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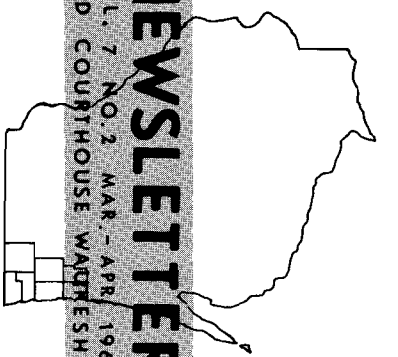
OLD COURTHOUSE WAUKESHA



STREAM WATER QUALITY REPORT COMPLETED

In December of 1963, the SEWRPC undertook, in cooperation with the State Board of Health, the State Committee on Water Pollution (now State Department of Resource Development), and the U. S. Public Health Service, a study of stream water quality in the Southeastern Wisconsin Region. The study was made as part of an intensive effort to adjust regional land use and transportation system development plans to the underlying and sustaining natural resource base. As such, it represents a highly unusual, if not unique, attempt to relate stream water quality to land use development and to forecast such water quality under alternative land use development patterns.

The results of this extensive study have now been published in SEWRPC Technical Report No. 4, Water Quality and Flow of Streams in Southeastern Wisconsin. This report, like the Commission soils report (SEWRPC Planning Report No. 8, Soils of Southeastern Wisconsin), provides the Region with information essential for guiding regional development along more healthful and attractive as well as more efficient and economical lines. Copies of the report have been sent to all participating units of government and to all libraries within the Region. The report is also available for general distribution within the Region at a price of $10 and outside the Region at a price of $15 per copy.

The Need for Water Quality Information

The uses of land and water within the Region are closely interrelated. Sound urban and rural development is dependent upon surface water resources for the dilution of treated sewage wastes, for the recharge of ground water aquifers, for the maintenance of desirable forms of aquatic life, for recreational purposes, and in some cases for water supply. The importance of stream water quality to regional development stems from the limitations that are imposed on water use by the natural mineral content of the water and by the organic and inorganic pollutants that are introduced by man from domestic, municipal, agricultural, and industrial sources. These limitations decrease the number of uses to which streams and adjacent land areas can be put, depending upon the mineral concentration and the type and quantities of pollutants present. The economic, aesthetic, and recreational potential of any area is, as a consequence, dependent upon water quality; and any meaningful assessment of the possible effects of urban development on the surface water resources of the Region requires information about the quantity and quality of the water in the major streams of the Region.

The quantity of water present in the streams is no less important than the quality of that water in evaluating the multi-purpose use potential of streams and the potential use of adjacent land. In southeastern Wisconsin streams are subject to significant change in seasonal flow. Large differences in flow also occur between the upper and lower reaches of the streams within the Region. Water uses that separately or collectively require the withdrawal of large quantities of stream water can induce low-flow conditions. Low-flow conditions, either natural or induced, can adversely affect water uses, such as waste assimilation and recreation. These and other uses can also be adversely affected by high-flow conditions, as can adjacent uses of land. Consequently, the quantitative, as well as qualitative, aspects of streamflow must be considered in the preparation of regional development plans and in the consideration of proposed multi-purpose use of the streams and of the adjacent land.

The regional planning effort, therefore, envisioned the need for information on the quality and flow of streams and on the interrelationships of this quantity and flow with land use as one of the more important considerations requiring attention if areawide development is to be properly adjusted to the underlying and sustaining resource base. Moreover, a comprehensive knowledge of the present and probable future quality and quantity of stream waters within the Region is of immeasurable value in every phase of the planning and development process at every level of government and to private investors as well.

About the Report

SEWRPC Technical Report No. 4 documents stream water quality data collected in the regional stream water quality study, relates the present condition of stream water quality within the Region to existing major sources of pollution, assesses the effect of stream water quality on various water uses, and explores the interrelationships existing between stream water quality and land use patterns. Numerous tables and water quality graphs present the factual and interpretive data produced in the study. Forecasts of future stream water quality within the major watersheds of the Region are presented for alternative land use development plans. The assumptions and rationale underlying these forecasts should prove of assistance in anticipating future stream water quality conditions within the Region.

The report consists of six chapters comprising 342 pages of text, maps, figures, and tables. The first two chapters present background information essential to a proper understanding and utilization of the water quality study findings, such as the purpose, scope, and duration of the study; the criteria used in selecting sampling stations; the sampling methods employed; a description of water quality parameters; the streamflow measurement techniques employed; and the frequency of sampling and measurement. The third chapter presents a detailed discussion of water quality standards for 10 selected major water uses. The fourth chapter describes the nature and significance of 31 selected

chemical and physical stream water quality parameters. The fifth chapter presents a description of present stream water quality, streamflow, and precipitation within the Region and presents forecasts of the probable future stream water quality in each of the 43 streams of the Region under alternative regional land use development patterns. The sixth chapter presents a summary assessment of present levels of stream water quality, of the effects of water quality on water uses and land use patterns, and of the forecast of probable future stream water quality conditions within the Region.

