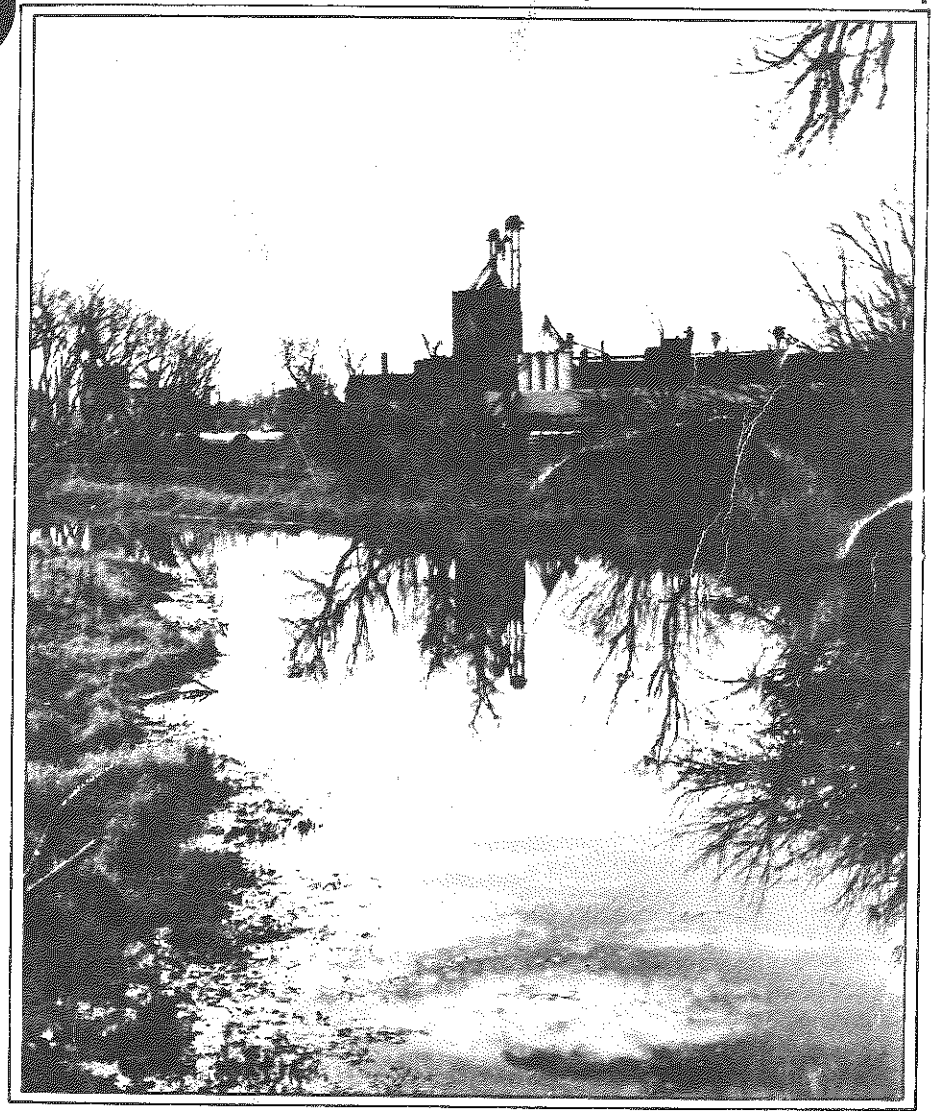
STARKWEATHER



STARKWEATHER

A Water Quality Plan for Starkweather Creek

This project financed in part with Section 208 funds from the Environmental Protection Agency, and with support from the Wisconsin Department of Natural Resources

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

DECEMBER 1983

DANE COUNTY REGIONAL PLANNING COMMISSION

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Acknowledgements

The following individuals, through their involvement on advisory committees of the Regional Planning Commission, have assisted in the development of this plan.

Environmental Resources Advisory Committee

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Kathryn Sayles
Royce Williams

Appreciation is also expressed to the many groups, individuals and neighborhood organizations who assisted in generating broader public support and awareness.

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RESOLUTION RPC NO. 308

REGARDING ADOPTING A WATER QUALITY PLAN
FOR STARKWEATHER CREEK

WHEREAS, the Dane County Regional Planning Commission is the designated water quality management planning agency for Dane County, Wisconsin; and

WHEREAS, the Commission has prepared a Water Quality Plan for Starkweather Creek to address longstanding issues and problems of community importance, and to improve the quality of the stream and adjoining land areas; and

WHEREAS, the Starkweather Creek plan has been developed with the assistance and involvement of interested agencies, units of government, groups, organizations and individuals; has benefitted from extensive public discussion and several public meetings; and has been the subject of two public hearings;

NOW, THEREFORE, BE IT RESOLVED, that the Dane County Regional Planning Commission adopts A Water Quality Plan for Starkweather Creek as an element, refinement and detailing of the Dane County Water Quality and Land Use Plans, and supports the plan recommendations as a guide to future actions to be undertaken to improve water and land resources in the watershed.

February 10, 1983
Date Adopted

Fred A. Raemisch, Secretary

AGENDA ITEM #____

Copy Mailed
to Aldermen _____

City of Madison, Wisconsin

SUBSTITUTE
A RESOLUTION _____

Adopting the Water Quality Plan for Starkweather Creek and Directing Further Action

Presented January 18, 1983
Referred Comm. on the Environment, Board of Public Works, Plan Commission, Parks Commission
Rereferred _____

Reported Back MAR. 1 1983

Adopted ✓ POF _____
Rules Susp. _____ Tabled _____
Public Hrg. _____

DRAFTED BY: Ald. Lufler
DATE: January 12, 1983
FISCAL NOTE: Specific projects and funding to be considered in future Capital Budgets.

APPROVAL OF FISCAL NOTE IS NEEDED BY THE COMPTROLLER'S OFFICE
Approved by
Comptroller's Office

SPONSORS: (Commission on the Environment), and Alds. Lufler, Onken, Blair, Fleming, Monks, Stewart, Bowser, Feitlinger, Kratsch and Olson

SUBSTITUTE
RESOLUTION NO. 38,853
FILE NUMBER 5499-83

WHEREAS, the Dane County Regional Planning Commission is the designated water quality management planning agency for Dane County, Wisconsin; and

WHEREAS, the Commission has completed preparation of a Water Quality Plan for Starkweather Creek to address longstanding issues and problems of community importance, and to improve the quality of the stream and adjoining land areas; and

WHEREAS, the Starkweather Creek plan has been developed with the assistance and involvement of interested City of Madison agencies and departments, other involved units of government, community groups and organizations and interested citizens; and

WHEREAS, the City of Madison is a designated water quality management agency (under the provisions of the Dane County Water Quality Plan) having jurisdiction within the watershed; and

WHEREAS, the Starkweather Creek plan contains detailed recommendations and an implementation program for future city actions to be undertaken to improve water and land resources in the watershed;

NOW, THERFORE, BE IT RESOLVED, that the Madison Common Council adopts the program recommendations of the Water Quality Plan for Starkweather Creek as a guide to future actions in the watershed, and agrees to work with other affected units of government toward implementation of the plan, as state funds and local resources allow.

BE IT FURTHER RESOLVED, that the Mayor will appoint a staff team from Engineering and Parks Divisions, and the Department of Planning and Development ~~be directed~~ to develop and refine specific first year implementation actions for consideration in the 1984 Capital Budget, and develop a five year implementation schedule for inclusion in the Capital Improvement Program. Projects to be considered for inclusion in the annual Budget should be submitted to the Commission on the Environment by September 1. The Commission on the Environment shall also be responsible for the annual review and reporting of implementation progress to the Common Council.

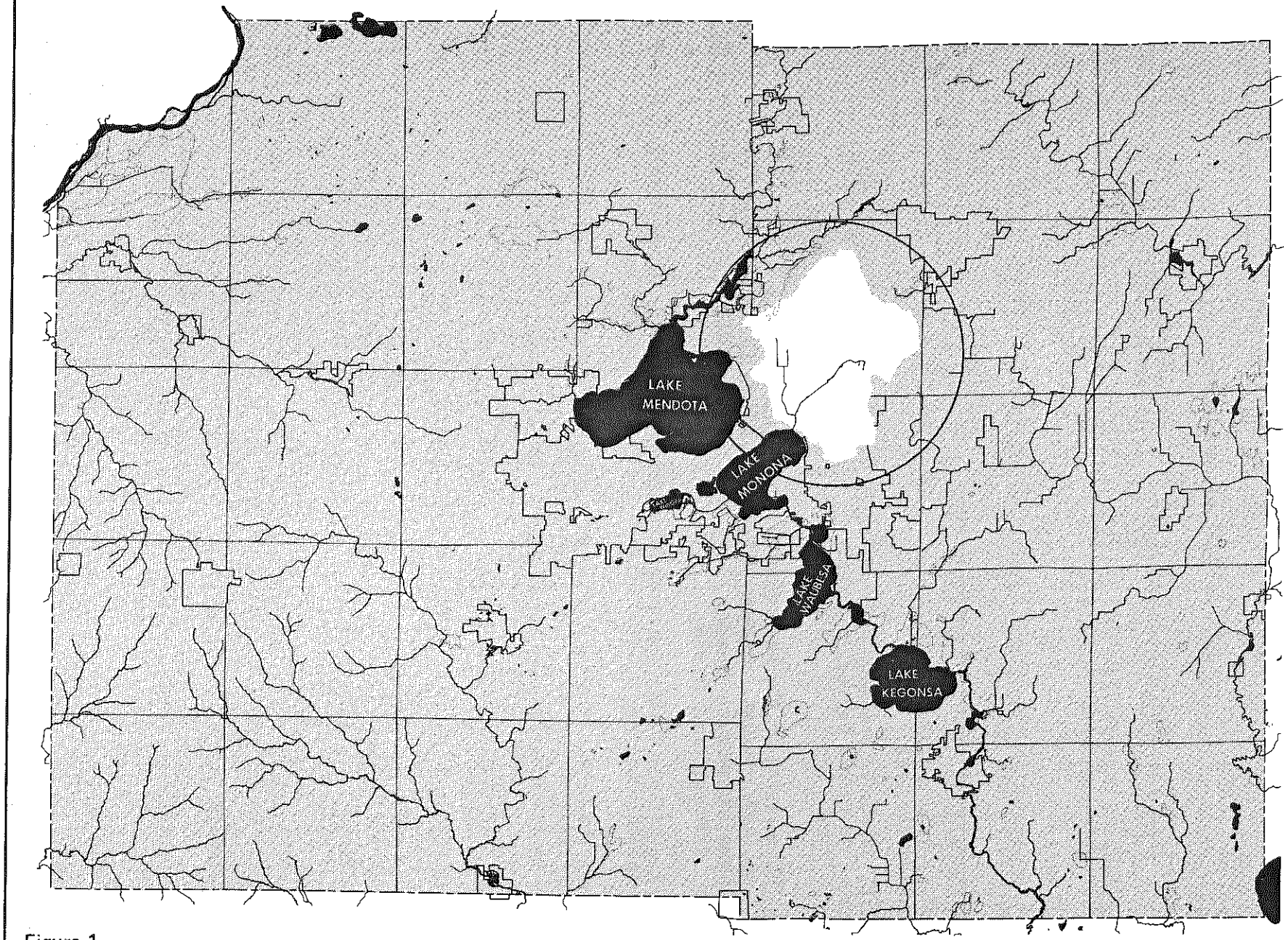


Figure 1

GENERAL LOCATION

STARKWEATHER CREEK WATERSHED

DANE COUNTY, WISCONSIN

1980

Scale in miles

Prepared by: THE DANE COUNTY REGIONAL PLANNING COMMISSION

"There are in nature many displacements of natural phenomena which can be attributed to the invasion of civilized man."

C. N. Sawyer et al.
Investigations of the Odor Nuisance
Occurring in the Madison Lakes, 1943.

INTRODUCTION

Background

The Starkweather Creek watershed (Figure 1) is a major tributary drainage area to Lake Monona, and is located on Madison's northeast side. The watershed encompasses an area of 15,300 acres (22.9 square miles, 5921 hectares), and the stream's East and West Branches drain areas of 5,500 acres and 7,600 acres, respectively. The Olbrich Park drainage basin and direct drainage to the creek's main stem comprise the remaining 2,200 acres. The Starkweather Creek watershed includes substantial portions of the City of Madison, and the Towns of Burke and Blooming Grove. Although Starkweather Creek is Madison's largest urban watershed, agricultural and rural open space uses comprise over 40% of the total watershed area.

Much of the stream we now know as Starkweather Creek has been shaped and created by man during the settlement, conversion and urbanization of the Madison Metropolitan area. The past and present water quality of Starkweather Creek reflect the community's use, misuse and alteration of the stream over the past 130 years.

Until the 1920's and the northeastward expansion of the urban area, Starkweather Creek was in the "backyard" of Madison's east side, and received little attention. As the city grew, so did the visibility -- and use -- of the stream. An expanding city produced more stormwater and industrial waste and Starkweather Creek was the recipient of these byproducts. In the headwaters of Starkweather Creek, agriculture was expanding and intensifying. Cultivation of once wet and "unproductive" lands had been made possible through draining, filling and channelization. Similarly, portions of Madison's east side were being developed and expanded at the expense of considerable areas of wetland - areas that have proved difficult to drain right up to the present time.

The impacts of settlement and urbanization on Starkweather Creek have been so great that in a 1979 report, the Dane County Regional Planning Commission noted that the creek "has been so altered by dredging and straightening that it is little more than an open storm sewer" (DCRPC, 1979a). Yet, despite the long history of neglect and abuse and the current condition of Starkweather Creek, it has intrinsic value to the city. First, the character of the stream corridor is unique inasmuch as no other open watercourse within the metropolitan area drains such a

variety of commercial, industrial, residential, and agricultural land uses. Second, the Starkweather Creek Watershed contains several of Madison's older, economically disadvantaged residential neighborhoods, where opportunities for redevelopment, conservation and environmental enhancement are being actively sought. Finally, Starkweather Creek provides drainage for runoff water from a large area of the city, and the Towns of Burke and Blooming Grove.

The status of Starkweather Creek as Madison's largest urban watershed, its visibility to many east side neighborhoods, its troubled history and the poor water quality conditions detected through stream monitoring have combined to produce an impetus for the undertaking of this study. A renewed emphasis upon the enhancement of older residential neighborhoods and their value as a place to live, and a need for subregional detailing and refinement of recommendations contained in the Dane County Water Quality Plan are factors which provide additional thrust for a comprehensive evaluation of the Starkweather Creek Watershed. Finally, the importance of Starkweather Creek's contribution of pollutants to Lake Monona and the impacts of its pollution upon citizens and fish and aquatic life require examination.

Study Design and Objectives

This study of Starkweather Creek is being supported by grants from the United States Environmental Protection Agency, and the Wisconsin Department of Natural Resources, with local funding being provided by Dane County, through the Dane County Regional Planning Commission. The objective of the current study of Starkweather Creek is to develop a comprehensive watershed management plan for implementation by the designated management agencies in the watershed. This is being accomplished in two phases, over an 18 month period, with this report being the product of the first, or inventory phase of the program. This report documents the characteristics of the Starkweather Creek watershed and includes past and present water quality conditions and sources of pollution. It includes a description of the water quality use potential of Starkweather Creek, describes the case for further action, and briefly describes the authority and recent activity of each of the management agencies in the watershed.

The second phase of the Starkweather Creek program is the development of management program alternatives and the detailing of a recommended management plan for dealing with the problems of Starkweather Creek. A report on the second phase of the program contains the recommended plan, alternatives which were considered, and indicates which units of government, agencies or businesses are responsible for carrying out plan recommendations. The recommended plan for Starkweather Creek will be available by mid-1981.

The role of area residents and elected representatives in developing a plan for the Starkweather Creek Watershed is important. Understanding the concerns residents have about Starkweather Creek, and gathering and

evaluating ideas expressed by residents will help the Regional Planning Commission and cooperating agencies to develop a more sensitive, realistic and achievable plan of improvements for the watershed. Involvement by elected representatives and key local units of government will improve the outlook for adoption and implementation of recommended programs by the responsible management agencies.

Watershed Socioeconomic Characteristics

The approximate 1970 population of the Starkweather Creek Watershed was 31,650 persons. In 1970, nearly fifty percent of the total population of the watershed was concentrated in four census tracts (see Figure 2) along the southern boundary of the watershed, nearest to Lake Monona and in the older, more densely developed residential areas. A comparison of 1960 and 1970 census data reveals a significant outward expansion of residential development in the watershed, which is most pronounced in the section east of Highway 51, west of Interstate 90, and south of Highway 151. Substantial new residential development has occurred in this area since 1970, as evidenced by the 1974 special census of the City of Madison.

The Starkweather Creek Watershed displays cultural diversity reflective of the variety of land uses and differing ages and types of development encompassed by the watershed boundaries. Areas within the watershed developed prior to 1945 display a mixture of residential, commercial and some industrial land uses, and experience some problems with deteriorating structures. Several of the older residential neighborhoods in the watershed contain pockets of substantial industrial land use (see later land use discussion), and large areas with potential for redevelopment (such as the Madison Metro Bus Barn site on Fair Oaks Avenue near Starkweather Creek).

More recently developed areas in the Starkweather Creek Watershed do not display the diversity and mixture of land uses found in older areas. 1970 average residential structure values in the newer residential neighborhoods within the watershed ranged from $24,400 to $26,100, equalling or exceeding the citywide average.

Average annual income per household in 1970 varied substantially across the Starkweather Creek Watershed. The census tract which includes the Dane County Regional Airport and surrounding areas had an average annual income of $7,700 in 1970, almost 40% below the 1970 citywide mean household income of $12,779. This census tract includes a significant area of public housing. Nearly 23% of the families in the tract were identified as having incomes below the poverty level in 1970. Average annual incomes shown on Figure 2 are for entire census tracts, whereas figures for residential structure values are only for those portions of the tracts which fall within the watershed.

The highest 1970 average annual household income for a census tract falling completely within the Starkweather Creek Watershed was $13,100, 2.5% above the 1970 citywide average. Several census tracts encompassing older neighborhoods within the Starkweather Creek Watershed had

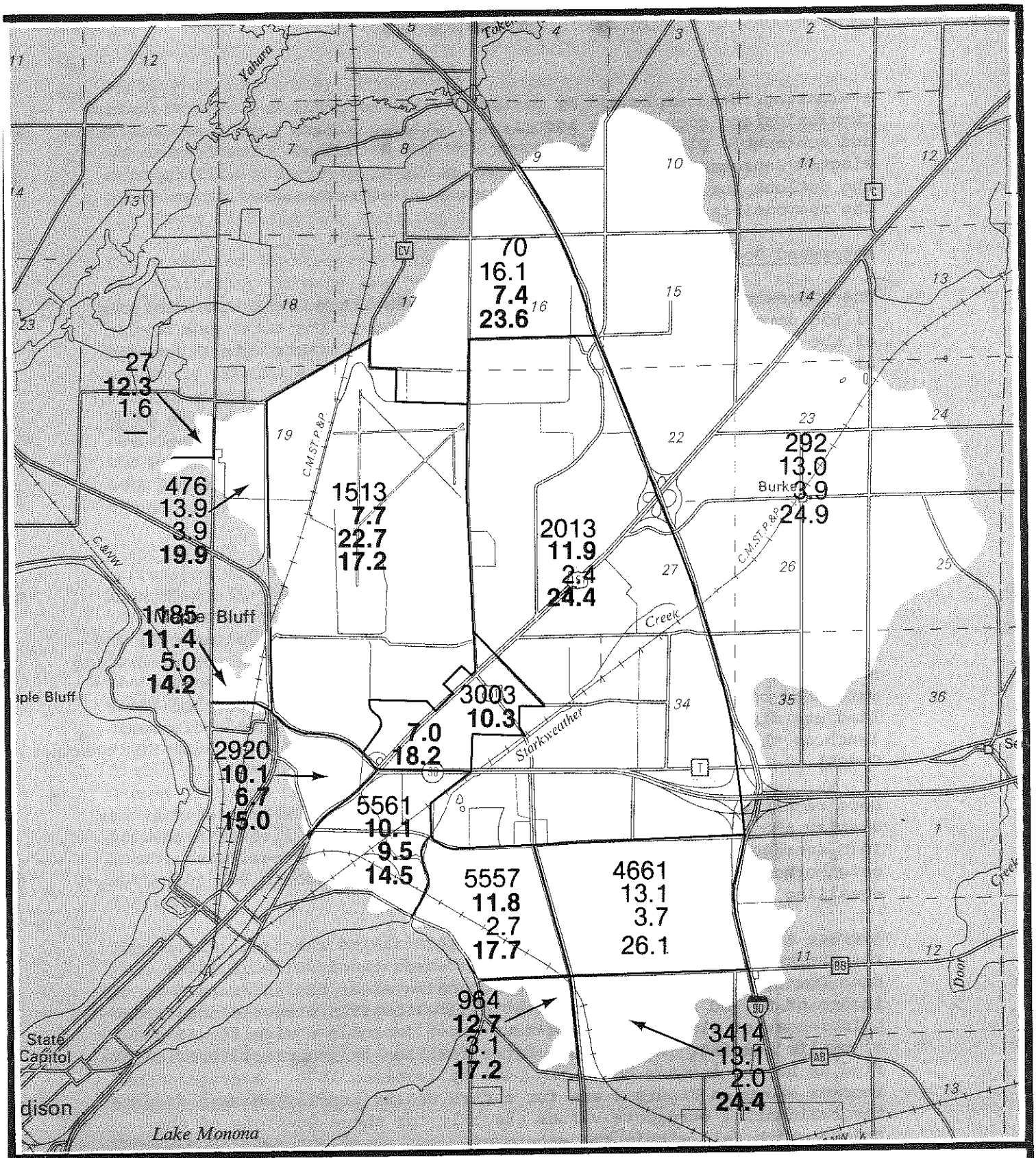


FIGURE 2

1970 SOCIOECONOMIC CHARACTERISTICS

ORDER AND DESCRIPTION OF STATISTICS

1185 Population in Portion of Tract in Watershed.

13.9 Mean Household Income in Total Tract, in $1000's. City Mean is $12,800.

5.0 Households Below Poverty Level in Total Tract. City Mean is 5.3 percent.

14.2 Mean Value of Residential Dwelling Units in $1000's in Portion of Tract in Watershed. City Mean is $24,500.

Bolder number designates area statistic substandard as compared to 1970 city mean value.

May, 1980

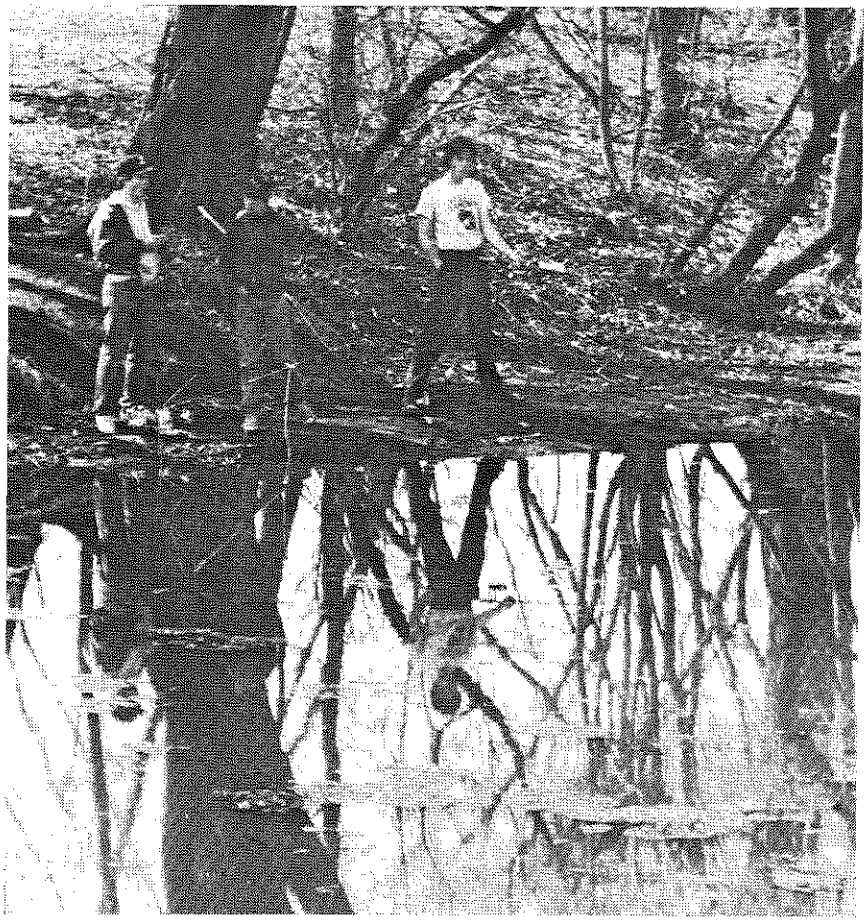
0 ½ 1

Scale in Miles

Prepared by:
The Dane County Regional Planning Commission

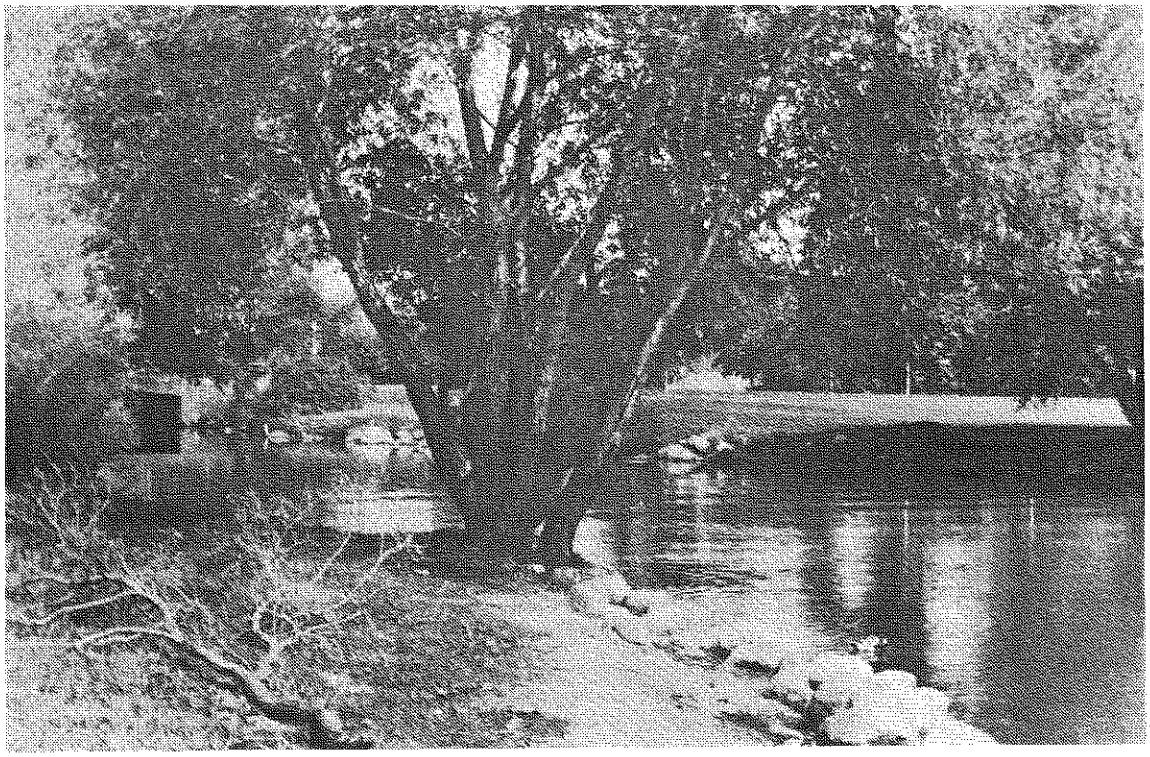
1970 average annual household incomes of $10,100 to $10,300, which is 19% to 21% below the citywide average. In 1970, 6.7% to 9.5% of the families living in those census tracts were classified as having incomes below the poverty level. The 1970 mean for the City of Madison was 5.3%.

The Starkweather Creek Watershed has substantial ethnic diversity which adds to the flavor of many of its neighborhoods. According to the 1970 census, fifteen to twenty percent of the residents in four of the watershed's thirteen complete or partial census tracts were of foreign stock. While Germany was the predominant country of origin for persons of foreign stock in all areas of the watershed, several neighborhoods had significant numbers of persons of Italian, Swedish, Polish, Russian and Mexican descent. Four census tracts in the watershed contained more than thirty Spanish speaking persons.



Neighborhood Children Play Along Starkweather Creek

The East Branch of Starkweather Creek Just Below the Headwater Springs



The Mouth of Starkweather Creek at Olbrich Park

WATER QUALITY

Starkweather Creek has been monitored sporadically for the Madison City Health Department, state pollution control agencies, university student research and special governmental studies since the early 1940's. More recently, the Dane County Regional Planning Commission has coordinated a county-wide monitoring program including four years of sampling during baseflow and storm events on Starkweather Creek and thirty other stations located on county streams or lake outlets.* This historical and recent information has provided a good background for analyzing the water quality of Starkweather Creek compared to its past quality and to other streams in the county. In 1979 and 1980, additional samples were collected for this study at other stations on Starkweather Creek (Figure 3) to document upstream water quality and to locate pollution sources. These samples were collected by Dane County Regional Planning Commission staff and analyzed by the Madison City Health Laboratory.

Baseflow Conditions

Starkweather Creek begins at springs and seeps just west of I90-94, but groundwater recruitment is too minimal to maintain high baseflow in the creek. The estimated seven-day low flow which occurs on an average of once in ten years ($Q_{7,10}$) is only 0.02 cfs on the West Branch and 0.10 cfs on the East Branch at Milwaukee Street (Holmstrom, pers. comm.). In fact, the Milwaukee Street stations are subject at times to strong wind blown currents which reverse the apparent flow in the creek.

Data collected from 1976-1979** at the Milwaukee Street bridges indicate that baseflow in both branches averaged about 2 cfs (cubic feet per second). In 1942-43, data collected at the same bridge over the East Branch showed more than twice as much flow (mean=5 cfs) (Appendix C). The original baseflow in the creek was probably even higher because by 1942 the stream channel and watershed use had been altered significantly and groundwater drawdown due to pumping*** may have already begun.

Due to groundwater inflow, the headwaters of both branches of Starkweather Creek remain relatively cool (14 to 16^{o} C) even on hot summer days and also remain warm enough in the winter to prevent freezing. However, this groundwater inflow is not sufficient to moderate temperatures in the lower part of the creek. Recorded temperatures at the Milwaukee Street bridges rise to 26^{o} C in the summer and both branches freeze over for several months during the winter.

---

* See Appendix B of the Dane County Water Quality Plan for a description of the county-wide monitoring program site locations, monitored parameters and laboratory methods. Also see Table 1 in this report for a four year summary of baseflow water quality at all Dane County stations.

** 1976-1979 baseflow monitoring data reported in Appendix A.

*** See later section on groundwater pumping for further discussion.

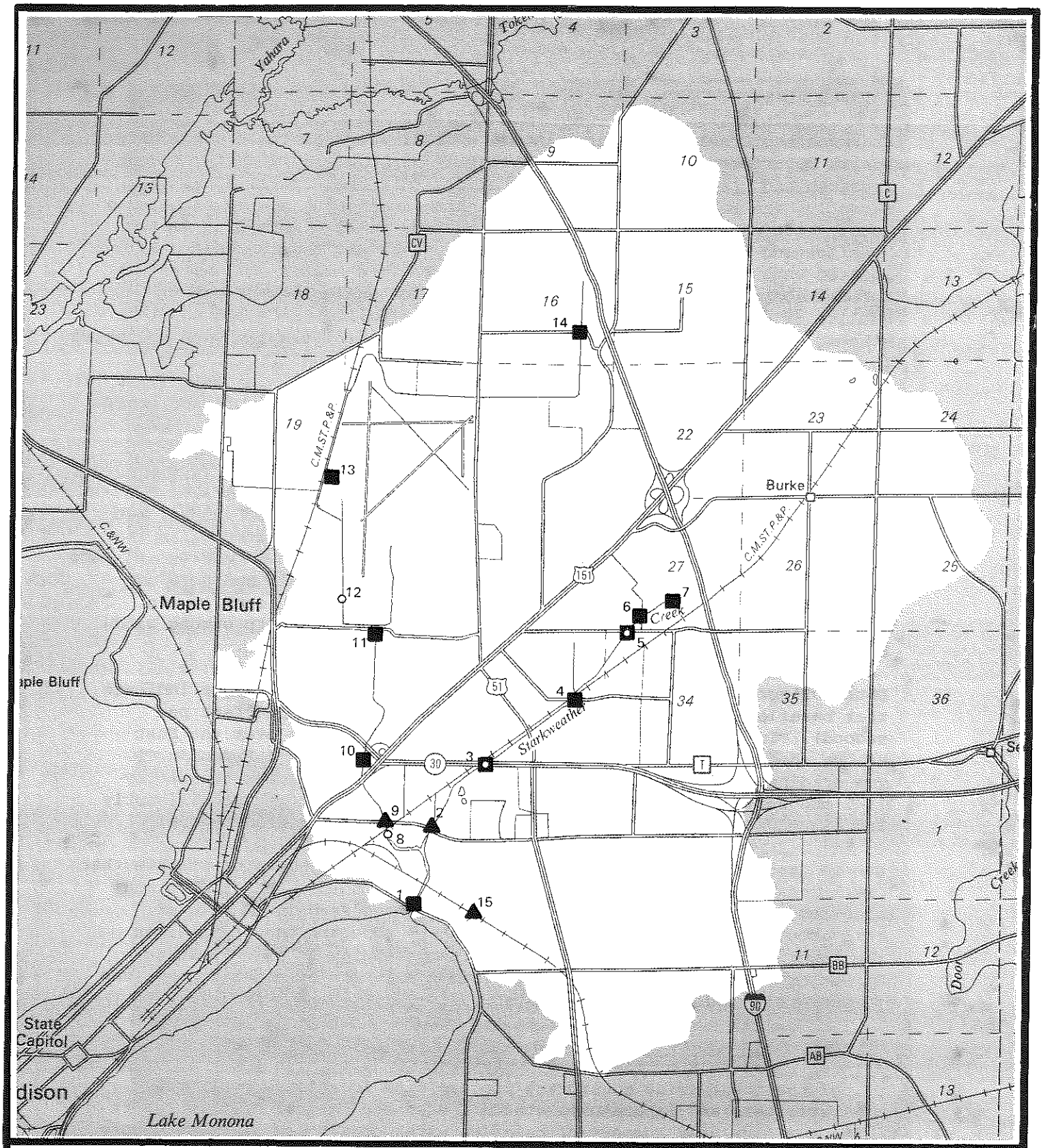


FIGURE 3
STARKWEATHER CREEK WATER QUALITY MONITORING STATIONS

TYPES OF STATIONS

- ▲ Flow and Water Quality Monitoring
- ■ Supplemental Water Quality Samples
- o Biotic Index

LIST OF STATIONS

EAST BRANCH

1. Atwood Avenue
2. Milwaukee Street
3. Highway 30
4. Sycamore Avenue
5. Lien Road
6. East Towne
7. Headwaters Pond

WEST BRANCH

8. C.M. St. P. & Pac. Railroad
9. Milwaukee Street
10. Commercial Avenue
11. Anderson Street
12. Swanson Road
13. International Lane
14. Hanson Road

OLBRICH PARK STORM SEWER

15. Dennett Drive

May, 1980

0 ½ 1

Scale in Miles

Prepared by:
The Dane County Regional Planning Commission

Dissolved oxygen concentrations are quite low in Starkweather Creek during hot, dry weather. Profiles run during a very low flow period in September, 1979, demonstrated that dissolved oxygen levels did not rise above 5 mg/l*(60% saturation) at any time during the day at any sampling station on the creek (Figure 4). Profiles taken under less extreme conditions show low dissolved oxygen levels (typical of groundwater) near the headwater springs, but oxygen levels increase for a distance downstream as oxygen from the atmosphere dissolves in the water. Further downstream, low dissolved oxygen levels occur at several stations indicating a variety of sources of oxygen demanding material. The limited data available suggest that the locations of the dissolved oxygen sags and, therefore, the locations of sources of pollution vary from one sampling period to the next. Sags have been noted on the West Branch at Commercial Avenue, East Washington Avenue, Milwaukee Street and Daley Street on different days. On the East Branch, dissolved oxygen depletion is regularly evident at Milwaukee Street, with some sags also occurring at Sycamore Avenue.

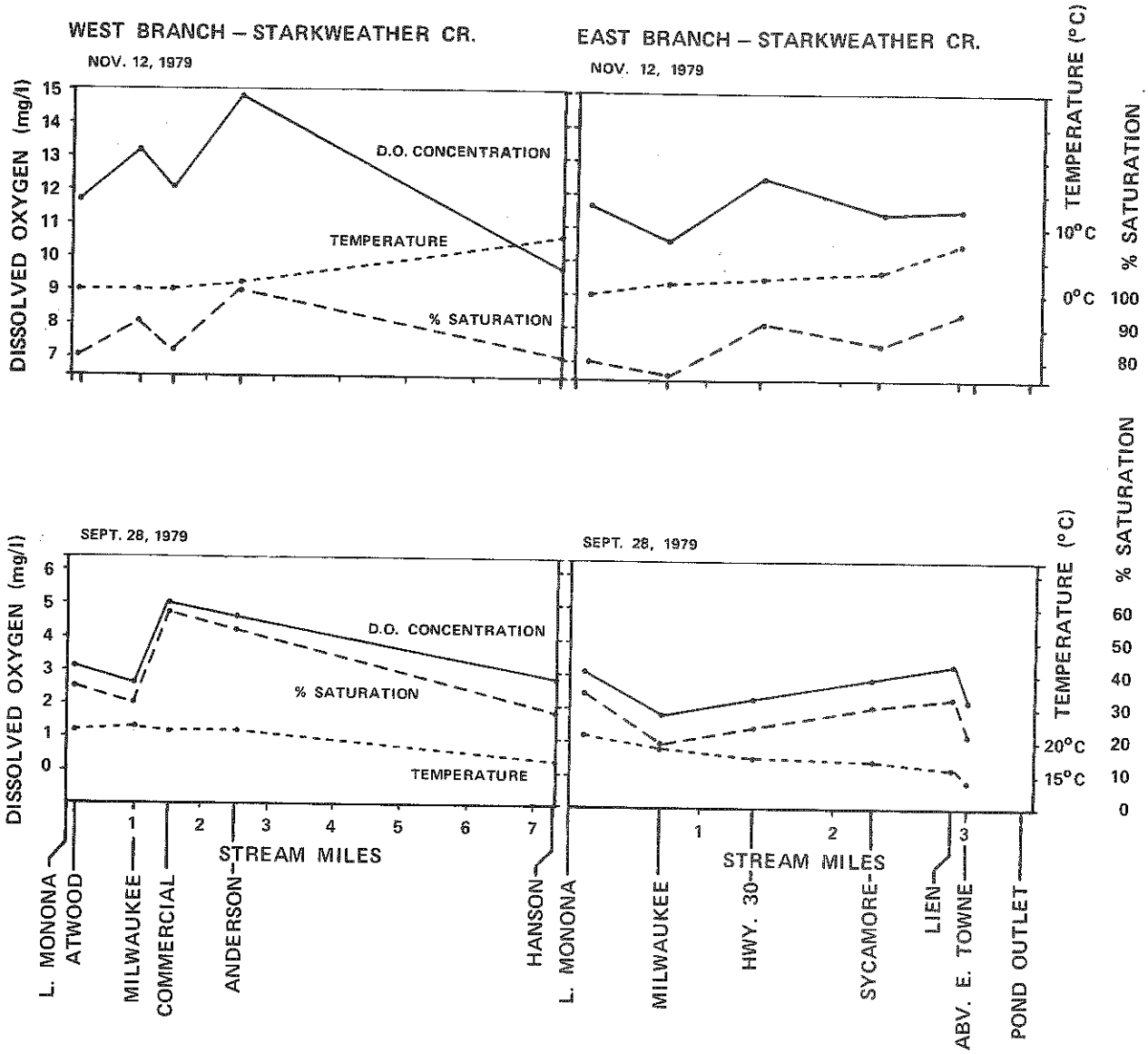
Levels of biochemical and chemical oxygen demand (BOD and COD) in Starkweather Creek are moderately high compared to other streams in Dane County (Table 1). During the last four years of monitoring at the West and East Branch Milwaukee Street bridges, baseflow COD concentrations averaged 19 mg/l and 23 mg/l respectively. According to the 1974-75 pollution survey, five day BOD concentrations at the same sites averaged 6 and 8 mg/l respectively, with a maximum of 13 mg/l (WDNR, unpubl.). The low dissolved oxygen levels in the creek may be attributed to these sources of oxygen demand and to conditions such as warm temperatures, low flow, flat gradients and consequent low reaeration potential.

For a stream which receives neither domestic sewage nor industrial process water, Starkweather Creek has relatively high baseflow concentrations of nutrients (especially nitrogen). Groundwater, which provides the first continuous flow in both branches of the creek, is very high in nitrates (8 to 10 mg/l). Nitrate levels generally decrease downstream to 2 to 3 mg/l at the Milwaukee Street bridges (Figure 5). The decrease in nitrate concentrations is more pronounced on the West than the East Branch, which may be indicative of less groundwater recruitment in the lower part of the West Branch. Conversion of ammonia to nitrate may also account for the relatively high nitrate concentrations in the lower East Branch. The four-year average baseflow nitrate concentration is only 1.72 mg/l in the West Branch as compared to 3.05 mg/l in the East Branch at Milwaukee Street. These average baseflow nitrate concentrations at the Milwaukee Street stations fall within the normal range (1 to 4 mg/l) for Dane County's streams in 1976-79.

*Five milligrams per liter is the minimum dissolved oxygen concentration considered acceptable for fish and other aquatic life according to standards set by the state (NR 102.02(3)). Some fish such as carp and bullheads can tolerate lower dissolved oxygen concentrations but most species require 5 mg/l.

FIGURE 4

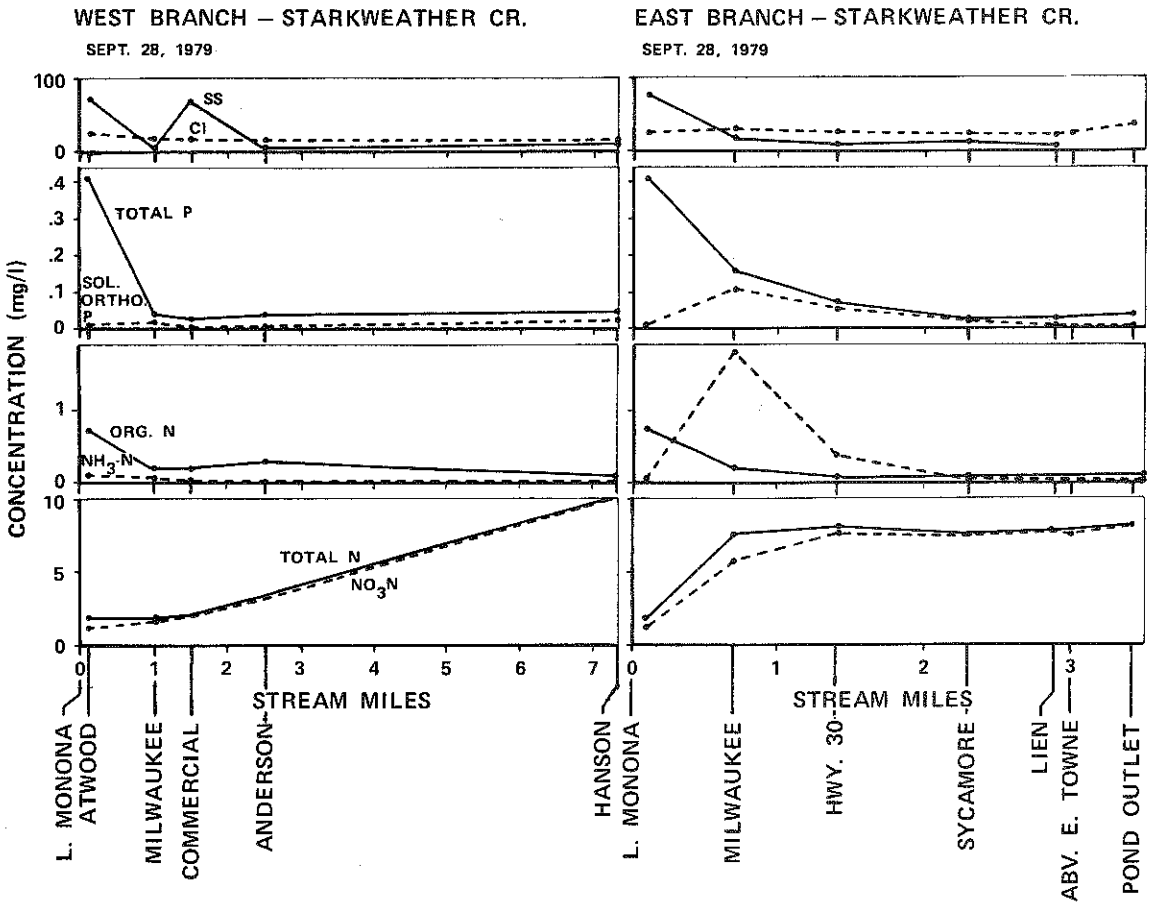
DISSOLVED OXYGEN PROFILES



A significant indicator of pollution in Starkweather Creek is ammonia nitrogen. Both branches of Starkweather Creek at Milwaukee Street exhibit average baseflow ammonia concentrations (West = .64 mg/l; East = 1.51 mg/l) higher than any other stream station in Dane County except those stations receiving substantial wastewater discharges (Table 1). Even though stations affected by lake water generally have higher baseflow ammonia concentrations (.19 to .27 mg/l) than flowing stream stations in

FIGURE 5

WATER QUALITY PROFILES



Dane County, lake backwater effects are not sufficient to explain all of the excess ammonia in Starkweather Creek, especially in the East Branch. While ammonia concentrations are highly variable on both branches of Starkweather Creek, East Branch concentrations at Milwaukee Street have a mean which is only slightly below the maximum value observed on the West Branch. The mean ammonia concentration for the West Branch at Milwaukee Street is just slightly above the minimum value observed on the East Branch. Recent profile data indicates that ammonia concentrations in the East Branch increase at Highway 30 and again at Milwaukee Street.

