB 1.0 Mile below US-73	596.6	210	3.8×10^5
	P-37	Platte R. at US-73 Bridge Junction	594.8	16	540
	M-34	Mo. R. at Nebraska City	559.7	70	3,800
	M-28	Mo. R. at St. Joseph Waterworks Intake	452.3	33	2,100
St. Joseph Area	M-28	Mo. R. at St. Joseph Waterworks Intake	452.3	33	1,800
	SJ-15	St. Joseph Municipal STP Eff.	446.4	436	4.2×10^6
(Feb. 4 thru May 5, 1970)	SJ-18	S. St. Joseph Industrial STP Eff.	445.6	508	11×10^6
	M-27	Mo. R. at St. Joseph Area Mixing Station	440.3	49	2,800
	A-25.5	Atchison STP Eff.	421.0	424	2.8×10^6
	L-24.5	Leavenworth STP Eff.	395.6	491	5.7×10^6
	M-23	Mo. R. at K.C. Waterworks Intake	370.5	56	3,150
Kansas City Area	M-23	Mo. R. at K. C. Water-works Intake	370.5	82	5,500
	K-22	Kansas R. at Central Ave. Bridge in K. C., Kansas	367.4	77	4,200
(Feb. 11 thru May 13, 1970)	M-103	K. C., Kansas STP Eff.	367.20	535	13×10^6
	M-104	K.C., Mo.Westside STP Eff.	367.19	290	0.9×10^6
	M-107-B	Big Blue R. at Mouth	358.0	95	8,300
	M-19	K. C., Mo. Blue River STP Eff.	358.0	381	2.7×10^6
	M-18	Mo. R. at Missouri City Power Plant Mixing Zone	345.4	87	6,100
	M-15	Mo. R. at Waverly	293.0	70	4,000