As a whole, the report constitutes an extremely important data base or bench mark on water quality conditions within the Region and, as such, should have lasting historic value. By providing definitive knowledge on present and probable future levels of stream water quality within the Region, it provides an important basis for the sound planning of land and water use and for the design and execution of land and water management programs within the Region.

Scope of the Work

The stream water quality study involved the establishment of 87 stream sampling stations on 43 streams and watercourses within the 12 major watersheds of the Region. A photographic record was made of each sampling station to provide detailed information on its situation and landmarks. A transit and tape field survey was made of each sampling station to record bridge or culvert dimensions (all sampling stations were located at bridges or culverts), angle of crossing, and stream cross sections. A bench mark for stream stage measurement was established at each sampling station. Stream water samples were collected at each of the 87 sampling stations on a monthly basis over a 14-month period and resulted in the collection of a total of 3,933 water samples. Data derived from the analyses of these samples provided the basic information regarding chemical, physical, and bacteriological quality of the stream waters. Streamflow records of nine U. S. Geological

Survey stream gaging stations within the Region, together with SEWRPC flow measurements made at 48 of the 87 sampling stations during seasonal periods of high- and low-flow, provided the basic information on the quantity of water flowing through the main streams and the major tributaries. Existing stream water quality and streamflow data previously collected by federal, state, county, and municipal agencies were collated to provide a valuable supplement to the original data collected in the SEWRPC work program. Finally, water quality standards for 10 major water uses were formulated to permit an appraisal and mapping of stream water quality within the Region and a correlation of present stream water quality and flow with existing major sources of pollution and with existing patterns of land use and population distribution.

To meet the objectives of the Commission water quality study, 34 stream water quality parameters or indicators were determined in laboratory analyses. Three of these were analytical prerequisites to the determination of ionic concentrations of calcium, magnesium, and carbon. The chemical, physical, biochemical, and bacteriological parameters determined are shown in Table 1. The total number of samples and number of analytical interpretations performed are shown in Table 2. The State Laboratory of Hygiene, in cooperation with the State Committee on Water Pollution, performed the analyses for 8 of the 34 parameters, while the Commission staff performed the analyses for the remainder.

The number and location of the sampling stations in each watershed of the Region are shown on Map 1. A permanent identifying designation was assigned to each sampling station, consisting of a two-letter prefix representing the watershed in which the sampling station is located and a number representing the particular station within the watershed in sequential downstream order.

Stream stage measurements were made in conjunction with the monthly stream water sampling program in order to obtain gross information on

Table 1

SEWRPC STREAM WATER QUALITY PARAMETERS: 1963

1. Silica	18. Oil[a]
2. Iron	19. Detergents (synthetic)
3. Manganese	20. Dissolved Solids
4. Chromium[a]	21. Hardness
5. Hexavalent Chromium[a]	22. Noncarbonate Hardness
6. Calcium	23. Calcium Hardness[b]
7. Magnesium	24. Magnesium Hardness[b]
8. Sodium	25. Alkalinity P[b]
9. Bicarbonate	26. Alkalinity M
10. Carbonate	27. Specific Conductance
11. Sulfate	28. Hydrogen Ion Concentration (pH)
12. Chloride	29. Color
13. Fluoride[a]	30. Turbidity
14. Nitrite	31. Biochemical Oxygen Demand[a]
15. Nitrate	32. Dissolved Oxygen
16. Phosphorus[a]	33. Coliform Bacteria[a]
17. Cyanide[a]	34. Temperature

[a] *Analyses conducted by the State Laboratory of Hygiene.*

[b] *Analytical prerequisites for determination of ionic concentrations of calcium, magnesium, and carbonate.*

Source: SEWRPC.

the monthly flow situation and to permit the calculation of stream depth at each station.

Water Quality Standards for Major Water Uses

The SEWRPC has no authority to establish, regulate, or enforce water quality standards of any kind within the Region. This power rests with the newly reorganized State Department of Resource Development, the Wisconsin Conservation Commission, and the Metropolitan Sewerage Commission of the County of Milwaukee. The interest of the Regional Planning Commission in water quality standards stems from the fact that water quality and pollution affect and are, in turn, affected by regional development patterns. Land and water use are inextricably interrelated and must be considered together in any meaningful comprehensive planning effort. Numerical expressions of water quality, that is, of the concentrations of dissolved or suspended foreign matter in water, have no significance as such in planning land and water use. Only where water

Table 2

NUMBER OF STREAM SAMPLES COLLECTED AND ANALYTICAL DETERMINATIONS PERFORMED BY THE STATE LABORATORY OF HYGIENE AND THE SEWRPC