Table 1

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979
Summary Table - Mean Values

PERIOD OF RECORD	STATION	FLOW cfs	TEMP (max) °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml	N:P ratio
1976-79	Badfish Creek @ CTH A		23	4.4	7.7	.38	2.5	10.5	2.3	15.1		6.2						17	30			19,400	2.44
1976-79	Badfish Creek @ STH 59	80	23	6.9	7.9	4.1*		6.5	1.8	12.1		4.0	1296	179	336			15	38			4,880	3.08
1977	Badger Mill Creek @ STH 69	5.7	24	9.4	7.8	.159	2.70	.65	.46	3.97	.723	.93	682	43	270	2.9	13			7	22	204,000	4.27
1976-79	Black Earth Creek abv. Black Earth (USGS gage)	28	21	11.6	8.0	.036	1.68	.08	.26	2.00	.113	.14	569	13	275	4.6	7			22	14	1,200	14.29
1976-79	Door Creek @ Hope Road	4.6	21	9.8	7.8	.053	2.84	.19	.65	3.71	.107	.19	725	21	314	8.1	9.1			52	50	870	19.53
1977-79	Frogpond Creek @ Franklin Road		20	9.9	8.0	.03	1.9	.2	.8	3.0		.2						2	15	30		1,800	15
1977-78	Koshkonong Creek @ Bailey Road	4.3		4.1	7.7	.071	1.86	7.15	2.39	11.71	3.15	3.42	1167	153	351	11.4	17					170,000	3.42
1977	Koshkonong Creek near STH 73	14	21	4.9	7.8	.177	4.33	.58	1.35	6.27	1.08	1.13	1010	66	310	3.6	18			14	221	16,000	5.55
1977-79	Koshkonong Creek @ Hoopen Road (Rockdale)	34	29	10.9	8.2	2.81*		.52	1.06	4.38	.192	.44	799	54	319	12	10	4.6	38	46	74	88	9.95
1976-77	Maunesha River @ Greenway Road	3.4	24	12.6	8.1	.030	2.89	.09	.50	3.49	.068	.09	647	21	277	1.8	12.3			22	39	630	38.78
1976-79	Mt. Vernon Creek abv. STH 92	16	19	11.4	8.1	.016	2.88	.08	.23	3.20	.032	.06	499	8	241	4.8	5			26	15	260	53.33
1976-79	Murphy Creek @ Beld Street	2.7	23	8.7	7.9	.027	.19	.32	.90	1.40	.024	.06	559	44	187	5.8	24			12	28	660	23.33
1976-79	Nine Springs Creek @ Moorland Road		20	8.6	7.9	.05	3.5	.2	.7	4.6		.2	680	23	275			2	43			3,600	8.0
1976-79	Pheasant Branch @ USH 12	1.5	24	8.4	7.7	.045	3.00	.21	.75	3.96	.038	.08	899	19	302	5.7	8	1.8		51	160	450	49.5
1978-79	Pheasant Branch @ Stamm House	2.6		10.3	8.0	.037	2.60	.15	.72	3.47	.034	.06	942	41	317	4.6	8			38	139	250	57.83
1976-79	Pheasant Branch @ CTH M		24	9.5	7.8	.072	2.19	.17	.64	3.19	.068	.10	679	17	280	8.0	8	2.0		23	55	320	31.9

Table 1 (Continued)

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979
Summary Table - Mean Values (continued)

PERIOD OF RECORD	STATION	FLOW cfs	TEMP (max) °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml	N:P ratio
1976-79	Rutland Branch @ CTH A		16	10.2	8.0	.02	3.9	.1	.3	4.4		.1						1	10			2,900	44
1976	Sixmile Creek @ Madison Street (Waunakee)	4.9	28	10.3	8.1	.026	3.10	.08	.56	2.80	.056	.09	594	12	287	3.0	22			17	20	260	31.11
1976-79	Sixmile Creek @ Mill Road	4.4	26	8.5	8.0	.028	1.58	.11	.50	2.20	.086	.12	629	20	295	4.0	12			34	36	1,600	18.33
1976-77	Spring Creek @ CTH M	3.7	27	10.4	8.0	.043	2.42	.21	.43	3.09	.098	.13	579	12	277	6.4	8.7			38		1,300	23.77
1976-79	Starkweather Creek-East @ Milwaukee St.	1.8	25	7.7	7.8	.23	3.05	1.51	.72	5.51	.124	.19	691	31	273	10.0	23			30	64	170	29
1976-79	Starkweather Creek-West @ Milwaukee St.	2.0	26	7.9	7.9	.065	1.72	.64	.92	3.36	.054	.12	719	20	295	6.9	18			37	96	3,380	28
1979	Sugar River - West Branch @ STH 92	16	18	10.2	7.9	.032	3.93	.22	.48	4.43	.287	.35	609	20	275	15.6	8			54	22	1,600	12.66
1977-78	Sugar River - West Branch @ Fritz Rd.	30	22	11.4	7.9	.024	2.88	.10	.43	3.42	.161	.25	517	14	234	9.9	6.1			39		640	13.68
1976-79	Token Creek @ USH 51		25	11.1	8.0	.032	3.43	.11	.41	3.98	.035	.07	558	10	267	7.8	11.1			51	21	260	56.86
1976-79	Yahara River @ Windsor	9.8	24	11.5	8.0	.024	2.92	.07	.33	3.32	.037	.06	608	19	270	3.9	7.1			36	34	230	55.33
1976-77	Yahara River @ STH 113		30	10.3	8.1	.042	1.47	.23	1.04	2.77	.110	.22	517	12	244	12.7	23					130	12.59
1976-79	Yahara River @ Lake Mendota Outlet				8.1	.018	.31	.27	.86	1.45	.063	.11	393	16	161	3.7	17					20	13.18
1976-79	Yahara River @ Lake Monona Outlet				8.0	.023	.26	.23	.92	1.44	.044	.09	417	22	160	4.7	20					22	16.0
1976-79	Yahara River @ Lake Waubesa Outlet	161	28	11.1	8.5	.24*		.19	1.1	1.48		.09	429	24	190			3.4	10	6	26	13	16.44
1976-79	Yahara River abv. Stebbinsville Dam		27	9.1	8.5	.02	.6	.2	1.5	2.5		.2	497	27	191			5	23			550	12.5
1976-79	Yahara River @ STH 59		25	9.3	8.2	2.2*		2.7	1.6	6.1		1.9	746					11	32			2,000	3.21

*NO_2-N plus NO_3-N.

Prepared by: Dane County Regional Planning Commission, May, 1980.

The increase at Milwaukee Street might be explained by the decay of algae and weeds blown up from the lake; but the ammonia at Highway 30 must be ascribed to some specific source(s) of pollution.

Baseflow organic nitrogen concentrations are also higher in Starkweather Creek at the Milwaukee Street stations than most other stream stations in Dane County. Samples collected in 1979 indicate that organic nitrogen concentrations tend to be highest at the station nearest the lake - Atwood Avenue (Figure 5). Therefore, the high organic nitrogen levels may be attributed in part to algae carried into the creek from the lake by southwesterly winds.

A summation of all forms of nitrogen indicates that the West Branch of Starkweather Creek at Milwaukee Street falls within the normal range for baseflow total nitrogen in Dane County streams. However, the East Branch at Milwaukee Street has an average baseflow total nitrogen concentration unsurpassed by any station in the county except those receiving substantial wastewater effluent. The mean baseflow total nitrogen value for the East Branch of Starkweather Creek at Milwaukee Street, based on four years of data, exceeds the maximum observed value at Milwaukee Street on the West Branch. The minimum observed East Branch value is considerably higher than the mean West Branch value. Available data for 1979 (Figure 5) shows a decrease in total nitrogen levels in the West Branch from the headwaters downstream with a leveling or slight increase at Milwaukee Street. The East Branch does not exhibit a similar decline in total nitrogen concentrations, probably due to downstream sources of ammonia and nitrate. The high nitrogen levels in the East Branch are apparently due to some baseflow source of ammonia and to groundwater high in nitrates. A comparison of 1942-43 data (Appendix C) for the East Branch at Milwaukee Street to the 1976-79 data (Appendix A) shows statistically significant increases in all forms of nitrogen with ammonia exhibiting the most dramatic increase - from .08 to 1.5/mg/l.

Total phosphorus concentrations in Starkweather Creek are not as unusually high as nitrogen concentrations. Average baseflow phosphorus concentrations in both branches are comparable to concentrations in other moderately polluted streams in the county (Sixmile, Spring and Black Earth Creeks). The average total phosphorus concentration on the East Branch (.19 mg/l) is somewhat higher than the West Branch (.12 mg/l) at Milwaukee Street. Maximum observed baseflow reactive phosphorus values on the East Branch are nearly twice as high as those on the West, and the mean reactive phosphorus value for the East Branch is higher than the maximum observed value for the West Branch.

One overall indicator of nutrient pollution used in lakes and streams subject to algae bloom problems is the nitrogen to phosphorus ratio. Generally, unpolluted streams with significant groundwater influx show much higher baseflow nitrogen to phosphorus ratios than those receiving domestic wastewater. Unpolluted stream stations also generally have higher baseflow nitrogen to phosphorus ratios than lake outlet or lake

backwater stations. The headwaters of Starkweather Creek exhibit the high nitrogen to phosphorus ratios typical of unpolluted streams in Dane County. The baseflow ratios at the Milwaukee Street staions (West = 28:1; East = 29:1) are much lower, but they are somewhat higher than both lake outlet or backwater stations and substantially higher than the ratios at stations affected by wastewater treatment plant effluent.

Starkweather Creek is relatively high in all dissolved solids, not just nutrients. Average specific conductance measurements at the Milwaukee Street stations (West = 720 umhos; East = 690 umhos) are comparable to those in Door, Nine Springs and Badger Mill Creeks. Of the streams monitored in Dane County, only Pheasant Branch (with its high sulfate levels) and Badfish and Koshkonong Creeks (with major wastewater discharges) have higher average baseflow measurements of specific conductance. Similarly, sulfate measurements in Starkweather Creek are moderately high (West = 96 mg/l; East = 64 mg/l).

Average baseflow chloride concentrations in the West Branch (20 mg/l) are moderately high (comparable to Sixmile and Pheasant Branch Creeks) while average chloride concentrations in the East Branch (31 mg/l) are quite high. Only Murphy Creek and streams with heavy wastewater loads have higher average baseflow chloride concentrations. Historical data indicate that chloride levels have increased dramatically in the East Branch of Starkweather Creek over the past 20 years from 11 mg/l in 1957-59 (MCHD, Lab Books, 1953-1979) to 31 mg/l in 1976-79. Although many of the high chloride measurements occur in the winter and early spring when road salt would be the most obvious source, some relatively high measurements occur at other times. Therefore, wastewater or cooling water contamination may cause some of the high chloride measurements.

Limited sampling for heavy metals indicates that most baseflow heavy metals concentrations at the Milwaukee Street stations are below analytical detection limits. However, lead concentrations in both branches (West = 4 µg/l; East = 28 µg/l) and the chromium concentrations (6 µg/l) in the West Branch exceed detection limits. Traffic-related wastes are the most likely sources of lead while commercial or industrial cooling water discharges are the most likely sources of chromium. Neither the lead nor the chromium concentrations appear to be toxic.

In recent years, no significant bacterial contamination was evident in Starkweather Creek until 1979, when high coliform measurements occurred regularly in the West Branch at Milwaukee Street (Appendix A, Table A-4). Since June, 1979, all of the fecal coliform bacteria samples collected at this site have violated the public health standards set by state administrative code (NR 102.02(4)).* Limited sampling** of upstream stations suggests that coliform counts in the West Branch increase upstream from Milwaukee Street to Anderson Avenue.

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* 200 colonies per 100 ml.

**Sampling was conducted in November when temperatures were too low for optimal bacterial growth.

In addition to the physical and chemical characteristics which have been monitored to assess the water quality of Starkweather Creek, the macroinvertebrate* population has been sampled to determine the overall quality of the stream. The results of the macroinvertebrate sampling have been analyzed using a biotic index developed specifically for assessing the quality of Wisconsin streams (Hilsenhoff, 1977). Data from the four sites sampled on Starkweather Creek generally indicate moderate to gross enrichment or disturbance (Table 3). These four sites are generally typical of the habitat in the creek - a channelized ditch without many pools or riffles. The only sample site with a "riffle" was the area under STH 30 where sandy fill from the highway plus accumulated trash have narrowed the channel and created some turbulence.

The quality of the East Branch appears somewhat better than the West Branch because the two East Branch sites have macroinvertebrate populations with moderately greater diversity and/or organisms indicative of somewhat better conditions. The Lien Road site has numerous amphipods (Gammarus) which prefer the cool temperatures of spring-fed streams. All of the sites sampled on both branches lack populations of mayflies, caddisflies and stoneflies which typically inhabit the higher quality streams in Dane County.

TABLE 2

BIOTIC INDEX VALUES FOR STARKWEATHER CREEK

SITE	HABITAT TYPE	BIOTIC INDEX***	WATER QUALITY	STREAM CONDITION
East Branch @ Lien Road**	Run	2.08	Good	Some enrichment or disturbance
East Branch @ STH 30*	Riffle	3.70	Poor	Significant enrichment or disturbance
West Branch @ Swanson Road**	Run	3.90	Very poor	Gross enrichment or disturbance
West Branch @ RR bel. Milw. St.*	Run	3.85	Very poor	Gross enrichment or disturbance

* Samples collected April 18, 1980 by Wis. Dept. of Natural Resources, Bureau of Research
** Samples collected May 16, 1979 by Wis. Dept. of Natural Resources, Bureau of Water Quality
***Based on the following scale from Hilsenhoff, 1977:

Biotic Index	Water Quality	Stream Condition
<1.75	Excellent	Clean, undisturbed
1.75-2.25	Good	Some enrichment or disturbance
2.25-3.00	Fair	Moderate enrichment or disturbance
3.00-3.75	Poor	Significant enrichment or disturbance
>3.75	Very poor	Gross enrichment or disturbance

*Aquatic insects, amphipods and isopods.

In summary, an examination of available monitoring data indicates that, under baseflow conditions, Starkweather Creek is significantly polluted in terms of elevated nutrient concentrations (especially all forms of nitrogen), and very low dissolved oxygen concentrations (day and night) during hot weather. Phosphorus concentrations are also moderately high. Compared to rural streams, chloride and lead concentrations are notably high in both branches, but neither appears to be toxic to fish. Although groundwater recruitment appears to be better in the East Branch, it is more polluted than the West Branch as indicated by significantly* higher mean ammonia, nitrate, phosphorus, chloride and lead concentrations. However, the East Branch does not have the bacterial contamination or elevated chromium concentrations evident in the West Branch.

High Flow Conditions

The only runoff event data presently available for Starkweather Creek was collected in 1976. According to this limited data, the amounts of discharge per unit area in the watersheds of both branches and the Olbrich Park Storm Sewer basin were relatively low compared to other monitored streams and storm sewered basins in Dane County (Table 2). Even though much of the Starkweather basin has been developed and covered with impervious surfaces, the relatively flat topography combined with stormwater retention basins and large areas of undeveloped land retain much of the precipitation which falls in the watershed. For example, in 1976 the portion of the Starkweather basin drained by the Olbrich Park storm sewer had a relatively low discharge coefficient (963 m^3/ha/yr) compared to the two other storm sewered basins monitored in Madison (Willow Creek = 2,007 m^3/ha/yr; Spring Harbor = 1,143 m^3/ha/yr). Similarly, the portions of the basin drained by the two branches of the creek had relatively low discharge coefficients (West = 1,030 m^3/ha/yr; East = 1,530 m^3/ha/yr).

Estimated unit area loadings of sediment (West = 80 kg/ha/yr; East = 102 kg/ha/yr) and total phosphorus (West = 30 kg/ha/yr; East = 42 kg/ha/yr; for 1976 were also low because these constituents are closely related to stormwater discharge (Table 3). On the other hand, total nitrogen loading is more closely related to baseflow concentrations. Consequently, the East Branch of Starkweather Creek, with its high baseflow concentrations of ammonia and nitrate, had a relatively high estimated total nitrogen loading (8.69 kg/ha/yr) in 1976. In contrast, the total nitrogen loading attributed to the West Branch (4.73 kg/ha/yr) was more moderate since baseflow concentrations of total nitrogen were lower.

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*Mean values for all of these constituents except lead are significantly different at the 95% confidence level according to statistical tests. Only one set of samples was analyzed for lead; therefore, statistical tests could not be applied to these data.

TABLE 3: NUTRIENT AND SEDIMENT LOADINGS IN DANE COUNTY STREAMS 1976 - 1977

MONITORING STATION LOCATION	WATERSHED AREA (ha)	DISCHARGE (m^3/ha)		TOTAL PHOSPHORUS (kg/ha)		TOTAL NITROGEN (kg/ha)		SUSPENDED SEDIMENT (kg/ha)	
		1976	1977	1976	1977	1976	1977	1976	1977
1. Starkweather Cr.[1] East @ Milwaukee Street	2,232	1530		.42		8.69		102	
2. Starkweather Cr.[1] West @ Milwaukee Street	3,086	1030		.30		4.73		80	
3. Pheasant Branch @ U.S. 12	4,906	890	531	1.00	.55	5.16		510	138
4. Sixmile Creek @ Mills Road	9,356	1640	710	.81	.29	5.01		293	39
5. Yahara River @ Windsor	19,095	1148	510	.52	.16	4.68		211	32
6. Token Creek @ U.S. 51	6,306	3390	2403	.73	.32	13.45		260	97
7. Mt. Vernon Creek above CTH A	4,194	3890	3040	.57	.36	12.02		176	92
8. Door Creek @ Hope Road	3,909	1780	1086	.74		9.42		192	
9. Spring Creek[1] @ CTH M	3,283	1910		.85		7.52		222	
10. Murphy Creek[1] @ Beld Street	2,071	1850		.12		2.90			
STORM SEWERS									
1. Olbrich Park[1,2]	603	963	1080	.07	1.00				
2. Spring Harbor[1,2]	818	1143	1360	1.3	1.1				
3. Willow Creek[2,3]	852	2007	2857	.88	1.8-2.5			281	879

[1]Total loading estimates based on partial monitoring data.
[2]Nutrient loading estimates based on partial monitoring data.
[3]Sediment loading estimates calculated by USGS based on daily sediment data.

Prepared by DCRPC.

CAUSES OF WATER QUALITY PROBLEMS

Starkweather Creek was once a small, meandering wetland drainage stream. The wetland drained by the West Branch was part of a large wetland area which included the Cherokee Marsh area drained by Token Creek. Groundwater flowing from a few springs and from wetland seeps provided a moderate amount of cool, steady baseflow in Starkweather Creek. Wetlands provided spawning areas for lake fish such as northern pike, walleye and bluegills. Now the creek is essentially an open storm sewer with little fish or other aquatic life. What happened?

The transformation of the Starkweather Creek Watershed and the creek itself for agricultural and urban uses has had a devastating impact on its flow and quality. The first recorded alteration of the creek occurred in 1841 when a dam and sawmill were constructed on the East Branch near the road now called Milwaukee Street (History of Dane County, Wisconsin, 1880). The City of Madison and the surrounding countryside was settled rapidly in the decades after the sawmill was built. By 1860, 6,611 people lived in Madison and 43,922 people lived in Dane County. At this time, the land in the Starkweather Creek basin was used primarily for diversified farming including the production of milk, eggs, fruits, vegetables and meat for the city. By 1858, an enterprising Yankee farmer named H.P. Hall had begun draining the extensive wetland area now known as Truax Field. He dug over seven miles of ditch to improve drainage on 340 acres of his farmland. Neighboring farmers were dismayed by this rash expenditure of money, but his efforts were the first glimmering of the future for Starkweather Creek and other wetland streams in Wisconsin (Madison, Dane County and Surrounding Towns, 1877). Fifty years later, the farmers in the Starkweather basin, like other farmers throughout the state, joined together and petitioned the circuit court to form a drainage district.

Channelization

Even the earliest (1904) U.S. Geological Survey maps do not portray the original channel of Starkweather Creek. Mr. H.P. Hall had already dug miles of ditches in the West Branch watershed and had assisted his neighbors in filling the wet area where the Sun Prairie Road (East Washington Avenue) crossed the West Branch (Madison, Dane County and Surrounding Towns, 1877). Beginning in 1911, the Starkweather Creek drainage district further improved drainage in the West Branch watershed and completely channelized the East Branch. The District also drastically altered the lower part of the creek to provide an efficient outlet to the lake (Figure 6). The total effect of the drainage work, which was completed about 1922, was to eliminate almost a mile of meander in the East Branch and main stem and to lower the stream surface one to three feet (Dane County Court Records).

The lower channel elevation combined with tributary tile and shallow ditch drainage systems, lowered the nearby shallow groundwater table, dewatered adjacent wetland soils and created more pasture and cropland. Recent studies have demonstrated that drainage of wetland soils generally results in the release of nutrients as the organic matter in the soils decomposes (Bentley, 1969; Amundson, 1970). Thus the load of nutrients carried by Starkweather Creek probably increased significantly as the wetland drainage was completed.

Channelization and other drainage work also affected the flow of water in the creek. Lowering the groundwater table and draining adjacent wetlands probably began the decline in baseflow in the creek. Stormwater and snowmelt was carried away from farm fields more efficiently by the ditches and peak flows in the creek increased. The meandering channel and adjacent wetlands, which once slowed stormwater flow and allowed settling of sediment and associated nutrients, were eliminated or bypassed. This change increased the creek's ability to carry water, sediment and associated nutrients from the land to the lake.

Channelization also decreased the creek's reaeration capability by lowering the gradient. According to a 1908 profile of the East Branch (Smith, 1908), the creek once had an average gradient of about 3 feet/mile from Lien Road to the lake. Even the lower stretches of the creek, from Highway 30 to Milwaukee Street and from Milwaukee Street to the lake, once had gradients of about 3 feet/mile. However, recent profiles of the creek indicate that the overall gradient of the East Branch is now only 1.6 feet/mile from Lien Road to the lake. Furthermore, the gradients from Highway 30 to Milwaukee Street and from Milwaukee Street to the lake are only about .25 and .5 feet/mile respectively. Although 3 feet/mile is relatively flat, the original gradient created more turbulence and thus more reaeration than the very flat gradient of the existing ditch allows.

Lake Backwater Effects

At times, both branches of Starkweather Creek are affected by lake backwater at least as far upstream as Milwaukee Street. Since the creek was deepened in the 1920's to provide a more efficient outlet to the lake, the bottom of the lower 1-1.5 miles of the creek has been below lake level. Furthermore, the straightening of the lower part of the creek, which was intended to provide a more efficient outlet to the lake, also created an efficient inlet for water, weeds and algae blown up from the lake by the prevailing southwesterly winds.

Monitoring of Starkweather Creek at the Milwaukee Street stations under lake backwater conditions shows the relatively low alkalinity and high organic nitrogen concentrations more typical of lake than stream stations. Furthermore, when the lake water blown up the creek carries blooms of algae or lake weeds, decaying cells tend to settle out in the creek. At times, oxygen demand from the decomposition of this organic matter

WATERSHED CONDITIONS-CIRCA 1910*

STARKWEATHER CREEK WATERSHED

FIGURE 6

* Information primarily from "Map of Starkweather Creek Drainage District", February 1911. Scale 1"=500'; L.S. Smith, E.R. Jones, and W.G. Kirchoffer, Engineers. Alignment of West Branch Starkweather Creek from Standard Topographic Quadrangle Map, 1904 U.S.G.S. Field Survey, H.M. Wilson, Geographer. Channelization of West Branch Starkweather Creek occurred as early as 1858.

Boundaries, Starkweather Creek Drainage District

Stream Channel Alignment, Approximately 1910

Drainage District Plan for Laterals & Ditches

Extent of "Marsh", Approximately 1910

June, 1982

N

0 1/4 1/2mi.

Prepared by:
DANE COUNTY
REGIONAL PLANNING
COMMISSION

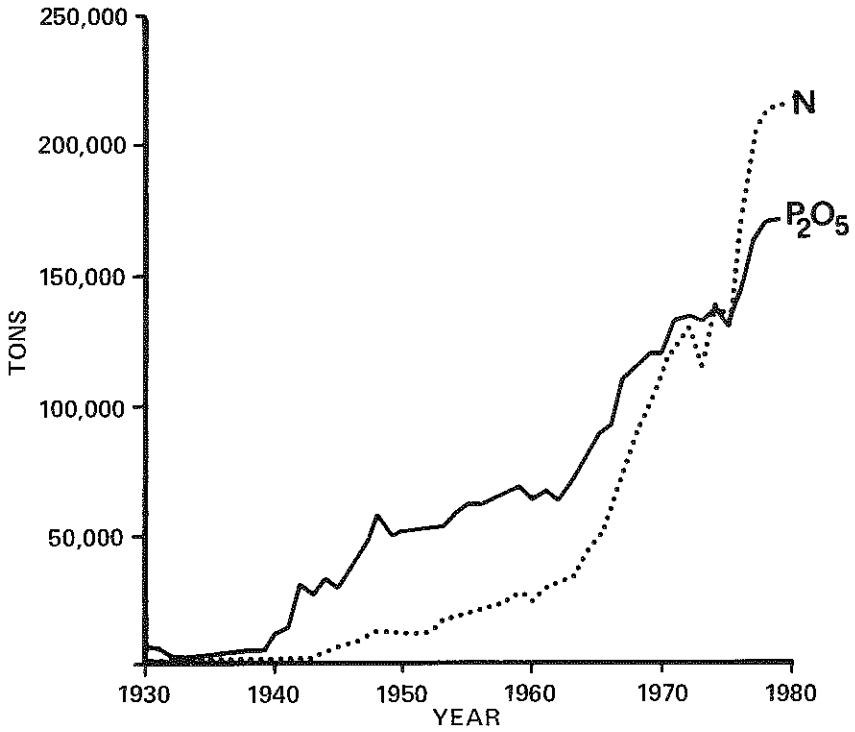
is high enough to practically exhaust the oxygen supply in the creek. One of the products of decomposition which occurs under the resulting conditions is ammonia - a constituent which is already excessively high in the East Branch due to upstream sources. In addition to causing visual pollution, the decaying algae and resulting low oxygen levels drive fish out of the creek and inhibit the growth of less mobile aquatic life.

Agricultural Practices

After channelization and accompanying wetland drainage, the most significant impact of agriculture on Starkweather Creek has been an increase in nutrients, notably nitrates, due to fertilizer use. With the notable exception of the Voit property north of Milwaukee Street, few cattle are grazed near the creek or its tributaries. The agricultural part of the Starkweather Creek watershed is largely devoted to cash grain farming - mostly corn.

Figure 7

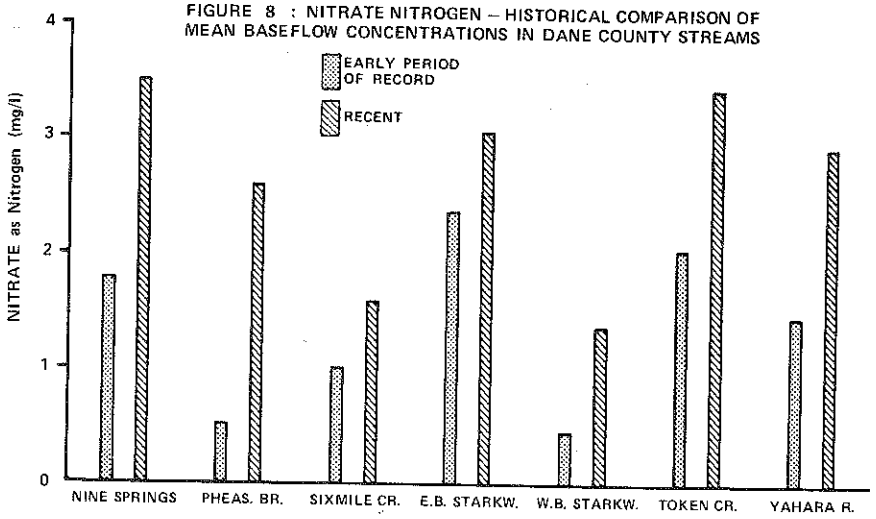
FERTILIZER USE IN WISCONSIN 1930-1979
TONS OF NITROGEN AND AVAILABLE PHOSPHORIC OXIDE CONSUMED



PREPARED BY: DANE COUNTY REGIONAL PLANNING COMMISSION JANUARY, 1980
DATA SOURCE: WISCONSIN AGRICULTURAL REPORTING SERVICE

As Figure 7 indicates, fertilizer use in Wisconsin has increased very rapidly since the end of World War II. In addition to receiving contaminated wastewater or storm runoff from fertilizer manufacturers, Starkweather Creek shows evidence of receiving increased loads of nitrogen from shallow groundwater probably polluted by the application of fertilizer to surrounding farm fields. Historical data for the Anderson Street station on the West Branch* indicate a substantial increase in baseflow nitrate concentrations (from .44 mg/l in 1955 to 1.98 mg/l in 1968-69) (MCHD, Lab. Books, 1953-1979; Kaufman, 1970). Historical data for other streams in the Yahara River basin (Sawyer et al., 1943 and 1944; Emelity and Hanson, 1949; Belter and Calabresa, 1950; MCHD Lab Books) indicate that baseflow nitrate levels have increased throughout the basin (Figure 8).**

FIGURE 8 : NITRATE NITROGEN – HISTORICAL COMPARISON OF MEAN BASEFLOW CONCENTRATIONS IN DANE COUNTY STREAMS



KEY:

STREAM	SITE	PERIOD OF RECORD
NINE SPRINGS CR.	Moorland Road	1942-44
	Moorland Road	1976-79
PHEASANT BRANCH	50 yd. above fork	1948-49
	Stamm House	1978-79
SIXMILE CREEK	Woodland Drive	1948-49
	Mill Road	1976-79
EB STARKWEATHER	Milwaukee St.	1942-43
	Milwaukee St.	1976-79
WB STARKWEATHER	Anderson St.	1955
	Anderson St.	1968-69
TOKEN CREEK	USH 51	1948-49
	USH 51	1976-79
YAHARA RIVER	STH 19	1948-49
	Windsor Golf Course	1976-79

Prepared by: Dane County Regional Planning Commission. May, 1980.

Historical Data Sources: Sawyer, 1942-44; Emelity & Hanson, 1949; Belter & Calabresa, 1950; Madison City Health Dept. Lab. Books.

* The only East Branch station with sufficient historical data to calculate average baseflow concentrations is at Milwaukee Street, which is below many historical pollution sources. However, data for this station also suggests some increase in nitrate levels from 2.4 mg/l in 1942-43 (Sawyer, 1943) to 3.05 in 1976-1979.

** More detailed analysis is needed to determine if this apparent increase in nitrate concentrations might be due to improved laboratory analysis techniques.

Urbanization

While farmers were channelizing Starkweather Creek, the City of Madison began to expand into the watershed. Between 1900 and 1940, most development occurred in the southwestern corner of the watershed (Figure 9) and consisted of a mixture of residential and commercial uses. Industrial development concentrated along the Chicago and Northwestern Railroad. Major industries located in the watershed included the United States Sugar Company, Madison Silo, Madison Plow, Four Lakes Ordinance, Madison Kipp and Oscar Mayer.

After World War II, the road network was improved and Madison expanded rapidly. On the east side, U.S. Highway 51 and State Highway 30 were relocated and changed to four-lane limited-access roads. Later, Interstate 90-94 was constructed through the eastern part of the Starkweather Creek Watershed. Between 1950 and 1960, urban development was largely contained by Highway 51; but after 1960, development spread into the area between Highway 51 and the Interstate. Much of the development which occurred after World War II was single family residences with little interspersion of commercial use. Most commercial development was strung out along East Washington Avenue and Highway 51. New industrial and warehousing areas were established along the Chicago, Milwaukee, St. Paul and Pacific Railroad, on Sycamore Avenue, and east of new Highway 51. The airport, which had been expanded for military use during the war, was further expanded to serve commercial traffic.

By 1979, only 45% of the watershed remained in agricultural or rural open space uses (Figure 10). About 19% is devoted to single and multi-family residences and farm buildings while 8% is in commercial or industrial use. Due to the location of the airport and several large highways in the watershed, a relatively large proportion of land (13%) is used for transportation facilities and other utilities. About 3% is used by the military, governmental agencies or service institutions such as nursing homes. Parks, Playgrounds, greenways and other urban open space uses occupy 4% of the watershed. The remaining 7% is vacant or undeveloped land.

As land in the Starkweather Creek watershed was developed for urban uses, a storm sewer system was added to the agricultural ditches to further enhance drainage (Figure 11). The parts of the watershed developed prior to 1960 characteristically have enclosed underground storm sewers. Only a few open ditches or concrete-lined cunettes remain in these older residential and commercial neighborhoods. In contrast, the stormwater drainage system installed after 1960 in the area south of Highway 30 between Highway 51 and the Interstate has retained some of the original drainageways as relatively natural greenways. Retention/detention basins have been incorporated into the system at several points - between Atlas Avenue and Highway 51, northwest of Coach House Drive, and at Acewood Pond. Acewood Pond is especially notable because it is a very attractive wetland with open water which attracts waterfowl and other wildlife.

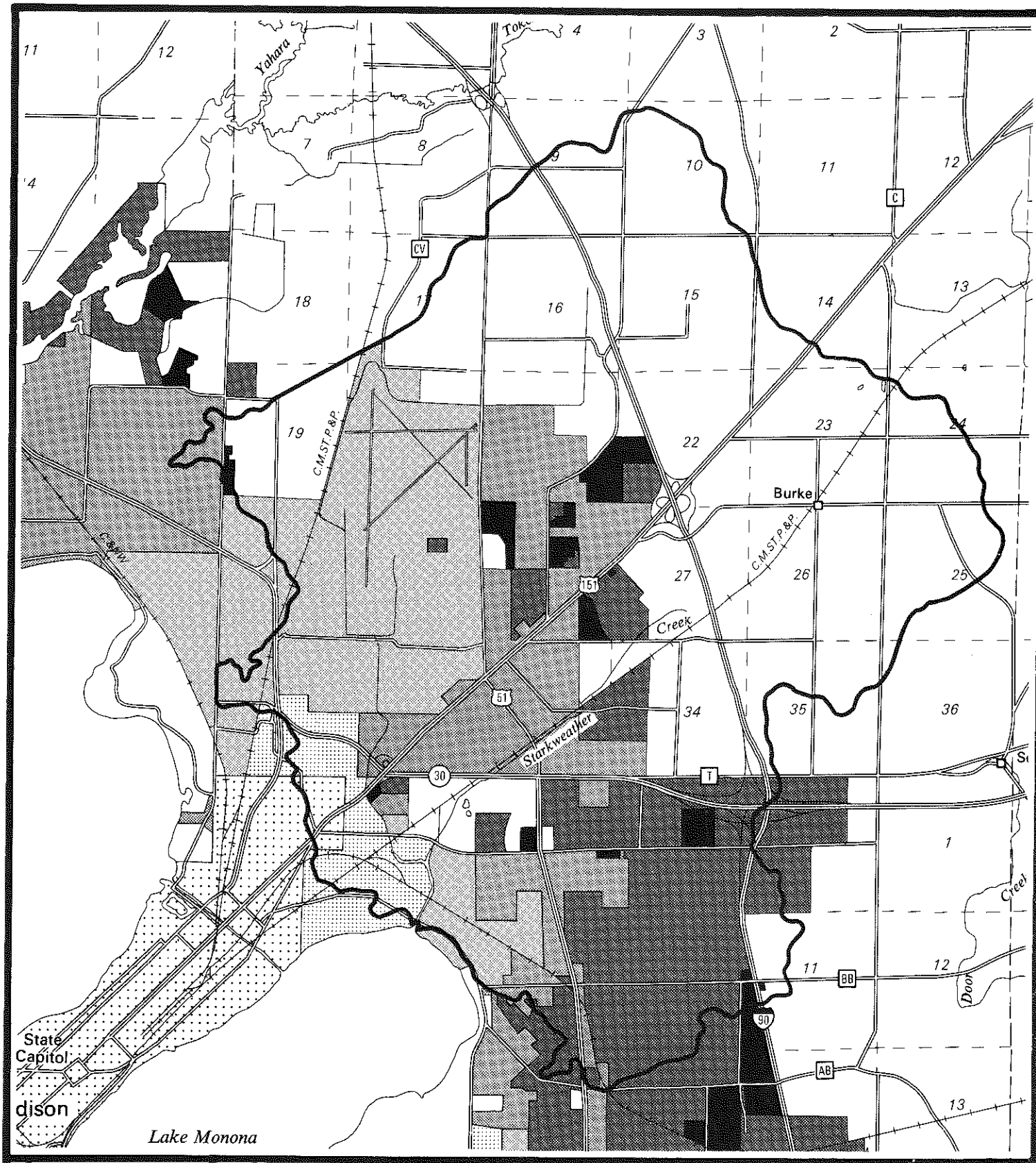


FIGURE 9

EXTENT OF URBANIZATION: 1900-1979

AS INDICATED BY ANNEXATION TO THE CITY OF MADISON

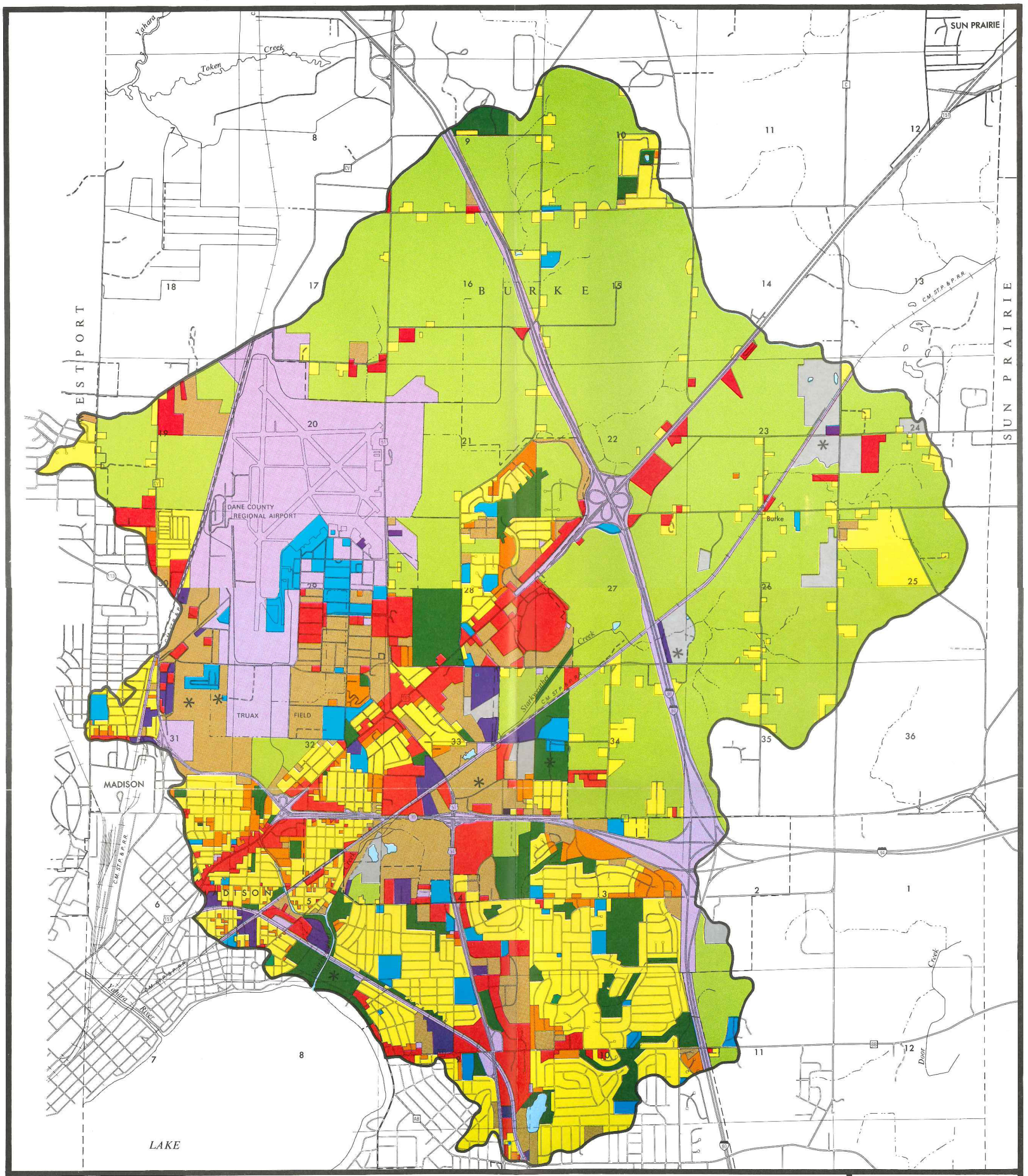
- Prior to 1900
- 1900-1939
- 1940-1949
- 1950-1959
- 1960-1969
- 1970-1979
- *Starkweather Watershed Boundary*

May, 1980

0 ½ 1

Scale in Miles

Prepared by:
The Dane County Regional Planning Commission



LAND USE

STARKWEATHER CREEK WATERSHED

As of 1979

- Residential·Single Family & Farmsteads
- Residential·Multi·Family
- Commercial·Trade & Services*
- Manufacturing*
- Transportation & Utilities
- Institutional
- Agricultural, Rural Open & Wooded Lands
- Vacant
- Recreation, Parks & Greenways
- Sand & Gravel Extraction

*Solid Waste Disposal Sites(existing & abandoned)

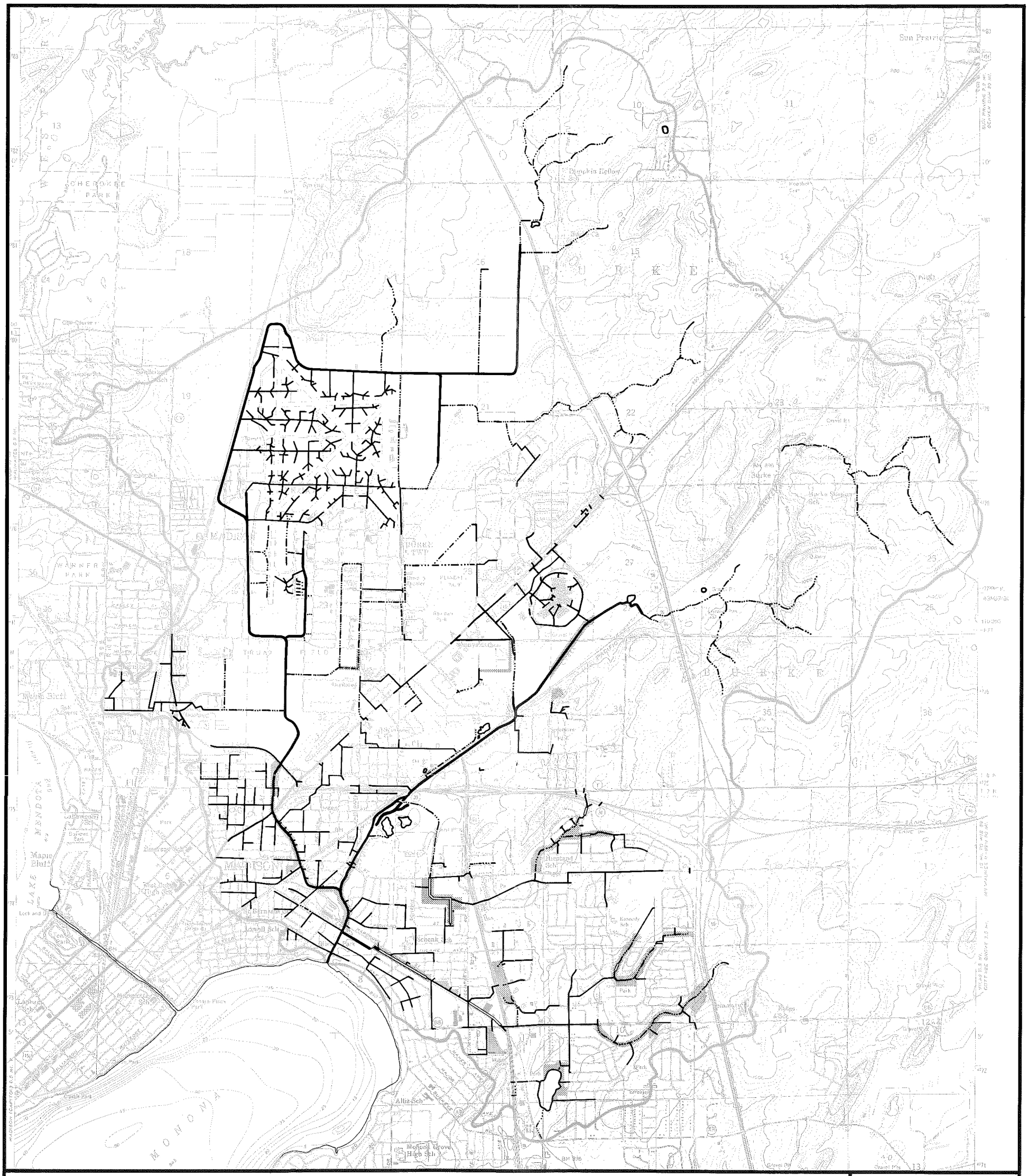
*Distinctions between commercial and manufacturing use based on SIC coding.

1mile

0 1/4 1/2 1

Prepared by: Dane County Regional Planning Commission

June, 1980



STORMWATER DRAINAGE NETWORK

STARKWEATHER CREEK WATERSHED

As of 1979

- Enclosed Storm Sewer
- Open Concrete Channel
- Intermittent Stream or Ditch
- Continuous Stream or Ditch
- Greenway, Drainage Easement, or Detention Area

1 mile

0 1/4 1/2 1

Prepared by: Dane County Regional Planning Commission

June, 1980

Urbanization has further altered both the hydrology and water quality of Starkweather Creek. The increase in areas covered by pavement and roofs, combined with the installation of curb and gutters and storm sewers has further increased peak flows in the creek. Runoff from the city streets now carries increased loads of heavy metals (especially lead) from traffic wastes into the creek. The faster flow of water in the urban stormwater drainage system has also increased the sediment and nutrient loads delivered to the creek. These effects of urbanization have been mitigated somewhat by the inclusion of greenways and retention/detention basins in some of the recent development. Greenways and retention/detention basins slow the rate of stormwater flow allowing sediments and associated nutrients to settle out. In some of the retention basins, stormwater is detained long enough to allow groundwater recharge.