COPROSTANOL & FECAL COLIFORM IN MISSOURI RIVER
Jan. through May — 1970 Survey

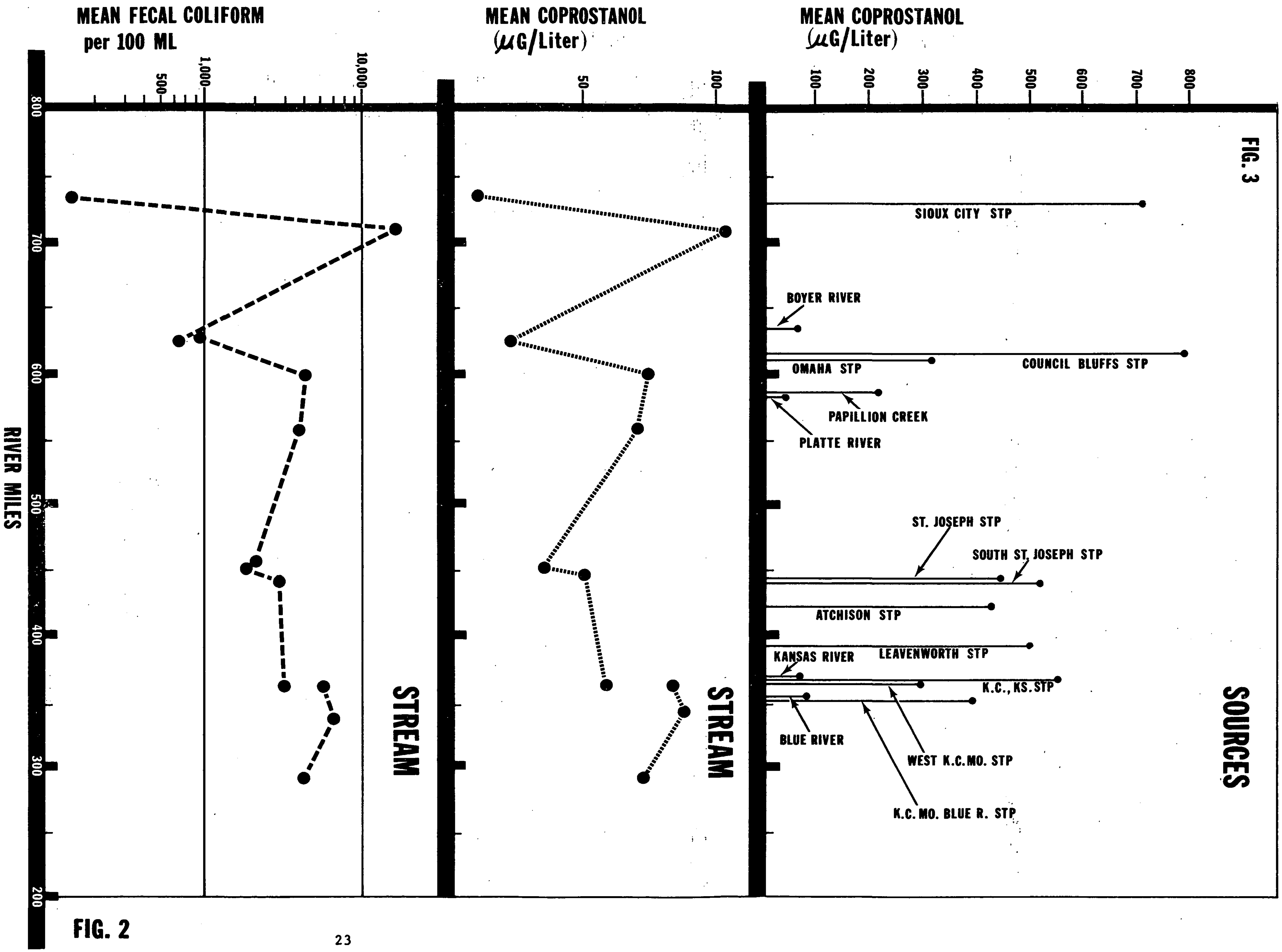


FIG. 2

FIG. 3