Type of Water Analysis	Number of Samples Collected	Number of Determinations	Analysis by
Complete Chemical Analysis	539	12,348[a]	SEWRPC[b]
Special Chemical Analysis			WSLH[c]
Fluoride, chromium, hexavalent chromium, phosphorus, and oil	48	240	
Cyanide	30	30	
Subtotal	*78*	*270*	
Supplemental Chemical Analysis	136		SEWRPC
Nitrate	--	101	
Detergents (synthetic)	--	12	
Specific Conductance	--	16	
Hydrogen Ion (pH)	--	9	
Color	--	18	
Turbidity	--	20	
Subtotal	*136*	*176*	
Determination of Biochemical Oxygen Demand	1,064	1,064	WSLH
Analysis for Dissolved Oxygen	1,066	1,066	SEWRPC
Determination of Membrane Filter Coliform Count	1,050	1,050	WSLH
Temperature Measurement (exclusive of that made as part of the complete chemical analysis)	--	520	SEWRPC
Subtotal - Determinations by SEWRPC		*14,110*	
Subtotal - Determinations by WSLH		*2,384*	
Total	3,933	16,494	

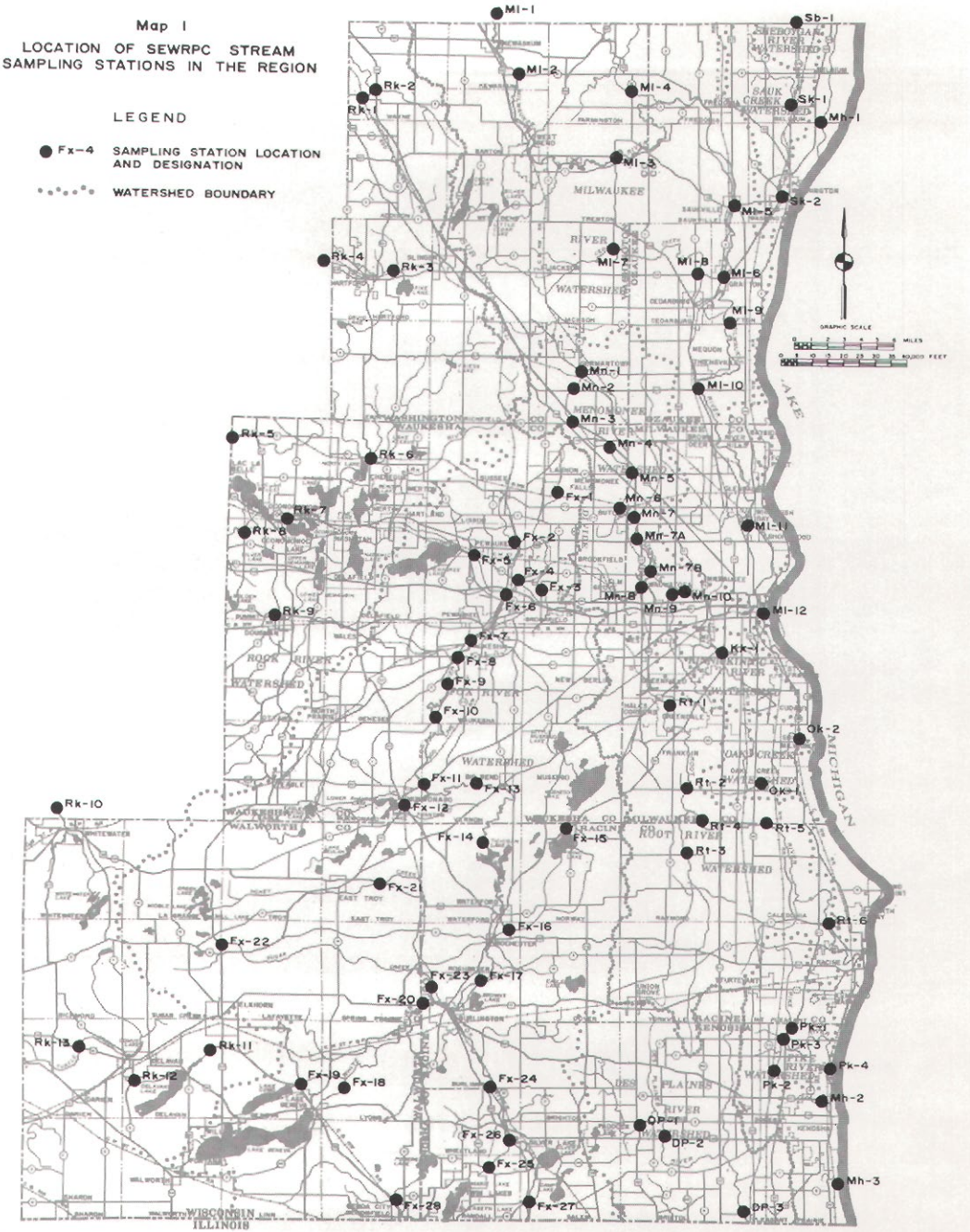
[a] *Includes 22 determinations made toward an additional complete chemical analysis.*

[b] *Southeastern Wisconsin Regional Planning Commission.*

[c] *Wisconsin State Laboratory of Hygiene.*

Source: Wisconsin State Laboratory of Hygiene; SEWRPC.

quality has been related to potential land and water uses and specific permissible maximum or minimum levels of concentrations of the several water quality indicators established in the form of standards can pollution be defined, land and water use related, future conditions and needs forecast, and land and water use plans prepared to meet these needs.