Industrial and Domestic Waste Disposal

Starkweather Creek has received a variety of industrial waste discharges. The earliest recorded source of industrial waste was the U.S. Sugar Company which discharged process water contaminated with sugar beets near the mouth of the creek (Alvord and Burdick, 1920).

Prior to and during World War II, most of the sources of wastewater were located on the West Branch of Starkweather Creek, rather than the East (Figure 12). Just south of the airport, the West Branch received domestic wastewater from the Burke Sewage Treatment Plant when the plant was used by the army during World War II (Sawyer et al., 1944). The direct discharge of domestic waste was eliminated after the war, but the Oscar Mayer Company bought the plant for industrial waste pretreatment. Process water contaminated with ammonia, phosphates and sewage from the Oscar Mayer operation has reached the West Branch either directly or indirectly for many years (Roth, 1952; WCWP, 1963; WDNR, 1971; WDNR, unpubl.). This part of the West Branch has also received groundwater polluted by leachate from the city landfill just north of the Burke plant (Kaufman, 1970). Further downstream near the Chicago, Milwaukee, St. Paul and Pacific Railroad, the Ray O'Vac Corporation once discharged water containing ammonia, oxygen-demanding material and heavy metals (notably zinc and mercury) from battery manufacturing. The Madison Kipp Corporation also discharged waste containing heavy metals and oxygen-demanding materials to this same storm sewer system. The Madison Bus Company garage has been responsible for periodic oil slicks as well as sediment and oxygen-demanding material discharged at the Fair Oaks Avenue Bridge. Below the confluence of the West and East Branches, the Madison Silo Corporation and Consolidated Paving Company (which replaced the Sugar Company) have periodically discharged water laden with sediment and concrete (Saley, 1971; WDNR, 1971; WDNR, unpubl.).

After World War II, a new type of industry moved into the Starkweather Creek Watershed - agricultural fertilizer manufacturing. The Royster Company discharged water contaminated with ammonia and phosphate to the upper end of the Olbrich Park storm sewer system and the Swift Agricultural Chemical Company on Mayfair Avenue discharged similar

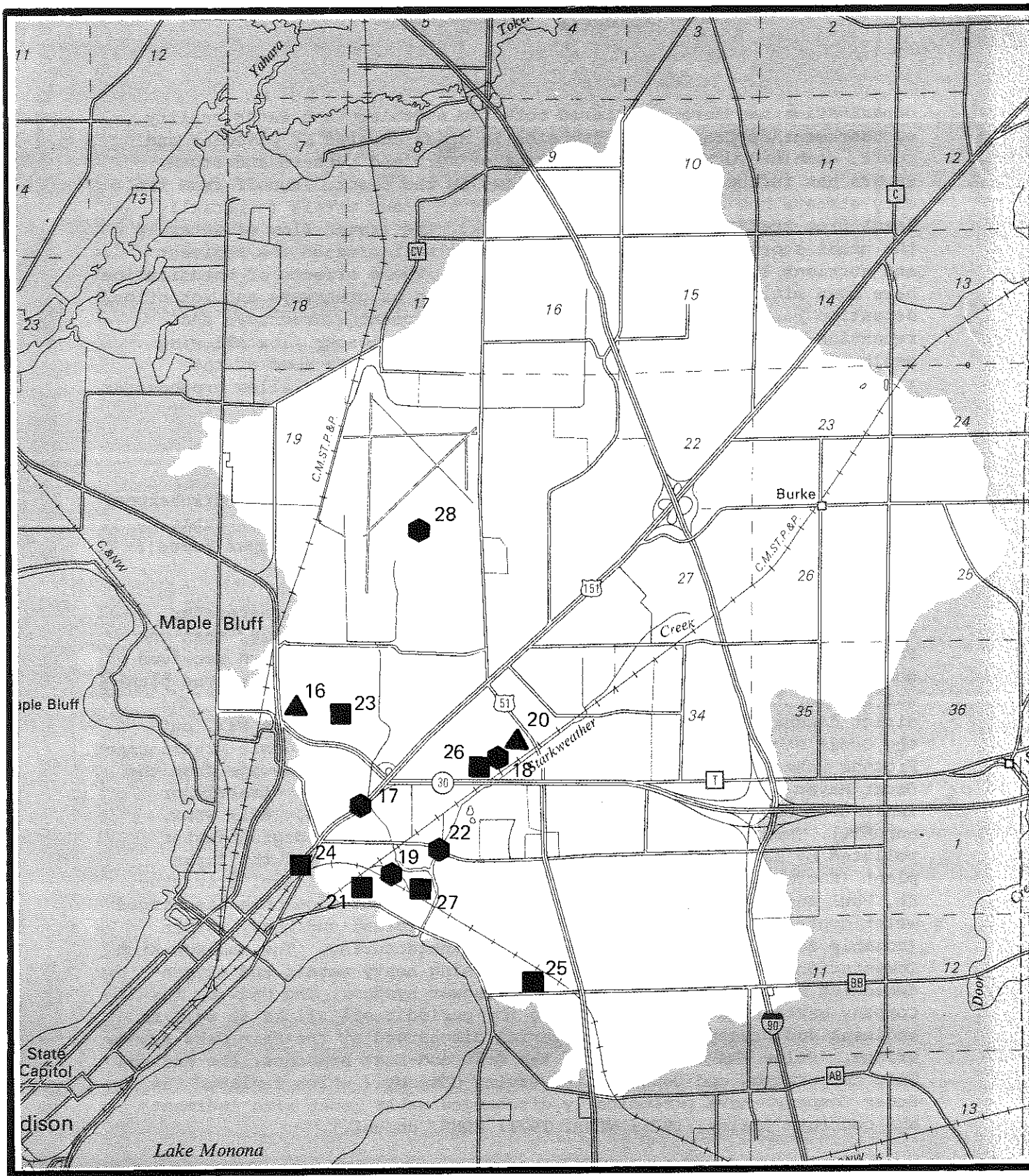


FIGURE 12
PAST SOURCES OF POLLUTION

- Process Water
- Sewage
- Contaminated Runoff
  Wash Water, Oil and Fuel

May, 1980

0 ½ 1

Scale in Miles

Prepared by:
The Dane County
Regional Planning
Commission

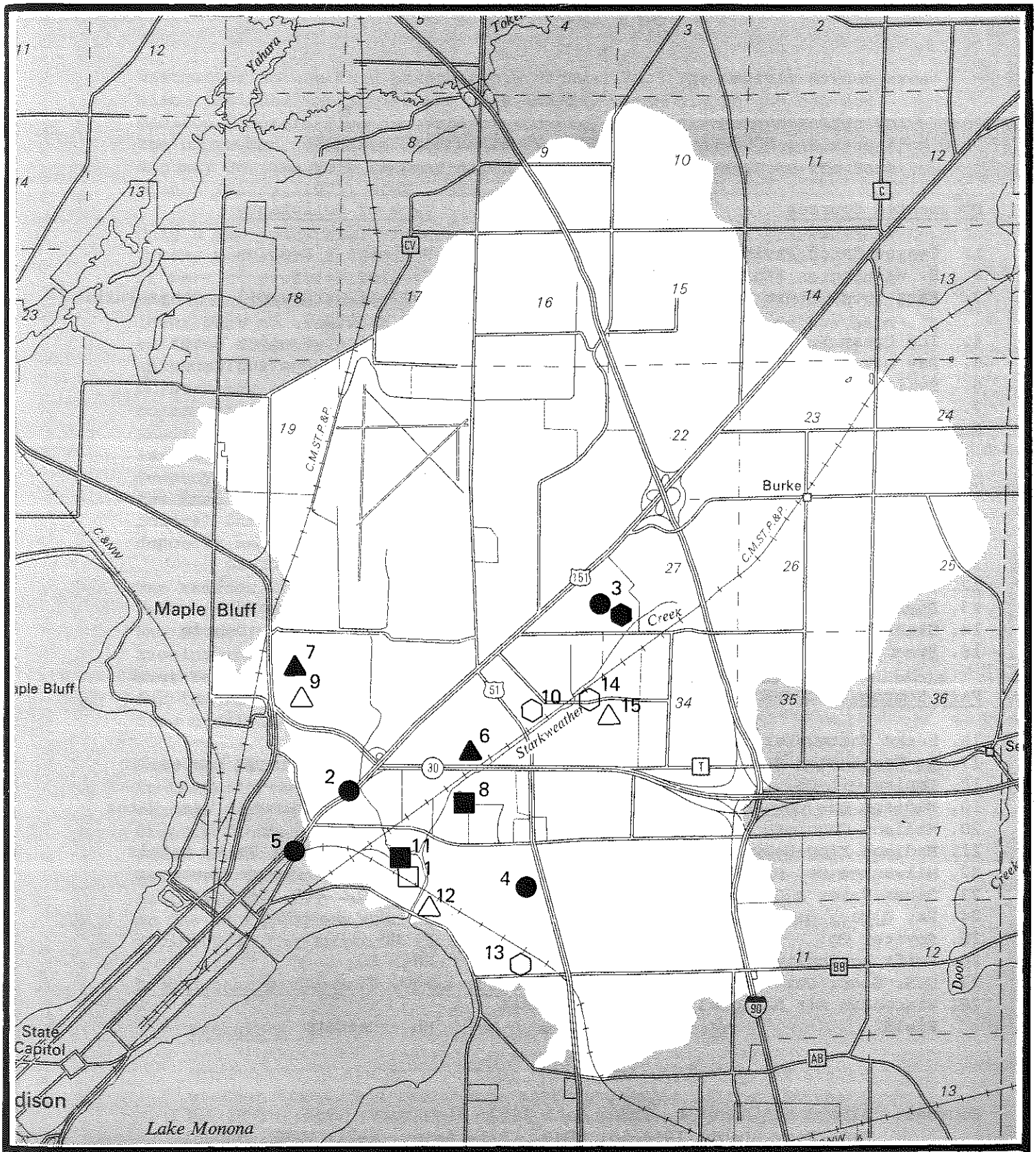


FIGURE 13

PRESENT AND POTENTIAL SOURCES OF POLLUTION

- Cooling Water
- Process Water
- Leachate from Residual Waste
- Contaminated Runoff

Filled symbols = Documented Sources
Open Symbols = Other Potential Sources

May, 1980

0 ½ 1

Scale in Miles

Prepared by:
The Dane County Regional Planning Commission

TABLE 4

SOURCES OF POLLUTION TO STARKWEATHER CREEK

Documented Sources	Type of Pollutants
1. Consolidated Paving Co.	Sediment & Erosion
2. E. Washington Storm Sewer	Cooling Water
3. East Towne Storm Sewer	Cooling Water, Oil & Other Parking Lot Wastes
4. Ice Cream Shops of Madison	Noncontact Cooling Water
5. Ray O'Vac, Division of ESB	Noncontact Cooling Water
6. Swift Agricultural Chemical Corp.	NH_3, PO_4
7. Truax Landfill	Leachate
8. Voit, E. C. and Sons, Inc.	Silt
Other Potential Sources	
9. Burke Sludge Lagoons	Leachate
10. Coal Storage Pile	Leachate
11. Madison Silos, Division of Chromalloy Amer.	Sediment & Concrete
12. Olbrich Landfill	Leachate
13. Royster Co.	NH_3, PO_4 in Runoff
14. Stearns Chemical Corp.	Chemical Spills, Debris
15. Sycamore Landfill	Leachate
Past Sources	
16. Burke Wastewater Treatment Plant	Sewage
17. E. Washington Storm Sewer	Oil & Other Garage Wastes
18. Empire Oil Co.	Oil
19. Madison Bus Co.	Oil, BOD, Sediment, Wash Water
20. Madison Concrete Pipe & Products Co.	Sewage
21. Madison Kipp Corp.	BOD, Cr & Other Heavy Metals
22. Milwaukee St. Storm Sewer	Oil & Other Garage Wastes
23. Oscar Mayer & Co.	NH_3, PO_4, BOD, Sewage
24. Ray O'Vac, Division of ESB	Zn, Hg, BOD, NH_3
25. Royster Co.	F, NH_3, PO_4
26. Swift Agricultural Chemical Corp.	NH_3, PO_4
27. U.S. Sugar Co.	BOD, N, P
28. Wisconsin Air National Guard & Truax Air Field	NH_3, Deicers

Sources: Alvord and Burdick, 1920; Roth 1952; Kingsbury, 1956; WCWP, 1963; Mad. Engr. Dept. 1964-65; WDNR, 1971; Saley, 1971; WDNR, unpubl.

wastewater to the East Branch above Highway 30. The Mayfair Avenue area also included the Empire Fuel Oil Company which discharged oil and Madison Concrete Pipe and Products Company which discharged sewage to the upstream end of the ditch known as the Swift Branch. Downstream from Highway 30, the Voit Company discharged gravel wash water to the East Branch (Saley, 1971; WCWP, 1963; Kingsbury, 1956).

Only a few industrial process water discharges remain on Starkweather Creek; most were connected to the Madison Metropolitan Sewerage District or were otherwise eliminated during the last 15 years. Madison Silos and Consolidated Paving may still sporadically discharge sediment to the lower part of the creek (WDNR, Unpubl.). The Voit discharge has been buffered somewhat by a change in the ditch system south of Highway 30 which allows much of the sediment to settle in an abandoned channel. Royster may still be responsible for elevated ammonia and phosphorus concentrations detected in stormwater runoff to the Olbrich Park storm sewer system. One of the most significant remaining sources of pollution is the residual waste left by the now defunct Swift Agricultural Chemical Company. The unusually high baseflow ammonia concentrations evident in the East Branch beginning at Highway 30 are most likely due to the lateral inflow of shallow groundwater polluted by fertilizer waste deposits and an abandoned wastewater lagoon.

The Madison Kipp and Oscar Mayer discharges have been eliminated and the West Branch of the creek now receives only noncontact cooling water from Ray O'Vac (WDNR, unpubl.). Cooling water, probably from air conditioning and cooling equipment, is also discharged to the West Branch at East Washington Avenue. These cooling water discharges may be responsible for the elevated chromium concentrations in the West Branch under baseflow conditions.

Both the West and East Branches receive litter from some of the industries in the watershed. Debris dams in the East Branch below Sycamore Avenue contain fifty gallon drums as well as loading pallets, probably from the Stearns Chemical Company which stacks its empty chemical containers and other trash close to the creek at the low end of its parking lot. The West Branch below Anderson Avenue is littered with styrofoam packing material, probably blown into the creek from either Tuscarora Plastics or the Packaging Corporation of America, which have warehouses in the vicinity of the airport.

Groundwater Withdrawal and Baseflow Declines

Background

Groundwater plays an important role in the hydrology of Starkweather Creek, and represents another example of the changes brought about in the watershed by settlement and urbanization.

As indicated earlier, Starkweather Creek originates at springs and seeps just west of Interstate Highway 90-94. Based on field surveys, the East Branch appears to begin with two continuous moderate-capacity springs above Lien Road, while the groundwater flow at the headwaters of the West Branch originates from diffuse seepage in a wetland area above Hanson Road.

Hydrogeology

The geologic characteristics of the East and West Branches of Starkweather Creek are surprisingly different, and provide valuable insights into groundwater recruitment. The bedrock surface under the East Branch rises relatively rapidly above Milwaukee Street, going from 600 feet above mean sea level to more than 800 feet in just 2.1 miles, a rise of 95.2 feet per mile. Depth to bedrock at the upper end of the East Branch is less than 25 feet, and more than 250 feet at Milwaukee Street. The saturated thickness of recent deposits overlying bedrock under the East Branch ranges from 200 or more feet at Milwaukee Street to 100 feet at Highway 30 to less than 25 feet near East Towne. The gradient of the groundwater surface surrounding the East Branch is relatively steep, ranging from an elevation of approximately 840 feet at Atwood Avenue, to 850 feet at Lien Road, to 870 feet just east of Interstate Highway 90-94.

The West Branch of Starkweather Creek is largely underlain by the preglacial Yahara River Valley. The bottom of this buried valley is about 260 feet below the land surface in the vicinity of the old Burke Wastewater treatment plant. For a distance of approximately four miles above Milwaukee Street, the bedrock surface underlying the West Branch is 250-300 feet deep, with a corresponding thickness of glacial drift. The bedrock surface does not become shallower until the stream turns eastward at the northern end of the airport (stream mile 5.5). From this point to Hanson Road (stream mile 7.3), the bedrock surface rises nearly 200 feet to about 50 to 70 feet below the land surface. The thickness of saturated deposits (glacial drift) is as much as 100 feet thick less than a mile south of Hanson Road.

The shallow groundwater surface in the vicinity of the West Branch of Starkweather Creek rises from about 840 feet at Milwaukee Street to about 850 feet at International Avenue (stream mile 3.7) except as discussed later. This represents a depth to shallow groundwater of 4 to 12 feet below the land surface. The 860 foot groundwater contour intersects the West Branch in the general vicinity of the Chase Ditch (stream mile 6.5).

Geologic conditions in the upper East Branch appear to favor the lateral movement and discharge of shallow groundwater and observations made during this study have confirmed the existence of two springs at the headwaters, as well as additional springs and areas of general groundwater inflow above Highway 51. The headwaters area of the West Branch of Starkweather Creek lacks the shallow bedrock and

relatively steep hydraulic gradient which typify the upper portions of the East Branch. In addition, a large area of deep muck soils is found in the vicinity of the West Branch above Highway 51. These characteristics clearly indicate that groundwater contribution to the upper West Branch is through diffuse seepage, rather than spring discharge.

Cause and Impact of Groundwater Level Declines

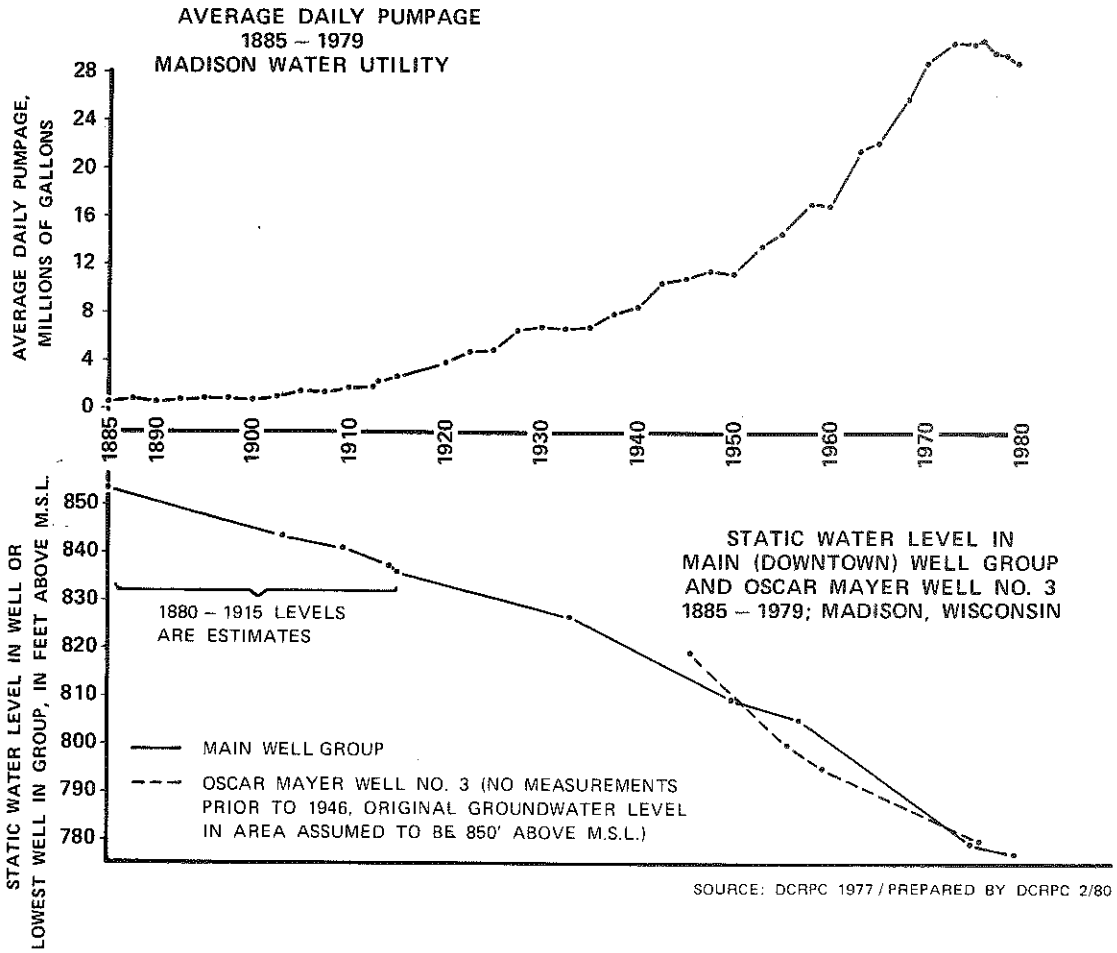
Madison's first municipal water supply well was drilled in 1882, to a depth of 751 feet. It was finished just into granite overlain by sandstone. The water level in the original well rose to 853.5 feet above sea level, some 4.5 feet above the surface level of Lake Mendota and 8.5 feet above the surface level of Lake Monona. As indicated by Figure 14, Madison's original wells supplied an average of less than 2 million gallons per day (mgd) of water to the city until 1912. By 1925, average daily pumpage reached 5 mgd. By 1956, it reached 15 mgd, and by 1971 it reached 30 mgd. In addition to Madison Water Utility wells, pumpage from private wells, such as those owned by Oscar Mayer and Company, has increased steadily over time.

The increasing withdrawal of groundwater in Madison has been accompanied by a progressive decline in the hydraulic head in the sandstone aquifer, by a less dramatic decline of the water table in the upper aquifer, and finally, by reductions in base flow to streams as the hydrologic system attempts to reach a state of equilibrium (DCRPC, 1977). Figure 14 illustrates the decline in static water level in the Madison main wells which has accompanied continued and increased pumping. The decline in static water level in Oscar Mayer well #3 is also plotted. The Oscar Mayer wells, which are located just southwest of the Old Burke wastewater treatment plant site, have been pumped since 1918 and are significant due to their proximity to the West Branch of Starkweather Creek.

By 1975, the static water level in the Madison main well group had declined to 74 feet below the original level, and the static water level in the Oscar Mayer well had dropped 73 feet. McCleod (1978) estimated that an additional decline of approximately 20 feet could be expected in the sandstone aquifer by the year 2000.

In the Madison area, the upper aquifer is generally leaky and allows movement of water into the sandstone aquifer. However, the rate at which water moves horizontally and vertically through the upper aquifer and the extent of upper aquifer drawdowns due to deep pumpage varies based on the nature of subsurface materials and the saturated thickness of the upper aquifer.

Figure 14



With respect to Starkweather Creek, the upper aquifer underlying the East Branch is generally less leaky than that under the West Branch. However, the saturated deposits underlying many areas of the East Branch are far thinner than those found in the preglacial Yahara River Valley, underlying the West Branch. These characteristics indicate that although the upper aquifer in the vicinity of the West Branch is more sensitive to deep pumpage than is the case in the East Branch basin, upper aquifer drawdowns which do

occur in the East Branch may spread over a considerable area in order to capture sufficient recharge to reach a state of equilibrium.

Figure 15 illustrates the outward displacement of the 850 foot groundwater contour from 1880 to 1975. Changes in this shallow groundwater contour caused by pumping of the sandstone aquifer are particularly important to Starkweather Creek since the East and West Branch channels have bed elevations which are generally between 840 and 850 feet. Of particular interest in Figure 15 is the historical displacement of the 850 foot contour on the West Branch. This displacement relates to the location of the cone of depression surrounding the Oscar Mayer wells as depicted in Figure 16.

Figure 17 is an attempt to describe graphically the relationship between historic and current groundwater levels and the level of the streambed in the Starkweather Creek watershed. Original (1880) and 1975 shallow groundwater levels along the length of the East and West Branches are represented in this figure as straight sloping lines, although the actual hydraulic gradient is probably quite irregular due to varying localized geological conditions, excavations, landfills and other disturbances. The point made by the illustration is that the relationship of shallow groundwater to the stream channel in both branches of Starkweather Creek may have been substantially altered by groundwater withdrawal. While there is insufficient data to establish the period in which the Oscar Mayer pumping started to have a pronounced impact on the West Branch, the little data available suggests that static water level declines in the Oscar Mayer well were especially rapid from 1945 through 1960.

Summary

Shallow groundwater movement in the vicinity of the West Branch and main stem of Starkweather Creek appears to have been heavily disturbed by the Oscar Mayer and Madison main well group cones of depression (see figure 16). There now appears to be little discharge of groundwater to the West Branch below the Dane County Regional Airport or to the main stem of the creek. Groundwater flow in the vicinity of the East Branch has not been as heavily disturbed by withdrawal, and observations and analysis confirm that groundwater discharge to the East Branch occurs above Highway 51.

McCleod (1978) projects a significant expansion of a 10 foot upper aquifer drawdown in the vicinity of the upper East Branch of Starkweather Creek by 2000. Increasing pumpage of the well responsible for this drawdown poses a threat to continued groundwater discharge to the stream. Little additional expansion of the drawdown which affects the West Branch is projected.

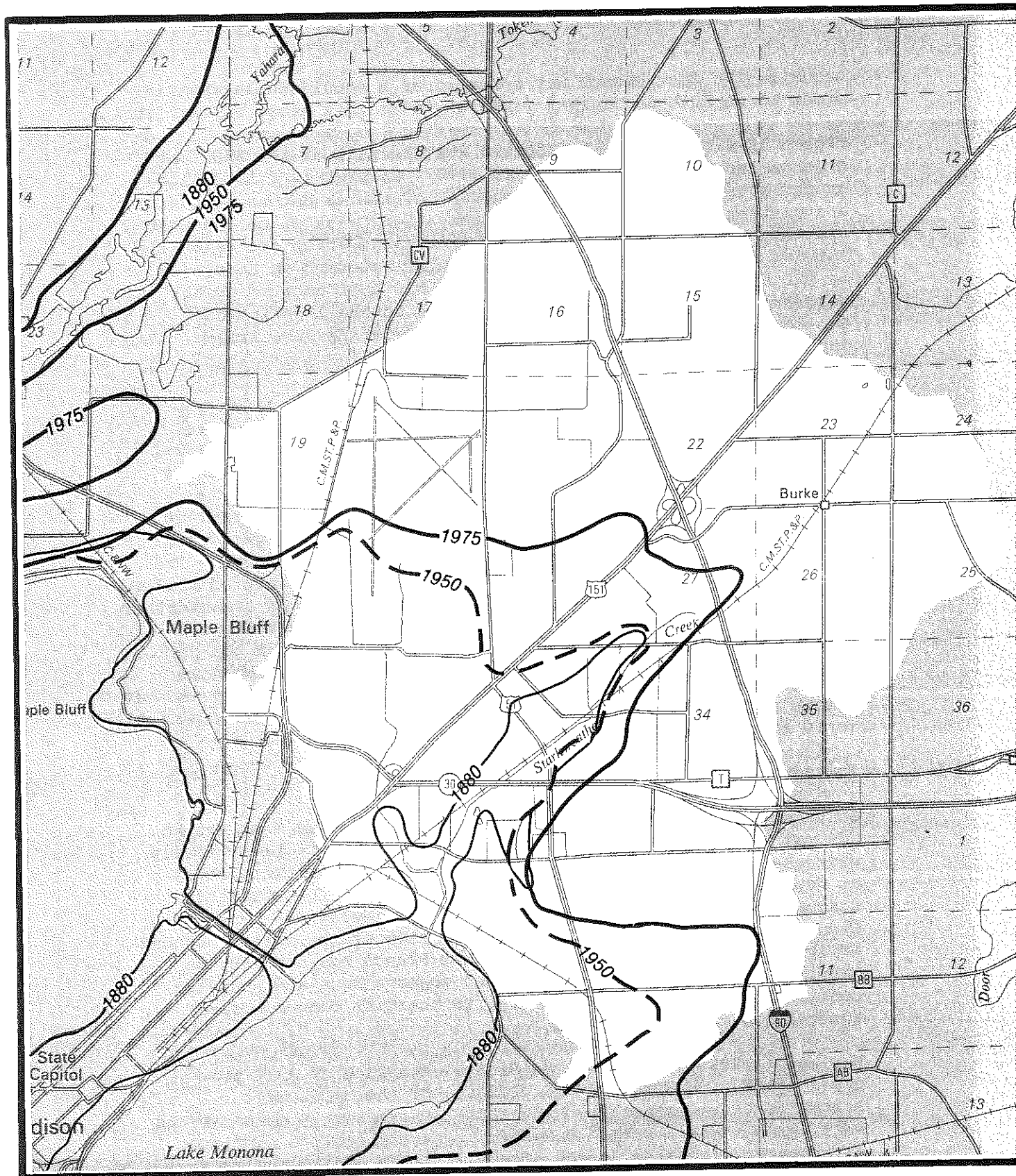


FIGURE 15

DISPLACEMENT OF THE 850 FOOT GROUNDWATER CONTOUR: 1880-1975

Location of the 850 Foot Above
Mean Sea Level Groundwater Contour:

1880

1950

1975

May, 1980

0 ½

Scale in Miles

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Regional Plan
Commission

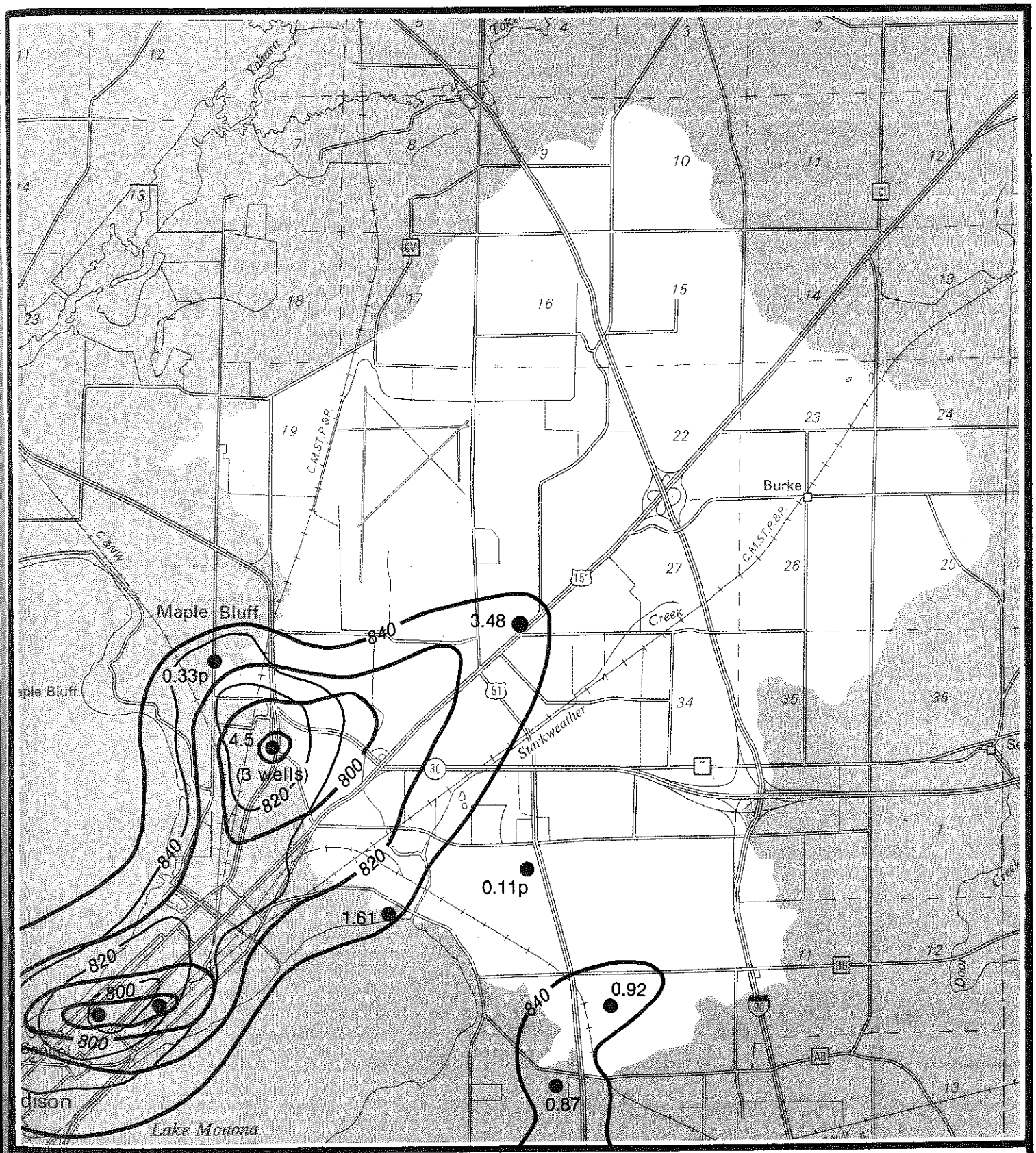


FIGURE 16

DEVELOPMENT OF THE GROUNDWATER CONE OF DEPRESSION: 1950-1975

May, 1980

1950 Groundwater Contour

1975 Groundwater Contour

840 *20 Foot groundwater contour intervals.*

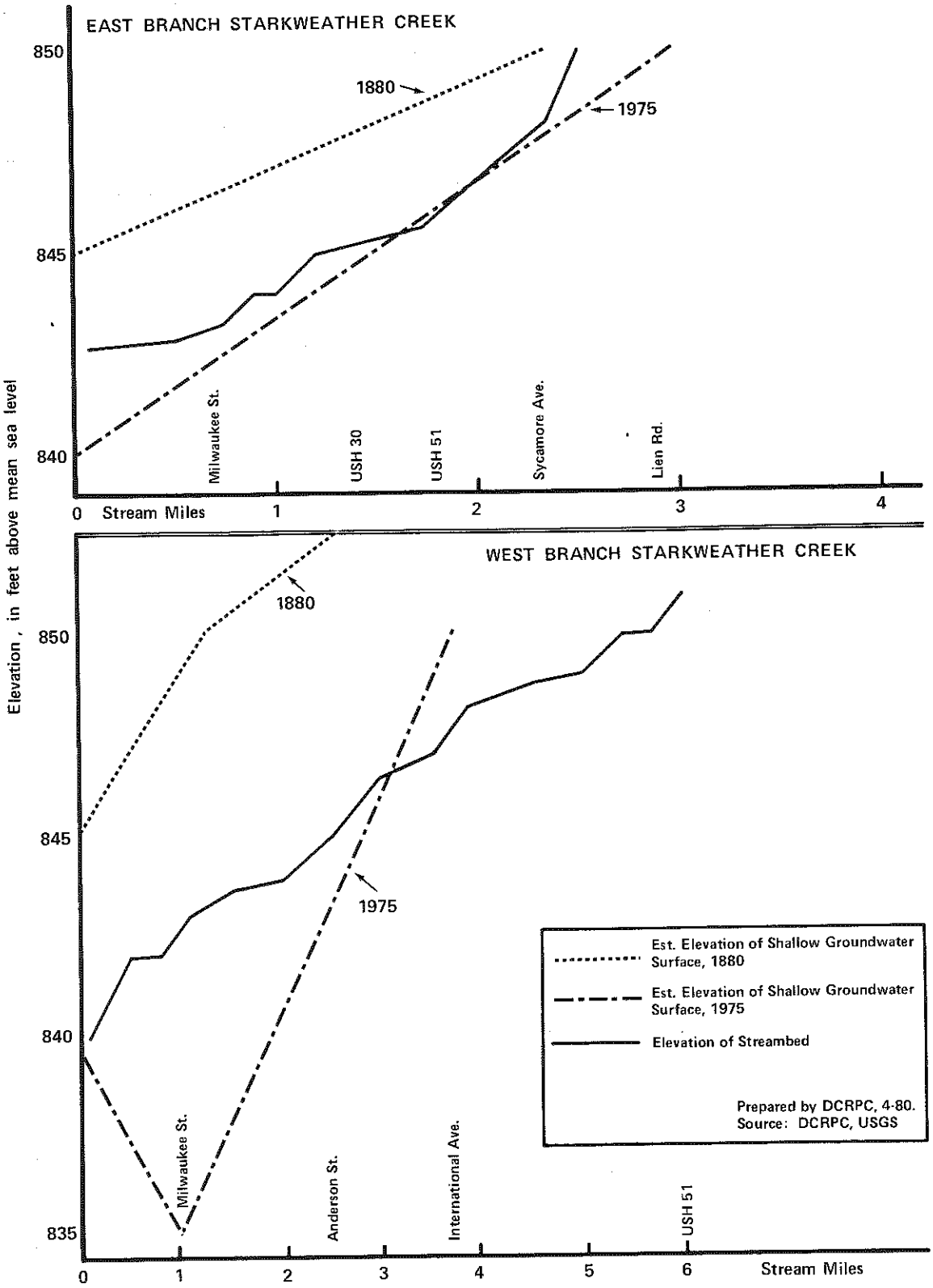
● 1.5 Well Location and 1975 Average Daily Pumpage in MGD.
p = wells only pumped for a portion of the year.

0 ½ 1
Scale in Miles

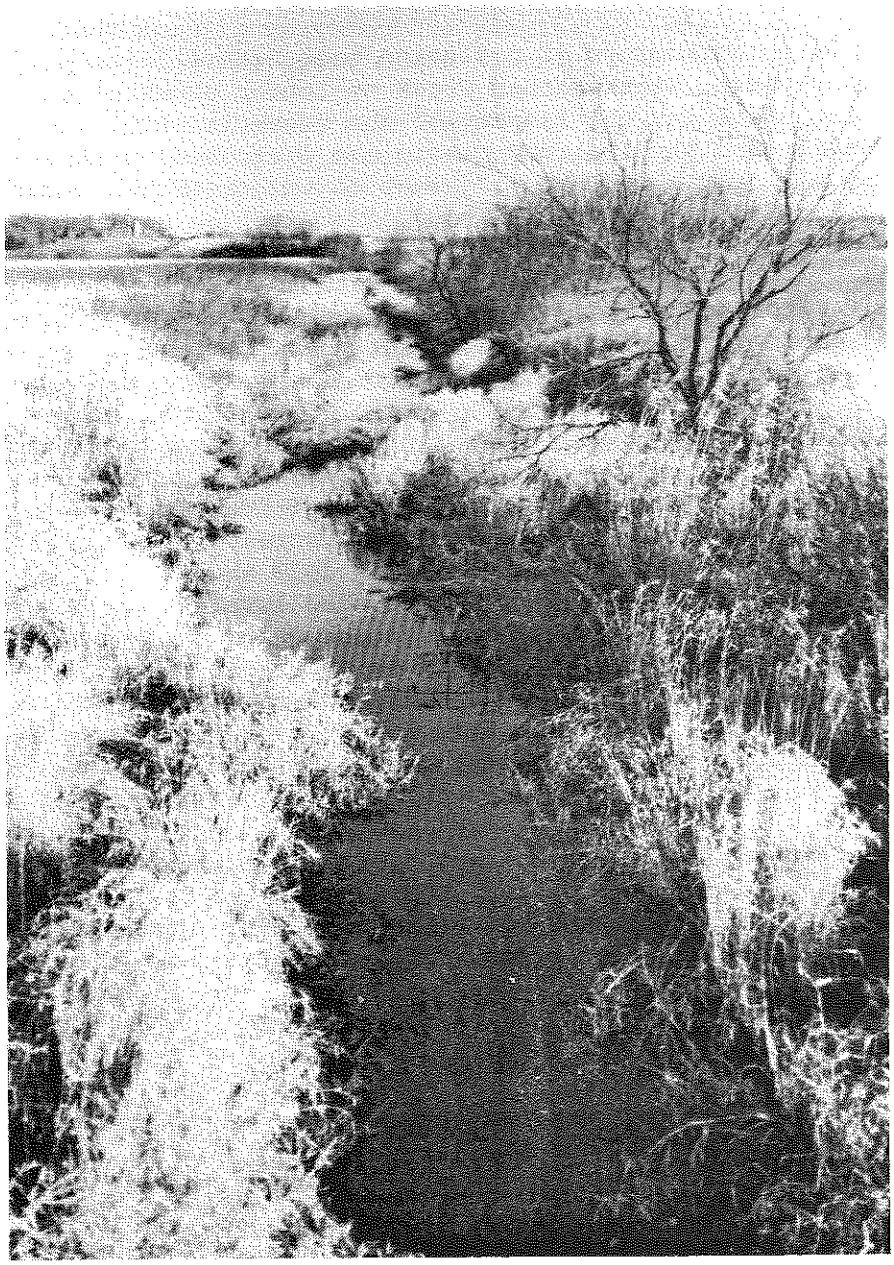
Prepared by:
The Dane County Regional Planning Commission

FIGURE 17

ESTIMATED RELATIONSHIP OF SHALLOW GROUNDWATER TO STREAMBED ELEVATION; STARKWEATHER CREEK 1880 & 1975.



Although there is insufficient historic flow data on Starkweather Creek to quantify declines in baseflow, the small amount of data available and the analysis of groundwater withdrawal support a belief that baseflow declines have been substantial. A reduction in groundwater input during critical low flow periods can act to reduce flow still further, increase stagnation in the flat lower reaches of Starkweather Creek, increase stream temperatures, and result in an overall degradation of baseflow water quality. Reduced groundwater input also tends to work to lower the baseflow nitrogen to phosphorus ratio since groundwater is a substantial source of nitrogen, especially nitrate.



Remaining Wetlands on the West Branch Provide Valuable Dry Weather Flow in the Creek

SIGNIFICANCE OF POLLUTION

Due to its length and location on the east side of Madison, the Starkweather Creek corridor has the potential to be an important environmental and recreational resource. However, the potential uses of the creek and adjacent lands for fishing, boating, wading, hiking, and picnicking have been limited by the poor quality of the fishery, bacterial contamination of the West Branch, unsightly debris dams, conflicting land uses and private ownership of some of the largest adjacent areas of undeveloped land. The poor water quality of the creek also contributes to the eutrophic conditions in Lake Monona.

Stream Use Limitations

Since major point sources of pollution have been eliminated over the past twenty years, Starkweather Creek no longer experiences periodic fish kills. However, the fishery of the creek is still limited by poor water quality and physical changes in the watershed. The drainage of virtually all of the wetlands adjacent to the creek has ended the spring spawning runs of northern pike and panfish such as bluegills, pumpkinseed and crappies. The summer fishery in the creek is limited by the extremely low dissolved oxygen concentrations which occur during hot weather. Carp and bullheads still frequent the creek and other species of fish swim up from the lake when oxygen and temperature conditions permit. Although ammonia concentrations in Starkweather Creek occasionally exceed the standard recommended by the U.S. Environmental Protection Agency, they do not exceed levels proven to be toxic to fish.*

During the last four years, both branches of Starkweather Creek generally met bacterial standards for body-contact recreation until 1979. However, data collected on the West Branch during 1979 showed fecal coliform bacteria counts which consistently exceeded levels considered safe from a public health standpoint. Although Starkweather Creek is not deep enough for swimming, its safety is important because it flows through heavily populated areas and is used occasionally by children, especially waders. The lower part of the creek (from just above the confluence and the East and West Branches to the lake) is used more intensively by boaters for access to Lake Monona.

Other recreational use of Starkweather Creek is focused on the remaining undeveloped lands along the creek corridor. City lands such as Olbrich, Lansing and Washington Manor Parks provide public recreational facilities adjacent to the lower part of the creek. City of Madison drainage or

*U.S. EPA recommends a standard of 0.02 mg/l un-ionized ammonia; tests prove 0.2 mg/l (rainbow trout) to 2.0 mg/l (carp) to be toxic to fish (U.S. EPA, 1976). According to 1976-79 baseflow monitoring, the highest concentration of un-ionized ammonia in the East Branch of Starkweather Creek was 0.10 mg/l (computed from total ammonia of 2.63 mg/l @ 24 C. and PH of 7.8 on 6/11/76).

road easements include other strips of public access along the creek. In addition, some privately owned sections of creek corridor are used by the public, notably the wooded section of the West Branch north of Aberg Avenue, and the picnic area south of East Washington Avenue.

Recreational use of the Starkweather Creek corridor is limited by a variety of factors, especially private ownership of significant undeveloped adjacent lands. Adjacent land uses have created visual and/or noise pollution along several sections of the creek corridor, notably near Sycamore Avenue, Highway 51 south to Highway 30, at the airport and downstream from Fair Oaks Avenue. In addition, public use of private lands has created problems in terms of littering, unrestricted use of motor bikes and fire hazards. Trash dumped, blown or washed into the creek has accumulated in unattractive tangles of branches and rubbish which create ponded areas where algae flourish and sediment is deposited.

Both city and rural residents also rely on Starkweather Creek to drain stormwater from extensive adjacent lowlands now used for housing, commerce and agriculture. The ability of the creek to carry stormwater has been impaired by debris dams, silt deposits in many parts of the channel and partially filled culverts. In addition, new development in outer parts of the watershed is being constructed without adequate retention/detention facilities or drainageway improvements. The resulting increase in stormwater runoff has eroded channels through neighboring farmland, increased loads of sediment and associated nutrients in the creek and caused silt deposits downstream. Major proposed stormsewer improvements in the city, notably the East Johnson-Hauk Street stormsewer, have the potential to substantially increase peak flows, causing bank erosion and increasing sediment and nutrient loading to the lake.

Lake Loading

In addition to affecting the use of the creek itself, the water quality of Starkweather Creek affects Lake Monona. In many ways, the loading of sediment and nutrients delivered to Lake Monona by Starkweather Creek is relatively moderate. By far the largest source of nutrients to Lake Monona is the Lake Mendota outlet, which contributes 62% of the annual total phosphorus and 47% of the annual total nitrogen loading to the lake. In contrast, Starkweather Creek contributes only 14% of the annual total phosphorus and nitrogen loadings to the lake.

Due to its flat topography and both natural and artificial retention areas, the Starkweather Creek watershed tends to retain much of the runoff and associated sediment and phosphorus. Therefore, compared to other streams in the county, Starkweather Creek carries a relatively low annual load of phosphorus and sediment (Table 3). Unlike phosphorus and sediment, nitrogen loading is more closely correlated with baseflow than storm events. Consequently, Starkweather Creek, with its high baseflow concentrations of nitrogen, carries a relatively high annual total nitrogen load compared to other streams in the county (Table 3). The relatively high annual total nitrogen loading combined with the relatively low annual total phosphorus loading yields a high nitrogen to phosphorus ratio for Starkweather Creek. This high ratio suggests that the overall effect of the nutrient loading from Starkweather Creek would tend to alleviate the nitrogen-stressed conditions which favor blue-green algae growth in Lake Monona.