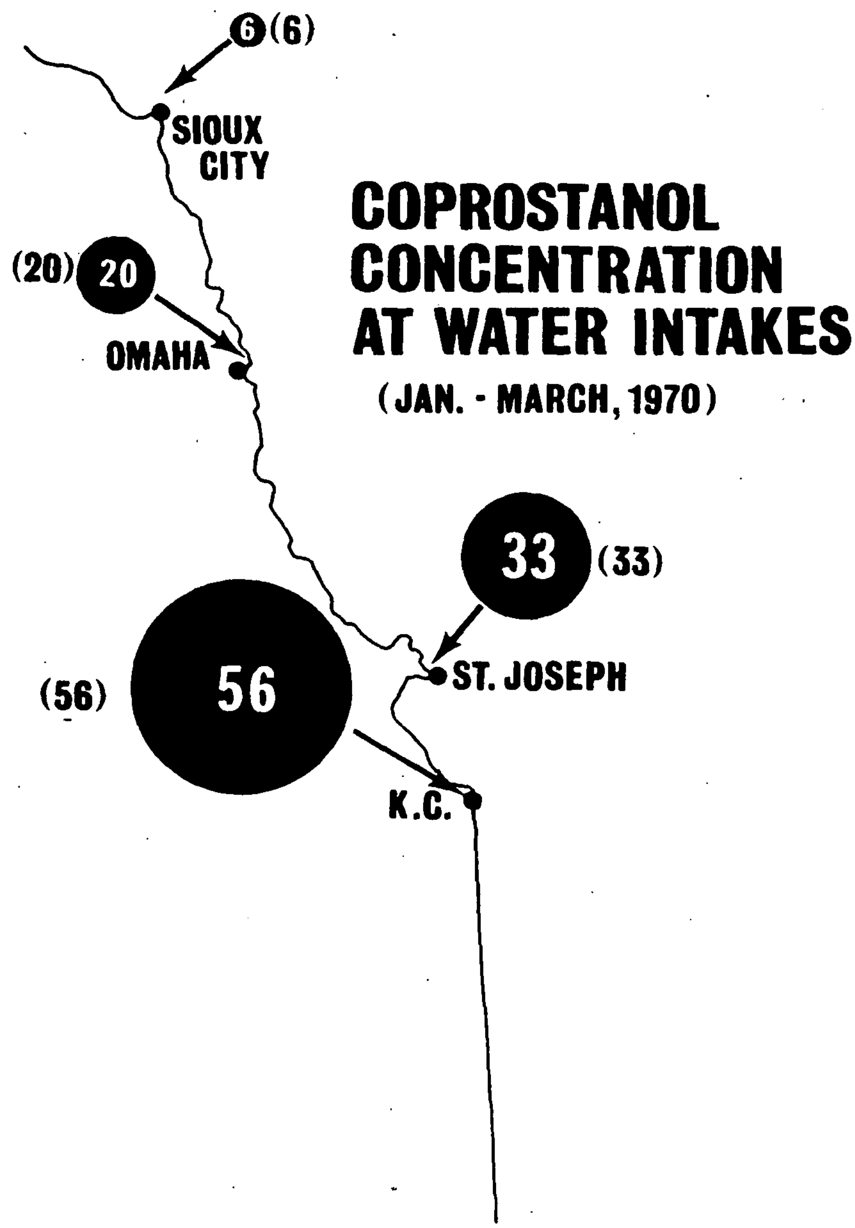

6 (6)
SIOUX CITY
(20) 20
OMAHA
COPROSTANOL CONCENTRATION AT WATER INTAKES
(JAN. - MARCH, 1970)
33 (33)
(56) 56
ST. JOSEPH
K.C.