Stream quality data were obtained from chemical, physical, biochemical, or bacteriological analyses of 3,933 water samples collected at 87 sampling stations established by the SEWRPC on 43 streams.

Water quality standards are of two types depending on whether the standards apply to the condition of a receiving stream or body of surface or ground water or whether they apply to the composition and extent of the waste discharges from a given source, such as to the effluent from a municipal sewage treatment plant or to waste discharge from an industrial plant. These two types of standards are often referred to as "receiving water standards" and "effluent standards," respectively. In Wisconsin pollution has been controlled historically primarily through the establishment of effluent standards. Mapping and appraisal of regional stream water quality for planning purposes, however, require the establishment of receiving water standards. At the time of the SEWRPC study, no such standards had been established in Wisconsin; and the Commission had to adopt for its purposes selected water standards, as related to 10 major water use categories. These standards had been established or recommended elsewhere by responsible state and federal agencies and by industry.

The water quality standards so adopted by the SEWRPC are intended to serve two principal purposes: 1) to provide a basis for mapping stream water quality in order to establish the spatial distribution and intensity of pollution within the Region, and 2) to provide a means of appraising the quality of untreated stream water relative to the following 10 water use categories: municipal (public) water supply, industrial water supply, cooling water supply, waste assimilation, livestock and wildlife watering, irrigation, preservation and enhancement of aquatic life, recreation, navigation (commercial), and aesthetic use. SEWRPC Technical Report No. 4 lists the water quality standards adopted by the Commission. The standards are expressed in terms of 29 parameters measured in the regional stream water quality study. Table 3, listing the adopted standards for three of the 10 major water use categories, is provided for illustrative purposes.

Water Quality Conditions

Present conditions of stream water quality within the Region are pre-

Table 3

WATER QUALITY STANDARDS FOR MAJOR WATER USES ADOPTED BY SEWRPC FOR STREAM QUALITY MAPPING AND APPRAISAL

Parameter[a]	Preservation and Enhancement of Aquatic Life			Recreation		Municipal (Public) Water Supply	
	Tolerant	Fish Facultative	Intolerant	Whole Body Contact	Partial Body Contact	Raw	Treated
Silica	---	---	---	---	---	---	---
Iron	---	---	---	---	---	---	0.3
Manganese	---	---	---	---	---	---	0.05
Chromium Hexavalent	0.5	0.5	0.5	---	---	---	0.05
Calcium	---	---	---	---	---	---	---
Magnesium	---	---	---	---	---	---	---
Sodium	---	---	---	---	---	---	---
Bicarbonate	---	---	---	---	---	---	---
Carbonate	---	---	---	---	---	---	---
Sulfate	---	---	---	---	---	---	250
Chloride	500	500	500	---	---	50-250	250
Fluoride	---	---	---	---	---	1.7	1.7
Nitrite	---	---	---	---	---	---	---
Nitrate	---	---	---	---	---	---	45
Phosphorus	---	---	---	---	---	---	---
Cyanide	0.025	0.025	0.025	---	---	---	0.01
Oil	---	---	---	---	---	---	---
Detergents	3.5	3.5	2.0	---	---	---	0.5
Dissolved Solids	---	---	---	---	---	---	500
Hardness	---	---	---	---	---	---	---
Alkalinity (total)	---	---	---	---	---	---	---
pH	6.0-9.0	6.0-9.0	6.0-9.0	---	5.0-9.0	6.0-9.0	---
Specific Conductance	---	---	---	---	---	---	---
Color	---	---	---	50	---	20-150	15
Turbidity	250	250	250	50	250	10-250	5
Biochemical Oxygen Demand	---	---	---	---	---	3.0-4.0	---
Dissolved Oxygen	3.0M[b]	4.0M[b]	5.0M	3.0M	3.0M	4.6-6.5	---
Coliform Count	---	---	---	2,400	5,000	5,000	1
Temperature (°F)	90	85	80	90	90	---	65

[a] *The limiting values of the chemical, physical, biochemical, and bacteriological parameters are expressed in ppm (mg/l) except pH, specific conductance, color, turbidity, coliform count, and temperature.*