Despite the moderate nature of the nutrient and sediment loading contributed by Starkweather Creek, a reduction in this source would be a vital element in a program to reduce loading of nutrients and sediment to Lake Monona. Recent analyses indicate that the total phosphorus loading to Lake Monona would have to be reduced to less than one third of the present loading to achieve a major change in the productivity of the lake.* Except for the Lake Mendota outlet, Starkweather Creek is the largest single source of nutrients and sediment to the lake. Furthermore, the relatively flat topography of the watershed would facilitate the use of retention and detention facilities, which are especially effective in reducing sediment and phosphorus loads.

Water Quality and Use Potential

Although many of the conditions which degrade the water quality and limit the use of Starkweather Creek could be improved, some would be extremely difficult and costly to change. Furthermore, the creek owes some of its limitations to natural conditions. Even with the removal of remaining pollution sources and control of stormwater inflows, Starkweather Creek will remain a relatively warm and fertile low-flow stream. The creek will support a limited warm water fishery dominated by carp and bullheads. Influxes of game fish from Lake Monona will occur during favorable oxygen and temperature conditions, but large spring spawning runs will not occur since wetland habitat appropriate for spawning has been drained or filled.

Even though the creek does not have sufficient flow or depth to be appropriate for swimming, it could meet public health standards for body contact recreation if bacterial contamination were eliminated in the West Branch. Only the lower part of the creek has sufficient depth to be navigable and to provide boat access to Lake Monona. Some maintenance dredging may be required to remove silt deposits that obstruct the channel.

Starkweather Creek and its tributaries have only a limited capacity for handling additional stormwater runoff without problems such as bank or channel erosion, silt deposits and flooding. Increases in stormwater runoff from new developments probably represent the greatest threat to the maintenance and improvement of water quality in the creek itself and the lake downstream.

The Starkweather Creek corridor has much untapped potential as a scenic and recreational resource for passive and active uses like picnicking, walking, and bicycling. Some sections of the creek corridor retain a natural character not found in many places on Madison's East Side. Trees or undeveloped lowlands isolate these parts of the creek from adjacent housing, commerce and industry. However, significant parcels of this undeveloped land adjacent to the creek remain unprotected by zoning, easement or public ownership.

*Input/output modeling based on 1976-1977 monitoring data indicated that a total phosphorus load to Lake Monona of 5,200 kg/yr would produce mesotrophic conditions, as compared to the present 16,000 kg/yr which produce highly eutrophic conditions. See Appendix H, Dane County Water Quality Plan.

MANAGEMENT AGENCIES

Management activities in the Starkweather Creek Watershed could be complicated since the watershed lies in several municipal jurisdictions. The City of Madison accounts for most of the developed area within the watershed, while the Towns of Burke and Blooming Grove cover the rural areas and some subdivisions. A small part of the watershed extends into the Town of Westport. Another governmental agency with jurisdiction over a significant part of the watershed and creek channel is the Dane County Airport Commission.

Dane County Drainage Board

The only agency with specific management responsibility and authority over all of the creek channel, its tributaries and most of the adjacent land is the County Drainage Board. Until 15 years ago, the Starkweather Creek Drainage District, like many districts in the state, was governed by its own board of three district commissioners. When state drainage district statutes were changed in 1965, responsibility for the Starkweather Creek Drainage District and other districts in the county was consolidated under the Dane County Drainage Board. According to State Statute, this board is required to "have all drains under its jurisdiction inspected annually to determine the need for maintenance and repair work" and to "maintain in good condition the drains in all districts...and to repair such drains when necessary" (Wis. Stats. s. 88.63(1)). The board is required to establish a fund for the payment of costs of maintenance and repair and to levy additional assessments to replenish the fund when it falls below "an amount equivalent to 5% of the confirmed benefits currently in effect in the district" (Wis. Stats. s. 88.63(2)). The board may go through the usual procedure for levying assessments - which requires public notice and hearing and approval by the circuit court judge (Wis. Stats. s. 88.23(1) and (2); s. **.06). Alternatively, the board may levy an assessment for maintenance funds without court approval by a two-thirds' vote of the board at a regular or special meeting held after giving public or private notice to all parties affected by the assessment (Wis. Stats. s. 88.23(2m)). In addition, the board must secure the approval of the Department of Natural Resources for work involving any ditch which was a navigable stream before ditching or had previous stream history (Wis. Stats. s. 30.10(4)(c); s. 30.12; s. 30.15, s. 30.19; s. 30.195; s. 30.20).

In order to carry out its delegated responsibilities, the board has the power to purchase and condemn land with the consent of the court, employ engineers and other assistants, purchase or lease and operate equipment, level spoil banks, enter any lands in or adjacent to the district, borrow money and issue bonds or notes (Wis. Stats. s. 88.21, s. 88.13 and s. 88.23(4)). In addition to its power to build and maintain drains, the board may, with the consent of the court, purchase, construct, operate and maintain a variety of other structures including levees, bulkheads, reservoirs, silt basins, holding basins, floodways and floodgates necessary to the successful drainage or protection of any district (Wis. Stats. s. 88.21(10)).

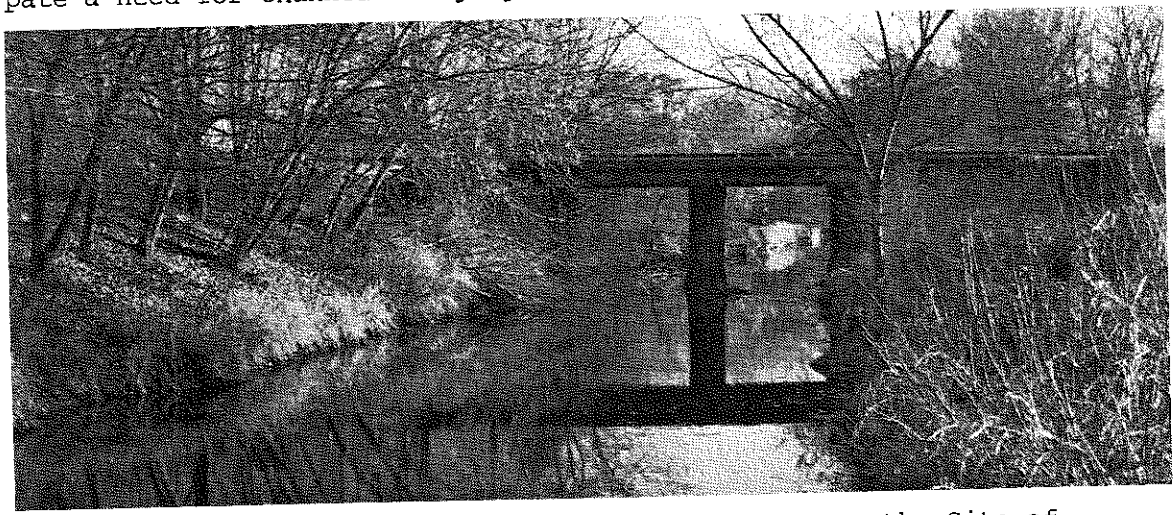
As of the 1978 annual report, the Dane County Drainage Board had only three cents left in the Starkweather Creek Drainage District fund and had not levied an assessment to return the maintenance fund to the required 5% level. The last time that an assessment was levied in the Starkweather District was in 1954 when the previous board, with court approval, authorized a 6% levy. With the exception of paying for cleaning 100 yards on East Lateral 3, the County Drainage Board has done little maintenance or repair work since assuming responsibility for the Starkweather District. According to the annual reports filed with the Circuit Court, the board has periodically inspected some of the ditches in the district, authorized a channel change on the Voit property and paid for the removal of some trees obstructing the ditches.

City of Madison

Most of the maintenance and repair work in recent years has been conducted by the City of Madison. Since 1965, the city has graded and cleaned up both banks of the West Branch from E. Washington Avenue to Aberg Avenue and the east bank of the East Branch from the C.&N.W. Railroad to Dawes Street. The city has also stabilized the east bank of the West Branch from Fair Oaks Avenue to Thorp Street with interlocking steel sheet piling and concrete slope wall. Furthermore, the city dredged the channel of the West Branch from Fair Oaks Avenue to Thorp Street, dredged the channel of the East Branch in the vicinity of the C. & N. W. Railroad and graded the banks and channel of the East Branch from Lien Road to East Towne. The Portland Parkway and the entire Walterscheit Drainageway (also called the Hargrove Drainage Ditch or Olbrich Park Storm Sewer) were improved by constructing cunettes or box culverts (Schoenbeck, corres.).

Dane County Airport Commission

The Airport Commission has also worked on the West Branch of Starkweather Creek since 1965. Sections of the channel were relocated when the new terminal was built thirteen years ago and when the north end of the main runway was extended two years ago. No bank maintenance or channel dredging has been completed in recent years, but airport plans anticipate a need for channel dredging within the next five years.



The West Branch Above Fair Oaks Avenue Has Been the Site of Several City Dredging and Bank Stabilization Projects

SUMMARY - THE CASE FOR FURTHER ACTION

The inventory of current and past conditions on Starkweather Creek has revealed a stream with a troubled history and long-standing record of moderate to severe water quality problems. An analysis of the full impact of man on the stream and of the dramatic changes brought about by alteration of the natural stream course is less than complete since presettlement conditions are not documented. Comparisons with other streams and the few records that exist describing the characteristics of Starkweather Creek before active drainage and channelization reveal a far different stream than that which we know today. While some of the physical alterations wrought upon Starkweather Creek may be reversible, most are not -- due to the extent of urbanization, the presence and placement of fixed structures, the extremely high cost of stream relocation and restoration measures, and the loss of extensive wetlands through draining and filling.

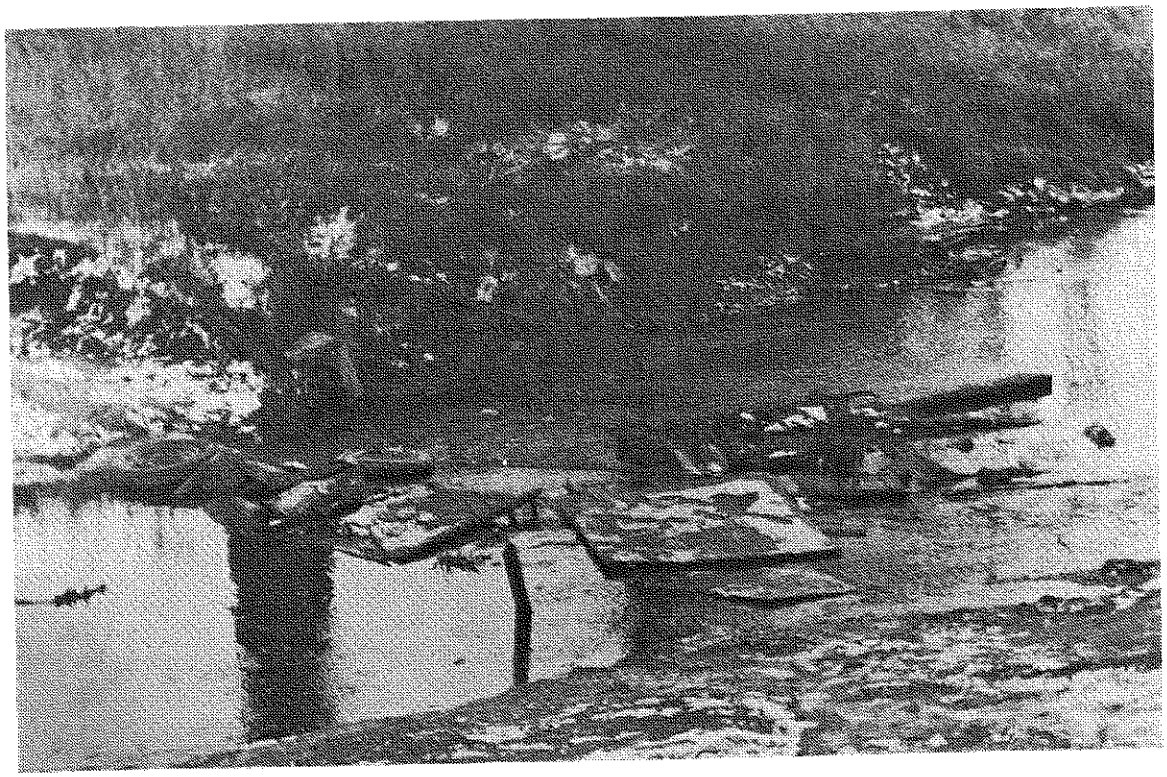
Industrial waste water disposal into Starkweather Creek has been a long-standing problem with documented sources discharging to the creek from 1910 through the early 1970's. While contaminated industrial point source discharges to the creek have apparently ceased, the stream still suffers from the residual effects of past industrial activities. The most noteworthy of these is the ammonia pollution which is probably attributable to the Swift and Company residual waste deposits. Occasional discharges and litter from commercial and industrial enterprises in the watershed represent a problem which has been observed during the course of this inventory. Thoughtless dumping of waste by individuals and use of the stream as a trash receptacle are additional problems which plague the creek in many locations.

A major and increasing use of Starkweather Creek in the past 40-50 years has been for the disposal of ever-increasing volumes of stormwater from the city, the Dane County Airport, and more recently, from development in unincorporated areas within the Town of Burke. Even as this study was being conducted, a proposal for a major stormwater relief project on Madison's East Side moved to the design stage, and a private developer tendered a proposal for significant new commercial development in the outer West Branch drainage area. Sound land use planning, careful review of development proposals, and the adoption of adequate runoff and erosion control measures will be important actions necessary to partially offset and mitigate the negative impacts of increased stormwater volume generated by future development in the watershed.

A review of current and historical data collected during the course of this study clearly indicates that the present water quality of Starkweather Creek is measurably worse, for most parameters, than it was 35 years ago. There is little evidence to indicate that the quality of Starkweather Creek will improve without concerted action on a watershed-wide basis. The corrective actions taken since the early 1950's to eliminate obvious point sources of pollution have undoubtedly aided the creek. Efforts undertaken by the City of Madison during the 1960's resulted in the elimination of several significant sources of pollution,

especially on the West Branch. Despite these actions which eliminated certain pollutants from the creek or reduced their levels, Starkweather Creek has some of the poorest overall water quality levels of any stream in Dane County not receiving wastewater effluent. As indicated previously in this inventory report, the sources and causes of Starkweather Creek's current water quality problems are diffuse and pervasive; and solutions are not readily apparent.

The long history of concern over Starkweather Creek and its location in the Madison community provide a basis for action. The comprehensive water quality management plan can be a vehicle for the development of an adequate agenda to improve the creek.



Trash in Starkweather Creek -- A Common Sight

PUBLIC PERSPECTIVE ON WATERSHED PROBLEMS AND SOLUTIONS

In September and October 1980, public opinion questionnaires on Starkweather Creek's problems and potential solutions were completed by 146 individuals. Over 600 questionnaires with postage-paid return envelopes were distributed within the watershed. A total of 128 questionnaires were returned by mail and an additional 18 were completed at two public meetings held in September 1980.

The public opinion questionnaire (included in Appendix E) was primarily designed to determine the types and frequency of use of Starkweather Creek by watershed residents, and the possible future uses of the creek if a program of improvements were to be carried out. Also examined were public attitudes toward a variety of possible remedial actions and public opinion on the importance of various watershed problems.

Questionnaires returned by City of Madison residents constituted 84 percent of the total return (123 responses). Twenty-one questionnaires (14 percent) were completed by Town of Burke residents. A total of 28 respondents (23%) living within Madison resided within two blocks of Starkweather Creek, while a total of 72 percent of the Madison residents (88 people) lived within five blocks of the creek. Thirty-seven percent of the rural dwellers responding to the questionnaire lived within 1/2 mile of the creek. Individuals living close to the creek were over-represented in the survey since distribution of the mail-in questionnaire was limited to a one mile wide corridor centered on the creek and its major tributaries.

Public Use

Table 5 indicates that Starkweather Creek is used infrequently by watershed residents, under present conditions. Fifty-three percent of the respondents use Starkweather Creek frequently or infrequently for scenic and visual enjoyment, making it the most popular of the listed uses. Walking along the stream corridor was the second most popular stream use, with sitting along the streambank ranking third. Although scenic enjoyment is the most popular frequent use of Starkweather Creek by a substantial margin (25% to 15%), it should be noted that between 34 and 56 percent of the respondents never use Starkweather Creek for each of the three most popular uses.

Individuals responding to the questionnaire indicated that their use of Starkweather Creek would increase substantially if the quality of the creek and adjacent lands were improved. As Table 5 shows, frequent use of Starkweather Creek for scenic enjoyment, sitting along the streambank and walking increases 1.8 to 2.6 times under improved conditions. Interest in use of the creek for fishing also increases significantly with improved conditions. The percentage of people indicating that they would never use Starkweather Creek for any purpose drops quite dramatically under improved conditions.

TABLE 5*

PUBLIC USE OF STARKWEATHER CREEK

Uses	% Using with Crrrent Conditions Frequently	Infrequently	Never	% Using with Improved Conditions Frequently	Infrequently	Never
Boat Access to Lake	13	13	60	19	21	44
Fishing	12	15	60	26	20	41
Scenic Enjoyment	25	28	34	46	22	19
Sit Along Stream-bank	13	22	56	34	22	29
Walk Along Corridor	15	24	50	32	25	29
Ski Along Corridor	5	3	74	10	14	53
Motorcycling	1	1	78	5	3	71
Trapping/Hunting	1	1	70	1	4	64
Other	1	1	29	3	1	25
Bicycling	-	-	-	25	15	40

*Sample size = 146; Numbers may not total 100% due to non-response to individual items.

Perceived Problems

Table 6 lists the most important problems of Starkweather Creek, according to those responding to the questionnaire. Seventy-three percent felt that litter and debris in the creek and on the streambanks was a very important problem which would affect their use of the creek. The possible health hazard represented by bacterial contamination was at least somewhat important to 94% of the respondents. Green or turbid water and poor urban stormwater drainage and flooding were the third and fourth most serious problems. Noisy or unsightly land uses ranked as the fifth most important problem. Lack of public access, trails and parks ranked sixth, although this response received a larger "somewhat important" vote than any other problem. Poor fishing and inadequate boat access to Lake Monona were generally viewed as unimportant problems by those answering the questionnaire.

TABLE 6*

MOST IMPORTANT PROBLEMS OF STARKWEATHER CREEK

Problem	% Listing as: Very Important	Somewhat Important	Not Important
• Litter and Debris In Creek and On Banks	73	11	6
• Possible Health Hazard (Bacteria)	69	25	4
• Green or Turbid Water	68	13	8
• Poor Urban Stormwater Drainage and Flooding	56	18	8
• Noisy or Unsightly Neighboring Land Uses	45	23	15
• Lack of Public Access, Trails, Parks	30	34	21
• Poor Farmland Drainage and Flooding	30	23	13
• Poor Fishing	27	26	29
• Inadequate Boat Access to Lake Monona	21	25	31

*Sample size = 146; Numbers may not total 100% due to non-response to individual items.

Possible Remedial Measures

Table 7 indicates public opinion regarding general remedial actions which might be undertaken to improve Starkweather Creek. The reader is referred to Appendix E for the complete wording of the question. Large percentages of the respondents favored many actions, since estimates of cost, effort or feasibility were not attached to each action. Eighty-five percent (124 persons) favored actions to locate and correct sources of industrial and commercial waste entering the stream, and to minimize potential health hazards by locating and correcting sources of bacterial contamination. Eighty-four percent favored actions to improve the appearance of the creek through control of nutrient sources, management

of weeds and removal of debris. The same number favored improvement of streambank appearance through vegetation and stabilization, and better control of litter.

Actions to control runoff from new development and to minimize soil erosion in the watershed ranked fifth and sixth in popularity among the eleven actions listed. While those actions were 15 to 18% less popular than the top ranked actions, they were not disfavored by a greater number of respondents (but more poeple expressed no opinion). The least favored actions for Starkweather Creek include improving fishing opportunities and fish habitat (50% in favor), improving drainage of farmland (43%) and improving boat access to Lake Monona through dredging a limited section of the creek (32%). Improvement of public access to the creek in urban areas through land acquisition, trail and park development is favored by 60% of those responding, but it also received the second largest number of responses as an action which should not be undertaken. Of the 20 individuals who did not favor improvement of public access through land acquisition and limited recreational development, seven lived within five blocks of Starkweather Creek, of which four lived within two blocks. Three urban area residents living adjacent to the creek answered the questionnaire; two of them did not favor improvement of public access.

TABLE 7*

REMEDIAL ACTIONS TO IMPROVE STARKWEATHER CREEK

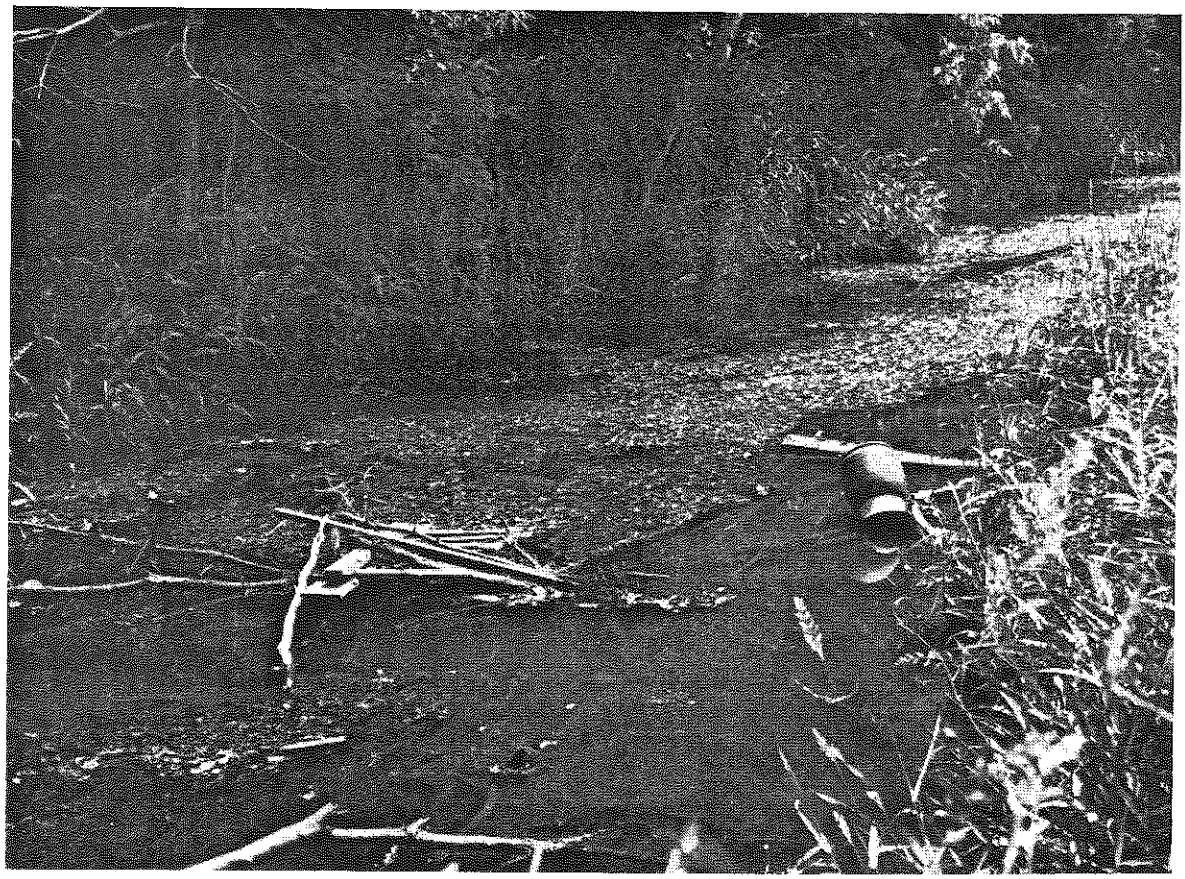
Actions	% Favor	% Disfavor
• Locate and correct commercial/industrial waste sources	85	1
• Locate and correct sources of bacterial contamination	85	1
• Improve appearance by nutrient control, weed management, debris removal	84	3
• Vegetate and stabilize streambank, control litter	84	3
• Control runoff from new developments	69	3
• Minimize soil erosion in watershed	66	2
• Increase storm sewer capacity to improve urban drainage	62	3
• Improve public access to creek in urban areas, develop trails and parks	60	14
• Improve fishing opportunities and fish habitat	50	8
• Improve drainage of farmland	43	5
• Improve boat access to lake by dredging creek	32	21

*Sample size = 146; Numbers may not total 100% due to no opinion responses and non-responses to individual items.

In summary, the major public uses of Starkweather Creek are for scenic enjoyment, and sitting and walking along the streambanks. No more than 25 percent of the respondents currently use the creek frequently for any of these purposes. With improvements in the creek and adjacent lands, public use of Starkweather Creek by the sample group would increase substantially, although the rank order of major uses would remain virtually identical.

The major problems of Starkweather Creek, as listed by questionnaire respondents, include litter and debris, high bacterial counts and algae blooms and turbidity. People are least concerned about poor fishing and inadequate boat access to Lake Monona.

To improve Starkweather Creek, those answering the questionnaire placed highest priority on the location and correction of sources of commercial and industrial waste and bacterial contamination. Improvements in the appearance of the stream and streambanks through nutrient control, weed management, landscaping and litter removal were also strongly favored. Improvements in fishing and boating conditions, and improved drainage of farmland were favored by less than 50% of the respondents.



The Public Places a High Priority on the Removal of Litter and Debris From Starkweather Creek

ALTERNATIVE WATERSHED IMPROVEMENT PROGRAMS

Alternative plans for the Starkweather Creek watershed were developed to illustrate the public choices for management of the stream and to provide a framework for public response to and public understanding of the many individual actions which constitute a comprehensive watershed program.

To provide a basis for developing the many remedial actions which might be included in an overall improvement program, identified watershed problems were reduced to six problem areas. These problem areas include: visual quality of the stream corridor; drainage network efficiency; flood control; recreation opportunities; open space supply; and wildlife habitat.

An initial list of actions which might be taken to improve Starkweather Creek was generated early in the planning process, to provide the broadest possible list of actions which might be organized into alternative program strategies. Possible actions were addressed to each of the six general problem areas, and to specific watershed needs, such as: improving dissolved oxygen levels; improving agricultural and urban drainage efficiency; decreasing runoff volumes and peak flows; reducing bacterial contamination; improving navigability; improving public access and recreational opportunities; minimizing land use conflicts; and reducing urban non-point sources and commercial and industrial waste and litter. A preliminary assessment of the entire list of actions was undertaken at this stage, but only those actions with excessively high costs, or low feasibility (such as various stormwater treatment and habitat improvement measures) were eliminated from further consideration.

Watershed Objectives

The alternative programs for the Starkweather Creek watershed address the full range of watershed objectives, but maximize the achievement of certain objectives, while placing less emphasis on others. The particular objectives addressed by the alternatives are listed below, and are based on the analysis of resource problems and use, as well as public perceptions as gaged by the public opinion questionnaire:

a) To reduce sediment loss from developed, developing and agricultural lands in the watershed, and reduce the delivery of sediment to Starkweather Creek, and consequently, Lake Monona.

b) To enhance the aesthetic and physical environment of the stream corridor, and to consider the aesthetic impacts of all actions taken within, or affecting, the stream corridor.

c) To enhance recreational opportunities within the stream corridor which are cost-effective and complement multi-purpose use, development and improvement of the stream corridor.

d) To encourage the conservation of valuable natural resource features in the watershed such as floodplains, wetlands,

steep slopes, areas of high quality vegetation, and other similar features.

e) To reduce nonpoint sources of pollution attributable to commercial and industrial establishments in the watershed, and reduce non-storm discharges of pollutants to the storm sewer system.

f) To minimize flooding and flood damage potential in the developed area of the watershed, and limit additional encroachment upon the floodplain.

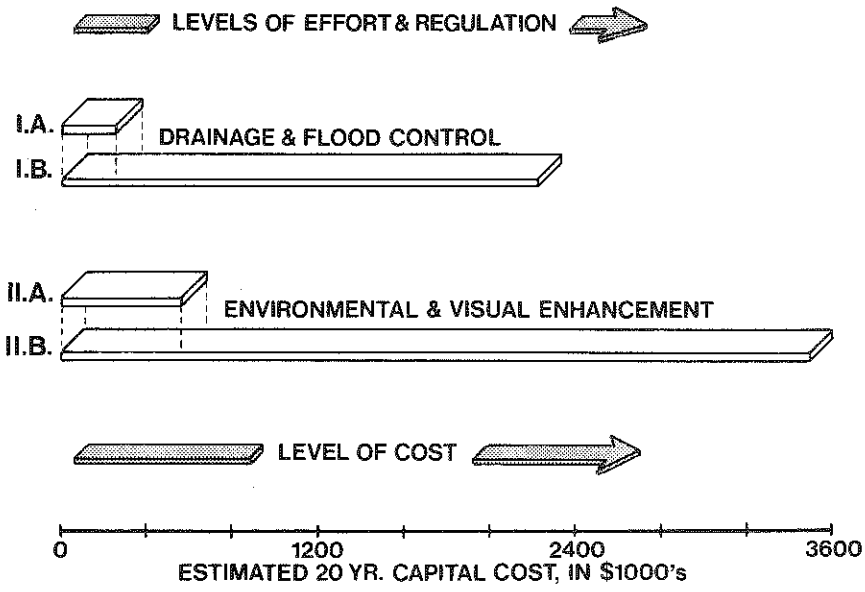
g) To provide for efficient drainage of developed and agricultural lands.

These watershed objectives generally fall into two categories, in that they primarily address watershed needs in the areas of drainage and flood control and environmental and visual enhancement. Thus, the alternative plans described in Tables 8 and 9 address these two different orientations by assembling sets of actions which place primary emphasis upon accomplishment of selected objectives. Since several of the objectives contain antagonistic elements (conflicts between accomplishing efficient drainage, flood control and environmental improvement), the actions contained in both sets of alternatives have been screened against the full set of objectives.

The alternative programs, designated as Set I and Set II, each contain two levels of action (A & B) which reflect minimum and maximum effective program efforts. Generally, the minimum effort alternatives focus upon voluntary actions, limited, regulation, and maintenance activities. The maximum effort relies more heavily upon structural measures, land acquisition and greater regulation.

FIGURE 18

ALTERNATIVE PROGRAMS



Drainage and Flood Control Alternatives

Level I.A., the minimum effort alternative for drainage and flood control, represents the smallest departure from existing and past management practices in the Starkweather Creek watershed. In contrast to past efforts, this alternative calls for a considerably higher level of drainage facility maintenance and depends on erosion and runoff control measures to reduce drainage structure improvement and maintenance needs, retain overall channel stability and reduce sedimentation. Level I.A. would emphasize the development of natural drainage facilities and stabilization of existing drainageways, rather than the construction of extensive storm sewer systems as urban development extends outward.

Level I.A. suggests greater surveillance of non-storm discharges to the storm sewer system than is currently practiced, and emphasizes reduction of commercial and industrial nonpoint source contributions through voluntary compliance with guidelines. Urban "housekeeping" practices such as street sweeping and leaf collection would remain at current levels under the minimum effort drainage alternative, and the use of stormwater infiltration practices would be encouraged.

Level I.B., the maximum effective effort alternative for drainage and flood control builds upon Level I.A., but focuses more heavily upon structural improvements and includes a storm sewer construction strategy which would tend to continue past trends in the incorporated area. Existing tributary ditches and drainageways would be replaced by storm sewers as development takes place, and the use of concrete-lined drainage channels (cunettes) would be emphasized instead of grassed channels. Level I.B. goes substantially beyond the minimum effort alternative in restoring and increasing the channel capacity of Starkweather Creek, and would result in dredging both branches from Highway 30 downstream to a point just south of the confluence. A segment of the West Branch from Milwaukee Street to Commercial Avenue would receive channel lining, and streambank vegetation would be controlled to increase flow efficiency and capacity.

Level I.B. contains runoff and source control measures similar to those included in the minimum effort alternative, but does suggest some improvements in street sweeping and leaf collection. In contrast to the minimum effort alternative, Level I.B. calls for the enactment of requirements to control the storage of commercial and industrial materials, near the creek, and to limit runoff leaving storage areas. (Level I.A. calls for voluntary compliance with standards and guidelines for materials storage.) Finally, level I.B. calls for public acquisition of land necessary to provide a continuous fifty-foot wide drainage access and maintenance easement along both banks of the creek within the City of Madison, where feasible. (The minimum level alternative calls for acquisition of easements to assure a fifty-foot total width along one or both banks of the creek within the city.)

Neither of the drainage and flood control alternatives for Starkweather Creek address the visual enhancement needs of the resource in a substantial way. Suggested trash and debris removal and vegetative control

STARKWEATHER CREEK WATERSHED ALTERNATIVE PLAN

ALTERNATIVE SET I: DRAINAGE AND FLOOD CONTROL ORIENTATION

- Primary Objectives Addressed: Provide Efficient Urban and Agricultural Drainage; Minimize Flooding Potential; Reduce Sediment Loss and Delivery
- Secondary Objectives Addressed: Enhance the Aesthetic and Physical Environment of the Stream Corridor; Reduce Commercial, Industrial and Other Nonpoint Pollution Sources; Enhance Recreational Opportunities

Primary Purposes of Suggested Actions	Level I.A. Actions Minimum Effective Effort	I.A. Estimated Cost (Present Value)	Level I.B. Actions Maximum Effective Effort	I.B. Estimated Cost (Present Value)
• Restore/Increase Creek Channel Capacity	• Remove Debris Dams and Deadfalls - West Branch, and East Branch Below Hwy. 51. • Selectively Dredge Silt Deposits, Concentrating on West Branch Between Milwaukee St. & E. Washington Ave. • Remove In-Stream Vegetation in Limited Reaches, Concentrating on Area Near and Below Confluence. • Clean Culverts, Especially on East Branch. • Control Creek Streambank Vegetation, Especially Where It Constitutes a Channel Obstruction. • Clean Streambed, Remove Trash and Debris.	$ 4,043. 18,384. 17,650. -- 32,293. (incl. in above)	• Remove Debris Dams and Deadfalls, Entire Stream. • Dredge from South of Confluence Upstream to Hwy. 30 on the East and West Branches. • Undertake Thorough In-Stream Vegetation Control Program. • Clean Culverts, Replace Those Which Are Flow-Restricting. • Same As Level A, But Treat Greater Length. • Undertake Streambed Trash and Debris Removal, Above Dredged Areas. • Continue Partial Channel Lining, With Sheet Piling or Other Material, From Milwaukee St. to Commercial Ave. on West Branch. • Clear and Smooth Channel Irregularities and Obstructions, Where Significant, Above Reaches Recommended for Dredging.	$ 6,064. 61,282. 41,732. 7,200. 64,585. (incl. in above) 324,789. 18,384.
• Improve Efficiency of Tributary Drainage--Urban and Agricultural	• Maintain and Clean Existing Storm Sewers. • Stabilize Critical Storm Discharge Ditches, Such As Olbrich Park, to Reduce Erosion, Increase Efficiency. • Remove Flow Obstructions From Tributary Ditches by Selective Cleaning (e.g., S.E. Truax Area). • Establish Well-Defined, Stable Drainageways in Agricultural and Urbanizing Areas in Burke and on the City Fringe (grassed waterways, grade stabilization structures, etc.).	-- 37,800. 40,865. 49,812.	• Same As Level A. • Line Critical Storm Discharge Ditches, Such As Olbrich Park, With Concrete. • As Development Occurs, Replace Existing Tributary Ditches With Storm Sewers. • In Agricultural Areas, Provide Improved Drainage Ditches and Channels, As Necessary. • In Developing Areas and in Storm Drainage Improvement Projects, Emphasize Use of Concrete Drainage Channels (Cunettes) Rather Than Grassed Channels.	-- 84,000. 408,651. 56,060. 153,244.
• Minimize Future Increases in Runoff Volume	• Encourage Measures to Minimize Increases in Impervious Cover in Development/Redevelopment of Watershed Areas. • Establish Runoff Control Requirements for New Development, Including Measures to Address Control Needs of Major Commercial/Industrial Plats. • Encourage Direction of Downspouts to Pervious Areas, Where Feasible. • Encourage Use of Porous Pavement on Parking Lots, Where Feasible.	-- (see erosion control) 7,500. (feasibility study) -- --	• Same As Level A. • Institute Comprehensive Runoff Control Requirements for All New Development; Consider Need for Requirements to Limit Impervious Area in Commercial/Industrial Developments. • Same As Level A. • Same As Level A. • Consider Opportunities for Enlargement of Existing Detention Basins.	-- (see erosion control) 7,500. (feasibility study) -- --

ALTERNATIVE SET I: DRAINAGE AND FLOOD CONTROL ORIENTATION - page 2.

- Primary Objectives Addressed: Provide Efficient Urban and Agricultural Drainage; Minimize Flooding Potential; Reduce Sediment Loss and Delivery
- Secondary Objectives Addressed: Enhance the Aesthetic and Physical Environment of the Stream Corridor; Reduce Commercial, Industrial and Other Nonpoint Pollution Sources; Enhance Recreational Opportunities

Primary Purposes of Suggested Actions	Level I.A. Actions Minimum Effective Effort	I.A. Estimated Cost (Present Value)	Level I.B. Actions Maximum Effective Effort	I.B. Estimated Cost (Present Value)
• Maintain Drainage System Capacity (Sediment and Other Source Control Measures)	• Control Streambank Erosion at Affected Locations. • Enforce Erosion Control Requirements for All Land Disturbing Activities. • Maintain Street Sweeping at Current Level. • Maintain Leaf Collection Programs at Current Level.	23,914. 44,781. -- --	• Same As Level A. • Same As Level A. • Improve Street Sweeping in Selected Areas of Basin. • Improve Leaf Collection.	23,914. 44,781. 251,542. 81,730.
• Maintain/Improve Drainage System Access, Maintenance Capability and Future Expansion and Improvement Flexibility	• Acquire Easements Necessary to Provide Continuous 50' Total Width Drainage Easement Along Creek Within the City. Access to Both Banks Desirable Where Possible. • Enforce Existing Easements, Where Being Violated. • Official Map Proposed Drainageways in Developing Areas.	34,054. -- --	• Acquire Land Necessary to Provide a Continuous Minimum 50' Width Drainage Easement Along Both Banks of Creek Within the City. • Same As Level A. • Same As Level A.	83,007. -- --
• Reduce Public Health and Safeth Hazards	• Locate and Eliminate Identifiable Sources of Bacterial Contamination. • Locate Possible Sources of Runoff Contamination From Commercial and Industrial Concerns and Suggest Remedial Measures (Guidelines, Standards, etc.). • Improve Surveillance/Increase Enforcement for Non-Storm Discharges to Storm Sewer System.	-- -- 59,765.	• Same As Level A. • Enact Requirements Controlling Storage of Commercial/Industrial Materials (Distance to Waterways, etc.), and Limiting Runoff Leaving Storage Areas. • Same As Level A.	-- -- 59,765.
• Prevent or Limit Flood Damage	• Continue Enforcement of Floodplain Zoning Ordinance (Madison) and Associated Development Impact Review. • Assess Need to Enlarge, Modify or Remove Flow-Constricting Structures.	-- --	• Same As Level A. • Same As Level A. • Assess Need for Flood Damage Prevention (Flood-Proofing) Measures for Structures in Flood-Prone Areas.	-- -- --
Total Present Value of Additional Public Costs*		$ 370,861.		$ 1,778,230.

*This figure does not include existing program expenditures for the various actions, nor does it include private sector expenditures. It represents the present value of future expenditures scheduled at various times throughout the planning period, assuming a 10% interest rate and a 20-year planning period.

Prepared by: Dane County Regional Planning Commission

STARKWEATHER CREEK WATERSHED ALTERNATIVE PLAN

ALTERNATIVE SET II: ENVIRONMENTAL AND VISUAL ENHANCEMENT

- Primary Objectives Addressed: To Enhance the Aesthetic and Physical Environment of the Stream Corridor; Enhance Recreational Opportunities in the Stream Corridor; Reduce Urban Nonpoint Sources of Pollution; Reduce Sediment Loss and Delivery
- Secondary Objectives Addressed: Provide Efficient Urban and Agricultural Drainage; Minimize Flooding Potential

Primary Purposes of Suggested Actions	Level II.A. Actions Minimum Effective Effort	II.A. Estimated Cost (Present Value)	Level II.B. Actions Maximum Effective Effort	II.B. Estimated Cost (Present Value)
• Establish Starkweather Creek Environmental Corridor	• Seek Land Use Plan, Park and Open Space Plan Amendments to Reflect the Full Extent of the Environmental Corridor.	--	• Same As Level A.	--
	• Official Map As "Proposed Parkway" Those Corridor Reaches Not Already Mapped, As Guidance for Dedication and Acquisition.	--	• Same As Level A.	--
	• Seek to Acquire Easements, to Provide Corridor Links (Both Conservation and Access Easements).	$ 136,812.	• Acquire Land to Provide Links for Basic Corridor. • Acquire Additional Linear Land Parcels to Complete and Expand Corridor, Provide Additional Open Space Opportunities.	$ 136,812. 68,406.
	• Enforce Existing Easements Where Being Violated.	--	• Same As Level A.	--
• Procect and Preserve Sensitive Areas, Minimize Stream Corridor Use Conflicts	• Seek Conservancy Zoning for Valuable Wetlands, Groundwater Source Areas (Dane County, City of Madison).	--	• Same As Level A. • Acquire High Priority Wetland Areas.	-- 673,756.
	• Adopt Comprehensive Shoreland Zoning to Prevent Future Use Conflicts, and Provide a Stream Buffer.	--	• Same As Level A.	--
	• Continue Enforcement of Floodplain Zoning Ordinances (County, City).	--	• Same As Level A.	--
	• Seek Setbacks, Screening From Private Riparians (Commercial and Industrial Concerns).	--	• Same As Level A, Except Require Setbacks and Screening for New or Altered Uses.	--
	• Enforce Drainage Course and Waterfront Development Provisions of Madison Zoning Code.	--	• Same As Level A.	--
			• Evaluate Feasibility of Relocation, Relocation Assistance for Selected Business, Industry Within Corridor (Primarily on Main Stem). • Consider Restoration of Selected Degraded Wetlands on East and West Branches.	(Cost not calculated)
• Increase, Enhance Recreational Opportunities With Stream Corridor	• Develop Pathways, Bikeways and Trails Within Stream and Tributary Corridors by Making Minimum Necessary Improvements on Existing Roadways, Access Easements and Parklands.	30,554.	• Provide Fully Developed Trails and Bikeways, Concentrating on Lower East and West Branches and Main Stem (below Hwy. 30).	61,108
	• Maximize the Usability of and Access to Existing Park and Recreation Facilities Located Within Stream Corridor.	--	• Acquire Lands to Improve, Expand Trail System. • Acquire Land Areas Contiguous to Environmental Corridor, Where Such Lands Have Significant Park and Open Space Potential.	(included under other action) 670,940.
	• Where Demand Exists, Develop New Low-Cost Water-Oriented Recreation Facilities on Existing Public Lands.	14,967.	• More Fully Develop Recreational Facilities in Corridor, Concentrating on Main Stem and Lower West Branch.	64,661.
	• Repair and Undertake Low-Cost Improvements to Boat Access Facilities at Olbrich Park (Maintain Current Extent of Access).	5,000.	• Improve Olbrich Park Public Boat Access Facilities. • Consider Dredging Channel From Mouth to Milwaukee Street on East Branch and Fair Oaks Avenue on West Branch, to Increase Navigable Length and Access to Private Property and Street Ends.	5,000. 24,512.
			• Consider Developing Small Scientific Study Area at Degraded Wetland Immediately North of O. B. Sherry Park.	10,200.
			• Complete Proposed Acewood Pond Acquisition Program.	(included under other action)

ALTERNATIVE SET II: ENVIRONMENTAL AND VISUAL ENHANCEMENT - page 2.

- Primary Objectives Addressed: To Enhance the Aesthetic and Physical Environment of the Stream Corridor; Enhance Recreational Opportunities in the Stream Corridor; Reduce Urban Nonpoint Sources of Pollution; Reduce Sediment Loss and Delivery
- Secondary Objectives Addressed: Provide Efficient Urban and Agricultural Drainage; Minimize Flooding Potential

Primary Purposes of Suggested Actions	Level II.A. Actions Minimum Effective Effort	II.A. Estimated Cost (Present Value)	Level II.B. Actions Maximum Effective Effort	II.B. Estimated Cost (Present Value)
• Improve Visual Quality of Stream and Stream Corridor Resource	• Remove Debris Dams and Deadfalls in High Visibility Locations, and Where They Impede Drainage.	$ 4,043.	• Undertake More General Debris Dam and Deadfall Removal, Entire Stream.	$ 6,064.
	• Improve Streambank Plantings and Remove Brush From Understory in High Public Visibility and Use Areas (Main Stem and West Branch Below East Washington Avenue).	63,018.	• Undertake Extensive Streambank Revegetation Program, Including Brush and Shrub Removal and Replacement Program.	94,527.
	• Establish Vegetative Buffers (Sight Barriers) to Minimize Major Visual Conflicts, Especially in Vicinity of East Washington Avenue, Sycamore Avenue, Bus Barns and Madison Silo (Work with Private Sector).	10,648.	• Same As Level A.	10,648.
	• Assure Full and Sensitive Consideration of Stream Corridor in Redevelopment Proposals (e.g., Bus Barns).	--	• Assess Potential for Relocation of Incompatible Land Uses.	--
	• Thoroughly Clean Streambed, Remove Trash and Debris.	(included under other action)	• Same As Level A.	--
	• Place Increased Emphasis on Surveillance, Law Enforcement and Citations to Ensure Removal and Prevention of Commercial and Industrial Waste and Litter.	(included under other action)	• Same As Level A.	(included under other action)
	• Selectively Harvest Instream Vegetation Below Milwaukee Street.	17,650.	• Same As Level A.	(included under other action)
			• Undertake Complete In-Stream Vegetation Harvesting and Treatment Program, Every Two Years.	41,732.
			• Consider Alternative Designs for Low Flow, Overall Stream Channel Improvement on West Branch, Between Milwaukee Street and E. Washington Avenue.	31,680.
• Conserve Stream Baseflow, Improve Visual and Water Quality During Baseflow Periods	• Protect Valuable Wetlands, Groundwater Source Areas (See "Protect and Preserve Sensitive Areas", Above).	--	• Same As Level A.	--
	• Enforce Runoff Control Requirements for All New Development, Encourage Retention and Infiltration Practices.	(see erosion control)	• Same As Level A, in Addition Require Limits on Impervious Area in Non-Residential Developments.	(see erosion control)
	• Encourage Incorporation of Natural Drainage and Detention, As Urban Drainage System Develops.	--	• Same As Level A.	--
	• Continue Water Conservation Efforts, Assess Impacts of Continued Withdrawals From Madison Unit Well #15.	--	• Same As Level A.	--
			• Consider Need for New Well Service to Minimize Drawdown in Vicinity of East Branch Headwaters.	7,020. (study)
	• Encourage Use of Infiltration Practices Such as Downspout Redirection and Porous Pavement in Developed Areas, Where Feasible.	7,500. (feasibility study)	• Same As Level A.	7,500. (feasibility study)
			• Augment Streamflow to 5 Cubic Feet per Second, Using Surface or Shallow Groundwater. (Cost assumes Use of Surface Water.)	165,061.**
			• Consider Placement of Breakwater, Floating or Fixed, Off Olbrich Park to Limit Wave Action and Movement of Plant Debris Up Creek.	42,000.
			• Determine Feasibility, Cost-Effectiveness of In-Stream Aeration for Lower East and West Branches. (Feasibility Study = $4,680.)	76,624.**

ALTERNATIVE SET II: ENVIRONMENTAL AND VISUAL ENHANCEMENT - page 3.