FIG. 3

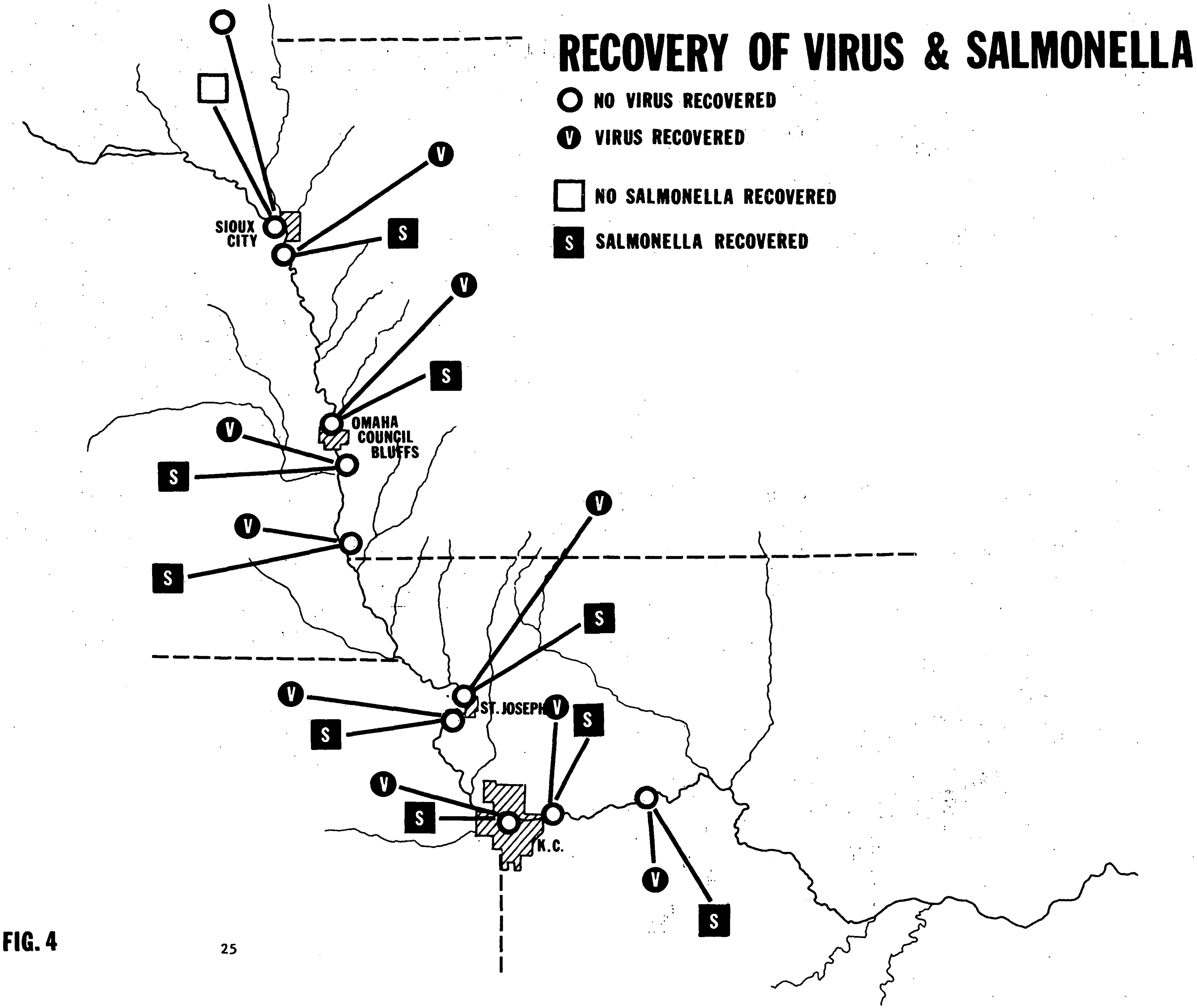

RECOVERY OF VIRUS & SALMONELLA
NO VIRUS RECOVERED
V VIRUS RECOVERED
NO SALMONELLA RECOVERED
S SALMONELLA RECOVERED
SIOUX CITY
OMAHA
COUNCIL BLUFFS
ST. JOSEPH
K.C.

FIG. 4

TABLE-V

VIRUS SAMPLING RESULTS

Sample Station	Description	Sample Date	Virus Recovered PFU*
M-52A	Missouri River Thacker Marina Sioux City	11/12/69	0
SC-49	Sioux City STP	11/12/69	41/Liter
M-48A	Missouri River downstream from Sioux City	11/12/69	1
OM-40A	Omaha STP	10/16/69	222/Liter
CB-40B	Council Bluffs STP	10/23/69	286/Liter
OM-208	Omaha Monroe St. Bypass	10/23/69	201/Liter
TC-210	Twin Cities STP	10/23/69	7/Liter
M-38	Missouri River - Bellvue, Nebr.	10/28/69	4
M-28	Missouri River at St. Joseph Water Intake	1/20/70	19
SJ-15	St. Joseph STP	1/20/70	44/Liter
SJ-18	St. Joseph Industrial effluent	1/20/70	67
M-27	Missouri River Palermo Landing	1/20/70	1
A-25.5	Atchison, Kansas STP	9/18/69	9.5/Liter
L-24.5	Leavenworth, Kansas STP	9/18/69	8/Liter

*PFU - Plaque Forming Unit - May be one virus or a clump of virus.

PERIPHYTON INVESTIGATION

THIS INVESTIGATION SUBSTANTIATES THE IMPACT OF WASTE EFFLUENTS ON THE RIVER

DOWNSTREAM FROM EACH MAJOR METRO AREA THERE WAS. . .

. . . Change in composition to pollution tolerent

OR

. . . Reduction of organisms

FISH TAINTING TEST

RESULTS

SIOUX CITY DOWNSTREAM FROM SLAUGHTER HOUSES & INDUSTRIAL WASTES	UNACCEPTABLE FLAVOR
COUNCIL BLUFFS & TWIN CITIES STP	UNACCEPTABLE FLAVOR
OMAHA STP	MOST UNACCEPTABLE FLAVOR
DOWNSTREAM OF CONFLUENCE OF PLATTE RIVER TO K.C.,KS.	ACCEPTABLE FLAVOR
FAIRFAX DUMP (K.C.)	UNACCEPTABLE FLAVOR
KANSAS RIVER	UNACCEPTABLE FLAVOR
DOWNSTREAM OF K.C.,KS. & K.C., MO. STP	UNACCEPTABLE FLAVOR

In a letter dated July 22, 1970 to Congressman John A. Blatnik, Chairman of the House Subcommittee of the Committee on Government Operations, Mr. David Howells, Director of the Water Resources Research Institute, University of North Carolina, stated in part,5/

"While water borne disease outbreaks have been comparatively infrequent in this country, we still experience them and there is no basis for complacency. Our conventional water treatment technology is not nearly as good as is often implied. In general, it does not remove dissolved organics and inorganics to say nothing of its questionable effectiveness for the removel of virus. There is a strong parallel between a citizen consuming dissolved materials of unknown toxicity over a prolonged period of time and the much-cited oyster concentrating dilute amounts of toxic materials from its aquatic environment until debilitating levels are reached. This is a vast submerged iceberg of potential peril to the public health. The fact that our epidemiological techniques are inadequate to define the problem is no indication that it does not exist. Nothing can be done about cumulative hazards of this type once demonstrated, except to take steps to prevent similar damage to the previously unexposed population."