[b] *Sixteen hours maximum exposure at indicated concentration. M = minimum permissible value.*

Source: Compiled by SEWRPC from five authorities as described in the text of the water quality report.

sented in the report by watershed and within each watershed by individual stream or watercourse. The existing level of water quality is presented in terms of the water quality parameters determined in the study, with particular emphasis upon chloride, dissolved solids, dissolved oxygen,

and coliform count concentrations and the relationship of these concentrations to desirable water uses. To summarize the most important aspects of the findings with respect to existing levels of water quality, the 43 streams of the Region were comparatively rated in terms of these four selected water quality parameters and then ranked in order of decreasing quality. The rank order of each stream in the sequence thus provides a comparative stream water quality rating for that stream with respect to the water quality parameter under consideration. The parameters are expressed and discussed in terms of maximum, weighted average, and minimum concentrations and in absolute as well as relative terms.

Important as the determination and analysis of existing levels of stream water quality are, one of the more interesting aspects of the report is the effort undertaken to forecast future levels of stream water quality within each of the major watersheds under the three alternative land use plans considered by the Commission in the preparation of a land use plan for the Region. These forecasts indicate that the anticipated increase of over 1 million people in the Region by 1990, with the attendant massive conversion of land from extensive rural to intensive urban uses, will, in the absence of sound integrated land and water use management, lead to severe and widespread stream pollution problems and a general deterioration of the overall environment within the Region. Illustrative examples of the manner in which existing and future stream water quality conditions are displayed in the report are included here in Figure 1 and Table 4. In addition, Table 5 is provided as an example of tabular displays of existing and forecast stream suitability for three of the ten major water uses for which standards were adopted.

General Conclusions on Water Quality

The following general conclusions have been drawn from the factual findings of this study with respect to stream quality conditions within the Region:

Figure 1

COLIFORM COUNT IN THE FOX RIVER

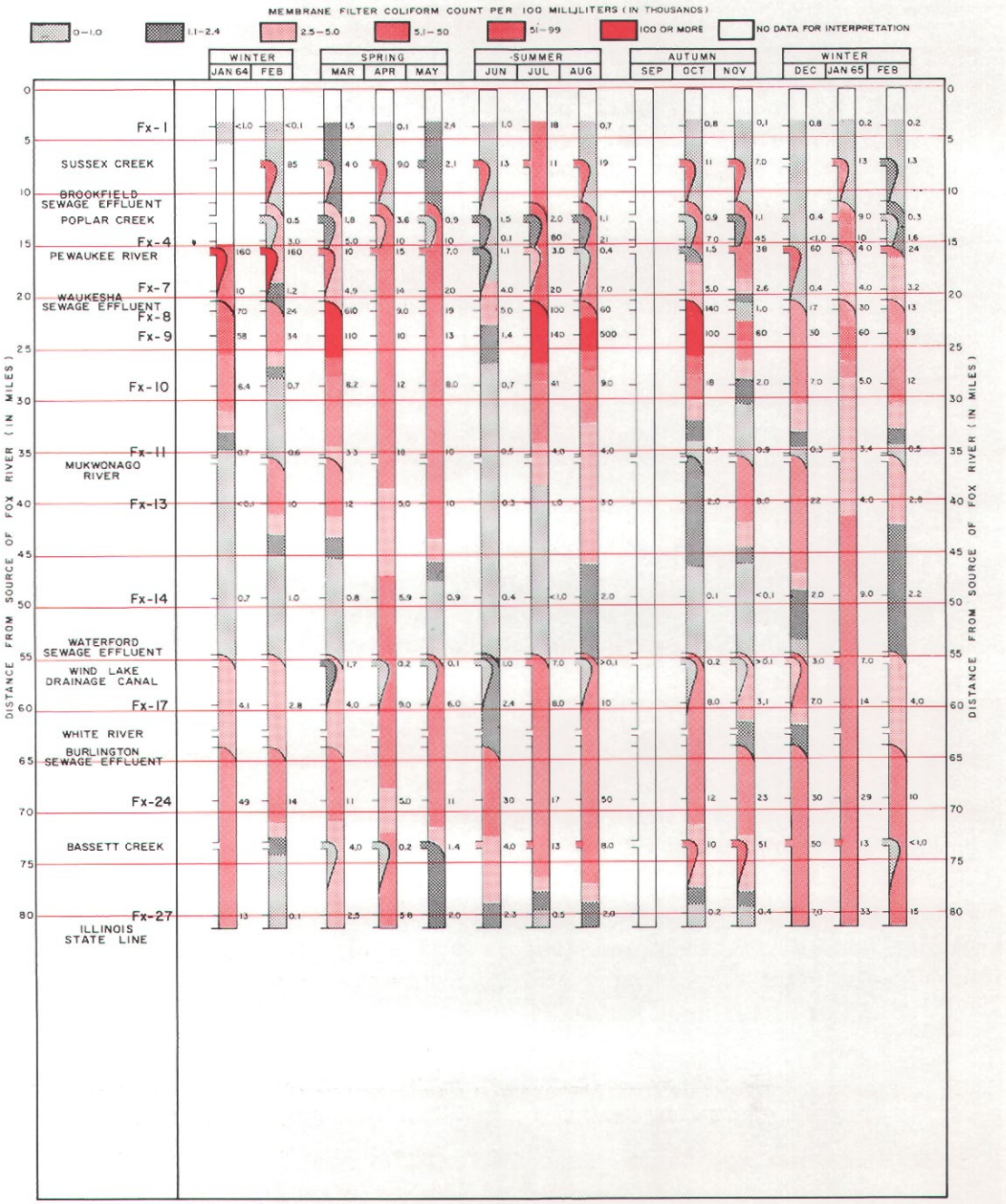


Table 4

FORECAST QUALITY OF THE FOX RIVER: 1990 ALTERNATIVE LAND USE PLANS

Stream	Parameter	Sampling Station	Stream Quality in 1964	Forecast Quality for 1990		
				Controlled Existing Trend Plan	Corridor Plan	Satellite City Plan
Fox River	Chloride (in ppm)	Fx-1	30[a]	150	40	120
		Fx-4	120	170	170	170
		Fx-7	65	170	170	170
		Fx-8	120	170	170	170
		Fx-11	65	From 100 to 150		
		Fx-13	55			
		Fx-14	55			
		Fx-17	50	From 50 to 100		
		Fx-24	45			
		Fx-27	30			
	Dissolved Solids (in ppm)	Fx-1	460[a]	650	500	600
		Fx-4	765	850	850	850
		Fx-7	600	800	800	800
		Fx-8	685	750	750	750
		Fx-11	575	From 600 to 700		
		Fx-13	520			
		Fx-14	520			
		Fx-17	500	From 500 to 600		
		Fx-24	485			
		Fx-27	445			
	Dissolved Oxygen (in ppm)	Fx-1	2.2[b]	Concentrations of less than 3.0 may be expected to occur most frequently.		
		Fx-4	3.2			
		Fx-7	5.1			
		Fx-8	4.0			
		Fx-11	6.4	Concentrations between 3.0 and 5.0 may be expected to occur most frequently.		
		Fx-13	7.3			
		Fx-14	8.4			
		Fx-17	10.0	More than 6.0		More than 6.0
		Fx-24	8.0			More than 4.0
		Fx-27	11.8			More than 6.0
	Coliform Count (in MFCC/ 100 ml)	Fx-1	5,100[c]	From 40,000 to more than 100,000		
		Fx-4	27,000	More than 100,000		
		Fx-7	9,000	More than 100,000		
		Fx-8	76,000	Less than 50,000		
		Fx-11	2,200	Less than 5,000		
		Fx-13	1,600	More than 15,000		
		Fx-14	900	More than 5,000		
		Fx-17	7,100	More than 20,000		
		Fx-24	27,200	More than 50,000		
		Fx-27	1,200	More than 3,000		

[a] *All chloride and dissolved solids concentrations in this column are based on water analyses for October 1964.*

[b] *All dissolved oxygen concentrations in this column are based on average for period June through September.*

[c] *All coliform counts in this column are based on average for period June through October 1964. No data for September 1964.*

Source: SEWRPC.

Table 5

EXISTING AND FORECAST SUITABILITY OF STREAMS IN SOUTHEASTERN WISCONSIN FOR 3 MAJOR WATER USES[a]