- Primary Objectives Addressed: To Enhance the Aesthetic and Physical Environment of the Stream Corridor; Enhance Recreational Opportunities in the Stream Corridor; Reduce Urban Nonpoint Sources of Pollution; Reduce Sediment Loss and Delivery
- Secondary Objectives Addressed: Provide Efficient Urban and Agricultural Drainage; Minimize Flooding Potential

Primary Purposes of Suggested Actions	Level II.A. Actions Minimum Effective Effort	II.A. Estimated Cost (Present Value)	Level II.B. Actions Maximum Effective Effort	II.B. Estimated Cost (Present Value)
• Reduce, Eliminate Urban and Agricultural Non-point Source Pollution; Reduce Possible Public Health and Safety Hazards	• Enforce Erosion Control Requirements for All Non-Agricultural Land Disturbing Activities.	$ 44,781.	• Same As Level A.	$ 44,781.
	• Provide Cost-Sharing for Conservation Practices in Agricultural Areas, Focusing Upon Establishment of Stable Drainageways on Creek Tributaries.	49,812.	• Provide Higher Level of Conservation Cost-Sharing Funds, and Broader Adoption of Soil Conservation Practices.	103,092.
	• Maintain Street Sweeping in Watershed at Current Levels.	--	• Selectively Improve Street Sweeping and Institute Frequent Sweeping for Large Parking Lots, Such as East Towne.	251,542.
	• Maintain Leaf Collection at Current Level.	--	• Improve Leaf Collection Efforts.	81,730.
	• Locate and Eliminate Identifiable Sources of Bacterial Contamination.	--	• Same As Level A.	--
	• Locate Sources of Runoff Contamination From Commercial and Industrial Concerns, and Require Remedial Measures.	--	• Same As Level A. • Enact Requirements Controlling Storage of Commercial/Industrial Materials (Distance to Waterways, etc.) and Also Limiting Runoff Leaving Storage Areas.	--
	• Improve City Surveillance/Increase Enforcement for Non-Storm Discharges to Storm Sewer System.	59,765.	• Same As Level A.	59,765.
Total Present Value of Additional Public Costs*		$ 444,550.		$ 2,739,161.

*This figure does not include existing program expenditures for the various actions, nor does it include private sector expenditures. It represents the total present value of all future expenditures scheduled at various times throughout the planning period, assuming a 10% interest rate and a 20-year planning period.

**Estimated capital and operating costs. Action contingent upon feasibility study.

Prepared by: Dane County Regional Planning Commission

measures will have a beneficial effect on the appearance of the stream. The acquisition of land to establish adequate drainage easement could reduce future encroachment upon the stream corridor, and result in the gradual reduction of existing encroachments. Requirements for storage of commercial and industrial materials might result in incidental visual improvements to the stream corridor.

The modest source control measures proposed in the drainage and flood control alternatives might bring about some improvements in water clarity in Starkweather Creek, and reduce the turbidity and suspended materials loads ordinarily associated with storm events. On the other hand, the overall increase in drainage system efficiency and delivery which might occur under the maximum effort alternative could act to negate some of the benefits of source control measures.

Environmental and Visual Enhancement Alternatives

The environmental and visual enhancement alternatives for the Starkweather Creek watershed emphasize stream corridor protection as an integral component of the watershed management strategy, which also includes source control measures. Natural resource protection measures are included to a greater degree than in the drainage and flood control alternatives, and measures to encourage greater public use of and access to the stream corridor are emphasized.

The environmental and visual enhancement alternatives represent a significant departure from the existing drainage-oriented management program for the Creek. The alternatives introduce aesthetic beauty as an important consideration in watershed management and stress the integration of recreational facilities and amenities into the stream corridor protection and improvement program.

The minimum and maximum effective efforts for environmental and visual enhancement (levels II.A. and II.B. in Table 9), contain actions directed at establishing a Starkweather Creek environmental corridor, protecting sensitive areas, increasing recreational opportunities, improving the visual quality of the stream and corridor, conserving stream baseflow, and reducing urban and agricultural nonpoint sources of pollution. The minimum effective effort alternative relies heavily upon voluntary cooperation and regulatory actions, attempts to maximize or increase the use of existing facilities, and low-cost maintenance and improvement measures.

The environmental corridor concept is a central feature of the environmental and visual enhancement alternatives. Environmental corridors are linear systems of open space which include environmentally sensitive lands and natural resources requiring protection from disturbance and development, as well as lands needed to meet open space and recreational use requirements.

Environmental corridors are a fundamental planning concept in regional and local land use and comprehensive planning in Dane County. Environmental corridors (referred to as open space corridors) were included in the initial Dane County Land Use Plan as adopted by the Regional Planning

Commission and the Dane County Board in 1973. Environmental corridors are elements of several key Land Use Plan policies related to environmental protection and enhancement, recreation and open space.

The protection and preservation of environmental corridors has a direct relationship to water quality enhancement through reduction of nonpoint source pollution and protection of natural drainage systems. As urban areas are developed, the amount of impervious land surface increases, resulting in dramatic increases in the total volume of storm runoff, and in the frequency and intensity of peak flows and flooding resulting from storms. Except in extremely high density urban areas, it is often advantageous to retain the natural drainage system rather than to enclose the entire storm drainage network in a system of pipes. Where development densities and land use patterns permit, the protection and preservation of natural drainage systems can result in lower costs than coventional storm sewer systems; can provide open space and recreation opportunities as well as scenic beauty associated with the streams and greenways incorporated in the environmental corridors; can provide for buffering and reduction of nonpoint source pollution by provision of vegetated areas which filter surface runoff; can reduce streambank and streambed erosion by vegetative stabilization and streambank protection; can provide opportunities to offset increased stormwater runoff volumes by providing for increased infiltration of storm runoff; and can offset the effect of increased peak runoff and increased flooding by providing opportunities for incorporating temporary storage and detention of runoff and flood waters. The environmental corridors also provide for the protection and preservation of sensitive environmental areas including wetlands, floodplains, woodlands, steep slopes and other areas which would result in impairment of surface or groundwater quality if disturbed or developed.

The minimum and maximum effort alternatives for environmental and visual enhancement contain measures to establish and protect an environmental corridor in the Starkweather Creek watershed. The maximum effort alternative seeks to expand the corridor beyond a minimum level, and to enhance recreational opportunities to a greater degree than the minimum effort. The following actions are included in the minimum effort plan alternative, to address corridor protection:

- Land use plan and park and open space plan amendments to reflect the full extent of the mapped environmental corridor.
- Official mapping of corridor reaches not already mapped, to serve as a guide for dedication and acquisition.
- Acquisition of easements (conservation and access) to provide corridor links.
- Conservancy zoning of valuable wetlands.
- Consideration of comprehensive shoreland zoning, to prevent stream use conflicts and provide a stream buffer.
- Setbacks and screening by commercial and industrial riparians (voluntary).

- Continued enforcement of floodplain zoning ordinances, and of the drainage course and waterfront development provisions of the Madison zoning code.

The maximum effort alternative contains additional measures relating to environmental corridor protection and improvement, including:

- Acquisition of land, rather than easement, to provide links for the basic environmental corridor.
- Acquisition of additional linear land parcels to complete and expand corridor, and provide additional open space opportunities.
- Acquisition of high priority wetland areas.
- Requirements for setbacks and screening for new or altered land uses within or along the stream corridor.

Actions to enhance recreational opportunities are included in the environmental and visual enhancement alternatives to provide additional support and impetus for corridor protection and enhancement actions, more fully use existing stream corridor resources, provide added public benefits and justification for stream corridor improvement and land acquisition expenditures, meet recreation and open space needs in under-served areas of the watershed, and focus greater public attention on the water resource.

The minimum effort alternative for environmental enhancement attempts to improve recreational opportunities within the stream corridor by maximizing the use and accessibility of existing parks, undertaking low cost improvements to recreation facilities, and upgrading trails on existing rights-of-way and public lands, where possible. The minimum effort alternative also includes measures to improve the scenic beauty of the stream corridor, as a means to enhance the utility and value of the resource. The alternative places substantial emphasis upon improved maintenance and ordinance enforcement for the removal of unsightly debris, trash and unwanted vegetation. It also recommends new streambank plantings along a limited section of the main stem and West Branch, and vegetative buffers and screens to minimize major visual conflicts.

Conservation of stream baseflow in Starkweather Creek is especially critical to the maintenance of good visual appearance during dry weather periods. Baseflow conditions occur in Starkweather Creek for as many as 90 to 120 days per year, and the frequency of baseflow periods has probably increased in recent years due to urban development (decreased infiltration, increased peak flows), drainage of wetland areas and withdrawal of groundwater for municipal and industrial supplies.

Minimum actions for conserving stream baseflow and improving appearance during baseflow periods include:

- Protection of valuable wetlands (through environmental corridor protection).

- Adoption of runoff control requirements for new development, including encouragement of retention and infiltration practices.

- Incorporation of natural drainage and detention during development of the urban drainage system.

- Continuation of water conservation efforts, and assessment of impacts of continued withdrawal from areas of critical drawdown.

- Assessment of the feasibility of wider use of infiltration practices such as porous pavement and downspout redirection.

In addition to corridor protection measures, the minimum effort alternative for environmental enhancement contained in Table 9 includes many actions to reduce urban and agricultural nonpoint sources of pollution reaching Starkweather Creek. The minimum effort actions include adoption of erosion control requirements for construction sites and developing lands, establishment of basic conservation practices on agricultural lands, and continuation of street sweeping and leaf collection efforts at current levels. Also included in the minimum level alternative are actions to improve city surveillance of non-storm discharges to the storm sewer system, and to better locate and correct sources of runoff contamination from commercial and industrial concerns.

The maximum effort environmental and visual enhancement alternative includes many of the actions contained in the minimum level, but involves more land acquisition, a higher level of regulation and higher capital expenditures. For example, the maximum effort environmental enhancement alternative takes a more aggressive approach to expansion of recreational opportunities within the stream corridor. Fully developed trails and bikeways would be constructed along the corridor, south of Highway 30 (Aberg Avenue). Acquisition of areas with significant park and open space potential adjacent to the corridor is envisioned in the maximum effort alternative, as is more complete development of recreational facilities and amenities along the lower reaches of Starkweather Creek within Madison. Dredging of the main channel of Starkweather Creek is included in the maximum level of effort, as is improvement of the Olbrich Park public boat ramp facility. Consideration is also given to the development of a small scientific study area in a degraded wetland near Milwaukee Street, and completion of land acquisition surrounding the Acewood Pond stormwater retention basin.

Improvement of the scenic beauty of the stream corridor appears to have substantial public support. In addition to the actions contained in the minimum level alternative, the maximum effort includes more extensive debris and trash removal, and contains a more ambitious streambank clearing and revegetation effort. The Level II B alternative also includes redesign and improvement of the West Branch stream channel between Milwaukee Street and East Washington Avenue. This redesign would be aimed at producing a more attractive stream, especially at low flow periods, and at improving the flood carrying capacity of the channel.

The maximum effort alternative proposes additional measures to control nonpoint sources of pollution in the watershed, including a higher level

of cost-sharing and broader adoption of agricultural conservation practices than the minimum program. It proposes selective improvement of street sweeping and frequent sweeping for large parking lots (e.g. East Towne). Also included are improved leaf collection, and the development and enactment of requirements to control the storage of commercial and industrial materials adjacent to surface waterways.

In addition to the actions contained in the minimum effort alternative, the maximum effort alternative includes several in-stream management actions which sould improve water clarity and appearance during baseflow periods. These alternative actions include augmenting streamflow, investigating the feasibility and effectiveness of in-stream aeration and considering placement of a breakwater at Olbrich Park to limit wave action and movement of plant debris up Starkweather Creek.

Cost of Alternative Plans

Table 10 lists the additional public costs which have been estimated for each proposed action and for each alternative. These costs do not include existing program expenditures or private sector expenditures, and are preliminary in nature. Costs are presented in a total present worth format, which includes all initial and future costs, capital as well as annual, discounted back to their present monetary value. A discount rate of 10 percent is used, and a number of assumptions about the future scheduling of expenditures are inherent in the present worth analysis.

Cost estimates for the alternative plan actions are based on cost data cited in current literature, recent local experience with control measures and practices, and very preliminary evaluations of site conditions for site-specific actions. Land acquisition cost estimates are based on rough per acre figures reflecting recent local government experience in land purchases and the opinions of staff of agencies involved in land valuation and purchase. Costs for alternative actions are more preliminary and less site-specific than those contained in the recommended plan for the Starkweather Creek watershed. They are intended to be illustrative of the range of costs which may be encountered in undertaking a watershed improvement program.

Alternative level I.A., the minimum effort with a drainage and flood control orientation, has a total present worth of approximately $371,000. The total capital cost of this alternative (see Table 10) is $252,000. Included in this capital cost is $80,000 for land acquisition. Alternative level I.B., the maximum effort with a drainage and flood control orientation, has a total present worth of approximately $1,780,000. The total capital cost of this alternative is approximately $2,230,000. Storm sewer construction and channel improvements represent the largest areas of capital cost assumed under this alternative. Also assumed is a capital cost of $195,000 for land acquisition.

Alternative level II.A., the minimum effort with an environmental and visual enhancement orientation, has an estimated total present worth of approximately $445,000. The total capital cost of this alternative is approximately $561,000. Land acquisition, stream corridor landscaping improvement and agricultural conservation practices represent the largest areas of capital expenditure. Alternative level II.B., the maximum effort in environmental and visual enhancement, has a total present worth of approximately $2,739,000 and a capital cost of approximately $3,524,000.

Table 10

Estimated Public Costs of the Alternative Plans[1]

Alternative	Level of Effort	Total Capital Cost[2]	Total Present Worth[3]
I: Drainage and Flood Control	Minimum	$ 252,338	$ 370,861
	Maximum	2,234,215	1,778,230
II: Environmental and Visual Enhancement	Minimum	$ 561,107	$ 444,550
	Maximum	3,524,162	2,739,161

[1]1981 Costs, not including existing program or private sector expenditures.

[2]Includes estimated construction and acquisition costs.

[3]Present worth of future expenditures scheduled at various times throughout the planning period, assuming a 10% annual interest rate and a 20-year planning period.

Public Response to Plan Alternatives

Two public meetings were held to review and discuss the alternative plans for Starkweather Creek and ascertain public preferences. A questionnaire on the alternative plans was developed and distributed at the public meetings. Broader distribution was impractical because a presentation of the alternatives was necessary in order to generate reaction. In addition to public meetings, alternative plans were discussed with the Regional Planning Commission, two of its advisory committees, and the Madison Commission on the Environment.

A copy of the questionnaire on alternative plans is included in Appendix E. Twenty-three of the individuals attending the two public meetings completed and returned questionnaires. Seventy-eight percent of the respondents lived in the City of Madison. Thirteen (56%) indicated that they lived or owned property within 10 blocks of Starkweather Creek. Only two individuals listed themselves as farm residents, and only one as a farm operator.

Six watershed management objectives were ranked by individuals responding to the questionnaire, as indicated in Table 11. People were asked to rank the three most important objectives. An overall tabulation indicates that the objective of reducing urban, commercial and industrial pollution sources received the greatest number of first place rankings, and the highest overall rank. Enhancement of the physical and visual environment of the stream corridor ranked as the second most important objective, and provision of efficient urban and agricultural drainage as the third. Reduction of overall soil loss and sediment delivery,

enhancement of recreational opportunities and reduction of flooding potential ranked fourth, fifth and sixth, respectively.

Table 11

Management Objectives for Starkweather Creek

Overall Rank	Objective	% of Respondents Ranking: 1st	2nd	3rd
1	• To reduce urban, commercial and industrial pollution sources	48	22	17
2	• To enhance the physical and visual environment of stream corridor	26	13	17
3	• To provide efficient urban and agricultural drainage	13	30	9
4	• To reduce overall soil loss and sediment delivery	4	17	26
5	• To enhance recreational opportunities	0	4	9
6	• To minimize flooding potential	0	0	9

The use of environmental corridors as a means to protect the creek and important adjacent lands was well supported by respondents with 16 people (70%) giving unqualified support and four individuals indicating support with reservations. Only one individual did not support the concept. Two were unsure.

As discussed earlier, the approach used on alternative plans was to present two fundamentally different program orientations, each with two different levels of effort and expenditure. The alternatives were intended to be illustrative in nature, and it was indicated to those attending the public meetings that any final plan would likely combine features of several alternatives. As indicated in Table 12, a combined total of 82 percent of those answering the questionnaire indicated a preference for the environmental and visual enhancement alternatives, with seventeen percent preferring the drainage and flood control alternatives. Of the 19 individuals supporting environmental and visual enhancement programs, 12 supported the maximum level of effort, while 3 of the 4 supporting a drainage and flood control orientation favored the minimum level of effort.

Table 12

Public Preference for Plan Alternatives

% Preferring	Alternative
13	I.A. - Drainage and Flood Control, Minimum Effort
4	I.B. - Drainage and Flood Control, Maximum Effort
30	II.A. - Environmental and Visual Enhancement, Minimum Effort
52	II.B. - Environmental and Visual Enhancement, Maximum Effort
0	"No Action" Alternative

When asked about willingness to pay for creek improvements, seven residents indicated that they would be willing to pay from five to fifteen dollars per year. Ten persons would pay thirty to fifty dollars per year for stream improvement programs, and five did not respond to the question.

Those answering the questionnaire favored the participation of businesses in creek improvement programs by a wide margin (see Table 13). All 23 respondents thought that businesses located along or draining to the creek should be required to take all steps necessary to prevent pollutants, trash and debris from reaching the creek. Seventeen individuals (74%) felt that businesses with creek frontage should be required to participate in improving the stream, including financial participation.

Table 13

Role of Business in Creek Improvement

Question	% Responding: Yes	No	Not Sure
• Should businesses along or draining to creek be required to prevent pollutants, trash and debris from reaching creek?	100	-	-
• Should businesses with creek frontage be required to participate in improvement, including financial participation?	74	13	13

Thirteen people responding to the questionnaire (56%) believed that soil erosion from urban fringe area agriculture should be controlled by ordinance, and that farmers should be required to use soil conservation

practices whether or not financial assistance is available. Thirty percent of the respondents thought that agricultural soil conservation practices should be required only if financial assistance is available. Two persons felt that the use of soil conservation practices should be completely voluntary.

The extent of public access to proposed environmental corridors, and the means of providing such access are seen as significant public issues in implementing the Starkweather Creek plan. Eighteen persons (78%) answering the questionnaire felt that public access for recreation, hiking or bike trails or scenic enjoyment should be provided through public acquisition of land or easements. Four persons felt that public access should be limited to streambank and vegetation maintenance purposes, and that public access for recreational or scenic enjoyment purposes should not be permitted except in existing parks and recreation areas. One respondent indicated that public access should not be permitted to additional areas, and that environmental corridor lands should be protected through zoning and other regulations, but should remain in private control.

Costs for the improvement or maintenance of Starkweather Creek might be borne by the general public, or by some limited segment which is perceived as receiving the greatest benefit from an improved stream. Some combination of the two approaches might also be employed. Fifteen individuals (65%) answering the questionnaire believed that stream improvement costs should be borne by the general public and paid through taxes and general purpose government revenues. Only two persons felt that residents and businesses along the creek should pay most of the cost through direct assessments, although an additional two respondents indicated that local funding for improvements on Starkweather Creek should be conditioned upon the availability of state or federal grants to cover most of the cost.

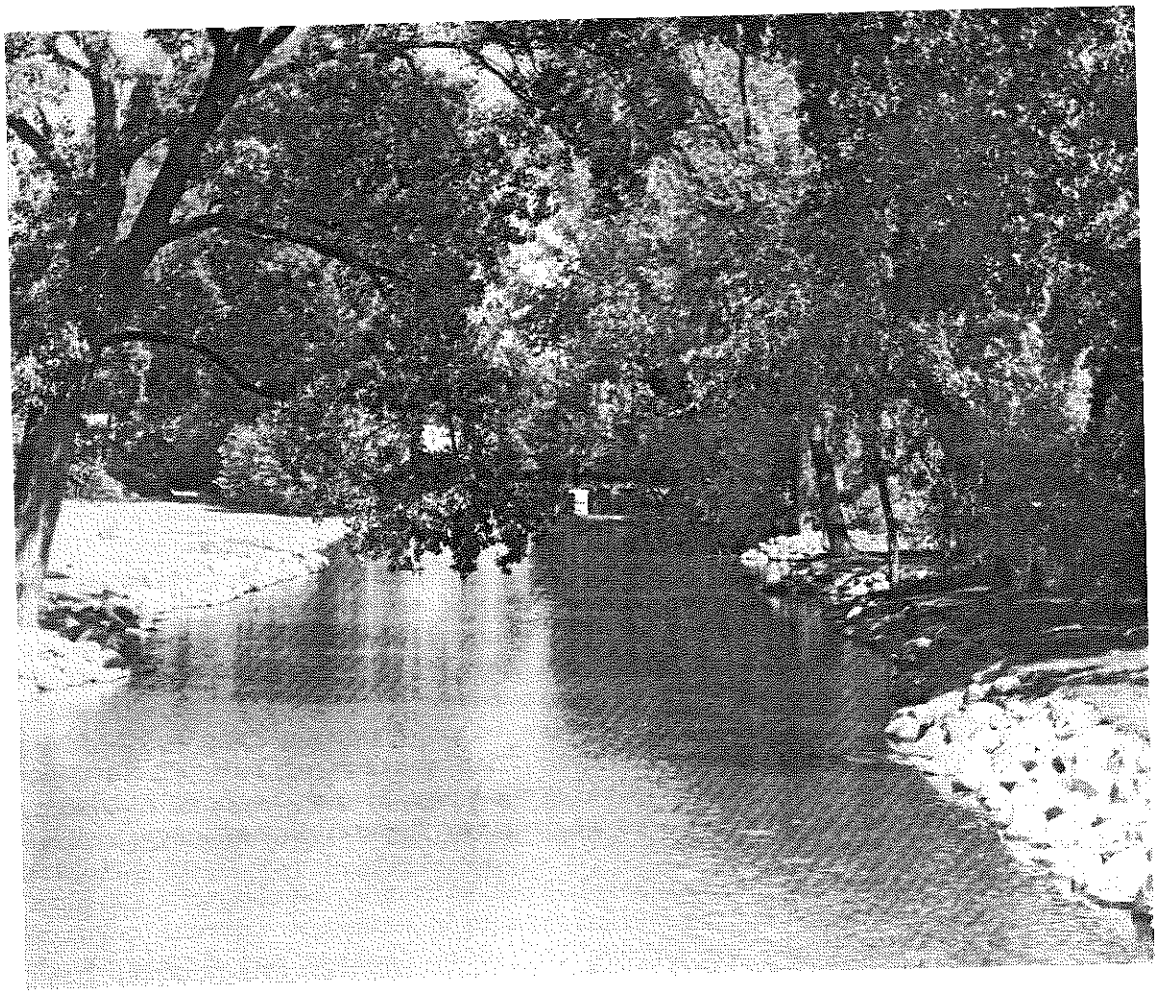
Summary

Although illustrative in nature, the alternative plans represent real choices for the direction of future water resources improvement activities in the Starkweather Creek watershed. A program emphasizing environmental and visual enhancement will require the greatest departure from current and past practice, and will tend to be more difficult to implement than a program with a drainage and flood control emphasis. Continued scarce resources at the local level and competing high priority public works projects will tend to limit funds available for Starkweather Creek, probably to levels of expenditure below those described for the "maximum effort" alternatives. However, designation of the Yahara-Monona watershed as a statewide priority watershed may assist in completing high priority improvements such as stormwater detention basins.

Public participation activities associated with the development of this plan have revealed substantial dissatisfaction with the current condition of Starkweather Creek and its stream corridor. Litter and debris in the stream corridor, possible health and safety hazards, and unsightly water conditions are important problems cited by a large majority of

individuals who responded to a public opinion questionnaire. More than sixty-five percent of those responding also felt that poor urban storm-water drainage and flooding, noisy or unsightly neighboring land uses and lack of adequate public access represented important problems. Sixty-five percent or more of the residents surveyed favored: reducing bacterial contamination; improving the appearance of the water and streambed through managing aquatic weeds and algae and removing debris and litter; improving the appearance of the streambanks; controlling commercial and industrial waste; limiting runoff from new developments; and improving public access and recreational opportunities.

Maintenance of adequate urban drainage and reduction of flood potential are important management program objectives to many Starkweather Creek watershed residents who have experienced drainage problems in past years. Clearly, these objectives must be addressed in the recommended program for Starkweather Creek. However, the overriding public interest in achieving substantial improvements in the appearance of the stream corridor minimizing potential health and safety risks and eliminating the more easily corrected sources of pollution dictates that the recommended program be oriented toward environmental and visual enhancement measures.



In Many Locations, Stream Corridor Improvements Can Transform the Creek into an Attractive Resource

RECOMMENDED WATERSHED IMPROVEMENT PROGRAM

Background

The recommended program for the Starkweather Creek watershed is based upon the analysis of watershed problems and needs, including public concerns expressed during the planning process, and an evaluation of the broad range of possible remedial actions encompassed within the watershed alternatives. The framework for the control of nonpoint sources of pollution originating from urban and urbanizing lands is addressed on a comprehensive areawide basis in the Dane County Water Quality Plan (DCRPC, 1979). The recommendations contained in the Water Quality Plan provide overall guidance for the approach to be taken in individual watersheds and urban basins. The Starkweather Creek watershed plan represents a refinement and detailing of the countywide plan. Site-specific recommendations are included, as is a detailed listing of implementation roles and responsibilities. Like the countywide plan, the Starkweather Creek recommendations stress a multi-purpose approach to watershed planning and management, which integrates recreation, open space, aesthetic quality, resource protection and growth and development objectives with water quality protection and improvement needs. As well as seeking integration with adopted county plans, the Starkweather Creek recommendations place emphasis upon locally adopted plans and policies (Madison land use and park and open space plans, Town of Burke land use plan), and recommend amendments and revisions to such plans where warranted based on detailed review and analysis, or previously unrecognized water resource protection needs.

The Starkweather Creek recommendations are organized into three categories of actions, namely watershed source control measures, stream corridor protection measures, and in-stream water quality improvement and management measures. These categories are interdependent, and work together to adequately address resource protection, public use, drainage and flood control, and water quality improvement needs.

The watershed source control category includes stormwater volume and peak flow reduction measures such as detention basins and infiltration practices (downspout redirection, porous pavement, infiltration basins and trenches), and regulatory measures such as construction site erosion and runoff control provisions. Agricultural soil conservation practices are included in the source control category, as are urban management or "housekeeping practices" such as street sweeping and leaf collection. Due to recurring annual costs, street sweeping and leaf collection are expensive, but they are the only practices which directly address pollutants residing on paved surfaces. Source control measures for the Dane County Airport, and well placement concerns to be addressed by the Madison Water Utility are also included in the watershed source control category.

Stream corridor protection and improvement is an important component of the Starkweather Creek management strategy, in that it provides additional measures for water quality improvement and protection, proposals to improve the visual quality of the corridor and, within the City of Madison, actions to promote greater public use of the stream corridor resource. On segments of Starkweather Creek within the City of Madison, a multi-purpose approach to stream corridor management will provide public benefits which will help to justify land acquisition costs in areas where regulatory measures will not provide adequate protection or where public access is needed. Furthermore, successful efforts to increase public use of Starkweather Creek will help to assure a greater level of visibility and public concern for the resource.

Stream corridor protection recommendations for Starkweather Creek include environmental corridor delineation and protection, through a combination of review, regulatory and legal mechanisms, and various forms (and degrees) of public acquisition. Also included are recommendations for recreational development within the stream corridor, adoption of a wetland protection district within the Madison Zoning Code, and the development of landscape and urban design plans for creek corridor segments. The development of a routine maintenance schedule and program for the stream corridor is also recommended.

In addition to watershed source control and stream corridor protection measures, several in-stream water quality improvement measures have been assessed in a preliminary fashion. The in-stream water quality measures addressed in the plan alternatives include, primarily, streamflow augmentation, in-stream aeration, and the construction of a breakwater or other physical barrier to prevent the movement of wind-blown vegetative debris up the creek. These measures are moderately expensive, and require further investigation as to feasibility and effectiveness. The physical limitations of Starkweather Creek limit both the range and effectiveness of water quality improvement measures which can be applied. The potential benefits and impacts of dredging are also addressed.

Implementation of both watershed source control and stream corridor protection measures recommended in this plan is necessary to fully realize the plan objectives. In-stream water quality improvement and management measures are viewed as being long-term measures requiring further evaluation. Their implementation is viewed as being contingent upon public demand and the need for further action, following the installation and enactment of recommended source control and stream corridor practices and programs.

Watershed Source Control Measures

This category of recommendations includes: stormwater volume and peak flow reduction measures (such as detention and retention basins and infiltration practices); agricultural soil conservation practices and construction site erosion and runoff control measures; urban "housekeeping" practices such as street sweeping and leaf collection; source control measures for the Dane County Airport; and water conservation and well placement considerations to be addressed by the Madison Water Utility.

S-1: The City of Madison should avoid further reductions from the current (1983) frequency of street sweeping in the Starkweather Creek watershed, and should place emphasis upon sweeping the older, densely developed residential areas in the lower portion of the watershed, as well as the East Washington Avenue, Milwaukee Street and Cottage Grove Road corridors. Thorough and extensive spring and fall sweeping efforts should receive a high priority.

Budgetary pressures upon the City of Madison forced a dramatic reduction in overall frequency of street sweeping activities in 1982. The City of Madison reduced frequencies from an average of one pass each seven to ten days, to one pass each 17 to 21 days. The reduction in service frequency means that the debris residing on paved surfaces is far more likely to be transported to surface waterways between sweepings. Based on local sampling conducted in conjunction with the Dane county Water Quality Plan (DCRPC, 1979), the estimated average "loading intensity"* of street debris is 625 pounds per curb mile of street, with old residential areas having even higher loading intensities.

During the street sweeping season, rainfall of 0.2 inches or more in a 24-hour period can be expected to occur once every 6.5 to 8.4 days (USGS, 1979). While more sophisticated interpretation of rainfall intensity data would be needed to show the likelihood of street debris being flushed to storm sewers by such a rainfall, literature indicates that the maintenance of an 0.2 inch per hour rainfall intensity for periods as short as 5 to 10 minutes flushes a high percentage of street debris quite efficiently (Sartor & Boyd, 1972). While water quality maintenance is only one of the objectives addressed by street sweeping, it does appear that the water quality benefits of street sweeping have been sharply reduced by the recent declines in the frequency of street sweeping. While the current budget pressures and high costs of sweeping make it difficult to justify frequent sweeping solely to meet water quality objectives, further reductions should be avoided if at all possible.

To assure maximum impact on water quality, street sweeping efforts in the Starkweather Creek watershed should be well focused. Intensive spring and fall cleanup efforts should be maintained, and sweeping frequencies maximized in the older and more densely developed portions of the watershed and on heavily travelled streets. These areas have greater potential pollutant loadings, and are generally directly connected to the storm sewer system. Fall cleanup efforts are especially important in older residential areas, where heavy leaf fall can yield substantial phosphorus loadings (as high as 1.02 pounds per curb mile based on local sampling).

S-2: A frequent sweeping program should be established for large commercial, institutional and industrial parking lots in the Starkweather Creek watershed, and opportunities for shallow ponding of stormwater on infrequently used areas of such lots should be investigated.

*A combination of locally observed and estimated data. The solids "loading intensity" is defined as the quantity of material residing on a typical street which is subject to being washed off by rainfall occurring at a random point in time.

Large impervious surfaces, such as parking lots and commercial establishments shown on the recommended plan map are significant sources of particulates, litter, oil, grease and other contaminants. The East Towne Mall, for example, contains an extensive private storm sewer system which drains 57 acres of pavement and 17 acres of rooftop area to Starkweather Creek. The impervious area of the parking lot alone is roughly comparable to a 5.5 mile segment of East Washington Avenue. Many of the largest impervious surface areas in the Starkweather Creek watershed are located relatively close to the stream or major tributaries.

The City of Madison should work with large commercial, institutional and industrial establishments to encourage improved maintenance of large paved surfaces, many of which drain to public storm sewers. The City of Madison (perhaps through the Commission on the Environment) should contact managers of establishments and make them aware of the importance of and need for parking lot sweeping. The city should explore opportunities for providing contractual sweeping services, where needs cannot be adequately met by private contractors.

Large parking lots are substantial sources of runoff volume and peak discharge in urban area watersheds. In particular, East Towne contributes large volumes of runoff to the East Branch. Earlier surveys of urban basins in the Madison area (USGS, 1979) have shown that infiltration or attenuation of parking lot runoff could reduce total runoff volumes by an estimated 12 to 25 percent, and peak discharge rates by an estimated 5 to 24 percent. Infiltration or temporary ponding of stormwater on infrequently used areas of large parking lots could provide hydrologic and water quality benefits. Relatively inexpensive approaches to ponding and infiltration are available.

S-3: Leaf collection efforts should be maintained in the Starkweather Creek watershed, and should focus upon the portions of the watershed south of Highway 30 and west of Highway 51, where the greatest leaf fall and delivery of pollutants to the stream are expected. Public education efforts are needed to provide consistent information on the proper disposal of leaves and vegetative debris.

Current public leaf collection practices in the watershed appear to be satisfactory, and should be continued. Past surveys of management practices in the Madison area have shown that public confusion often results from the use of different leaf removal methods and programs in different neighborhoods. Clear and consistent information should be provided to watershed residents regarding the proper disposal of leaves and garden debris, in order to facilitate public collection efforts. Instructions telling residents to bag leaves or reuse them on their property would avoid confusion, and allow for more efficient public collection.

Leaves have occasionally been stockpiled near the banks of Starkweather Creek, as a temporary means of storage until city crews can properly dispose of them. Such stockpiling should be avoided or done in locations where no leachate will reach storm sewers or the stream.

S-4: The use of infiltration practices, including the redirection of roof drains to grassed areas, the installation of infiltration basins and trenches, and the installation of porous pavement should be generally encouraged in those portions of the watershed east of Highway 51, and evaluated on a case by case basis in the remainder of the watershed. The City of Madison, the Town of Burke and other units of government in the watershed should encourage the incorporation of infiltration practices on public and private projects and lands, where feasible and appropriate.

For existing developed and developing areas in the Starkweather Creek watershed, infiltration practices represent a means to reduce runoff volume and peak discharge, and maintain stream baseflow through shallow groundwater recharge. Infiltration practices can also help to address problems of limited downstream drainage capacity, and reduce future stormwater drainage facility needs. Infiltration is one of the few practices which addresses dissolved and particulate pollutants.

Hydrologic modeling of several storm sewered basins in Madison (USGS, 1979) indicated that infiltration of rooftop runoff, by diverting downspouts from paved to grassed areas, would reduce runoff volumes by seven to 22 percent, and peak discharges by seven to 31 percent. Use of porous pavement in parking lots was shown to reduce runoff volumes and peak discharges an average of 20 percent and 17 percent, respectively. Downspout redirection has not been pursued on a widespread basis in the City of Madison, but has been recommended in the Dane County Water Quality Plan (DCRPC, 1979) and the Sixmile-Pheasant Branch Creek Watershed Plan (WDNR, 1981). In the Starkweather Creek watershed, downspout redirection should be promoted in those areas of the watershed which have not experienced widespread problems with inadequate drainage and shallow groundwater. The greatest opportunities appear to exist in the portion of the watershed East of Highway 51 and south of Highway 30.

Infiltration basins and trenches represent possible stormwater management practices in developing areas of the watershed. As an alternative approach to conventional drainage facilities, or as a complement to on-site detention, induced infiltration practices can provide a sensitive approach which is particularly applicable to small to medium size developments and parking lots. In addition to pollutant and stormwater volume reduction benefits, groundwater recharge helps to maintain baseflow in Starkweather Creek during dry periods. In its review of site plans for new developments, the City of Madison should encourage consideration of infiltration practices, where soil conditions and depth to groundwater appear suitable. The City of Madison should also assess opportunities for incorporating infiltration trenches into the stormwater drainage system, as new areas develop.

Porous pavement is a promising stormwater management technique which may be applied in existing and newly developed areas. Porous pavement offers a significant opportunity for stormwater control in older developed areas, where limited open space and an underground stormwater transport system preclude many of the more commonly used practices. If porous asphalt pavement proves to be technically feasible and competitive in cost with conventional pavement and associated drainage facilities, there could be wide application for porous pavement in new and replacement construction throughout the area.

Research into porous pavement and the body of available literature on the practice have expanded in recent years, although installations are still very limited in number and geographic distribution. To answer questions about the performance and durability of asphalt porous pavement under Dane County conditions, the Dane County Water Quality Plan and the Sixmile-Pheasant Branch Creek Watershed Plan have recommended the establishment of field tests in parking lot and residential street applications. A parking lot demonstration of porous pavement has been recommended for Wisconsin Fund cost-sharing in the Sixmile-Pheasant Branch priority watershed.

In the Starkweather Creek watershed, large areas with shallow depth to groundwater and relatively impermeable soils will limit the use of asphalt porous pavement. Generally, the practice should be most appropriate for the more upland, outlying areas of the watershed east of Highway 51, and for limited areas in the lower portion of the watershed. The City of Madison should encourage the use of porous pavement, where appropriate, especially in commercial and industrial plats with a high proportion of impervious surfaces. Opportunities for incorportation of porous pavement and other infiltration practices into public streets and parking lots should be sought by the City of Madison. Public buildings, such as schools and the east side Streets Division garage offer good opportunities for feasibility tests of asphalt porous pavement parking lots.

S-5: Dane County should act, within its authority, to improve construction site erosion and runoff control in the unincorporated areas of the Starkweather Creek watershed. The county should first complete a construction erosion and runoff control needs assessment, already underway as part of another project.

Local units of government in the watershed, including towns, should exercise the full extent of their existing authority to bring about improved construction site erosion and runoff control on developing lands. Towns should discuss and coordinate their activity with the City of Madison and Dane County, to assure a consistent and uniform approach conducive to compliance by builders and developers.

The City of Madison recently adopted a comprehensive construction site erosion and runoff control ordinance which addresses all land disturbing activities of over 4,000 square feet within the city. The city will also exert erosion and runoff control authority over subdivision plats and certified surveys within the unincorporated extraterritorial review area. The entire unincorporated portion of the Starkweather watershed is within Madison's extraterritorial area. Madison's erosion and runoff control ordinance will not affect lot-by-lot or single developments in the unincorporated area which occur without land division.

Dane County currently has discretionary authority to require preparation of an erosion control plan for all land divisions in unincorporated areas of the county. As is the case with Madison's extraterritorial authority, the county's authority applies only to the subdivider and does not extend to land disturbing activities which do not involve land division. Dane County is engaged in an assessment of the need and means to expand erosion and runoff control requirements to address significant nonagricultural land disturbing activities in unincorporated areas. The outcome of this assessment will determine additional measures which Dane County can take to control non-agricultural erosion. It appears questionable whether Dane County can presently adopt a general erosion and runoff control ordinance without a countywide referendum.

Until such time as Dane County completes their assessment of need and prepares recommendations for nonagricultural erosion and runoff control in unincorporated areas, local units of government in the watershed, including towns, should exercise the full extent of their existing authority. Towns and Dane County should take every opportunity to comment on erosion control needs for development activities which do not involve land division. Towns should discuss and coordinate their approach to erosion and runoff control with the City of Madison and Dane County, to assure a consistent and uniform approach conducive to compliance by builders and developers.

Arguably, towns with village powers have adequate authority to enact general erosion and runoff control ordinances applicable to all land disturbing activities. However, towns should carefully consider the difficulty and cost of administering such ordinances before enacting them. The manpower needs of plan review, permitting and field inspection will almost certainly tax the capacity of smaller towns, or represent a substantial financial burden if such services are contracted for. Towns considering the adoption of measures should seek assistance from the Dane County Regional Planning Commission, and should discuss proposals with the City of Madison to ensure consistency and coordination.

S-6: The City of Madison, the Town of Burke, and other involved local units of government should assess and further develop detention storage needs in the Starkweather Creek watershed, focusing on the general areas indicated on the recommended plan map. Official map revisions to reflect anticipated future detention areas should be considered.

Further, it is recommended that future public detention basins be designed to address both runoff control and water quality (sedimentation) needs, and that the opportunities for incorporation of infiltration practices be fully considered.

The recommended plan map indicates that numerous potential stormwater detention opportunities exist in the Starkweather Creek watershed. Several of these possible locations are proposed in order to address existing concerns regarding excessive runoff volumes, stormwater quality and maintenance of groundwater recharge. Others relate to projected future detention needs, as additional watershed development occurs. The full feasibility and exact location of detention areas cannot be determined until further study is undertaken.

Stormwater detention facilities form an important component of the Starkweather Creek source control strategy, and address flooding and drainage concerns as well as water quality improvement needs. Sediment and other recommended source control measures must be carried out in concert with stormwater detention.

Detention on the West Branch of Starkweather Creek has the greatest potential for limiting increases in flooding potential in the lower reaches of the Creek, below East Washington Avenue, and providing limited sediment reduction benefits. The low gradients, moderate flows and long distances of travel in the upper reaches of the West Branch near and north of the airport indicate that sediment delivery from the outlying, upland areas of the West Branch is probably quite low. As indicated on the recommended plan map, potential detention basin locations in the West Branch drainage area are limited in

number and size, and could best address limited areas of new development or individual projects. The Federal Aviation Administration has expressed concerns regarding the establishment of detention basins near the Dane County Airport, and such basins should be of the "dry" type in order to avoid attracting waterfowl.

Two of the potential detention basin locations in the East Branch drainage area could serve large tributary land areas with substantial future development potential. One of these potential locations, in the vicinity of Interstate 90, Lien Road and the East Branch channel (S.E. ¼, Section 27, Town of Burke) has a tributary drainage area of approximately 2200 acres. The need for such a basin is dependent upon the extent and location of future development in the area, and the exact location of the basin should be determined through further study and discussion with local officials and landowners.

Several areas offering natural potential as detention basins exist between Highway 51 and Lien Road, on the East Branch. Detention in this reach can address existing runoff from East Towne and East Washington Avenue and future runoff from new upstream development, as well as provide some water quality and groundwater recharge benefits. Specific sites for a basin, if needed, should be selected by further engineering study conducted as part of an overall detailed assessment of stormwater detention needs. City of Madison and Town of Burke engineers should participate in this assessment.

Detention opportunities for the southern one-third of the Starkweather Creek watershed should be directed at reducing peak flows to downstream capacity limits of the existing drainage system, and prevention of channel erosion in steeper channel segments in upland areas.

Detention basins in the Starkweather Creek watershed should generally be designed as multi-purpose facilities, to further park and open space objectives, and complement environmental corridor uses, where appropriate. Modern detention basin design is based on multiple design objectives, including the ability to safely pass very large storms, and to detain smaller (e.g., 10-year) storms which have the greatest effect on the formation and stability of drainage channels. Modern multi-purpose design principles also provide for detention times of 24 to 36 hours to provide substantial sediment control and water quality benefits. To the extent feasible, detention basins in the Starkweather Creek watershed should incorporate contemporary design principles, be designed for detention times of 24 hours or more, and incorporate infiltration facilities.

Several of the potential detention basin locations in the Starkweather Creek Watershed are on lands currently located in the Town of Burke. Should any of these basins be developed by the City of Madison, proper acquisition of lands will be necessary. Due to this consideration and the possibility that joint city-town financial participation in basin development might be desirable, the City of Madison should fully coordinate stormwater detention basin planning with the Town of Burke and, where appropriate, Blooming Grove. Recommendation C-1 and the City of Madison implementation program, included in a later section of this plan, address the preliminary costs and timing of development of recommended detention basins and associated land acquisition measures.

S-7: A coordinated program of agricultural soil conservation assistance should be encouraged in the Starkweather Creek watershed, with the Town of Burke and the Dane County Land Conservation Committee (LCC) cooperating to facilitate contacts with farm landowners. Designation of the Middle Yahara (Yahara-Monona) watershed (which includes Starkweather Creek) as a Priority Watershed under the Wisconsin Fund Nonpoint Source Abatement Program should be sought by the RPC, LCC, City of Madison, Town of Burke and other local agencies. Existing cost-sharing funds should be made available to the extent possible. Special emphasis should be placed upon the promotion of conservation tillage methods, and the establishment of stable drainageways through the installation of grassed waterways and other stabilization practices.

A visual inspection of agricultural land in the Starkweather Creek watershed indicates that substantial areas of cropland are devoid of land treatment measures. Row crops, farmed up and down two to twelve percent slopes are common. Agricultural conservation problems appear to be most severe in the lands immediately adjoining the City of Madison and abutting Interstate Highway 90. Large land areas in sections 15, 22, 23, 26 and 27 in the Town of Burke appear to have high potential for sheet and rill erosion, with numerous gullies. These conditions are not particularly unusual in agricultural lands bordering the City of Madison, where there is little incentive for the installation of long-term conservation practices. In some cases, erosion on these urban fringe agricultural lands can be attributed to additional runoff generated by outlying developments which discharge to unprotected croplands. Runoff from highways and roads has also caused cropland erosion problems in the Town of Burke.