The investigations define in large part the size of that iceberg Mr. Howells describes. The long held concepts of what is pollution, what are the limitations of water treatment systems must come in for drastic revision.

5/ Letter dated July 22, 1970 from Mr. David Howells, to Congressman John A. Blatnik.

Multiple barriers are needed to protect the health and welfare of the downstream water users. The Public Health Service in its statement to the Water Quality Standards Conference in Council Bluffs, Iowa - propounded the need for secondary treatment and necessary bacterial control on the Lower Missouri River as a minimum.6/ Dr. Graham Walton, Mr. Edwin Geldreich, and Mr. T. A. Ferris left no doubt on this point. Their common position with the Federal Water Quality Administration and the Secretary of the Interior is not only supported but has been demonstrated by subsequent investigations.

- Who can ignore a 15 fold increase in dissolved organics in terms of concentration as you progress downstream?
- Who can ignore positive virus cultures from waste sources in the river downstream and at the water intakes at Omaha and St. Joseph when none are found upstream from Sioux City, Iowa?
- Who can ignore the positive Salmonella samples found in the waste sources, in the river downstream and at the water intakes at Omaha, St. Joseph, Kansas City, and in the river at Waverly, Missouri when none were found upstream from Sioux City in the Missouri River?
- Who can ignore the fact that the conditions of steady state in the Lower Missouri occur 70-85 percent of the time and that during this time up to 85 percent of the bacterial and organic loads are from specific municipal and industrial sources?

6/ Proceedings, Conference to Consider Establishment of Water Quality Standards for the Missouri River Basin Interstate Waters - State of Iowa, April 15-16, 1969 Council Bluffs, Iowa. pp. 295-302

The Regional and National Field Investigations Center field teams backed by highly skilled experts in virology, bacteriology, biology, organic chemistry, etc., have effectively challenged the long held dependence upon single or simple quality parameters such as Dissolved Oxygen. If quality degradation can be demonstrated as it has on a difficult river like the turbulent muddy Missouri, then there is no question similar effects can be shown with relative ease on any other river in the country. Let there be no mistake - the viability of the Federal (and for many states) requirement for secondary treatment with bacterial control has been demonstrated.

EPILOGUE

The situation on the Missouri River with respect to this issue is almost academic at this point. The State of Missouri has advanced its mandatory secondary treatment requirement for all cities and towns on the Missouri and Mississippi Rivers from 1982 to December 31, 1975. The Secretary of the Interior approved this change. It is important to note that St. Charles, Missouri on the Mississippi River above the Alton Lock and Dam will have tertiary treatment by 1972 and the State has called for a similar schedule for secondary for cities and towns above that point.

The State of Nebraska has submitted to the Federal Water Quality Administration a schedule of December 31, 1975 for secondary treatment and any additionally needed bacterial control on the Missouri River at its October 9, 1970 Water Pollution Control Council Meeting. The City of Omaha has already hired engineers to design the needed facilities.

Council Bluffs, Iowa has already committed itself to similar treatment to meet the December 31, 1973 deadline set by Secretary Hickel.

Sioux City, Iowa has hired engineers to design the needed secondary system and subsequently has also been cited by the State of Iowa to proceed based upon the data supplied by the Federal Water Quality Administration and confirmed in a visit by state field technicians after the Federal data receipt.

In November, 1970 Commissioner Dominick met with the Governor of Iowa and a tentative resolution of the differences was achieved. All cities on the Missouri River will be required to put in secondary treatment with bacterial control.

Kansas City, Kansas has committed itself to secondary treatment by December 31, 1975 and the Kansas Board of Health is in substantial agreement on necessary modifications to its water quality standards to be fully approvable. A mandatory December 31,1975 outside date for completion of secondary treatment or its equivalent plus needed bacterial control is included.

The causes and effects are made up of many parts in analyzing these actions individually and collectively but there is no question the strength of the Federal position grew with each increment of data collected and analyzed in the hallmark Missouri River investigations. Rediscovery of the wheel is sometimes necessary to free it from the rut of locked-in concepts.