Stream or Watercourse	Waste Assimilation		Preservation and Enhancement of Aquatic Life		Recreation			
					Whole-Body Contact		Partial-Body Contact	
	Existing 1964	1990	Existing 1964	1990	Existing 1964	1990	Existing 1964	1990
Des Plaines River	S4*	S4*	S	U2	U2	U2	U2	U2
Brighton Creek	U4	U4*	U5	U5	U5	U5	U2	U2
Fox River	S4*	S4*	U2	U2	U2	U2	U2	U2
Sussex Creek	U4*	U4*	U5	U5	U5	U5	U5	U5
Poplar Creek	U4*	U4	U2	S	U	U	S	S
Pewaukee River	U4*	U4*	U2	U2	U5	U5	U5	U5
Mukwonago River	S4	S4	S	S	U5	U5	S	S
Muskego Canal	U4*	U4*	U2	U2	U	U	U2	U2
Wind Lake Drainage Canal	U4	U4*	S	U2	U	U	S	U2
White River	S4*	S4*	S	S	U2	U2	U2	U2
Como Creek	U4*	U4*	U5	U5	U5	U5	U5	U5
Honey Creek	U4*	U4*	U2	S	U2	U2	U2	U2
Sugar Creek	U4*	U4*	S	S	U5	U5	S	S
Bassett Creek	U4	U4*	U2	U2	U5	U5	U5	U5
Nippersink Creek	S4*	S4*	S	S	U5	U5	S	U2
Kinnickinnic River	U4*	U4*	U5	U5	U5	U5	U2	U2
Menomonee River	S4*	S4	U2	S	U2	U2	U2	U2
Little Menomonee River	U4*	U4	U2	S	U5	U5	U5	U5
Underwood Creek	U4*	U4	U5	U5	U5	U5	U2	U5
Honey Creek	U4*	U4	U5	U5	U5	U5	U2	U5
Sucker Creek	U4*	U4*	U2	U2	U2	U2	U2	U2
Pike Creek	U4*	U4*	U2	U2	U5	U5	U2	U2
Barnes Creek	U4*	U4	U5	U5	U5	U5	U2	U2
Milwaukee River	S4*	S4*	U2	U2	U5	U5	U2	U2
North Branch Milwaukee River	S4*	S4*	S	S	U2	U2	U2	U2
Cedar Creek	S4*	S4*	U2	U2	U5	U5	U2	U2
Oak Creek	S4*	S4*	S	S	U5	U5	U2	S
Pike River	S4*	S4	U2	S	U5	U5	U2	S
Pike Creek	S4*	S4	U2	S	U5	U5	U2	S
East Branch Rock River	S4*	S4*	U2	U2	U2	U2	S	U2
Kohlsville River	S4	S4	S	S	U5	U5	S	S
Rubicon River	S4*	S4*	S	S	U5	U5	U2	U2
Ashippun River	S4*	S4*	U2	U2	U5	U5	S	S
Oconomowoc River	S4*	S4*	S	U2	U5	U5	U2	U2
Bark River	S4*	S4*	S	S	U5	U5	U2	U2
Whitewater Creek	S4*	S4*	S	U2	U5	U5	U2	U2
Jackson Creek	S4*	S4*	U2	U2	U5	U5	U2	U2
Delavan Lake Outlet	S4*	S4*	S	U2	U5	U5	S	U2
Turtle Creek	S4*	S4*	S	S	U2	U2	U2	U2
Root River	S4*	S4	U2	S	U2	U2	U2	S
Root River Canal	U4*	U4*	U2	U2	U5	U5	U2	U2
Sauk Creek	S4*	S4*	U2	U2	U5	U5	U2	U2
Tributary of Sheboygan River	U4*	U4*	U2	U2	U5	U5	U2	U2

Table 5 (continued)

Symbols: S - Suitable stream for the specified use.
S4 - Waste assimilation capacity commonly not exceeded.
S4*- Waste assimilation capacity commonly exceeded by one or more pollutants.
U - Unsuitable stream for the specified use.
U2 - Substandard quality.
U4 - Unsuitable for waste assimilation under low-to-moderate flow conditions.
U4*- Unsuitable for waste assimilation under low-to-moderate flow conditions. Polluted stream.
U5 - Inadequate stream depth.

[a] *The evaluations of the suitability of the streams for the 3 major uses are based on the raw water quality of the streams.*

Source: SEWRPC.

1. The original, naturally high quality of the streams and watercourses of the Region has markedly deteriorated through the impact of human activity. Stream quality conditions within the Region reflect the deleterious effect of human activity as reflected, for example, in the chloride, dissolved solids, dissolved oxygen concentrations, and in the coliform counts found in this study. Stream pollution may, therefore, be considered as occasionally or persistently severe either locally or widespread in all of the 12 major watersheds within the Region.

   When considered in the light of existing and potential water uses, the study findings indicate the seriousness of the water pollution problem within the Region.

2. The deterioration of stream quality has impaired or prohibited certain water uses associated with an attractive urban, suburban, and rural environment, particularly full recreational use and use as an aesthetic setting for high-value residential park development. The pollution of streams and watercourses of the Region is directly related to urbanization, with the major waste sources being municipal sewage treatment plants and industries. Of the

339.7 square miles of the Region presently developed for urban use, 217.0 square miles, or approximately 64 percent, are served by 53 public sanitary sewage treatment plants, with a total connected population of about 1,419,000 persons, or 84.7 percent of the population of the Region. Of this total connected population, approximately 168,000 persons, or 11.8 percent of the total connected population, are presently served by 44 sewage treatment plants that discharge treated wastes to the 43 streams and watercourses within the Region. Lake Michigan receives the effluent from nine sewage treatment plants with outfalls in or very near the lake. These nine plants serve an estimated 1,196,000 persons.