Agricultural erosion in the Starkweather Creek watershed generates sediment and associated nutrients, as well as dissolved nutrients which tend to degrade water quality and are partially transported to Lake Monona. An additional concern in the Starkweather Creek watershed is filling of the stream channel due to sediment deposition. Low stream gradients and velocities combined with high levels of particulate pollution have resulted in the accumulation of nutrient-rich streambed deposits in Starkweather Creek, which reach depths of 3 to 5 feet in some locations. This deposition reduces stream channel capacity and aggravates flooding and drainage problems, as well as contributing to oxygen deficiency and plant and algae growth problems in stagnant reaches of the stream.

Additional special funding for agricultural conservation practices in the Starkweather Creek watershed would be available if the Middle Yahara (Yahara-Monona) watershed (which includes Starkweather Creek) were designated a Priority Watershed for funding under the Wisconsin Fund. This watershed has been nominated as the highest priority watershed for Dane County for future Wisconsin Fund designation, but has not yet been designated. Continued attempts to obtain priority status for the watershed will be made. In the meantime, available funds from existing agricultural conservation programs (federal and county) can be utilized to address land treatment needs of the relatively small area of agricultural land within the Starkweather Creek watershed.

Through the Town of Burke Land Use Plan (Town of Burke, 1981), the town has established policies to encourage farmers within the town to use soil conservation practices and follow soil conservation plans. The town has also adopted policies relative to the protection and preservation of agricultural lands, policies opposing the careless alteration of surface runoff patterns,

and goals to preserve the integrity of the natural hydrologic system and minimize disruption of floodplains and drainageways. This plan calls for the town board to coordinate and facilitate contacts between farmland owners and the Dane County Land Conservation Committee for the purposes of providing information and education on low cost practices, such as conservation tillage, and to provide an initial step leading to the development of new farm conservation plans and cost-sharing agreements.

The agricultural soil conservation strategy in the Starkweather Creek watershed should be responsive to the transitional nature of much of the agricultural land in the watershed. It should also be responsive to the need to maintain the integrity of the hydrologic system as lands undergo development. Conservation tillage methods should be intensively promoted in the Starkweather Creek watershed. Conservation tillage allows substantial soil erosion control benefits, while maintaining current crop production capability. The savings in fuel and time attributable to conservation tillage methods should more than offset the initial costs associated with practice change. Despite the attractiveness of conservation tillage and its increasing use and acceptance, resistance to even this level of practice change has been encountered in urban fringe agricultural areas. Cost-sharing funds are not normally available for conservation tillage practices, but the LCC may be able to work in cooperation with agricultural credit and cooperative organizations to promote shared leasing arrangements for conservation tillage equipment. Conservation tillage practices would be eligible for Wisconsin Fund nonpoint cost-sharing, if this watershed were a designated Priority Watershed.

The installation of grassed waterways should be encouraged in the Starkweather Creek watershed, as a means of stabilizing the drainage network and reducing peak flows and sediment delivery. As development moves outward, especially into transitional agricultural areas as designated on the Town of Burke Land Use Plan, well-maintained grassed waterways will work in conjunction with other resource protection measures to assure the long-term stability and integrity of the drainage network. Other conservation measures may be needed based upon detailed evaluations by soil conservation field technicians. Changes in farming practices may also offer substantial benefits in the Starkweather Creek watershed, such as discouraging fall plowing and considering elimination of headrows on sloping croplands.

The success of agricultural conservation measures in the Starkweather Creek watershed depends upon an aggressive program of landowner contacts and education. Cooperative efforts between the Dane County Land Conservation Committee and the Town of Burke can aid the most effective use and distribution of the limited funds available through county and federal cost-sharing programs.

S-8: The City of Madison should increase surveillance of non-stormwater discharges to the storm sewer system, and work with businesses and industries along Starkweather Creek to seek correction of sources of contaminated runoff. Sufficient manpower should be made available to accomplish this activity. Neighborhood involvement in Creek surveillance activities should be encouraged.

The Madison Commission on the Environment should move to contact businesses in the Starkweather Creek watershed to inform them of the importance of their actions and cooperation in improving water quality, and to remind them of existing city codes regulating the discharge of wastes. The Town of Burke may also wish to contact businesses in the town to seek their cooperation, and remind them of applicable town codes.

The City of Madison has considerable authority under Chapter 7 of the Code of Ordinances to abate sources of pollution whether introduced to surface waters through the storm sewer system, by overland runoff or subsurface seepage. A permit system has been established to regulate non-stormwater discharges to the storm sewer system, such as cooling water, and provides a basis for registering such discharges and recording their characteristics. In addition to this, the State of Wisconsin operates a permit system for larger discharges.

While conscientious efforts are made to enforce Madison's discharge ordinance, there are probably unregulated discharges attributable to lack of knowledge of the ordinance, carelessness, and insufficient city staff time available for inspection and surveillance.

Enforcement of Madison's more general water pollution control ordinance (Chapter 7.46 of the Municipal Code) is seriously hampered by lack of available staff resources. This section of the Municipal Code directly addresses runoff from commercial and industrial storage areas, and any discharges of polluting substances by individuals or businesses. Due to the cumulative impact of miscellaneous discharges of pollutants to Starkweather Creek by businesses and individuals, increased surveillance and enforcement efforts are recommended in this plan. In order to increase awareness among businesses, this plan recommends that the Madison Commission on the Environment write to businesses in the incorporated area of the watershed to inform them of the significance and impact of their discharges, and the existence of city codes regulating such discharges. The plan also recommends that the city encourage and provide technical support for organized citizen volunteer efforts to establish creek and storm sewer discharge surveillance programs, possibly through neighborhood organizations. The Town of Burke may wish to establish a similar program.

S-9: The Dane County Regional Airport should take all reasonable steps to ensure that the transport of aircraft and runway deicers and aircraft fuels to Starkweather Creek is minimized, and that spills of such materials are contained on the airport property.

The Dane County Regional Airport should inform all businesses and lessees at the airport of basic guidelines and criteria for waste storage and disposal, and stress the importance of limiting discharges of wastes to storm drains.

As indicated on the stormwater drainage network map, the Dane County Regional Airport is served by an extensive storm sewer system. Spillage from aircraft maintenance and refueling operations could easily result in transport of jet fuels, grease and oil compounds and deicers to Starkweather Creek.

Personnel involved in refueling, deicing and other maintenance operations should be periodically briefed on treatment of any spills, since rapid containment and application of absorbants is important. Any oil-water separators which are installed at the Dane County Airport should be regularly inspected and maintained.

Routine aircraft maintenance, washing and repair operations at the Dane County Airport offer many opportunities for petroleum, solvents and other pollutants to enter storm drains. Separate areas and facilities for the temporary storage of waste products should be provided, clearly labeled, and inspected frequently.

S-10: The Madison Water Utility should continue its water conservation efforts, and should carefully consider the effects of future groundwater withdrawals and well placement upon shallow groundwater levels in the upper East Branch Starkweather Creek drainage area.

The East Branch of Starkweather Creek is fed by several springs near the East Towne shopping center, and by diffuse seepage from wetland areas upstream of Highway 51. As indicated on pages 37-43 of this plan, additional drawdown of the upper aquifer feeding the East Branch could substantially reduce groundwater discharge to the stream. Past modeling (McCleod, 1978) has projected worsening of the upper aquifer drawdown in the vicinity of the upper East Branch by the year 2000. Unit well #15, on East Washington Avenue, appears to be largely responsible for this projected drawdown.

This plan recommends that the Madison Water Utility consider the impacts of future well placement and service capacities upon shallow groundwater levels within its Master Plan of Waterworks Improvements. Specifically, the impacts of continued withdrawal from Unit Well #15, and the impacts of placement of a new unit well proposed for Bultman Road just north of Highway 30 should be evaluated as part of an update of the Madison Water Utility Master Plan. Since the proposed Bultman Road well will not likely be pursued prior to the Master Plan revision, service improvements for the east side can then be reassessed in light of upper aquifer drawdown concerns.

Stream Corridor Protection Measures

This category of recommendations includes measures to protect environmental corridors, provide for greater public recreational use of the stream corridor (where appropriate), establish wetland protection requirements, develop design and landscape concepts for urban stream corridor segments, and establish a regular maintenance program for the Starkweather corridor.

C-1: Units of government having jurisdiction in the Starkweather Creek watershed should consider and take appropriate actions, as opportunities arise, to protect and preserve the lands within the environmental corridors shown on the recommended plan map. Corridor lands within the City of Madison should be protected through a combination of review, regulatory and legal mechanisms, and various forms of public acquisition, especially where public access and recreational use are desired. Corridor lands within the towns should be protected primarily through review, regulatory and legal mechanisms, with the protected lands remaining primarily in private ownership. In all cases, environmental corridors should be included in local land use plans and town plans. Official mapping of corridors should be considered in the portion of the watershed within the central urban service area.

Acquisition of environmental corridor lands should be considered only where public ownership is necessary to achieve community objectives. Acquisition is necessary where public access or use is desired, and should also be considered where no other measures will adequately protect sensitive or environmentally valuable lands.

The protection and management of environmental corridors plays an especially important role in the overall management strategy for the Starkweather Creek watershed. Stream corridor protection and the prevention of incompatible uses complement watershed source control measures and assure continuity and protection of the natural drainage network in the large areas of the Starkweather Creek watershed subject to urbanization. The environmental corridors can also provide important public recreation and open space benefits which help to justify investments in water quality improvement and stream corridor protection measures (including land acquisition). Public access and use is not intended nor desirable in all areas of the environmental corridor. The resource protection needs of some areas are better met by limiting or preventing public access.

The environmental corridors depicted in the recommended plan map (see summary plan brochure) consist of resource-based environmentally sensitive lands and those lands necessary for the continued future protection of the natural drainage system and water resources. The potential for increased deterioration of water quality and for damage to integrated environmental systems exists if these sensitive areas and resources are not protected. A more complete description of each of the environmental corridors is provided in Appendix D, as well as a description of key corridor features and specific proposed actions. As indicated on the recommended plan map, several of the upland segments of the environmental corridor, located in the Town of Burke, are associated only with intermittent drainage. The sole purpose of these segments is to reserve adequate land area to safely transport anticipated future stormwater flows, as designated by engineering design (including involvement by the Town of Burke engineer).

Maintenance or establishment of vegetative cover within the environmental corridors creates a buffer zone which serves to attenuate overland flow to drainageways, and reduces the delivery of sediment and associated pollutants. In addition, drainageways in the watershed are afforded a measure of protection from accelerated channel erosion which may be due to increased upland development or to poor or negligent management practices. The protection of environmental corridors in urbanizing areas of the Starkweather Creek watershed preserves stormwater management options which may be exercised during the land conversion process, and reserves sufficient land area to provide for the incorporation of natural stormwater management and drainage facilities at the time of development. The existence and official recognition of the corridor can also provide a guide for dedication of lands during the platting process.

The Starkweather Creek corridor, especially within the City of Madison, has the potential to offer significant recreation and open space opportunities, by linking and building upon existing public parks (such as Olbrich Park and botanical gardens and O.B. Sherry Park) and providing walking and bike trails which connect residential and commercial activity centers with each other and with points of scenic or recreational interest, such as the lakeshore or the creek itself. The recreation and open space opportunities provided by the establishment and protection of the environmental corridor will also promote greater public use and visibility of the resource, and foster additional public concern.

The protection of the Starkweather environmental corridor also offers opportunities for maintaining and improving the aesthetic quality of the stream resource. As indicated in this plan, visual improvement of the stream appears to have substantial public support, and can act to heighten public perception and concern. Corridor protection can provide future assurance that visually conflicting land uses and visual intrusion will be minimized. Lastly, the environmental corridor provides wildlife habitat protection and improvement benefits, a valuable resource to the urban area.

Several means and levels of protection for environmental corridors are recommended in the Starkweather Creek watershed. At the present time, land acquisition is recommended for high priority land areas within the City of Madison which fulfill important corridor functions and provide substantial park and open space opportunities. Public access is proposed for most of these urban corridor lands within the City of Madison.

No measures to facilitate public access, including land acquisition, are proposed for lands along the West Branch of Starkweather Creek east of U.S. Highway 51 and the Dane County Regional Airport, nor for lands along the East Branch northeast of Sycamore Avenue. Existing publicly owned lands in these areas are subject to existing regulations with respect to public access. Review, regulatory and legal protection measures appear adequate for corridor lands in the town, and for some lands within the City of Madison. An adequate level of protection against additional draining, filling or alteration of water levels should be provided for wetland areas along the upper West Branch, east of the Dane County Regional Airport. Other wetland areas north and west of the airport should receive similar protection.

Several wetland areas within the Starkweather Creek watershed environmental corridor may be affected by Wisconsin's shoreland-wetland protection program. The Wisconsin legislature recently expanded the program to apply to incorporated cities and villages as well as unincorporated areas. This law requires zoning of mapped wetlands which are located within shoreland areas. Statutes define shoreland areas as lands located within 1,000 feet of the ordinary high-water mark of navigable rivers or streams or to the landward side of the floodplain, whichever distance is greater.

Counties, cities and villages are not required to zone shorelands and associated wetlands adjacent to farm drainage ditches if:

- Such lands are not adjacent to a natural navigable stream or river;
- Those parts of the drainage ditches adjacent to these lands were nonnavigable streams before ditching; and
- Such lands are maintained in nonstructural agricultural use.

Due to the character and history of Starkweather Creek, these exceptions raise questions about the extent to which Dane County and the City of Madison will be required to adopt ordinances to protect wetlands such as those adjacent to Starkweather Creek. Thus, this plan generally recommends that wetlands in incorporated and unincorporated areas of the watershed be protected through available, locally adopted zoning, acquisition, or other protective measures which prohibit any additional dredging, filling, draining, tiling and excavation, except for maintenance and repair of existing drainage systems necessary for the continuation of existing agricultural operations.

The following general measures are recommended for the environmental corridors shown on the recommended plan map:

- Within the Central Urban Service Area, the City of Madison should either officially map as "parkway" those corridor reaches not already designated as such, or the corridor should be protected through wetland or other protective zoning. Official mapping can serve to protect drainageways from development in the future by precluding the issuance of building permits. Official mapping does not generally affect nonstructural land uses. Zoning provides broader protection from a variety of land disturbing uses, although present nonconforming land uses may continue.

- The Madison Land Use Plan, the Town of Burke Land Use Plan and other local plans (park and open space, etc.) should be amended to reflect the delineated environmental corridors and provide an additional basis for protecting the stream corridor against adverse development.

- As opportunities arise, the City of Madison should seek to acquire priority lands indicated on the recommended plan map and located in Sections 4, 5 and 9, T.7N., R.10E., City of Madison, and Section 32, T.8N, R.10E, City of Madison.

- Several large degraded wetland areas abutting the eastern boundary of the Dane County Regional Airport, in Sections 16 and 21 Town of Burke, should be afforded protection from additional draining, filling, excavation, tiling or alteration of water levels, except for maintenance and repair of existing drainage systems necessary for continuation of existing agricultural operations.

- Wetland zoning or other measures affording a similar level of protection should be promoted and sought by the City of Madison, and the Town of Burke (acting through Dane County) for corridor lands not currently adequately protected by drainage course, waterfront development and floodplain zoning (City of Madison) or by the shoreland and floodplain management ordinance (Dane County). The more significant areas recommended for such protection include, among others: the wetland/floodplain area on the north side of the East Branch of the creek just east of Highway 51; the floodplain and wetland areas north of Aberg Avenue and south of Anderson Street (on the West Branch) which are not proposed for short-term acquisition and not under existing public ownership; and wetland areas in Section 19, Town of Burke, west of the airport. Protective measures should be fully discussed with local management agencies and should be consistent with adopted plans and policies.

- Land resources which are targeted for eventual public acquisition should be afforded appropriate levels of short and mid-term protection through zoning, official mapping, or other suitable measures and acquired through dedication or purchase at the appropriate time.

- Easements, rather than fee simple acquisition, may be more appropriate where access is needed only for public maintenance. Where public access is desired for recreation, easements are recommended only where fee simple acquisition cannot be negotiated, or where the easement can be obtained at substantially lower cost than outright acquisition.

C-2: The City of Madison should designate the floodplain and wetland areas in the eastern 1/2 of the northeast 1/4 of Section 5 and the northwest 1/4 of Section 4, Town of Blooming Grove as future park and open space lands, and place a high priority on acquisition of these lands.

Acquisition of the eastern half of the area should be accomplished soon after feasibility studies and site use proposals have been completed. If firm development proposals for all or part of the area under consideration are tendered by the landowners prior to public acquisition, the city should seek dedication of lands which are unsuitable for development, and should assure that wetland and floodplain areas are treated sensitively.

The northern half of the land area bounded by Starkweather Creek, Highway 30, Highway 51 and Milwaukee Street contains a large area of degraded wetland, and a broad expanse of floodplain. The land contains several abandoned drainage ditches (portions of the former main ditch of Starkweather Creek), a tributary drainage ditch which receives stormwater from the East Milwaukee Street - Hiestand Park area, two large gravel pit ponds, an active sand and gravel extraction area, and gently rolling topography. One of the gravel pit ponds on the site is relatively deep, and contains a fair panfish population. A power transmission line which crosses the site represents a limitation for certain uses. However, the entire area of approximately 80 acres has the potential to provide a major east side open space and park area. Some wetland on the site may have limited potential for restoration.

Acquisition of this site would represent a highly visible and major contribution to the utility and value of the Starkweather Creek environmental corridor. The "Mautz property", representing the eastern half of the site in question, was recently annexed to the City of Madison, and has been the subject of several development proposals in recent years. The continuing prospect of development indicates that the City of Madison should move quickly to assess site use and feasibility of acquisition. Official map and land use plan amendments to reflect the full extent of the environmental corridor should also be processed.

The western half of the area in question, known as the "Voit property", is within the Town of Blooming Grove. Development pressure on this property is probably quite limited due to the existence of an active sand and gravel operation, and the poor access to the property. Thus, acquisition of this parcel could probably be delayed until somewhat later in the plan implementation period. In the meantime, official map and land use plan amendments to reflect the environmental corridor should be processed.

Existing zoning on the parcel recommended for consideration for future park and open space land is largely M-1: Manufacturing, with C-2: Commercial in the northwestern corner. The Madison Land Use Plan indicates a broad corridor encompassing parts of the west and far north of the site as parks

and conservancy with a neighborhood design district (mixed residential) in the southwest corner and community commercial in the southeast corner. Ultimate use of the land parcel might best consist of conservancy (parks and recreation) land in the northern half to two-thirds, with more intensive mixed residential and commercial development fronting on Milwaukee Street in the southern third and Highway 51 on the eastern fringe (in areas not affected by the floodplain or wetland).

Madison's 1977 Parks and Open Space Plan indicates that the portions of the Voit and Mautz properties under discussion are located in an area of neighborhood park deficiency. The plan does indicate that detailed study of the area's park opportunities is necessary. Earlier parks plans have indicated the site as a possible future park location. Development proposals for the area should be sensitive to park deficiencies, and to the need for wetland protection.

C-3: Where substantial public use is anticipated (in the City of Madison), recreational development within the streamside zone of the Starkweather Creek environmental corridor should consist primarily of trails and low-cost streamside facilities such as picnic tables and small shelters. Trail development in the stream corridor and along drainage courses in the watershed should address weaknesses in the existing bikeway and pathway network, and tie together major park and open space and natural resource areas. Initial recreational development should focus on the lower Starkweather Creek watershed area, generally south of Highway 30 (Aberg Avenue) within the City of Madison.

No additional measures are recommended to improve boat access to the lower reaches of Starkweather Creek.

Intensive forms of recreational development are not advisable in the streamside zone of the Starkweather Creek corridor. Recreational development in this area should be primarily related to facilities which aid the enjoyment and use of the stream resource, and those facilities (such as trails) which complement and take advantage of the linear nature of the environmental corridor. The need for more intensive forms of recreational activity not associated with the presence of the stream resource can best be met by playing fields, playgrounds and existing park facilities in the vicinity of Starkweather Creek.

Based on public opinion surveys and physical limitations of the stream resource, there appears to be little support for additional facilities or management actions to improve boating access and conditions in Starkweather Creek above Olbrich Park. The low bridge on the Chicago and Northwestern Railroad and the shallow channel limit practical access to canoes and similar craft. During baseflow periods, water depth near the confluence of the East and West Branches does not exceed 18 inches. Historic records indicate that this depth was probably close to four feet at the time the main ditch was constructed by the drainage district. Maintenance and some limited improvement of the boat ramp and platforms at Olbrich Park (used for access to Lake Monona) does appear to be necessary and warranted.

C-4: Dane County, in consultation with the affected towns, should enact wetland zoning provisions, consistent with state law, to protect those important mapped wetlands outside the City of Madison shown on the recommended plan map. In addition, the City of Madison, in consultation with surrounding towns, should consider the adoption of a wetland protection district within the incorporated area, to apply to mapped wetlands as designated in the "Wisconsin Wetlands Inventory" for Dane County. Except through variance procedures or continuation of legally nonconforming uses, filling, draining, removal of topsoil or alteration of water levels should be prohibited in the wetland district. The wetland zoning ordinance should meet the requirements of the Wisconsin shoreland-wetland protection program, but provide protection for all wetland areas deemed to be of local importance.

Current regulations do not provide sufficient protection for wetland areas within the City of Madison. Shoreland wetlands, associated with lakes and streams, receive a small measure of protection from incompatible use and alteration via floodplain zoning and drainage course provisions contained in the Madison Zoning Code. Protection for unfilled shoreland wetlands exceeding five acres would be expanded somewhat if Madison complies with the minimum requirements of the state shoreland wetland law enacted in 1982.

A higher level of protection should be considered to assure maintenance of the character and function of wetland areas within the Starkweather Creek watershed and other urban area drainage basins. Even degraded wetland areas, many of which are being filled and developed, can fulfill important baseflow maintenance functions in Starkweather Creek, and provide flow attenuation to reduce the downstream impacts of increased stormwater flow generated from upland developments. Consideration of use of lower quality or degraded wetland areas as sites for stormwater detention or retention areas could provide useful water quality benefits, reduce stormwater detention costs through use of natural sites, and aid restoration of wetland function and habitat. Small and degraded wetland areas also contribute to wildlife habitat and other environmental corridor functions.

Existing City of Madison conservancy zoning district provisions are generally adequate for protection of wetland areas against significant incompatible land uses. Additional requirements restricting filling, draining and alteration of water levels are needed to more fully protect lands within any proposed wetland zoning district. Pending local review and discussion, the Wisconsin Department of Natural Resources "Wisconsin Wetlands Inventory" could be used as a preliminary basis for defining the boundaries of a proposed wetland zoning district in the City of Madison.

C-5: The City of Madison should prepare landscape and urban design plans for the aesthetic improvement of the Starkweather Creek corridor within Madison, concentrating effort on areas of high public use and visibility which are in need of improvement. Madison Parks Division and Planning and Development Department should cooperate on design concepts for vegetative and general landscape improvement, and incorporate stream corridor protection and improvement measures into plans for development proposals in Neighborhood Design Districts and other development opportunity areas.

Maintenance and vegetative improvement programs on Starkweather Creek, undertaken as funding becomes available, should adhere to the landscaping and design concepts.

The visual environment of many segments of Starkweather Creek suffers from poor vegetative management, lack of existing vegetation, encroachment of unsightly or incompatible development into the stream corridor, or lack of adequate maintenance with respect to litter and debris removal. (Appendix D provides a brief analysis of existing stream segment conditions, and discusses suggested remedial actions to improve the visual environment and landscape of the stream corridor.) The visual attractiveness of the stream resource is important in building and sustaining public use (where intended) and generating public concern and support for creek maintenance and improvement measures.

The intent of this recommendation is to develop detailed design concepts and drawings for aesthetic improvement of the Starkweather corridor within Madison, including landscaping and vegetative management to provide buffering. screening, environmental improvement and increased plant diversity. Other elements of urban form and design should also be considered in the corridor design concepts.

Design concepts should relate to adjacent land parcels undergoing or being considered for redevelopment, such as the old Madison Metro bus barns site on Fair Oaks Avenue.

Initially, visual analysis and design concept efforts should focus on high public visibility and use areas, primarily on the West Branch below East Washington Avenue, and the East Branch below Milwaukee Street. The West Branch from East Washington Avenue to Fair Oaks Avenue, the corridor adjacent to the Madison Silo - Garver Feed property between Fair Oaks Avenue and the Chicago and Northwestern Railroad bridge, and the eastern streambank from south of O.B. Sherry Park to Atwood Avenue should be completed first. Maintenance and vegetative improvement programs should follow the design and landscaping plans which are developed. Businesses and residential property owners along the Creek should be encouraged to participate in visual improvement efforts, and to follow the design concept plans. To encourage businesses and individuals to follow the design concepts, they might be produced in brochure form, and widely distributed.

C-6: The City of Madison Public Works Department should develop a regular maintenance program for Starkweather Creek, to assure the routine removal of accumulated debris and trash by the Parks and Streets Divisions.

The Public Works Department should provide support and assistance to private and neighborhood groups and organizations wishing to conduct stream cleanup activities.

Starkweather Creek is plagued with large quantities of trash and debris, which create an eyesore, may impede drainage and can pose a safety hazard to children who wade in the stream.

Regular removal of trash and debris, including dead and fallen trees and vegetation, will assure improved stream and corridor appearance. Volunteer groups and organizations have undertaken cleanup campaigns on Starkweather Creek. The City of Madison should encourage and assist such activities by providing equipment and personnel for their safe and efficient conduct. Public support for improvement and maintenance projects, acquisition of lands, and involvement in volunteer activities are directly related to the public perception of Starkweather Creek, which is in turn heavily influenced by the aesthetics and appearance of the stream and nearby lands.

In-Stream Water Quality Management Measures

The complex problems of Starkweather Creek which have been brought on by wetland drainage, urbanization, ditching and channelization, poor land management practices, and increased groundwater withdrawal have produced a stream with severely limited potential for water quality improvement. The flat stream gradient, the loss of natural baseflow, and the dramatic changes in hydrology of Starkweather Creek are generally irreversible. However, several mechanical and structural measures could act to improve the water quality of the Creek.

Increasing stream baseflow through flow augmentation offers one of the few opportunities for substantial improvement in the physical, chemical and biological quality of Starkweather Creek. With increased flow, water temperatures would decrease, dissolved oxygen levels would increase, green and blue-green algae blooms would occur less frequently, and floating, decaying vegetative debris would be less likely to accumulate in the lower reaches of the Creek. The composition of the Creek's biological community might also change significantly. While the greatest benefits of streamflow augmentation would be achieved by the use of groundwater, this practice raises concerns about aggravating existing shallow groundwater level declines, which reduce stream baseflow. A second option, purchase of water from the Madison Water Utility, is prohibitively expensive and not in keeping with current successful water conservation efforts. Thus, the flow augmentation method assumed for Starkweather Creek entails pumping of water from Lake Monona, to be distributed to the Creek near Highway 30 (Aberg Avenue).

WQ-1: Baseflow augmentation for Starkweather Creek should be further evaluated, but undertaken only if recommended source control and stream corridor protection measures do not meet water quality improvement and stream use needs.

In-stream aeration and breakwater construction should be considered in conjunction with flow augmentation, as practices which may provide additional water quality improvements once recommended source control and stream corridor actions are undertaken.

To be effective, flow augmentation in Starkweather Creek should be designed to raise stream baseflow to at least five cubic feet per second (cfs) for about 100 to 120 days per year. During this period, a minimum of two million gallons per day (mgd) would be added to each branch. This is a large quantity of water, essentially the equivalent of the amount which could be supplied by two of Madison's larger municipal water wells. In the alternative discussed earlier, surface water would be pumped from Lake Monona and released into Starkweather Creek at some point below Highway 30.

Such flow augmentation would undoubtedly improve the visual quality of Starkweather Creek, above the confluence of the East and West Branches. The impacts on the main stem are likely to be substantially less dramatic, since this section of stream is submerged in lake backwater. The increase in overall use potential attributable to flow augmentation is likely to be limited, since the physical constraints such as depth will not be altered. Although the stream's water quality and fishery would improve with flow augmentation, species diversity is not likely to increase appreciably, and public demand for fishery improvement in Starkweather Creek is quite low.

In many respects, the prospects for future use of flow augmentation in Starkweather Creek will hinge on the success and impact of recommended watershed source control and stream corridor protection measures, and upon the value which the public places on additional visual quality improvements which might be gained through flow augmentation.

Other measures which might be effective in improving water quality in Starkweather Creek include in-stream aeration and construction of a breakwater barrier at the outlet to Lake Monona. In-stream aeration would be designed to raise dissolved oxygen levels, particularly in lower reaches of the creek where low flow and decaying plants combine to deplete oxygen in the water. Construction of a breakwater barrier at the mouth of the creek would help to prevent algae and weeds being driven up into the lower part of the creek by prevailing winds. (A breakwater would also enhance recreation by providing a fishing platform.)

Both in-stream aeration and a breakwater would be most effective if combined with low flow augmentation. These three practices should be considered jointly as the most promising approach to improving baseflow water quality conditions in Starkweather Creek. The cost of these practices, combined with limited effectiveness and questionable public demand for an improved fishery, indicate that implementation should await the results of carrying out the watershed source control practices and stream corridor protection measures recommended earlier.

Baseflow augmentation, in-stream aeration and breakwater construction can, therefore, be viewed as long-term possibilities. Further evaluation of these practices should be conducted as watershed source control and corridor protection measures are carried out.

WQ-2: Dredging of Starkweather Creek should be undertaken only where needed to provide adequate hydraulic capacity of the channel to control flooding. Dredging alone offers few water quality or use benefits in Starkweather Creek.

Dredging may be necessary to maintain the capacity of Starkweather Creek to carry floodwaters, especially in the West Branch. Dredging should be conducted selectively, and only where needed. As part of a program involving other in-stream water quality improvement measures, dredging may expand the use potential of Starkweather Creek, when and if public demand for additional in-stream uses materializes. Sediments in the lower West Branch may be quite high in pollutants from urban runoff, past industrial discharges and by-passing of wastewater, so dredging should be conducted carefully. Disposal sites for dredged material should be located and designed carefully.

IMPLEMENTATION PROGRAM

Institutional Roles and Responsibilities

As described earlier in this plan, institutional responsibility for management of the Starkweather Creek watershed is somewhat fragmented, and the watershed has suffered from past management actions and strategies which have been directed toward single, and often conflicting, objectives. This plan will serve to direct management agencies toward coordinated actions which accomplish multiple objectives, and advance overall watershed goals.

The City of Madison, the Towns of Burke, Blooming Grove and Westport, Dane County (and the Airport Commission) and the Dane County Drainage Board are the primary management agencies with jurisdiction in the Starkweather Creek watershed. For all practical purposes, the roles of the Towns of Blooming Grove and Westport in watershed management are very minor. Intergovernmental coordinating groups and committees should be used in carrying out the watershed plan, where they exist. For instance, a Burke-Madison Liaison Committee should be participants.

City of Madison

General Authority. Among general purpose units of government, the City of Madison has the largest jurisdictional area within the watershed, and the broadest grant of statutory authority to allow implementation and financing of the recommended watershed improvement programs (see "An Analysis of the Legal Authority of Cities to Implement an Areawide Water Quality Plan"; DCRPC, 1977). Under its home rule powers and express grants of statutory authority (generally under Chapters 62, 66 and 67 Wisconsin Statutes), the City of Madison may act to manage and control navigable waters and act broadly in the interest of the public health, safety and welfare to accomplish nonpoint source control and watershed improvement programs. In addition, the city has the following statutory authorities which are important to its role in carrying out the Starkweather Creek watershed plan:

- Authority to acquire land and water rights for the benefit of the public, including lakes and river improvements.

- Authority to establish parkways and parks, and limited authority to require subdividers to dedicate land for public purposes.

- Authority to plan the future location of waterways and sewers, and include proposed parkways on the official map.

- Authority to protect water quality and drainage system efficiency and integrity through the zoning code (setbacks from waterways, conditional use permit requirements for lands on existing or proposed parkways, prohibition of filling, obstructing or altering drainageways and water bodies).

- Authority to finance improvements through acceptance of grants, various forms of temporary, short-term and long-term borrowing, and to levy special assessments for benefits conferred upon limited geographic areas.

- Authority to issue municipal bonds for public works and watershed improvement purposes listed in Wisconsin Statutes.

Local Ordinances. The City of Madison has enacted local ordinances which authorize the city to address many of the recommended management actions contained in this plan. However, like many local ordinances, enforcement has been undertaken primarily in response to complaints, or has been uneven due to inadequate staff capacity, lack of clearly designated enforcement responsibility, or lack of awareness regarding the ordinances. Following is a partial listing of Madison's ordinances related to water pollution control, and the Chapter and Section of the Code of Ordinances in which they appear:

Section 7.32 Prohibiting Deposit of Rubbish and Refuse on Streets, Grounds or in Waters.

Section 7.33 Requiring Connection of Buildings and Waste Sources to Sanitary Sewers.

Section 7.34 Prohibiting Discharge of Drains to Gutters and Streets.

Section 7.35 Requiring Proper Disposal of Septic Tank Effluent.

Section 7.42 Limiting the Land Disposal of Solid Wastes, Manure and Substances Within, and Within One Mile of the City.

Section 7.46 Prohibiting Any Polluting or Spilled Material From Reaching Lakes or Streams, and Regulating Storage of Polluting Substances.

Section 7.47 Regulating the Discharge of Nonstorm Water to the Storm Sewer System.

Section 7.48 Regulations on the Sale and Use of Fertilizers and Herbicides.

Section 10.17 Prohibiting Deposit of Salt, Grass, Leaves and Other Rubbish on Streets or in Gutters.

Section 10.19 Prohibiting Dumping of Rubbish in Any Public Place.

Section 14.02 Prohibiting Filling of Lakes, Rivers and Other Waterways.

Section 16.23 Subdivision Erosion Control.

Section 28.04(13) and 28.04(19) Drainage Course and Waterfront Development Provisions, Madison Zoning Code.

Chapter 37 Erosion and Stormwater Runoff Control.

Clearly, several of these ordinances are duplicative, and some consolidation and streamlining might be desirable. In all cases, the ordinances should clearly indicate the department, division or individual responsible for administration and enforcement. In general, authority to abate sources which may constitute a health hazard rests with the director of public health, except that nonstorm water discharge permits are jointly administered by the Health and Engineering Divisions, and certain sources attributable to street debris or refuse are under the control of Streets Division. Zoning and subdivision codes are administered by the Department of Planning and Development.

Implementation Responsibility. The City of Madison has by far the largest role in implementation of the recommended plan for Starkweather Creek. The breadth of the proposed role is consistent with the city's existing nonpoint source management responsibilities (street sweeping, leaf collection), with its role in stormwater and drainage facilities management, and with its role in park and public land management and improvement. The assignment of responsibility for certain actions is also prescribed by existing ordinances and codes.

Within the recommended plan, the City of Madison should focus its initial implementation effort upon the suggested short-range actions contained in Table 14. This five-year program provides additional guidance and translates the general 20-year plan recommendations into specific actions which will lay the groundwork for long-range efforts. The short-range actions consist of high priority measures which should be undertaken early in the implementation period, to establish program momentum and lead to the realization of the broader recommendations. Costs indicated in Table 14 should be considered as rough estimates, and represent only additional public costs anticipated during the five-year short-range period.

Beyond the short-range priority actions described in Table 14, several significant actions should be undertaken by the City of Madison in the sixth through tenth years of plan implementation. Of these actions, the following should be considered in the sixth through eighth years, as they make substantial contributions to the utility of the Starkweather Creek environmental corridor, and to the achievement of watershed objectives:

- Consider acquisition of the wetland, floodplain and surface water areas in the northwestern quarter of the property bounded by East Branch Starkweather Creek, Highway 30, Highway 51 and Milwaukee Street (the northern portion of the "Voit property). (Adjoining "Mautz property" proposal is contained in implementation years 2-5);

- Consider installation of a detention basin between Highway 51 and Lien Road, if recommended in a complete engineering study and analysis of need for stormwater management, detention and drainage structure improvement on the upper East Branch. The engineering study should consider future urban development, and management of tributaries to the East Branch, such as the Sunnyside stormwater ditch.

Other sixth through tenth year actions include considering completion of the Acewood Pond park acquisition, initiating installation of corridor landscape, design and recreational facility improvements, obtaining land and easements to complete the stream corridor below Highway 30, and installing detention basins as indicated by the extent of new development.

Eleventh through twentieth year actions which should be considered by the City of Madison include the continuation of corridor landscaping, design and recreational improvements, continued development of stormwater detention basins, and further assessment of in-stream water quality management measures, as warranted. The City of Madison, Town of Burke and Dane County (including the Airport Commission) should discuss the most appropriate approach to protection or acquisition of lands north of Aberg Avenue on the West Branch, and to protection of wetland and floodplain areas west of the airport in Section 19, Town of Burke.

TABLE 14. CITY OF MADISON SHORT RANGE IMPLEMENTATION ACTIONS
YEARS 1-5

TYPE OF ACTION	SUGGESTED MEASURES	IMPLEMENTATION SCHEDULE: YEARS 1-5 (1 2 3 4 5)	TOTAL ADDED COSTS, YEARS 1-5*	ESTIMATED COST OF FIRST YEAR ACTIONS
- Plan/Map Amendments	- Amend Madison land use and park and open space plans to reflect environmental corridor. - Amend official map to reflect environmental corridor, including drainage features, within the central Urban Service Area.		$ 3,500 $ 2,300	$ 3,500 $ 2,300
- Regulatory and Review Initiatives	- Implement recently adopted erosion/runoff control ordinance. Encourage infiltration and on-site stormwater discharge practices through the review of site plans for new development. - Consider adoption of comprehensive municipal wetland protection measures. - Seek conservancy zoning for corridor lands requiring protection, but not proposed for short term acquisition.		$ 3,300 $ 2,100	
- Source Control, Maintenance and Surveillance	- Continue street sweeping, maintain current level of effort. Emphasize sweeping lower part of watershed and commercial streets. - Continue leaf collection programs, provide public information directed at proper disposal of leaves and garden debris by urban homeowners. - Provide staff to work with stream corridor businesses to correct known or potential sources of contaminated runoff, and encourage parking lot sweeping. - Increase staff surveillance of non-stormwater discharges to creek. Assist neighborhood creek watch efforts. - Establish and initiate routine annual creek maintenance program, and encourage the involvement and cooperation of neighborhood groups.		$ 14,900 $ 18,300 $ 9,400 $ 28,300	$ 6,840 $ 7,020 $ 2,340 $ 7,020
- Feasibility Studies, Site Proposals	- Develop site use proposals, feasibility studies for park and open space use of floodplain/wetland areas (Mautz-Voit properties) bounded by E. Branch Starkweather, Highways 30 and 51. - Develop design concepts for stream corridor segments below Highway 30, including proposed improvements of recreational facilities (trails, etc.). - Develop thorough assessment of watershed stormwater detention opportunities, sizing, costs and staging.		$ 9,400 $ 11,700 $ 11,300	$ 9,400
- Land Acquisition	- Consider acquisition of floodplain and wetland on "Mautz property" bounded by Highways 30 & 51. - Consider acquisition of possible detention basin site on the East Branch between Highway 51 and Lien Road.		$314,500 $ 44,700	
- Site Development	- Initiate site development for detention basin on the East Branch between Highway 51 and Lien Road.		$ 38,900**	
TOTAL COST (PRESENT WORTH) OF SHORT RANGE IMPLEMENTATION PROGRAM			$512,600	$38,420

* Total Present Worth of Additional Public Costs, Years 1-5 Only. For citywide actions, costs represent an estimate of portion allocable to Starkweather Creek Watershed. An interest rate of 7-5/8 percent has been used to determine present worth.

** One-half of estimated total present worth of costs for basin development.

▬▬ Concentrated or Intensive Effort
▪▪▪▪▪▪▪▪▪▪ Continuing Activity

The role prescribed for Madison is a significant one. Many of the actions prescribed for the city simply amplify the need for continuation or expansion of existing ongoing efforts, such as street sweeping, leaf collection, and stormwater surveillance. Although these practices are routinely conducted, they should not escape evaluation and analysis since their recurring labor and operation and maintenance costs are quite high. On the other hand, source control or "housekeeping" practices are important measures in the developed portion of the Starkweather Creek watershed, and should be adequately defended during annual consideration of the operating budget.

Several of the actions recommended for implementation by the City of Madison represent significant departures from current or planned practice, and entail moderate to high capital expenditures. These include:

- Detention basin development;

- Environmental corridor acquisition proposals within the city;

- Environmental corridor recreational development within the city; and

- Corridor revegetation/landscaping.

Land acquisition proposals contained in the recommended plan are expected to generate significant discussion, due to current fiscal constraints. However, long-term considerations of the importance of these acquisitions to environmental corridor integrity, their value as a future public open space resource, and the detrimental impacts which would accompany their development must be brought to bear on these discussions.

Town of Burke

General Authority. Among general purpose units of government, the Town of Burke has the second largest area of jurisdiction within the watershed. While town powers as dictated by Wisconsin Statute are somewhat more limited than those of cities (see "An Analysis of the Legal Authority of Towns to Implement an Areawide Water Quality Plan"; DCRPC, 1977), the Town of Burke has adequate authority to undertake the water quality improvement programs contained in this plan.

Since the Town of Burke board has been granted village board powers, it has broad authority to act for the health, safety and welfare of the town, including water resource related matters. Towns have adequate statutory authority to levy taxes and special assessments for nonpoint source control programs (within statutory limits). They may also issue general obligation bonds for revenue-producing improvements.

Implementation Responsibility. The Town of Burke's responsibilities in plan implementation relate directly to the resource conservation and protection needs in the town. The following actions and roles are recommended for consideration by the Town of Burke in implementing the plan:

- Consider amending the Town Land Use Plan to reflect the environmental corridors, and to provide protection to intermittent drainageways outside of the central Urban Service Area.

- Utilize the policies contained in the Town Land Use Plan to guide land use and development decisions.

- Consider and discuss with affected landowners wetland zoning for mapped wetlands in environmental corridors.

- Review and comment upon plats (and where possible, other development proposals) to assure adequate consideration of the protection and integrity of the environmental corridor.

- Review and comment upon plats and other developments with regard to the adequacy of erosion control measures and provisions for drainage and control of runoff.

- Undertake drainage channel maintenance or improvement work, where necessary, in cooperation with landowners, the Dane County Drainage Board, and the City of Madison.

- Cooperate with the Dane County Land Conservation Department to facilitate contacts with farm landowners, to promote the development of farm conservation plans and the installation of soil conservation practices. The town should cooperate in an aggressive education and information effort, emphasizing conservation tillage and maintaining stable drainageways through such practices as grassed waterways.

Dane County Airport Commission

General Authority. Under Chapter 114 of Wisconsin Statutes, counties, cities, villages and towns may acquire, establish, own, operate, maintain, enlarge, and protect airports or landing fields. The Dane County Board of Supervisors exercises control over lands within the Dane County Regional Airport which include approximately 4.2 miles of the West Branch of Starkweather Creek, several tributary ditches, and numerous storm sewers which drain much of the airport.

Implementation Responsibility. With respect to the airport, Dane County has two primary roles within the context of the watershed plan. These are, in the short-term, the development and approval of spill containment and pollution control measures and guidelines, and in the long-term, the continuing surveillance of pollutants and maintenance of the stream channel and drainage network on the airport property.

Starkweather Creek dredging and maintenance needs for the channel within the airport property should be evaluated during the first several years of the planning period. A schedule of improvements should be prepared and necessary work carried out in consultation with the City of Madison.

Dane County and the Dane County Airport Commission can plan an important auxiliary role in protection and preservation of the Starkweather Creek environmental corridor. In its Master Plan, the airport proposes to acquire certain lands for the purposes of extending clear zones, buffering major approaches, or preventing development from encroaching upon the airport. Since several land areas surrounding the airport are included in the Starkweather Creek environmental corridor and are proposed to be considered for public purchase, the land acquisition program of the airport may coincide with corridor resource protection needs.

Buffer lands acquired by the airport will generally be maintained in their present use, with no intent to provide public access or develop recreational facilities. The use objectives of management agencies for a given parcel of land may differ. Therefore, it is proposed that the airport consult with and notify the City of Madison (Parks Division and Planning and Development Department), Dane County (Parks and Zoning Departments), the Town of Burke and the Dane County Regional Planning Commission regarding land acquisitions under consideration. Management agencies may wish to consider shared use or purchase of certain parcels on the periphery of airport buffer lands.

Dane County Farm Drainage Board

General Authority. The authority of the Dane County Farm Drainage Board was reviewed earlier in this plan. Until December, 1980, the Drainage Board had authority over the entire creek channel, its tributaries and most of the adjacent land. Upon petition by the City of Madison in 1980, the Circuit Court heard and ordered the transfer of authority over portions of the Starkweather Drainage District in the City of Madison to the Madison Common Council. The court order further stipulated that the assets of the Drainage District are to be used to benefit remaining areas of the District which are not within the City of Madison. As noted earlier in this plan, the assets of the Starkweather District fund total only three cents, and assessments have not been levied since 1954. The maintenance and repair fund has not been replenished to the statutorily required level of five percent of the confirmed benefits in effect in the District.

Implementation Responsibility. The limitations of drainage district law and limited capacity of the drainage board structure to deal with urban and developing lands are well recognized. The 1980 transfer of authority for portions of the Starkweather District within the City of Madison will provide greater financial capacity and flexibility for creek maintenance and improvement, and eliminate the need for the city to seek Drainage Board approval for actions within the District. At the same time, the transfer provides a greater opportunity for the remaining portions of the Starkweather District to function to address agricultural and related drainage problems in the outlying areas of the watershed. The 1980 and 1981 annual reports for the Starkweather Drainage District note the continuing accumulation of trash and debris in the East Branch of the Starkweather Creek, and the need for maintenance. The increasing amount of stormwater discharge to the West Branch, due to new development, is also noted.

In the first five years of the planning period, the Farm Drainage Board should work with the Burke and Blooming Grove town boards to thoroughly inventory drainage problems, improvement needs and possible solutions in the unincorporated areas of the Starkweather Creek watershed. Based on this inventory, consideration should be given to levying an assessment upon the drainage district, and thereafter maintaining the district fund at the required level of five percent of the confirmed benefits in the portion of the district outside of the City of Madison.

Dane County Land Conservation Department

The role of the Dane County Land Conservation Department in the Starkweather Creek watershed plan is to provide technical and financial assistance, information and education to farm landowners in the watershed regarding agricultural conservation practice needs. In the short-term, the Department should consider cooperating with the Town of Burke to facilitate landowner contacts, promote the preparation of farm conservation plans, and create an awareness of available cost-sharing funding, whether provided through the ACP or Dane County programs.

The Department should also assist the Town of Burke in pursuing an aggressive information and education campaign to emphasize the use and benefits of conservation tillage practices. Where warranted and feasible, the Department may wish to assist landowners in equipment sharing and lease arrangements for conservation tillage equipment.

Neighborhood and Volunteer Groups and Organizations

Neighborhood groups and organizations have played an active role in the development of the Starkweather Creek watershed plan, and have participated in stream improvement activities for a number of years. Neighborhood organizations are an important and effective voice in the local political arena, and often play key lead or supporting roles in bringing issues before the Madison Common Council for action. Neighborhood organizations can also effectively educate and inform residents, or organize special projects or activities requiring collective efforts.

The roles of neighborhood organizations, volunteer and civic service groups in assisting the implementation of the Starkweather Creek plan fall primarily into three categories, namely: direct action; information and education; and generating political support through lobbying efforts. Much emphasis has been placed on direct action by groups and organizations. In Starkweather Creek, organizations have concentrated on stream clean-up activities, and cooperating with city departments to improve surveillance of non-stormwater discharges from storm sewers. This type of involvement in maintenance and surveillance is valuable, and the City of Madison should encourage and assist such efforts in the future.

The actions of individual urban homeowners are important in improving the quality of urban stormwater runoff. Through their newsletters, meetings and other means, neighborhood organizations can play a significant role in informing homeowners of the preferred means of disposal of leaves, yard and garden debris, and the proper management of fertilizers, herbicides and pesticides. Neighborhood groups should coordinate their information campaigns through the Madison Streets Division, the City Health Department, and City Parks Division.

Neighborhood groups and organizations in the Starkweather Creek watershed should consider establishing an annual "action agenda" for creek improvement. This agenda would focus on generating support for selected implementation actions indicated in this plan, to help assure timely and continued implementation of plan recommendations. The action agenda should include no more than one or two manageable items per year. Plans for direct neighborhood action, as well as information, education and lobbying efforts may be included in the action agenda.

Cost of the Recommended Program

The additional public costs of implementing the recommended program for the Starkweather Creek watershed are presented in Table 15. These costs are presented in three different formats, for each type or category of expenditure. Included in initial or capital costs are estimates of construction, material and labor costs for capital expenditures, one-time staff costs for special projects such as feasibility studies and site use proposals, and land acquisition costs. These expenditures are scheduled to occur at various times during the 20-year planning period.

Annual costs included in Table 15 consist of recurring costs for continuing activities. These costs generally include staff or labor costs for program operation, administration or maintenance. In the case of information and education efforts, annual costs for airing public service announcements are included. Since many continuing programs are citywide in nature, a portion of the total continuing costs of such programs has been allocated to the Starkweather Creek watershed.

Agricultural nonpoint source control practice costs for the Starkweather Creek watershed have also been expressed as an equivalent annual practice cost, since cost-sharing payments to agricultural landowners are expected to continue throughout the planning period, as farm conservation plans are

gradually implemented. Some agricultural nonpoint source control practices, such as conservation tillage, are funded on the basis of anticipated annual practice costs. Only the public costs (cost-shared portion) of agricultural conservation measures are reflected in Table 15.

Total present worth costs included in Table 15 consist of all initial and future costs, capital as well as annual, discounted back to their present monetary value. A discount rate of 7 5/8 percent is used, and a number of assumptions about the future scheduling of expenditures are inherent in the present worth analysis.

Cost estimates for the recommended Starkweather Creek watershed plan are based on cost data cited in current literature, recent local experience with control measures and practices, and preliminary evaluations of site conditions for site-specific actions. Land acquisition cost estimates consider current tax assessments and transactions for comparable properties, and recent local government experience in land purchases. Agricultural nonpoint source control costs are based on unit area conservation treatment needs developed as part of the Dane County Water Quality Plan, and current cost-sharing rates for agricultural conservation practices. These figures should be treated as general indicators of agricultural nonpoint source control costs, since detailed farm conservation planning is necessary to develop more refined cost information.

A review of the cost estimates in Table 15 indicates that proposed land acquisition and stormwater detention basin construction are the largest capital expenditures. Stormwater detention basin construction cost estimates include all significant opportunities for public detention sites within the watershed. Four neighborhood level basins and three larger basins are envisioned over the twenty year planning period. The most appropriate stormwater detention strategy for the watershed is subject to a detailed feasibility study.

Land acquisition is scheduled to occur throughout the planning period, as discussed in the preceding section on implementation roles and responsibilities. As suggested previously, a cooperative acquisition program involving two or three agencies will help to ease the burden of acquisition costs. The costs of land acquisition are not sunk costs, and such expenditures should be viewed in a different light than investments in equipment or structures which are subject to depreciation and have limited salvage values.

Estimated annual costs presented in Table 15 are low since few new continuing programs requiring administrative or operating expenditures are proposed as part of the watershed plan. Also, only a small portion of the cost of new continuing citywide programs has been allocated to the watershed. The largest annual operation and maintenance expenditure associated with the recommended plan is the establishment of a routine annual maintenance program for the stream corridor. Active neighborhood involvement in stream clean-up activities can help to defray some of the anticipated annual expenditures.

TABLE 15. TOTAL PUBLIC COSTS OF THE RECOMMENDED PROGRAM: STARKWEATHER CREEK WATERSHED*

TYPE OF ACTION	INITIAL OR CAPITAL COSTS	ANNUAL COST	PRESENT WORTH OF ALL COSTS OVER 20 YEARS [1]
Feasibility Studies, Site Proposals	$ 37,440	--	$ 32,313
Runoff and Non-stormwater Discharge Surveillance and Correction	$ 14,040	$ 4,680	$ 56,146
Public Information and Education	$ 3,000	$ 3,840	$ 41,777
Stream Corridor Maintenance	--	$ 7,020	$ 70,890
Stormwater Detention Basin Construction[2]	$ 332,148- 432,148	--	$ 158,012- 194,536
Plan/Map Amendments; Regulatory Initiatives	$ 11,700		$ 11,200
Agricultural Nonpoint Source Control	--	$11,685[3]	$ 117,999
Corridor Landscaping, Trail and Recreational Development	$ 272,648	--	$ 142,776
Land Acquisition	$ 983,700	--	$ 653,179
TOTAL	$1,654,676 1,754,676	$30,735	$1,284,292 1,320,816
Present Worth of Land Salvage Value Present Worth of Other Salvage Values			$ 226,255 $ 29,100
Net Present Worth			$1,028,937 1,065,461

*Costs are based on estimated expenditures for the entire 20-year planning period, and do not include existing program expenditures for various actions, or private sector costs.

1 This figure represents the present monetary value of all additional initial and future public costs over a 20-year period. Future costs are discounted at a rate of 7-5/8 percent.

2 Detention basin costs include preliminary estimates for a basin in the vicinity of Sycamore Avenue, and rough lump sum estimates for four neighborhood level and two larger basins. A range of costs is given.

3 This is an equivalent annual cost, representing five percent of the total estimated cost-sharing payments for agricultural practices over the entire planning period.

Prepared by: Dane County Regional Planning Commission

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APPENDIX A

Water Quality Monitoring Data

Starkweather Creek

1976-1980

TABLE A-1

East Branch of Starkweather Creek
Baseflow Water Quality
Annual Averages 1976-1979

DATE	FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1976																			
mean	2.3		8.2	7.8	.23	3.03	1.43	.79	5.43	.095	.17	672	27	265	12.1	31.0		73	142
min	.8	0	5.5	7.5	.021	1.92	.12	.24	3.67	.050	.08	388	12	166	2.6	1.05			< 10
max	7.0	25	11.6	8.0	.64	4.01	2.80	2.11	7.11	.169	.35	937	58	307	64	150.26			430
#samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10		1	10
1977																			
mean	.5		5.0	7.7	.15	2.95	1.41	.68	5.19	.162	.23	719	32	252	8.2	18.9	14		200
min	.5	0	3.5	7.5	.01	1.30	.10	.11	3.74	.023	.05	616	10	207	2.8	< 5	12		50
max	.6	24	7.2	7.9	.52	4.19	3.34	1.29	6.45	.351	.48	849	63	298	20	33.4	16		380
#samples	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3		4
1978*																			
mean	1.1		8.5	7.8	.259	3.16	1.62	.97	5.99	.154	.21	704	37	291	10.4	22	39		125
min	.5	1	4.35	7.6	.006	1.25	< .03	.34	2.45	.115	.04	619	19	262	2.0	< 5	12		< 10
max	1.8	19	13.0	8.0	.963	4.06	3.23	1.97	7.96	.190	.37	806	55	312	32	64	65		270
#samples	3	2	3	4	5	5	5	5	5	5	5	4	4	4	5	4	2		4
1979																			
mean	1.2		8.8	7.6	.30	3.09	1.65	.37	4.91	.112	.15	691	33	294	6.1	7	36	54	238
min	0	0	4.5	7.4	.023	1.98	.64	.08	2.88	.090	.11	619	30	274	1.3	< 5	8		10
max	6.0	20	14.5	7.8	.937	4.75	2.47	.83	6.92	.139	.21	857	39	308	13.0	12	87		600
#samples	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	1	5
1976-1979																			
mean	1.8		7.7	7.8	.23	3.05	1.51	.72	5.51	.124	.19	691	31	273	10.0	23	30	64	170
min	0	0	3.5	7.4	.006	1.25	<.03	.08	2.45	.023	.04	388	10	166	1.3	< 5	8	54	< 10
max	7.0	25	14.5	8.0	.963	4.75	3.34	2.11	7.96	.351	.48	937	63	312	64	150.26	87	73	600
SD	2.0		3.02	.17	.28	.97	1.08	.56	1.40	.069	.11	125	14	37	13.6	32	28		162
CV	1.1		.39	.02	1.20	.32	.72	.78	.25	.55	.59	.18	-.44	.14	1.36	1.40	.93		.95
#samples	23	22	23	24	25	25	25	25	25	25	25	24	24	24	25	23	10	2	23

*Excluded 2 samples following fertilizer spill (2/13/78 and 3/31/78).

Prepared by: Dane County Regional Planning Commission, May, 1980.

TABLE A-2

East Branch of Starkweather Creek
Baseflow Water Quality
Complete List of Data 1976-1979

DATE	FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1/21/76	2.4	0	11.6	8.0	.027	3.86	2.80	.26	6.95	.076	.08	937	58	306	4.0	10			< 10
3/26	7.0	11	8.6	8.0	.64	3.20	1.88	.40	5.55	.109	.18	762	29	300	3.9	12			10
5/13	5.0	12	5.7	7.9	.090	3.15	2.40	.40	6.03	.103	.13	861	28	281	4	18			180
6/11	3.0	24	6.0	7.8	.304	1.92	2.63	1.52	6.38	.169	.33	544	23	264	7.6	59			110
7/8	1.1	25	5.5	7.9	.208	2.42	1.01	.68	4.32	.099	.15	599	13	230	4.7	1.05			90
8/10	.8	21	6.5	7.8	.407	3.23	.64	.30	4.58	.052	.16	623	27	242	3.2	16.41			430
9/2	1.0	18	9.8	7.7	.021	2.25	.24	1.16	3.67	.054	.15	388	12	166	24	9.4			160
9/29	.9	12	8.4	7.9	.286	3.85	.12	.83	5.09	.050	.08	635	18	286	3.3	12.93		73	260
11/5	.9	3	10.1	7.5	.292	2.39	2.32	2.11	7.11	.162	.35	682	29	264	64	20.56			160
12/2	.8	0	9.5	7.7	.027	4.01	.29	.24	4.57	.077	.10	689	34	307	2.6	150.26			< 10
1/6/77		0	6.8	7.9	.031	4.19	1.14	.11	5.47	.023	.08	742	63	290	7	8.84			
2/8		0	3.5	7.8	.097	3.85	.51	.45	4.92	.050	.05	849	17	298	20	15.55			10
5/25	.5	24	3.8	7.5	.519	1.30	3.34	1.29	6.45	.351	.48	700	37	242	5.5	31.7	13		380
8/1	.5	23	3.7	7.8	.009	2.42	.10	1.21	3.74	.173	.29	616	10	207	5.6	33.4	16		360
10/12	.6	10	7.2	7.7	.106	2.97	1.97	.34	5.38	.214	.25	690	31	224	2.8	< 5	12		50
2/13/78*		0	6.6	7.7	.115	6.57	10.10	5.33	22.12	.130	.17	982	128	292	2.0	< 4			< 10
3/31*					.272	5.53	5.46	2.14	13.40	.178	.26				3.3				
4/27	2.6		13.0	7.8	.244	3.11	3.23	.93	7.51	.174	.19	734	42	284	2.0		12		< 10
7/12	4.0	19	4.35		.006	4.06	< .03	1.97	5.99	.190	.31				32	64	65		200
9/7	.5			7.6	.963	3.83	2.60	.57	7.96	.126	.37	655	31	262	6.4	8			270
10/13	1.0			8.0	.051	1.25	.12	1.02	2.45	.165	.04	806	19	312	4	11			20
12/11	1.8	1	8.0	7.7	.029	3.57	2.12	.34	6.06	.115	.15	619	55	304	7.8	< 5			
4/11/79	6.0	5	14.5	7.8	.937	4.22	.64	.33	6.13	.104	.11	857	39	306	1.5	< 5	87		100
6/26	.1	18	4.5	7.4	.356	2.01	1.10	.83	4.29	.111	.18	590	33	274	12.5	12	49		600
9/5	.1	20	8.6	7.5	.082	2.47	2.47	.08	2.88	.114	.21	524	30	282	13.0		27		300
10/15	0	7	6.0	7.6	.099	1.98	1.98	.51	4.31	.090	.12	684	30	302	2.2	7	8		180
12/13	0	0	10.5	7.8	.023	4.75	2.04	.10	6.92	.139	.14	801	35	308	1.3	< 5	9	54	10

*Fertilizer spill contamination.

Prepared by: Dane County Regional Planning Commission, May, 1980.

TABLE A-3

West Branch of Starkweather Creek
Baseflow Water Quality
Annual Averages 1976-1979

DATE	FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1976																			
mean	1.7		7.9	7.8	.088	.91	1.10	1.04	3.13	.061	.15	704	18	292	10.0	23			
min	.2	0	4.2	7.5	.002	.10	.04	.34	.79	.017	.02	429	7	190	1.4	2.67		80	329
max	7.0	26	11.9	8.1	.278	2.90	3.16	2.42	5.61	.149	.31	929	33	475	44	36.85			10
#samples	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	9			1,600
1977																		1	10
mean	1.6		5.6	7.9	.047	1.23	.16	.81	2.25	.085	.12	687	14	268	3.1	17.5	22		
min	.5	9	2.9	7.7	.022	.16	.07	.62	1.27	.017	.03	580	11	240	2.4	< 5	19		640
max	2.1	23	10.7	8.1	.085	3.23	.29	1.06	3.94	.164	.21	836	20	296	4.3	28.5	27		300
#samples	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		880
1978																			3
mean	3.4		8.8	7.8	.058	2.66	.54	.99	4.25	.054	.11	782	26	311	6.9	16	43		
min	0	0	2.50	7.7	.010	.13	.06	.44	1.23	.016	.01	722	19	282	2.0	7	38		340
max	9.1	19	17.3	7.9	.106	5.77	2.27	2.41	6.84	.126	.24	842	30	358	17	41	48		10
#samples	5	2	3	4	6	6	6	6	6	6	6	4	4	4	6	5	2		900
1979																			4
mean	1.6		8.7	7.8	.038	2.72	.14	.65	3.41	.023	.04	718	23	307	4.1	12	43	111	
min	0	0	4.3	7.7	.018	.43	.07	.25	.89	.005	.01	524	19	285	1.3	7	26		13,600
max	8	21	13.0	7.9	.062	5.37	.19	1.14	6.62	.059	.09	883	31	340	9.0	16	67		260
#samples	5	5	5	5	5	4	5	5	4	5	5	5	5	5	5	4	5	1	50,000
1976-1979																			5
mean	2.0		7.9	7.9	.065	1.72	.64	.92	3.36	.054	.12	719	20	295	6.9	18	37	96	3,380
min	0	0	2.50	7.5	.002	.10	.04	.25	.79	.005	.01	429	7	190	1.3	2.67	19	80	10
max	9.1	26	17.3	8.1	.278	5.77	3.16	2.42	6.84	.164	.31	929	33	475	44	41	67	111	50,000
SD	2.7		3.8	.15	.067	1.66	1.00	.59	1.93	.046	.09	140	8.0	55	8.8	11	16		10,600
CV	1.33		.49	.02	1.03	.97	1.57	.64	.57	.86	.75	.19	.40	.19	1.3	.62	.43		3.14
#samples	23	20	21	22	24	23	24	24	23	24	24	22	22	22	24	21	10	2	22

Prepared by: Dane County Regional Planning Commission, May, 1980.

TABLE A-4

West Branch of Starkweather Creek
Baseflow Water Quality
Complete List of Data 1976-1979

DATE	FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1/21/76	.9	0	8.5	7.9	.015	2.90	.23	.34	3.49	.017	.02	878	14	304	1.4	21			60
3/26	7.0	11	9.1	8.1	.039	2.17	1.89	1.00	5.10	.057	.10	840	21	320	5.2	28			160
5/13	4.0	13	4.2	7.7	.104	1.26	3.16	1.09	5.61	.067	.16	864	33	326	6.7	35			80
6/11	2.0	23	6.5	7.9	.278	.37	2.82	1.09	4.56	.149	.21	729	26	297	4.4	28			560
7/8	1.0	26	9.3	8.1	.098	.40	.11	1.85	2.46	.075	.29	610	9	254	12	36.85			90
8/10	.4	22	4.9	7.8	.031	.24	.15	1.02	1.44	.054	.18	531	12	240	8.7	21.20			30
9/2	.2	19	4.2	7.8	.002	.29	.04	.46	.79	.059	.10	429	7	190	3.4	20.0			60
9/29	.4	13	11.0	8.0	.026	.10	.09	.68	.90	.020	.04	593	13	238	1.7	11.42		80	10
11/5	.7	3	11.9	7.9	.052	.96	.06	.42	1.49	.025	.13	640	15	272	12	2.67			1,600
12/2	.4	0	9.2	7.5	.233	.45	2.40	2.42	5.50	.084	.31	929	33	475	44				640
5/25/77	.5	23	2.9	7.7	.022	.16	.29	1.06	1.53	.164	.21	580	12	240	4.3	28.5	19		880
8/1	2.1	23	3.1	8.1	.085	.31	.13	.75	1.27	.075	.11	645	11	267	2.6	19	19		740 est
10/12	2.1	9	10.7	8.0	.035	3.23	.07	.62	3.94	.017	.03	836	20	296	2.4	< 5	27		300
3/31/78					.098	5.77	.23	.74	6.84	.017	.07				5.0				
4/27	9.1		17.3	7.9	.064	3.32	.08	1.11	4.57	.016	.04	798	26	306	2.0	13	48		10
7/12	5	19	2.5		.010	1.93	.06	2.41	4.42	.126	.24				17	41	82		200
9/7	0			7.9	.038	.13	.34	.71	1.23	.122	.16	722	19	296	4.3	9			900
10/13	1.0			7.8	.106	2.02	2.27	.44	4.84	.023	.16	842	30	282	4.3	7	38		250
12/11	2.0	0	6.5	7.7	.029	2.77	.28	.55	3.62	.021	.01	764	29	358	4.3	9			
4/11/79	8	4	11.3	7.9	.055	5.37	.15	1.05	6.62	.005	.02	857	31	298	2.9	16	46		260
6/26	.1	18	4.3	7.7	.062		.19	1.14		.059	.09	636	19	285	4.5	16	28		9,700
9/5	.1	21	7.1	7.8	.030	.43	.18	.25	.89	.019	.05	526	26	312	9.0		50		3,500
10/15	0	6	8.0	7.8	.025	1.93	.12	.45	2.52	.009	.01	691	19	300	3.0	8	26		50,000
12/13	0	0	13.0	7.9	.018	3.15	.07	.36	3.61	.023	.02	883	20	340	1.3	7	67	111	4,300

Prepared by: Dane County Regional Planning Commission, May, 1980.

TABLE A-5

Starkweather Creek
Special Baseflow Samples 1979-80

DATE	STATION	TEMP °C	D.O. mg/l	pH s.u.	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	TOT P mg/l	CL mg/l	SUS SOL mg/l	MFCC col/100ml
9/10/79	E.B. abv. East Towne Storm Sewer			7.30	7.5	.16	.06	7.72		25.3		
	E.B. @ Lien Road			7.45	7.3	.01	.02	7.33		25.4		
	E.B. @ Sycamore			7.65	6.2	.02	.02	6.24		31.5		
	E.B. @ STH 30			7.88	6.7	1.08	.25	7.03		27.9		
	E.B. @ Milwaukee Street			7.58	4.5	1.7	.08	6.28		26.6		
9/28/79	E.B. @ Spring above Pond				2.55	.02	.06	2.63	.03	24.5		
	E.B. @ Headwaters Pond Outlet				8.2	.02	.10	8.32	.04	37.3		
	E.B. abv. East Towne Storm Sewer	14.0	2.2		7.6					24.5		
	E.B. @ Lien Road	16.0	3.3		7.9	.02	.06	7.98	.03	25.0	10	
	E.B. @ Sycamore Avenue	17.0	2.9		7.6	.02	.04	7.66	.03	25.7	12	
	E.B. @ STH 30	17.5	2.3		7.7	.36	.06	8.12	.07	26.7	10	
	E.B. @ Milwaukee Street	19.0	1.8		5.7	1.75	.17	7.62	.16	31.4	18	
	M.S. @ Atwood Avenue	21.0	3.1		1.25	.02	.7	1.97	.41	24.5	76	
11/12/79	E.B. @ Lien Road	7.2	11.5		6.4	.01	.98	7.39		24.5		
	E.B. @ Sycamore Avenue	3.3	11.4		5.9	.01	.40	6.31		34.0		
	E.B. @ STH 30	2.2	12.5		6.1	.50	.40	7.0		51		
	E.B. @ Milwaukee Street	1.7	10.6		5.7	2.2	.44	8.3		45.9		
	M.S. @ Atwood Avenue	0	11.7		3.5	.88	.62	5.0		33.3		
9/28/79	W.B. @ Hanson Road	16.5	2.8		10	.01	.10	10.11	.05	18.1	12	
	W.B. @ Anderson Street	21.0	4.6		3.2	.01	.22	3.43	.04	17.8	8	
	W.B. @ Commercial Avenue	21.0	5.0		2.0	.01	.16	2.17	.03	17.8	70	
	W.B. @ Milwaukee Street	21.5	2.6		1.75	.04	.16	1.95	.04	19	8	
11/12/79	W.B. @ Hanson Road	7.2	9.8		7.6	.02	.78	8.4		25.2		
	W.B. @ Anderson Street	1.1	14.8		3.6	.11	.68	4.39		16.7		360
	W.B. @ Commercial Avenue	0	12.0		3.3	.04	.50	3.84		16.5		90
	W.B. @ East Washington Avenue											100
	W.B. @ Milwaukee Street	0	13.2		4.1	.03	.78	4.91		20.1		70

Prepared by: Dane County Regional Planning Commission, May, 1980.

TABLE A-6

East Towne Storm Sewer
Storm Event Sampling (April 3, 1980)

PARAMETER	ABOVE	AT	BELOW
pH (s.u.)	7.45	7.05	7.30
Total Phosphorus (mg/l)	0.03	0.05	0.04
Suspended Solids (mg/l)	170	260	190
Hardness (mg/l)	356	98	216
Specific Conductance (umhos)	720	340	530
Nitrate Nitrogen (mg/l)	7.4	6.5	4.3
Ammonia Nitrogen (mg/l)	0.073	0.98	0.51
Organic Nitrogen (mg/l)	0.57	0.85	0.70
Chlorides (mg/l)	26	27	26
Soluble Potassium (mg/l)	1.4	1.0	1.2
Soluble Sodium (mg/l)	9.8	16.5	12.5
Heavy Metals (mg/l) (Soluble/Total)			
Cadmium	.001/.003	.002/.003	.002/.003
Chromium	.00/.00	.00/.01	.00/.01
Cobalt	.00/.00	.0/.0	.0/.0
Copper	.00/.01	.01/.05	.00/.03
Iron	.02/.29	.03/.52	.03/.40
Lead	.0/.0	.00/.05	.00/.01
Manganese	.03/.03	.05/.04	.03/.04
Nickel	.00/.00	.00/.01	.00/.01
Tin	.0/.0	.0/.0	.0/.0
Zinc	.00/.01	.22/.29	.09/.13
Silver	.00/.01	.00/.04	.00/.02
Barium	.05/.05	.0/.0	.05/.0
Total Heavy Metals	.1/.4	.3/1.0	.2/.7

Prepared by: Dane County Regional Planning Commission, May, 1980.

APPENDIX B

Baseflow Water Quality

Dane County Streams and Lake Outlets

1976-1979

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979

PERIOD OF RECORD	STATION		FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1976-79	Badfish Creek	mean			4.4		.38	2.5	10.5	2.3	15.1		6.2						17	30			19,400
	@ CTH A	min		1	0	7.3	.02	.1	1.3	.1	7.5		1.7						3	4			100
		max		23	9.8	8.1	1.22	9.6	18.8	5.1	22.7		10.8						49	106			195,000
		SD			3.1		.32	2.4	5.1	1.3	4.2		2.1						11	24			42,700
		#samples		36	35	35	36	36	36	27	27		33						36	36			35
1976-79	Badfish Creek	mean	80		6.9		4.1*		6.5	1.8	12.1		4.0	1296	179	336			15	38			4,880
	@ STH 59	min	63	0	1.1	7.5	.4		.2	.2	6.1		1.4	1008	140	294			2	4			20
		max	107	23	11.9	8.3	11.0		15	5.4	18.2		6.9	1590	241	386			43	118			74,000
		SD	12		2.6		2.6		4.2	1.0	3.0		1.3	158	24	33			8	28			13,100
		#samples	21	54	54	53	55		55	46	46		55	41	20	19			51	53			49
1977	Badger Mill Creek	mean	5.7		9.4		.159	2.70	.65	.46	3.97	.723	.93	682	43	270	2.9	13			7	22	204,000
	@ STH 69	min	2.2	1	4.1	7.5	.008	1.56	<.04	.14	2.81	.343	.58	637	28	254	1.1	< 5			1		2,100
	(near mouth)	max	12	24	15.7	8.1	.353	4.28	2.22	.78	7.12	1.31	1.44	758	72	284	7.8	28.5			17		1,000,000
		SD																					
		#samples	8	7	7	8	8	8	8	8	8	8	8	7	8	8	8	5			7	1	5
1976-79	Black Earth Creek	mean	28		11.6		.036	1.68	.08	.26	2.00	.113	.14	569	13	275	4.6	7			22	14	1,200
	abv. Black Earth	min	18	0	7.1	7.8	.003	.93	.02	.06	1.11	.051	.05	522	3.4	254	1.3	< 4			4	9.8	180
	@ USGS gage	max	43	21	15.0	8.4	.13	2.36	.32	.82	2.67	.202	.37	628	40	290	18	15.5			48	18	3,600
		SD	7		2.2		.029	.49	.08	.19	.47	.044	.07	31	7	10	4.1	3.4			13	3.2	1,300
		#samples	18	14	15	16	18	17	18	18	17	14	18	16	17	17	14	13			17	6	11
1976-79	Door Creek	mean	4.6		9.8		.053	2.84	.19	.65	3.71	.107	.19	725	21	314	8.1	9.1			52	50	870
	@ Hope Road	min	2.0	0	3.4	7.1	.003	.74	<.03	.21	1.37	.056	.06	616	15	280	1.8	< 5			1	36	< 10
		max	9.9	21	15.7	8.2	.116	5.0	.97	2.92	7.54	.205	.63	919	33	338	38	13			210	81	3,400
		SD	2.3		2.9		.047	1.13	.20	.56	1.39	.044	.13	63	5	16	9.6	2.8			44	13	1,300
		#samples	25	22	24	24	25	25	24	24	25	14	25	25	24	24	14	9			23	13	22
1977-79	Frogpond Creek	mean			9.9		.03	1.9	.2	.8	3.0		.2						2	15			1,800
	@ Franklin Road	min		0	6.91	7.6	<.01	1.1	<.1	.4	2.2		.1						1	3			< 1
		max		20	14.3	8.3	.10	4.7	.4	1.2	5.9		.4						3	67			12,700
		SD			2.2		.03	.89	.1	.2	1.1		.1						.6	15			3,200
		#samples		18	18	19	19	19	19	11	11		19						19	19			16
1977-78	Koshkonong Creek	mean	4.3		4.1		.071	1.86	7.15	2.39	11.71	3.15	3.42	1167	153	351	11.4	17			30		170,000
	@ Bailey Road	min	2.1		0.7	7.2	.019	.07	.16	.92	6.68	1.38	.59	884	93	302	2.8	< 5			20		300
		max	6.9		8.2	7.9	.162	5.91	15.48	10.53	26.09	5.35	6.74	1453	192	386	52.0	29			40		1,000,000
		SD	1.9		3.2		.049	2.13	4.96	2.92	5.65	1.25	1.79	183	31	38	14.8	11					346,000
		#samples	7		4	9	9	10	10	10	10	10	10	9	9	9	10	7			2		8
1977	Koshkonong Creek	mean	14		4.9		.177	4.33	.58	1.35	6.27	1.075	1.13	1010	66	310	3.6	18			14	221	16,000
	near STH 73	min	8.4	1	3.0	7.6	.014	2.20	.10	1.03	3.37	.409	.40	900	54	260	2.0				1		140
		max	18	21	7.3	7.9	.348	9.08	1.79	1.57	10.86	1.942	2.11	1148	87	344	6.0				27		80,000
		SD			1.9		.125	2.74	.74	.31	2.59	.619	.76	92	14	30	1.5						36,000
		#samples	4	6	6	6	6	6	6	6	6	6	6	6	6	6	6	1			4	1	5

*NO_2-N plus NO_3-N.

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979
(continued)

PERIOD OF RECORD	STATION		FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1977-79	Koshkonong Creek	mean	34		10.9		2.81*		.52	1.06	4.38	.192	.44	799	54	319	12	10	4.6	38	46	74	88
	@ Hoopen Road	min	11.5	0	6.9	7.7	1.18		<.02	.44	2.60	.170	.18	776	33	312	2.2	< 5	.9	2	12		< 10
	(Rockdale)	max	56	28.5	14.8	8.8	4.3		1.8	2.8	8.26	.222	.95	825	88	330	23	16	18	200	77		180
		SD	13		2.7		1.27		.57	.63	1.39		.20						4.8	55			
		#samples	16	16	15	14	16		16	16	16	4	16	5	4	4	4	3	11	12	4	1	4
1976-77	Maunesha River	mean	3.4		12.6		.030	2.89	.09	.50	3.49	.068	.09	647	21	277	1.8	12.3			22	39	630
	@ Greenway Road	min	1.4	2	9.3	7.8	<.001	1.08	<.03	.11	1.63	.010	.01	548	11	238	0.5	2.6			1	36	< 10
		max	14	24	17.3	8.5	.058	5.54	.44	.89	5.96	.214	.25	886	27	348	5.2	28.0			59	42	3,000
		SD	3.5		2.6		.017	1.45	.11	.24	1.35	.064	.07	93	5	33	1.3	6.7					810
		#samples	13	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15			4	2	13
1976-79	Mt. Vernon Creek	mean	16		11.4		.016	2.88	.08	.23	3.20	.032	.06	499	8	241	4.8	5			26	15	260
	abv. STH 92	min	11	1	7.4	7.7	<.003	1.15	0	.04	1.21	.009	.01	428	3	216	1.4	< 1			1	14	< 10
		max	29	19	14.6	8.3	.037	4.22	.32	.64	4.47	.064	.16	589	21	262	20	13.0			48	17	1,400
		SD	4.3		1.8		.008	.77	.08	.15	.79	.012	.03	35	3	11	4.0	2.9			14	2	275
		#samples	33	28	29	33	33	32	33	33	32	33	33	33	33	33	33	28			28	3	25
1976-79	Murphy Creek	mean	2.73		8.7		.027	.19	.32	.90	1.40	.024	.06	559	44	187	5.8	24			12	28	660
	@ Beld Street	min	<.4	2	5.8	7.5	.002	.06	.04	.32	.74	<.005	.02	419	9	155	1.0	< 5			1		< 10
		max	5.81	23	15.3	8.2	.306	.45	1.72	1.68	2.61	.046	.11	679	66	254	16	44			33		7,300
		SD	1.61		3.6		.070	.12	.40	.37	.51	.011	.03	70	16	27	4.6	13			12		1,800
		#samples	17	6	6	18	18	17	18	18	17	18	17	18	18	18	17	16			6	1	16
1976-79	Nine Springs Creek	mean			8.6		.05	3.5	.2	.7	4.6		.2	680	23	275			2	43			3,600
	@ Moorland Road	min		6	5.3	7.5	.02	1.5	0	0	2.8		0	550	15	220			1	4			1
		max		20	12.3	8.5	.14	4.7	.3	3.0	5.8		1.1	800	34	304			12	293			45,000
		SD			2.2		.03	.8	.1	.6	.7		.3	65	4	22			2	55			8,700
		#samples		11	34	35	35	35	34	26	25		34	23	23	23			34	34			32
1976-79	Pheasant Branch	mean	1.5		8.4		.045	3.00	.21	.75	3.96	.038	.08	889	19	302	5.7	8	1.8		51	160	450
	@ USH 12	min	.48	0	3.7	6.9	0	.41	<.03	.24	1.26	.010	.03	650	14	240	2.6	< 4	.4		8	87	< 10
		max	4.3	24	14.2	8.2	.15	7.3	.50	2.06	6.83	.086	.18	1140	20	358	14	22	4.4		96	300	2,300
		SD	1.0		2.4		.026	1.55	.12	.37	1.55	.020	.04	128	4	26	2.3	5	1.0		25	76	519
		#samples	40	34	37	39	43	42	24	24	23	24	44	39	36	36	23	14	19		36	20	33
1978-79	Pheasant Branch	mean	2.6		10.3		.037	2.60	.15	.72	3.47	.034	.06	942	41	317	4.6	8			56	139	250
	@ Stamm House	min	.58	0	7.8	7.8	.007	.95	<.03	.19	1.63	.010	.01	830	31	282	2.6	< 5			18		10
		max	4.4	17	12.8	8.2	.119	5.92	.28	2.42	6.95	.092	.23	1128	77	374	7.6	13			104		700
		SD	1.4		2.2		.032	1.43	.09	.64	1.78	.026	.06	98	14	28	1.6	3			26		280
		#samples	10	6	8	9	10	9	10	10	9	10	10	9	9	9	9	8			9	1	5
1976-79	Pheasant Branch	mean			9.5		.072	2.19	.17	.64	3.19	.068	.10	679	17	280	8.0	8	2.0		38	55	320
	@ CTH M	min		0	2.1	7.1	0	.26	<.03	.19	1.21	.008	.02	451	11	170	2.4	< 4	.6		3	22	< 10
		max		24	14.5	8.3	.32	3.83	.42	1.06	4.84	.387	.45	1000	23	326	22	18.1	3.7		128	150	6,200
		SD			3.5		.066	1.21	.12	.28	1.13	.082	.07	121	35	40	5.6	4.3	.9		35	35	1,140
		#samples		29	35	39	38	37	20	20	19	19	39	39	33	33	19	13	18		30	19	28

*NO_2-N plus NO_3-N.

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979
(continued)

PERIOD OF RECORD	STATION		FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1976-79	Rutland Branch	mean			10.2		.02	3.9	.1	.3	4.4		.1										
	@ CTH A	min		1	7.9	7.6	.01	3.2	0	0	3.5		0						1	10			2,900
		max		16	14.3	8.5	.03	4.6	.5	1.3	5.4		.2						1	1			10
		SD			1.5		.005	.4	.1	.3	.5		.1						3	41			55,000
		#samples		34	35	35	36	35	36	36	25		33						1	10			9,600
																			36	36			33
1976	Sixmile Creek	mean	4.9		10.3		.026	3.10	.08	.56	2.80	.056	.09	594	12	287	3.0	22			17	20	260
	@ Madison Street	min	2.1	1	4.8	7.6	.003	1.69	<.03	.23	2.36	.020	.02	524	10	253	1.3	2.2			1		< 10
	(Waunakee)	max	2.4	28	14.3	8.4	.051	3.13	.35	1.12	3.37	.116	.12	801	17	330	5.7	86			46		740
		SD	2.1		2.7		.017	.46	.11	.28	.38	.032	.04	84	3	24	1.3	25			16		250
		#samples	9	9	9	9	9	8	9	9	8	7	9	9	9	9	9	9			7	1	9
1976-79	Sixmile Creek	mean	4.4		8.5		.028	1.58	.11	.50	2.20	.086	.12	629	20	295	4.0	12			34	36	1,600
	@ Mill Road	min	1.3	0	4.4	7.6	.002	.51	<.03	.13	1.21	<.005	.02	506	6	226	.6	2.6			1	27	< 10
		max	7.0	26	12.5	8.4	.095	3.33	.59	1.01	3.93	.592	.62	975	49	350	15.0	29.0			125	45	13,000
		SD	1.7		2.8		.023	.70	.14	.21	.72	.091	.10	96	9	26	3.1	7.5			27		3,200
		#samples	2.7	22	22	27	44	43	44	44	43	44	44	27	27	27	44	22			22	2	22
1976-77	Spring Creek	mean	3.7		10.4		.043	2.42	.21	.43	3.09	.098	.13	579	12	277	6.4	8.7			38		1,300
	@ CTH M	min	1.8	1	6.7	7.6	.016	.63	<.04	.07	1.41	.023	.03	501	7	252	1.6	3.7			5		< 10
		max	8.3	27	14.3	8.2	.104	4.22	1.54	.83	4.56	.564	.69	696	20	320	15.3	22			157		11,000
		SD	1.5		2.6		.026	1.03	.34	.23	.86	.12	.15	46	3	15	3.9	5.0			39		2,900
		#samples	18	16	16	18	18	18	18	18	18	18	18	18	18	18	18	14			17		14
1976-79	Starkweather Creek-	mean	1.8		7.7		.23	3.05	1.51	.72	5.51	.124	.19	691	31	273	10.0	23			30	64	170
	East @ Milwaukee St.	min	0	0	3.5	7.4	.006	1.25	<.03	.08	2.45	.023	.04	388	10	166	1.3	< 5			8	54	< 10
		max	7.0	25	14.5	8.0	.963	4.75	3.34	2.11	7.96	.351	.48	937	63	312	64	150			87	73	600
		SD	2.0		3.0		.28	.97	1.08	.56	1.40	.069	.11	125	14	37	13.6	32			28		160
		#samples	23	22	23	24	25	25	25	25	25	25	25	24	24	24	25	23			10	2	23
1976-79	Starkweather Creek-	mean	2.0		7.9		.065	1.72	.64	.92	3.36	.054	.12	719	20	295	6.9	18			37	96	3,400
	West @ Milwaukee St.	min	0	0	2.5	7.5	.002	.10	.04	.25	.79	.005	.01	429	7	190	1.3	2.67			19	80	10
		max	9.1	26	17.3	8.1	.278	5.77	3.16	2.42	6.84	.164	.31	929	33	475	44	41			67	111	50,000
		SD	2.7		3.8		.067	1.66	1.00	.59	1.93	.046	.09	140	8	55	8.8	11			16		10,600
		#samples	23	20	21	22	24	23	24	24	23	24	24	22	22	22	24	21			10	2	22
1979	Sugar River, West	mean	16		10.2		.032	3.93	.22	.48	4.43	.287	.35	609	20	275	15.6	8			54	22	1,600
	Branch @ STH 92	min	13	2	8.6	7.7	.013	3.15	<.03	.11	3.64	.208	.24	547	15	266	7.1	< 5			30		20
	(abv. Mt. Vernon	max	20	18	12.5	8.3	.063	4.54	.60	1.29	4.97	.432	.55	661	24	288	34.5	14			117		3,300
	Creek)	SD																					
		#samples	5	5	5	5	5	5	5	5	4	5	5	5	5	5	5	4			5	1	5
1977-78	Sugar River, West	mean	30		11.4		.024	2.88	.10	.43	3.42	.161	.25	517	14	234	9.9	6.1			39		640
	Branch @ Fritz Road	min	18	0	9.6	7.6	<.002	1.30	<.03	.06	1.92	.046	.14	438	9	194	2.5	3.6			9		< 10
	(bel. Mt. Vernon	max	41	22	14.4	8.2	.039	4.22	.27	.81	4.82	.270	.42	565	22	252	18	11.7			92		1,200
	Creek)	SD	7		1.8		.012	.84	.09	.20	.83	.053	.09	39	4	16	6.1	2.7			27		420
		#samples	14	10	11	14	14	14	14	14	14	14	14	14	14	14	14	10			13		9

BASEFLOW WATER QUALITY
Dane County Streams and Lake Outlets: 1976-1979
(continued)

PERIOD OF RECORD	STATION		FLOW cfs	TEMP °C	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3- N mg/l	ORG N mg/l	TOT N mg/l	REAC P mg/l	TOT P mg/l	COND umhos	CL mg/l	ALK mg/l $CaCO_3$	TURB FTU	COD mg/l	BOD_5 mg/l	SUS SOL mg/l	SUS SED mg/l	SO_4 mg/l	MFCC col/100ml
1976-79	Token Creek	mean	17		11.1		.032	3.43	.11	.41	3.98	.035	.07	558	10	267	7.8	11.1			51	21	260
	@ USH 51	min	14	0	7.0	7.7	<.001	1.94	<.03	<.06	3.03	.004	<.01	458	4	236	1.1	< 1.0			1	19	< 10
		max	27	25	15.8	8.3	.078	5.14	.84	1.76	5.68	.134	.16	660	17	288	27	83			148	23	1,700
		SD	3		2.3		.019	.73	.15	.37	.57	.028	.04	45	3	12	8.0	15.9			35		410
		#samples	33	29	30	32	33	31	33	33	31	33	33	32	33	32	32	30			30	2	29
1976-79	Yahara River	mean	9.8		11.5		.024	2.92	.07	.33	3.32	.037	.06	608	19	270	3.9	7.1			36	34	230
	@ Windsor	min	4.8	0	7.8	7.7	<.001	1.39	<.03	<.03	1.86	<.004	<.01	480	8	188	.6	1.3			2	28	< 10
		max	16	24	17.9	8.3	.064	5.42	.78	1.83	5.45	.109	.14	724	25	306	23	22			102	39	1,000
		SD	2.2		2.0		.012	.95	.10	.27	.92	.020	.04	54	3	22	4.1	4.9			25		210
		#samples	58	27	28	32	58	56	58	58	56	58	58	32	32	31	58	28			32	2	28
1976-77	Yaraha River	mean			10.3		.042	1.47	.23	1.04	2.77	.110	.22	517	12	244	12.7	23					130
	@ STH 113	min		0	5.6	7.8	.009	.12	.06	.14	1.06	.012	.01	423	7	198	1.0	3.7					< 10
		max		30	21.6	8.6	.084	3.93	.68	1.69	4.64	.404	.72	668	16	334	37	73					590
		SD			4.7		.020	1.49	.20	.60	1.15	.110	.21	93	3	46	13.0	22					240
		#samples		10	10	10	10	10	10	10	10	10	10	10	10	9	10	9					9
1976-79	Yahara River	mean					.018	.31	.27	.86	1.45	.063	.11	393	16	161	3.7	17					20
	@ Lake Mendota	min				7.6	<.003	.03	<.03	.15	.57	<.005	.03	334	3	96	.7	< 1.0					< 10
	Outlet	max				8.7	.153	.96	.93	2.32	3.09	.126	.29	481	19	194	24	43					60
		SD					.028	.28	.21	.40	.48	.035	.05	34	3	17	4.1	11					18
		#samples				40	50	50	50	50	50	50	50	39	40	39	47	22					9
1976-79	Yahara River	mean					.023	.26	.23	.92	1.44	.044	.09	417	22	160	4.7	20					22
	@ Lake Monona	min				7.6	<.003	<.02	<.03	.48	.81	<.005	.03	359	13	134	.8	< 5					< 10
	Outlet	max				8.4	.251	1.12	.84	3.02	3.45	.114	.18	593	28	278	17	39					80
		SD					.043	.26	.16	.40	.46	.024	.03	41	3	24	3.8	9					20
		#samples				34	45	45	45	45	45	45	45	34	34	33	40	18					10
1976-79	Yahara River	mean	161		11.1		.24*		.19	1.1	1.48		.09	429	24	190			3.4	10	6	26	13
	@ Lake Waubesa	min	5.5	0	4.7	7.5	.01		<.02	.6	.8		.04	323	20	158			1.2	0	1	22	< 1
	Outlet (McFarland)	max	621	28	14.9	9.2	.9		.57	2.2	2.2		.20	552	31	298			6.6	22	13	29	100
		SD	127		2.2		.24		.17	.4	.32		.03	49	3	35			1.4	7	5	2	17
		#samples	43	42	42	42	42		41	41	42		40	41	13	13			30	25	9	13	36
1976-79	Yahara River	mean			9.1		.02	.6	.2	1.5	2.5		.2	497	27	191			5	23			550
	abv. Stebbinsville	min		0	.54	7.6	0	.1	0	.1	.5		.1	370	20	144			1	2			0
	Dam	max		27	16.9	9.2	.07	1.5	1.0	4.0	5.1		.5	610	35	230			11	54			4,800
		SD			3.4		.02	.4	.2	.9	1.0		.1	65	4	21			3	16			1,100
		#samples		36	35	36	37	36	37	29	28		36	22	22	21			37	36			35
1976-79	Yahara River	mean			9.3		2.2*		2.7	1.6	6.1		1.9	746					11	32			2,000
	@ STH 59	min		0	3.2	7.5	.1		<.02	<.2	1.9		.11	450					1	3			< 10
		max		25	14.2	8.8	7.6		10.8	3.9	15.5		6.7	1300					82	126			41,000
		SD			2.7		1.8		2.8	.8	2.8		1.4	259					12	24			3,200
		#samples		54	53	54	55		55	46	46		52	20					52	54			50

*NO_2-N plus NO_3-N.

Prepared by: Dane County Regional Planning Commission, May, 1980.