3. The population of the Region is expected to increase by over 1 million persons in the next 25 years, thereby greatly increasing the connected populations of all of the sewage treatment plants and requiring the construction of new plants and tributary collection systems in certain areas of the Region. The pollution of the streams and watercourses of the Region is also related to storm water runoff and to the development of residential areas served by on-site sewage disposal systems which fail to function properly on certain soils. Over 15 percent of the present population of the Region, about 255,000 persons, is served by on-site sewage disposal systems. Detailed operational soil surveys covering the entire Region indicate that over 49 percent of the Region is covered by soils unsuitable for such septic tank sewage disposal systems.

Although municipal sewage treatment plants are concluded to be the most important sources of pollution with respect to almost all of the parameters determined in the study, it is not implied that these plants are necessarily operating below efficiency or are of defective design. Although the wastes may be processed by conventional secondary sewage

treatment methods, the discharge of treated sewage into the natural waterways of the Region poses a real and potential threat to the quality of the receiving streams because of the low natural base flow of the streams and concomitant low waste assimilation capacity. Moreover, ordinary sewage treatment methods do not remove all plant nutrients from the effluent and, therefore, serve to greatly enrich the streams. Such enrichment is indicated by the levels found by this study to prevail in many of the streams within the Region. Without the application of technically feasible means for improving the quality of the effluent from municipal sewage treatment plants and ultimately removing nutrients, the stream quality forecasts prepared in the study clearly indicate that the natural waste assimilation capacities of many of the streams and watercourses will be overwhelmed by increased treated waste loadings; and certain streams will be reduced to little more than open sewers.

At least three general courses of action appear to be required if further deterioration of stream quality within the Region is to be avoided.

1. Further intensive urban development dependent upon on-site sewage disposal systems on soils not suited to the proper functioning of such systems must be avoided and this growth directed instead into those areas of the Region which can be readily served by gravity drainage sanitary sewer systems tributary to existing and, in some cases, new sewage treatment plants.

2. Within the context of a regional sanitary sewerage system plan and a comprehensive watershed planning program for each of the major watersheds within the Region, provision must be made either for the export of liquid wastes or for the provision of higher levels of treatment than are presently being provided. The latter course of action requires technological advances in the field of sewage treatment.

3. Since the study clearly indicates a relationship between urbanization and stream pollution, it must be recognized that pollution abatement is, within southeastern Wisconsin, basically a problem of land use. Consequently, it will be extremely important in the preparation of future land use plans at the local, county, and regional levels to adjust, wherever possible, the future land use pattern to the waste assimilation capacities of the streams and watercourses. Such adjustment must be recognized as a complex design problem involving many factors and can best be accomplished within the context of comprehensive watershed planning programs properly related to an areawide regional planning effort. Perhaps the singularly most important conclusion indicated by the study is the close relationship between land use and stream pollution within the Region and the need to plan future land use and water quality control elements simultaneously. It is, indeed, dangerous to assume that technological advances in waste treatment will always solve pollution problems and that the application of these technological advances will always be economically feasible. Therefore, increased emphasis should be placed on coordinated land and water use planning in all future pollution abatement and water quality control efforts within the Region.

WHAT IS MEANT BY A WATER QUALITY "PARAMETER"?

Pure water in the strict chemical sense is not known to exist in nature. Even rainfall contains dissolved gases. If all water were chemically pure, there would be no water quality problems, no need for water quality studies, and no life on earth as we know it. In reality water, regardless of source, always contains foreign matter; and under most conditions this foreign matter is vital to the support of plant and animal life. Consisting of inorganic and organic substances in solution or suspension, these "impurities" can enhance or detract from the usefulness of water as a vital substance in the biologic and economic existence and welfare of man. The kinds and amounts of foreign matter contained determine the suitability of a particular source of water for a particular use. Hence, the concept of "water quality," a term relating to the chemical, physical, biochemical, and bacteriological aspects of water as determined by water analyses that affect its usefulness to man.

Thus, water quality may be determined by chemical, physical, biochemical, and bacteriological tests of representative water samples. These tests, or analyses, are developed for the specific purpose of determining the quantity or magnitude of a given substance, physical property, or organism in a given quantity of sampled water. These substances, physical properties, and organisms are referred to as "parameters"; and the quantity or magnitude of the parameter is expressed on a numerical scale. Thus, the term parameter, as used in water quality studies, is defined as a chemical substance, a physical property, or an organism analytically determined in a water sample as an indicator of water quality. There are literally hundreds of possible water quality parameters available for study; and this number can be expected to increase as new processes, products, and materials are developed by a highly industrialized and technological society. Water quality analyses are generally expensive to perform and are often time consuming. Water quality surveillance must, therefore, of necessity involve a selection for determination, from the hundreds of possible parameters, those specific ones which best meet the objectives of the study.

QUOTABLE QUOTE.....

"Human occupation of the world has operated chiefly to harm the landscape, and not to preserve it.

What is needed.....is a new frame of mind and the application of some new perspective in water planning.

.....the belief that technology can solve any water problem is wrong since it obstructs consideration of alternative nontechnological solutions that might be preferable."

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