APPENDIX C

Historic Baseflow Water Quality

Dane County Streams

TABLE C-1: HISTORIC BASEFLOW WATER QUALITY
Dane County Streams

PERIOD OF RECORD	STATION		FLOW cfs	D.O. mg/l	pH s.u.	NO_2-N mg/l	NO_3-N mg/l	NH_3-N mg/l	ORG N mg/l	TOT N mg/l	TOT P mg/l	ALK mg/l $CaCo_3$	BOD_5 mg/l	SUS SOL mg/l	SO_4 mg/l	N:P ratio
1942-44	Nine Springs Creek @ Moorland Road	mean				.04	1.78	.30	.62	2.72	.48	275		43		5.7
		min				.01	.14	.10	3.42	.80	.08	258		2		
		max				.26	2.84	.73	.15	5.30	7.30	316		1273		
		SD				.043	.798	.125	.506	.888	.927	13		155		
		#samples				67	66	67	67	67	67	61		67		
1948-49	Pheasant Branch betw. N. Br. and Century Ave.	mean	.48	9.1		.012	.514	.140	.424	1.05	.21	296	2.0		124	5.0
		min	.10	6.2	7.4	.0032	.016	.020	.008	.115	.13	250	.3		35	
		max	.99	14.1	8.4	.018	1.46	.364	.783	2.41	.30	330	4.0		309	
		SD	.24	2.5		.016	.435	.134	.273	.679	.06	21	1.7		63	
		#samples	13	14	13	14	14	13	13	14	13	14	13		14	
1948-49	Sixmile Creek abv. Woodland Dr.	mean	3.0	8.6		.066	1.04	.351	.687	2.04	.50	293	7.0		7.8	4.1
		min	2.0	5.0	7.3	.002	.080	.032	.358	.756	.02	250	2.0		2.0	
		max	4.0	13.3	8.5	.136	1.74	1.47	1.115	3.21	.92	330	42.0		13.3	
		SD	.98	3.0		.082	.56	.47	.243	.82	.25	26	11.7		3.8	
		#samples	11	11	10	11	11	10	10	11	11	11	11		11	
1942-43	Starkweather Creek-East @ Milwaukee Street	mean	5.1			.02	2.38	.080	.36	2.84	.14	282		22.1		20.3
		min	3.2			.007	.08	.022	.12	.60	.06	250		4.5		
		max	7.3			.06	4.00	.26	1.11	4.22	.52	310		217		
		SD	.92			.01	1.16	.051	.22	1.04	.08	15		38.8		
		#samples	29			29	29	29	29	29	29	18		29		
1955	Starkweather Creek-West @ Anderson St.	mean		7.7		.45*		.10	.36	.91	.10	259	3.0			9.1
		min		.9	7.7	.04		.02	.16	.27	.02	226	1.1			
		max		11.9	8.5	1.02		.29	1.08	1.47	.26	294	5.6			
		SD		2.8		.40		.09	.25	.41	.08	22	1.5			
		#samples		12	12	11		12	12	11	12	11	12			
1968-69	Starkweather Creek-West @ Anderson St.	mean				1.39*		.47	.57	2.41	.10	320				24.1
		min			7.0	.13		.07	.01	.41	.02	234				
		max			8.3	6.5		1.25	1.57	5.64	.27	386				
		SD				1.42		.38	.58	1.67	.058	39				
		#samples			21	36		36	35	36	21	21				
1948-49	Token Creek @ USH 51	mean	10.2	9.4		.036	2.05	.123	.458	2.62	.17	279	3.5		9.5	15.4
		min	10.0	6.2	7.6	.003	.118	.008	.185	1.16	.10	248	1.9		3.0	
		max	10.6	14.4	8.2	.086	3.20	.250	.820	3.75	.27	370	6.0		18.4	
		SD		2.9		.022	.83	.082	.208	.68	.05	29	1.2		4.2	
		#samples	4	14	13	14	14	13	13	14	14	14	13		14	
1948-49	Yahara River abv. STH 19	mean	5.8	9.6		.034	1.46	.276	.628	2.02	.25	285	2.62		9.0	8.1
		min	5.0	5.9	7.3	.003	.072	.0098	.221	1.31	.12	257	1.50		6.4	
		max	7.9	12.3	8.3	.098	2.88	.625	.720	3.19	.35	340	4.50		14.7	
		SD	.95	3.1		.024	.65	.554	.700	.52	.08	22	.98		3.2	
		#samples	7	14	14	14	14	13	14	14	14	14	13		14	

*NO_2-N plus NO_3-N.

Data sources: Sawyer, 1942-43; Burgy, 1949; Emelity and Hanson, 1949; Belter and Calabresa, 1950; Burgy, 1950; Ketchum, 1954; Madison City Health Dept. Lab. Books.

Prepared by: Dane County Regional Planning Commission, May, 1980.

APPENDIX D

Description of the Starkweather Creek Environmental Corridor and Possible Management Actions

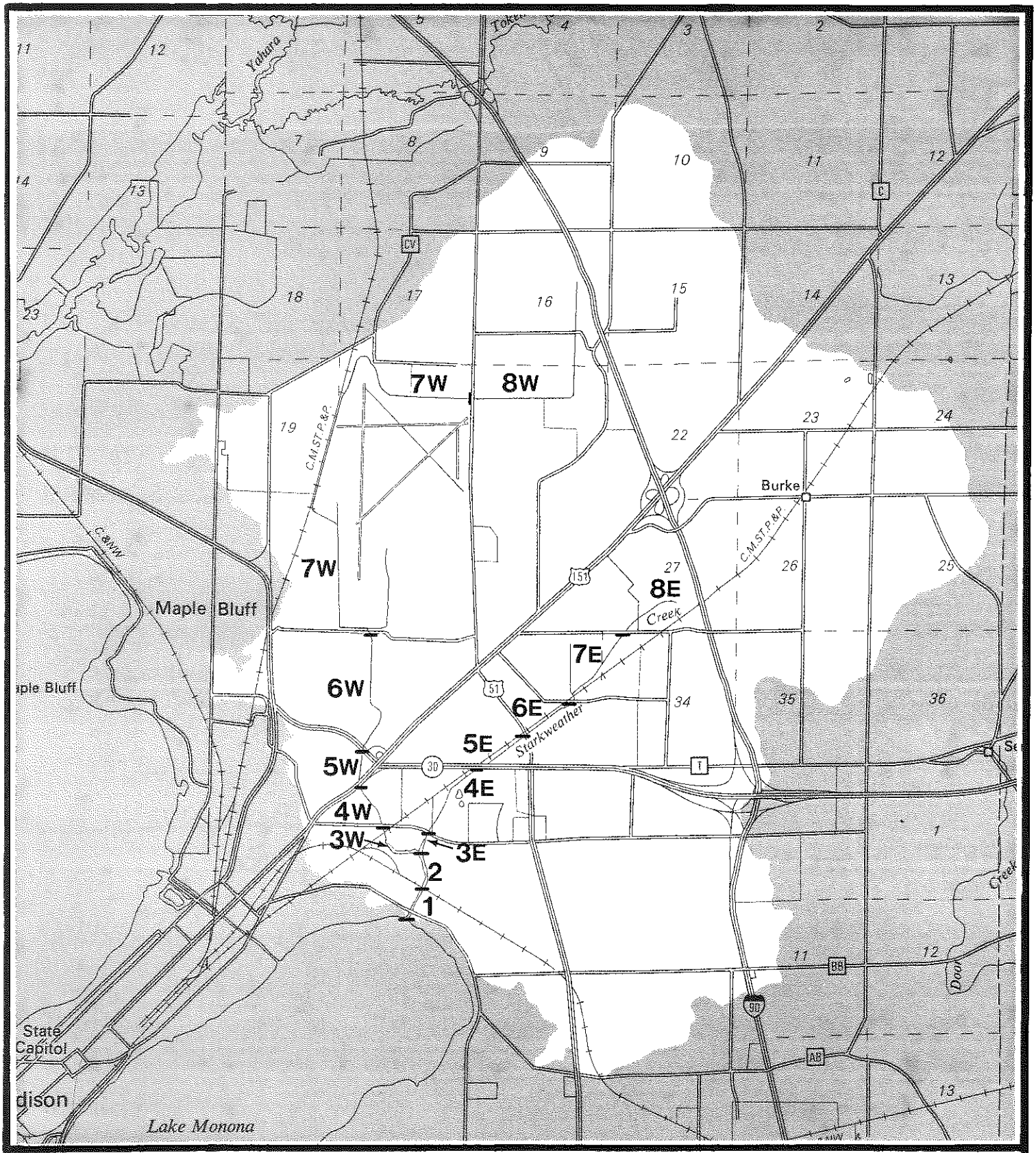

FIGURE D-1
STARKWEATHER CREEK STREAM SEGMENTS

3E
3W
} STREAM SEGMENT NUMBERS

— SEGMENT DIVIDING LINES

May, 1980

0 ½ 1
Scale in Miles

Prepared by:
The Dane County Regional Planning Commission

Introduction

For descriptive purposes, the Starkweather Creek environmental corridor (see recommended plan map) has been divided into fourteen planning segments as shown on Figure D-1. Limits of these segments are as follows:

Stream Planning Segments - Starkweather Creek

	East Branch		West Branch
1.	Mouth to Chicago and Northwestern railroad tracks - main stem.		
2.	Chicago and Northwestern tracks to confluence East and West Branches.		
3E.	Confluence to Milwaukee Street.	3W.	Confluence to Milwaukee Street.
4E.	Milwaukee Street to CTH "30".	4W.	Milwaukee Street to East Washington Avenue.
5E.	STH "30" to USH "51".	5W.	East Washington Avenue to Aberg Avenue.
6E.	USH "51" to Sycamore Avenue.	6W.	Aberg Avenue to Anderson Street.
7E.	Sycamore Avenue to Lien Road.	7W.	Anderson Street to USH "51".
8E.	Above Lien Road.	8W.	USH "51" and above.

A verbal description of each segment of the stream corridor will be provided in this Appendix, and includes discussion regarding the visual characteristics and quality of the stream, its banks, the existing vegetation in the corridor, noteworthy natural resource features and objectionable elements and intrusions into the corridor.

Corridor Descriptions

Stream Segment 1; Lake Monona to Chicago and Northwestern railroad bridge: This segment of the Starkweather Creek environmental corridor begins at Olbrich Park on the northeastern shore of Lake Monona. The mouth of Starkweather Creek is approximately 100 feet wide at this point, and the width of the stream tapers to about 40 to 50 feet from the Atwood Avenue bridge northerly to the railroad bridge. The water depth in this reach is generally less than five feet, at the channel centerline. The deepest portion is from the Olbrich Park boat ramps, just north of Atwood Avenue, southerly to the mouth. Near the railroad bridge at the north end of the segment, depths are generally around two feet.

Drainage district plans of 1911 and more recent channel cross sections show that considerable siltation has occurred in this segment, perhaps reducing depth by two to four feet over the past thirty years. Apparent streamflow is sluggish in this section, since backwater from Lake Monona affects the lower mile of the stream. This sluggish flow implies that much of the suspended sediment carried in Starkweather Creek is deposited on the streambed of the lower reaches.

The shoreland of Lake Monona near the mouth of Starkweather Creek affords attractive views of Madison's downtown, and is heavily used. Between the Olbrich Park boat launching ramps and Lake Monona, the banks of Starkweather Creek extend two to three feet above water level. Prior to a 1983 improvement project, bare and eroded areas were in evidence along the banks and near the mouth of the creek. The existing vegetation along the streambank between Atwood Avenue and the lake shore is now in good condition, following the removal of many undesirable species as part of the 1983 streambank project. Attractive cottonwood dominate the canopy layer of segment 1 in several places, but lack the diversity needed to substantially improve the corridor's visual environment.

Between Atwood Avenue and the railroad bridge, there is a well-defined but narrow corridor on the east bank of the creek. Here the understory vegetation is in very poor condition and extremely overgrown. On the west bank, there is a large open area which was the sight of the Olbrich Park boat houses. This is being redeveloped as part of the Olbrich Botanical Gardens. Public access to the Starkweather Creek environmental corridor is freely available throughout segment 1 from just south of the railroad bridge to Lake Monona.

The Olbrich Park or Walterscheit drainageway discharges to Starkweather Creek just south of the C & NW railroad bridge. The discharge channel for this 1,645 acre urban storm-sewered basin is about 20 feet wide, and enters on the east bank of Starkweather Creek.

Stream Segment 2; Chicago and Northwestern railroad bridge to the confluence of East and West Branches: This segment of Starkweather Creek includes limited but accessible land on and adjacent to the

eastern streambank and very limited less easily accessible public land along the western streambank. Industry has encroached upon a dedicated greenway along the west streambank. The streambanks extend two to four feet above water level throughout segment 2, and are slightly eroded, especially on the western bank.

Normal water depths decrease from about 2½ feet at southern end of segment 2 to about 1½ feet at the northern end, near O.B. Sherry Park. This entire segment is affected by backwater from Lake Monona, and subject to apparent reversals of flow due to wave action from Lake Monona on very windy days. Several storm sewers draining local streets discharge to segment 2 and cause localized debris problems.

The existing environmental conditions in segment 2 are varied, but generally deteriorated. While the strip of public land between Starkweather Drive and the eastern streambank has been landscaped in the past and provides a moderately attractive passage for the pedestrian, invasive and unwanted plant species are inhabiting the streambank and reducing its quality. The western streambank area is overgrown with undesirable vegetation, and made unattractive by the encroachment of an industrial parking lot and storage area upon the streambank. This encroachment is within a dedicated greenway. Public access to this area has been limited by fences. Trash and debris are common along the streambanks in segment 2.

A small wetland near the confluence of the East and West Branches is a valuable resource feature of segment 2. This wetland, somewhat triangular in shape with an area of 2.5 acres, complements the visual environment of the confluence of the East and West Branches. Waterfowl and turtles are often observed in this small wetland, which is relatively inaccessible. Unfortunately, sediment from a neighboring commercial/industrial area appears to have damaged this wetland to the extent that invading weed species may be out-competing wetland plants.

Stream Segment 3E; East Branch, Confluence to Milwaukee Street: This segment of Starkweather Creek runs along the East Branch, from the confluence northward to Milwaukee Street. The water surface of the East Branch narrows from 35 feet at the confluence to 20 feet at the Milwaukee Street bridge. Normal water depths gradually diminish through this reach from about 1½ feet to less than one foot. Emergent rooted aquatic plants are common in this reach, as is decaying floating vegetation from farther upstream. This reach is affected by backwater from Lake Monona.

A large public park, O.B. Sherry Park, borders the east side of this stream segment and includes a bicycle and pedestrian path which generally parallels the stream and then crosses the East Branch via a small footbridge. The west side of this stream segment does not include public lands. Vegetative conditions along the east bank of segment 3E are relatively good, since many of the plants were installed as landscaping for O.B. Sherry Park. Unfortunately, improved maintenance appears necessary as many undesirable plant species such as honeysuckle and shrubby willows are becoming established along the eastern streambank

of this segment and segment 2, directly downstream. Vegetation on the west bank of segment 3E is not well maintained. Near the confluence on the west bank, vegetation is crowded, overgrown and unmanaged. Residential development borders the western streambank. On the eastern streambank of this stream segment is a small wetland, bordered by O.B. Sherry Park and Milwaukee Street. This wetland is approximately 2.9 acres in size. It appears to have been adversely impacted by surrounding development and runoff from the roadway. Unwanted species have begun to invade the wetland.

Stream Segment 3W; West Branch, Confluence to Milwaukee Street: This stream segment runs along the West Branch, from the confluence of the East and West Branches to Milwaukee Street. From the bottom to top of the segment, the West Branch water surface narrows from 40 feet to about 22 feet at Milwaukee Street. Backwater from Lake Monona normally affects only the downstream half of this reach, unless Lake Monona is unusually high. Water depths vary from 2½ feet near Fair Oaks Avenue to about 1½ feet near Milwaukee Street. Storm sewers collecting runoff from a number of local streets discharge to segment 3W. There appears to be some build up of debris on the streambed of the West Branch near the confluence.

The existing environmental and visual conditions along segment 3W are deteriorated, but do reflect potential for improvement. The northerly streambank has virtually no public land, except a short, 20 foot wide grassed strip which parallels the stream near Fair Oaks Avenue. The rear lot lines of residential properties extend to the streambank, limiting opportunities for corridor expansion and scenic improvement or management. This segment of stream was improved by the City of Madison in the 1960's, and the bank grading and stabilization has lent a manicured, if somewhat sterile appearance to the northerly streambank.

A dedicated greenway and a proposed parkway parallel the southerly streambank in segment 3W. Streambank vegetation is not well managed along the southerly bank, and debris, litter and undesirable plants spoil the appearance of the area. However, the southerly bank does offer substantial potential for expansion of the environmental corridor and provision of public access and passage along the Creek which are currently unavailable in this area. The major opportunity is in the vicinity of the now disused Madison Metro bus barn property on Fair Oaks Avenue. Redevelopment proposals for this area have been generated by the City of Madison, and will be under consideration for several years. The upstream half of the southerly streambank in segment 3W includes a small mapped wetland of 2.9 acres and an existing broad city greenway which also serves limited park and recreation needs. The floodplain broadens considerably just south of Milwaukee Street to encompass these features.

Stream Segment 4E; East Branch, Milwaukee Street to State Highway "30" overpass: This segment of the East Branch of Starkweather Creek extends from Milwaukee Street, where the normal water surface width is about 20 feet, to the Highway "30" overpass where the stream is about 15 feet wide. The streambanks along this portion of the creek extend as much as six to eight feet above the water surface. This segment is about seven-

tenths of a mile long, and its westerly bank is bounded by neighborhood commercial and residential development along Fair Oaks Avenue north of Milwaukee Street.

The easterly bank is adjacent to a sand, gravel and cement operation which has two large quarry ponds adjacent to it. Adjoining and paralleling the stream corridor in the northern half of this segment are several old ditches which were formerly part of the main channel. A tributary ditch known as the Eastmoreland Ditch enters the East Branch Starkweather Creek from the east near the northern end of segment 4E. Associated with the Eastmoreland Ditch which runs easterly and southerly from the creek are a large extension of the floodplain and a mapped wetland area of approximately 47.5 acres.

Streambank vegetation in segment 4E consists mostly of common grasses. Trees and shrubs are fairly sparse. Trash and debris do not appear to be as great a problem here as on other segments of the stream. This may be due to the relative inaccessibility of this stream segment. The Madison official map indicates proposed parkway along the East Branch and Eastmoreland Ditch through this segment. This is generally 200 feet wide but increases to 500 feet in one location.

Lands within the environmental corridor lying east of stream segment 4E appear to have substantial potential for development as a recreation and open space resource. Due to large expanses of floodplain, wetland and very poor soils, this area is not particularly suitable for development. With eventual rezoning and acquisition (through purchase or dedication) the area could be managed as a park with ponds suitable for fishing and swimming, restored native plant communities and passive and active recreational areas. Such management would greatly enhance the utility and value of the Starkweather Creek environmental corridor.

Stream Segment 4W; West Branch, Milwaukee Street to East Washington Avenue: This one-third mile segment of the West Branch extends from Milwaukee Street, where the normal water surface width is about 20 feet, northward to East Washington Avenue where the stream is about 15 feet wide. Dry weather water depths range from about 1½ feet near Milwaukee Street to less than one foot near East Washington Avenue. Many storm sewers draining local streets discharge to this stream segment, as well as a major interceptor storm sewer and storm sewers draining East Washington Avenue. Silt, debris and trash are often apparent on the streambed of this segment. Streambanks extend about five to seven feet above the normal water surface in this reach.

Throughout most of this segment, the creek is bordered on one or both sides by neighborhood streets. These streets are typically separated from the creek by a ten foot wide grassed strip, which is part of the street right-of-way. This strip is not well maintained in places, and the streambanks also suffer from poor maintenance. Shrubby weeds and undesirable plants need to be cut on a regular basis. Crownvetch planted by Madison several years ago as part of a streambank improvement project is not yet well established.

At present, the visual appeal of this part of the West Branch is limited, as is the potential for improvement. The proximity of

streets bordering the stream precludes any significant expansion or widening of the corridor, although a trail or bikeway linking Milwaukee Street and East Washington Avenue could conceivably be accomodated on either the east or west side of the creek. A more pleasing visual environment within the stream corridor could be achieved through careful landscaping and design improvements. Litter and debris removal are especially important in this reach.

Stream Segment 5E; East Branch, State Highway "30" to U.S. Highway "51": This segment of the East Branch is about 0.4 miles long, and the normal water surface width varies from 15 to 20 feet. Streambanks range from two to six feet in height. The main ditch of Starkweather Creek is virtually straight in this reach, and is crossed by two railroad sidings which serve adjacent businesses. The culverts which carry flow under these sidings are heavily silted and partially clogged. A tributary ditch, known as the Swift Branch, enters the main ditch in this segment. The Swift Branch once formed part of the main channel of Starkweather Creek. The Madison official map shows a 100 to 200 foot wide proposed parkway paralleling the creek throughout this segment.

This section of the East Branch is heavily impacted by neighboring industries. These include lumber and building supply warehousing and retailing, heavy truck sales, repair and manufacturing, feed grain processing, fuel oil transfer and storage, concrete pipe and form manufacture and storage, and dairy equipment sales, storage and stainless steel fabrication.

The environmental quality of this creek section is very poor, largely due to the impacts of business and the highway and rail corridors. Debris and trash are widespread throughout this area, with noticeable accumulations near the Highway "30" overpass where access is easy and children frequently play. Truck parts, barrels, and various wood products are especially noticeable in this area. Also prevalent throughout this section are unsightly tree and brush piles, as well as discarded ties from railroad maintenance operations. Soil erosion is a problem under the Highway "30" overpass, where tightly compacted fill is devoid of vegetation cover. Rooted aquatic vegetation is abundant in the creek throughout this planning segment.

Vegetation throughout this section of the stream corridor consists largely of nuisance weeds, undesirable woody plants and shrubs, and reed canary grass. This cover provides little visual interest and limited habitat opportunities. The industrial and manufacturing firms constitute a poor visual backdrop to the stream corridor.

Improvement of this section of the stream corridor should begin with thorough removal of trash and debris, followed by regular routine maintenance and surveillance. The eroded banks under the Highway "30" overpass should be properly planted and stabilized. Businesses located along the eastern streambank, and especially the truck equipment company, should consider fencing the rear property line to prevent trash and debris from being blown, thrown or falling into the creek. Maintenance throughout this segment of the creek will involve businesses and the City of Madison, as well as highway and railroad crews.

Major improvement in the aesthetic environment of this segment should be viewed as a long-range objective. Some improvement could eventually be brought about through the enactment of more stringent storage, setback and screening requirements for industrial, commercial and warehousing uses adjacent to waterways or shorelands, and through the construction of trails and related facilities which could be provided if public access and use of this area is to be facilitated during the planning period.

Stream Segment 5W; West Branch, East Washington Avenue to Aberg Avenue: Over this 0.3 mile segment of the West Branch, normal water surface widths vary from 12 to 15 feet. Dry weather water depths range from less than a foot near East Washington Avenue at the south end of this segment to about 1½ or 2 feet near Commercial Avenue. A number of local storm sewers discharge to this segment. The flood plain of the West Branch is about 2,000 feet wide at several points along this segment, and encompasses a substantial area of single family residential development.

Throughout this reach, the West Branch is bordered on the west side by a city greenway which averages fifty feet in width and provides a vegetative buffer from adjacent parking lots. Near Aberg Avenue at the north end of the stream segment, a small park is located adjacent to the greenway paralleling the west bank. In the northern half of this segment, between Aberg and Commercial Avenues, a 100 foot wide city greenway parallels the eastern streambank. Just south of Commercial Avenue, the city official maps shows a narrow proposed parkway paralleling the east bank of the stream and traversing several existing residential and commercial properties.

This stream segment is in generally good condition, except in the immediate vicinity of East Washington Avenue. Lawn grasses prevail within the greenway, and reed canary grass grows densely along the streambanks in the northern half of this segment (between Commercial Avenue and Aberg Avenue). In addition to the planting of reed canary grass, the city has also undertaken some tree and shrub planting in the corridor between Commercial and Aberg Avenues.

No major management actions are needed in this segment. Debris removal and routine maintenance should be carried out regularly. In the long run, any redevelopment proposals for the east side of the creek between East Washington and Commercial Avenues should provide for greenway dedication to establish a vegetative buffer strip.

Stream Segment 6E; East Branch, U.S. Highway "51" to Sycamore Avenue: This segment of the East Branch is one-half mile in length. The Swift Branch of Starkweather Creek parallels the main channel through part of this segment. During periods of normal flow, water surface width in this reach is about 20 feet. Water depth during normal flows is about one foot. A mapped wetland of approximately six acres borders the stream corridor on the north, immediately east of and adjacent to Highway "51". On the south side of the stream corridor in the same vicinity is a smaller wetland of approximately 1.4 acres. At the upstream end of the Swift Branch are several small, shallow ponds.

Lands bordering the stream corridor in segment 6E have been poorly managed. A landfill area of nearly 20 acres on the south side of the creek has received earth fill and demolition debris for many years, resulting in wetland destruction and filling of the floodplain. On the north side of the creek, several small ponds at the upstream end of the Swift Branch have been badly degraded by drainage and residual materials from a coal storage area maintained by an electric utility. Along Sycamore Avenue at the upstream end of segment 6E automobile body shops intrude into the stream corridor. Existing vegetation along the stream corridor consists of weeds and brush in the understory, along with undesirable trees such as box elder. However, many desirable trees are also located along the stream corridor and should be preserved.

Many actions should be taken to protect the stream corridor in segment 6E. The wetland and floodplain areas on the north side of the creek should be protected from filling, draining, alteration of water levels and development through conservancy or similar protective zoning. Since the ponds at the upstream end of the Swift Branch are currently used by neighborhood children for ice skating, the recreational potential of the area to serve as a park for development to the north should be assessed, and consideration given to official mapping and eventual acquisition. The practice of coal storage in this area should be discontinued, or properly managed so that no runoff leaves the storage piles. Near Sycamore Avenue, a buffer strip should be established along the stream as businesses redevelop or alter their operations.

On the south side of Starkweather Creek, industrial and commercial developments have been proposed along segment 6E. The City of Madison should assure that a minimum buffer strip (75 feet) is dedicated along the stream to provide for protection and possible future public passage. Since shallow groundwater essential for maintenance of stream baseflow has also been observed entering Starkweather Creek in this vicinity, retention and natural management of stormwater runoff should be encouraged by the city for development in this area.

Stream Segment 6W; West Branch, Aberg Avenue to Anderson Street: This 0.9 mile segment of the West Branch of Starkweather Creek traverses land owned by Dane County and runs through a wooded corridor for part of its distance. Water surface width during periods of normal flow is about 12 feet throughout this segment, and streambanks rise five to eight feet above the normal water surface. The stream segment is intercepted by two lateral ditches. One of these ditches was originally used as a discharge channel for the abandoned Burke wastewater treatment plant. The other ditch drains commercial and industrial development on the east side of the Dane County Airport.

Between Aberg Avenue and the Burke drainage ditch, a 200' wide proposed parkway is shown on the official map. The existing corridor is wooded and shrubby, increasing in width from 100 feet in the south, near Aberg Avenue to 700 feet in the north, near the Burke ditch. Earthen trails parallel the stream.

It is apparent that this area has received heavy use, and has been used frequently for off road motorcycle riding. In many places the

streambanks have been stripped of their plant cover and are tightly compacted, leading to erosion problems. Understory vegetation has been uprooted and trampled by motorcycles and people resulting in a loss of groundcover close to the stream. The dense canopy cover, consisting largely of boxelder, allows little light penetration during the growing season, thus discouraging groundcover growth. Campfire sites, beer cans, litter and debris which sometimes dam the stream also spoil the visual environment of the area.

Several actions could be taken to improve conditions in this area. Selective tree cutting in the corridor would open the dense canopy layer and allow more light to reach the streambanks and adjacent areas, thus encouraging the growth of stabilizing vegetation. While replacement of boxelders with several more attractive native tree species might be desirable for visual diversity and wildlife habitat, it is unlikely that short term demand for use of the area will justify such expense.

Cultivation and planting of the streambanks and adjacent lands should be considered to limit erosion and repair past damage. Access control to the area should also be considered to attempt to eliminate or sharply limit off road motorcycle and other inappropriate uses. Regular maintenance to remove trash and debris will also help to improve the visual environment of the area, and drainage efficiency of the stream.

The value of this area to serve local park and recreation needs should not be overlooked. As of 1980, 250 persons lived immediately adjacent to this area. A small neighborhood park in the area was recently lost to development.

Between the Burke drainage ditch and Anderson Street, the nature of the stream corridor vegetation changes dramatically. In this area, the stream corridor and adjacent lands consist of mapped wetland areas with reed canary and other grass cover, and several irregularly cultivated areas. There is no bank erosion in evidence and no other problems are apparent.

The lack of plant diversity in this area produces visual monotony and decreases habitat value since there are few edge and transition zones.

Few management actions appear to be warranted in this portion of segment 6W. The proximity of the airport and location of this area immediately under the southern runway approach do not provide an attractive environment for wildlife habitat development or increased public use. If the county continues to rent land for crop cultivation, vegetative buffer strips should be maintained along the creek and lateral ditches, and additional draining or filling should be prohibited.

Stream Segment 7E; East Branch, Sycamore Avenue to Lien Road: This 0.6 mile segment of the East Branch runs from the industrialized Sycamore Avenue area northeastward through an area of mapped wetland to Lien Road, just south of East Towne shopping center. During periods of normal flow, the water surface of the stream is from 15 to 20 feet wide, and the stream is fairly shallow (6 to 8 inches).

Rooted aquatic vegetation is abundant in the stream, especially to the immediate north of Sycamore Avenue where a lateral ditch from the north enters the East Branch. Trash and debris are commonly found in the stream, especially near Lien Road and near Sycamore Avenue.

Throughout stream segment 7E, vegetation in the immediate stream corridor consists of mixed grasses typical of a wet meadow, and a few widely scattered dogwood and willow shrubs. The existing vegetation appears to offer adequate cover for wildlife (although diversity is very limited) and an adequate vegetative buffer along the stream. Vegetative maintenance could be improved so that deadfall and cuttings are removed from the creek, rather than creating the debris dams and blockages which are often seen in this segment.

The major problems associated with segment 7E occur near Sycamore Avenue and are partially attributable to the intrusion of businesses into the stream corridor. This intrusion causes aesthetic and potential water quality problems. Runoff from parking lots and storage areas near the stream directly enters Starkweather Creek in the vicinity of the Sycamore Avenue bridge. A variety of chemicals, gasoline, oil and solvents as well as Portland cement are stored or used in businesses near the creek, and subject to wash off by rainfall.

Several field surveys conducted during this planning process have shown markedly different and heavily disturbed streambed conditions near Sycamore Avenue, as compared to areas upstream and downstream on the East Branch. Typical of the observations at Sycamore Avenue was a July 1980 survey when the stream water was turbid with grey suspended matter, and the bottom was nearly devoid of algal or macrophytic plant life. Slime masses were abundant, and observed as either wooly coatings on submersed objects or tufts and strands 15 or more inches long streaming in the current. Color of the slimes varied from milky white in fresh growth to grey-white, brown and rust. These biologic slimes were not apparent at other locations on the East Branch.

Several actions can help to reduce the potential water quality problems and improve the visual environment of the area near Sycamore Avenue. Obvious drainage channels leading directly from surface parking, storage or loading areas to the creek should be closed, and drainage redirected. Materials containing water soluble compounds, empty chemical containers or vessels, or any materials susceptible to transport by runoff (gas, solvents, cement, etc.) should be covered and preferably, stored away from the creek. Greater setbacks of businesses from the stream, and screening vegetation should gradually be sought as conditions change or redevelopment occurs.

The wetland and floodplain areas in segment 7E have considerable potential for use in the management of stormwater flow and pollutants from existing and anticipated upstream development. A stormwater management needs and feasibility study should be undertaken to determine the size and location of stormwater detention basins and other needed structures and facilities. In addition to reserving land for anticipated stormwater and drainage structures, a vegetative buffer should be maintained along the East Branch of Starkweather Creek through segment 7E, and adequate land reserved for ultimate public access and passage (perhaps beyond the 20 year planning period).

Stream Segment 7W; West Branch, Anderson Street to U.S. Highway "51": This 3.5 mile segment of the West Branch loops around the outer perimeter of the Dane County Regional Airport. During periods of normal flow, the water surface width in this segment varies from 12 to 15 feet at the downstream end to about 8 feet at the upstream end. The overall gradient of this section of the creek is quite flat - about 1.4 feet per mile - and the ditches are quite deep at the upstream end of the segment in order to maintain positive flow. Just above Anderson Street, a tributary ditch enters the creek from the east. This short ditch drains the lower east side of the Dane County Airport.

An extensive storm sewer and drain tile system drains the entire airport, and discharges to the West Branch throughout segment 7W. This storm sewer system has a pronounced effect on flow in the West Branch, and elevates the hydrograph for several days following large rainfalls.

Several large mapped wetland areas border Starkweather Creek in segment 7W. The largest area (over 200 acres) is located near the south end of the ariport. Two smaller wetland areas, totalling about 60 acres, border the creek (and the airport) in the northern half of segment 7W. The large southern wetland is located on county property. About 15 acres of the remaining wetland area is under county ownership.

Stream corridor vegetation in segment 7W is dominated by reed canary, wet meadow grasses, and other common grasses. Shrubby willows and cottonwoods are found along the stream in several locations, and are especially thick near Swanson Street, where deadfall occasionally forms debris dams. Cattails are found at several points along and near the stream in the southern half of segment 7W.

Vegetative management should be undertaken in segment 7W as part of an overall drainage maintenance program. Dead and fallen trees and shrubs should be removed from the stream regularly, and streambank vegetation trimmed as warranted. Other maintenance activity necessary in the stream segment includes dredging, to remove nuisance sediment deposits which have accumulated in the flat ditches and may impede drainage.

Other actions which should be taken in segment 7W include measures to protect portions of the environmental corridor (especially wetlands) which are not currently owned by Dane County. Such measures would include shoreland-wetland zoning, adequate consideration of environmental corridor protection needs in review of new development proposals, and completion of the airports' land and easement acquisition program.

Stream Segment 8E; East Branch above Lien Road: This segment of the East Branch includes 0.9 miles between Lien Road and Interstate Highway "90". The Interstate is located approximately 3.8 miles from the mouth of the creek at Olbrich Park. During periods of normal flow, the water surface at Lien Road is about 15 feet wide, but it narrows to just a few feet about 0.2 miles upstream, above the East Towne shopping center storm sewer. Further upstream in this segment

is a small pond, about 0.4 acres in surface area. Above the pond are at least two springs, which provide the first continuous flow to the East Branch. A small mapped wetland area, about 1.4 acres in size, is located on the east side of the creek near its intersection with Lien Road. A portion of this wetland area appears to be cultivated irregularly.

During 1983, lands containing a portion of the southerly 3,000 feet of segment 8E were annexed to the City of Madison and included in a preliminary plat for development. The stream corridor and some associated sensitive lands in this area were rezoned to a conservancy classification based on detailed evaluation undertaken as part of the plat review process. The conservancy corridor within the platted area ranges from 300 to 600 feet wide.

Stream corridor vegetation in segment 8E is in generally good condition, and consists of a mixture of shrubs and grasses, with trees further upstream near the pond. A length of about 1,000 feet above Lien Road is vegetated with crownvetch, which was planted when East Towne was developed. Generally, vegetation in segment 8E appears to require little more than routine maintenance. If any revegetation is undertaken, a variety of native grasses, plants and shrubs should be used in preference to monotypic cover such as the existing crownvetch.

The primary objective of management activities affecting segment 8E should be the maintenance of shallow groundwater levels to preserve discharge from the springs and groundwater seepage which provide valuable baseflow to the East Branch of Starkweather Creek. Onsite detention of stormwater runoff from proposed new development should be emphasized, as should measures to restrict the amount of impervious cover in the vicinity of this stream segment. Wetland areas which are not included in the area recently rezoned to "conservancy" should be given protection against draining, filling or alteration of water levels, except for ordinary stream maintenance.

Stream Segment 8W; West Branch, above U.S. Highway "51": Above U.S. Highway "51", the continuously flowing portion of the West Branch extends about 4,000 feet due east and 4,600 feet due north to a point north of Hanson Road and just south of Interstate "90 & 94", in the Town of Burke. Above this point, the stream is intermittent. Intermittent tributaries and a lateral ditch intersect the main stem of the West Branch from the south, and drain developed and developing areas on the north side of U.S. Highway "151" and near the intersection of Interstate "90 & 94" and U.S.H. "151" (see Figure 11 in the main report).

Large areas of mapped wetland surround the upper West Branch throughout segment 8W, between Highway "51" and the Interstate (see the recommended plan map). Many of these areas are cultivated in the years when they are dry enough to allow spring planting. Seepage from these wetland areas provides a good quantity of relatively clean baseflow to the West Branch (although nitrogen levels are high -- typical of shallow groundwater in the area). Maintenance of this baseflow

through protection of these wetland areas is important to the West Branch, since groundwater pumping has caused a sharp decline in groundwater contributions to the West Branch below the Dane County Airport.

The vegetation of the West Branch stream corridor above Highway "51" is characterized by typical wet meadow grasses, except on recently cultivated or disturbed lands where brushy weeds predominate. Typical wetland shrubs, such as red osier dogwood, can be found in some of the mapped wetland areas which have not been cultivated for many years. Many of the intermittent drainageways in the upper West Branch traverse cultivated fields and have little, if any vegetative protection. Eventually, it would be desirable to establish grassed waterways along unprotected intermittent drainageways, and establish vegetative buffers along the main ditches and laterals in areas with continuous flow. Otherwise, removal of dead vegetation to maintain drainage appears to constitute the major vegetative management need in segment 8W.

Public access and measures to facilitate public use along segment 8W do not appear to be needed during the planning period. The area is generally beyond current concentrations of residential development, and has limited attractiveness for public use at this time. However, the area does have wildlife habitat value despite the proximity of the airport and the associated noise impacts. No specific widllife habitat management or development measures are proposed at this time.

The greatest management need in the environmental corridor adjacent to segment 8W is the maintenance of shallow groundwater levels through protective zoning of wetlands. Such zoning will protect the wetlands from any intensive forms of development, and will prohibit draining, filling and alteration of water levels except for maintenance activities to allow continuation of existing agricultural operations. On-site detention of stormwater runoff from newly developing areas on the urban fringe will also benefit the upper West Branch, as will construction site erosion control measures.

APPENDIX E

Public Opinion Questionnaires

STARKWEATHER CREEK WATERSHED PUBLIC OPINION QUESTIONNAIRE

PLEASE READ EACH QUESTION CAREFULLY AND ANSWER ONLY THOSE QUESTIONS APPROPRIATE TO YOU.

1. Where do you live?
   ___ City of Madison
   ___ Town of Burke
   ___ Town of Blooming Grove
   ___ Other: _____

If you are an urban resident:

How close is your residence to the creek?
___ Adjacent
___ Two blocks or less
___ Three to five blocks
___ Other:_____

If you are a rural resident:

Do you:
___ Live on a farm
___ Not live on a farm

How close is your land to the creek?
___ Adjacent
___ Within 1/4 mile
___ 1/4 to 1/2 mile
___ Other:_____

2. How do you and/or members of your family PRESENTLY use Starkweather Creek? (Check one response for each line.)

	Never	Infrequently (5 times/year or less)	Frequently (more than 5 times/year)
a) Boat access to Lake Monona	____	____	____
b) Fishing	____	____	____
c) Scenic/visual enjoyment	____	____	____
d) Sit along streambank	____	____	____
e) Corridor for hiking or walking	____	____	____
f) Corridor for cross-country skiing	____	____	____
g) Corridor for motor biking	____	____	____
h) Trapping, hunting	____	____	____
i) Other (specify)_____	____	____	____

3. IF IN THE FUTURE the quality of the creek and adjacent lands were IMPROVED, how would you and your family like to use the creek? (Check one response for each line.)

	Never	Infrequently (5 times/year or less)	Frequently (more than 5 times/year)
a) Boat access to Lake Monona	____	____	____
b) Fishing	____	____	____
c) Scenic/visual enjoyment	____	____	____
d) Sit along streambank	____	____	____
e) Corridor for hiking or walking	____	____	____
f) Corridor for cross-country skiing	____	____	____
g) Corridor for motor biking	____	____	____
h) Corridor for bicycling	____	____	____
i) Trapping, hunting	____	____	____
j) Other (specify)_____	____	____	____

4. In terms of your present and future use of Starkweather Creek, how important are the following problems? (Check one response for each line.)

	Very Important	Somewhat Important	Not Important
a) Lack of public access, trails, parks			
b) Litter and debris in creek and on banks			
c) Noisy or unsightly neighboring land uses			
d) Green or turbid water			
e) Poor fishing			
f) Inadequate boat access to Lake Monona			
g) Possible health hazard (bacteria)			
h) Poor urban stormwater drainage and flooding			
i) Poor farmland drainage and flooding			
j) Other (specify) _____			

5. IF YOU ARE AN URBAN RESIDENT living in the Starkweather Creek watershed, do you experience problems due to poor drainage of stormwater (ponding, wet basement, etc.)?

_____ Never
_____ Occasionally
_____ Frequently

6. IF YOU OWN OR OPERATE A FARM in the Starkweather Creek watershed, do you experience problems with poor farmland drainage?

_____ Never
_____ Occasionally
_____ Frequently

IF YOU OWN OR OPERATE A FARM, do you experience problems with soil erosion?

_____ Yes
_____ No

7. In your opinion, what should or should not be done to improve Starkweather Creek? (Check one response for each line.)

	Should be Done	Should Not be Done	No Opinion
a) Improve boat access to Lake Monona by dredging the lower part of the creek . . .			
b) Improve public access to the creek in urbanized areas by acquiring land along the stream and developing trails and parks . . .			

7. (Continued)

	Should be Done	Should Not be Done	No Opinion
c) Improve the appearance of the streambank by establishing vegetation, stabilizing eroding areas, controlling litter, etc. . . .	_____	_____	_____
d) Minimize potential health hazards by locating and correcting sources of bacterial contamination . . .	_____	_____	_____
e) Locate and correct sources of industrial and commercial waste entering stream . . .	_____	_____	_____
f) Improve fishing access and fish habitat and work to improve fishing opportunities . . .	_____	_____	_____
g) Improve the appearance of water and streambed by controlling obvious sources of nutrients, managing aquatic weeds and algae, and removing debris and litter from stream . . .	_____	_____	_____
h) Improve drainage in low-lying parts of the city by increasing storm sewer capacity . . .	_____	_____	_____
i) Improve drainage of farmland . . .	_____	_____	_____
j) Minimize soil erosion in the watershed . . .	_____	_____	_____
k) Control runoff from new developments . . .	_____	_____	_____

Comments:

Please return this questionnaire to the Dane County Regional Planning Commission, Room 114, City-County Building, Madison, Wisconsin 53709, by October 30, 1980, if possible.

QUESTIONNAIRE

STARKWEATHER CREEK ALTERNATIVE PLANS

1. Where do you live?
   _____ City of Madison
   _____ Town of Burke
   _____ Town of Blooming Grove
   _____ Other: _____

2. How close is your residence (or property) to Starkweather Creek?
   _____ Adjacent
   _____ Two blocks or less
   _____ Three to five blocks
   _____ Other: _____ miles or _____ blocks

3. a) Are you an urban or farm resident? (Check one.)
      _____ Urban resident
      _____ Farm resident
   b) Do you operate a farm in the watershed?
      _____ Yes
      _____ No

4. Following are six objectives of a management program for Starkweather Creek. Rank the three objectives which you feel are most important. Please rank three most important, writing 1 for most important, in space provided.
   _____ To provide efficient urban and agricultural drainage
   _____ To reduce urban, commercial and industrial pollution sources
   _____ To enhance the physical and visual environment of the stream corridor
   _____ To minimize flooding potential
   _____ To enhance recreational opportunities
   _____ To reduce overall soil loss and sediment delivery

5. Do you support the environmental corridor concept as a means of protecting the creek and important adjacent lands, while improving the public value of the stream resource? (Check one.)
   _____ Yes _____ Not sure
   _____ No _____ Generally support, but with reservations

6. A final plan will likely combine features of several alternatives, but of those alternative programs presented, which do you feel will best address the problems of Starkweather Creek, and meet the needs of the watershed's residents? (Check one.)
   _____ Alternative I.A. - Drainage and Flood Control, Minimum Effort
   _____ Alternative I.B. - Drainage and Flood Control, Maximum Effort
   _____ Alternative II.A.- Environmental and Visual Enhancement, Minimum Effort
   _____ Alternative II.B.- Environmental and Visual Enhancement, Maximum Effort
   _____ "No Action" Alternative

7. As a watershed resident, what is the maximum amount per year you would pay to support creek improvement? (Check one.)

   _____ $ 5.00 _____ $30.00 _____ Other (Specify)
   _____ $15.00 _____ $50.00

8. a) Should private businesses located along or draining to Starkweather Creek be required to take all necessary measures to prevent pollutants, trash and debris from reaching the Creek? (Check one.)

_____ Yes
_____ No
_____ Not sure

b) Should businesses with Creek frontage be required to participate in improving the stream corridor, including financial assistance? (Check one.)

_____ Yes
_____ No
_____ Not Sure

9. Madison is considering an ordinance to limit erosion and runoff from construction and new development in the urban area. Should there also be an ordinance requiring farmers on the urban fringe to use soil conservation practices? (Check one.)

_____ Farmers should be required to use soil conservation practices whether or not financial assistance is available.
_____ Farmers should be required to use soil conservation practices only if financial assistance is available.
_____ Use of soil conservation practices should be voluntary, not required.

10. Some alternatives propose an "environmental corridor" along the creek which includes streambank buffer strips, natural resource protection areas, and parks and recreational areas. (Check one.)

_____ Public access to these areas for recreation, hiking or bike trails, or scenic enjoyment should be provided through public acquisition of land or easements.
_____ Public access to these areas should be limited to streambank and vegetation maintenance purposes. Public access for recreation, hiking or bike trails, or scenic enjoyment should not be permitted except in existing parks and recreation areas.
_____ Public access should not be permitted to additional areas. These areas should be protected through zoning and other regulations, but should remain in private control.

11. Considering the benefits of improving Starkweather Creek, who should bear most of the costs of improvement or maintenance? (Check one.)

_____ The general public, including all watershed residents and businesses, should pay most of the cost through taxes and general government revenues.
_____ Residents and businesses along the creek itself should pay most of the cost through direct assessments.
_____ Local funds should not be spent unless state or federal grants are available to cover most of the cost.

Other Comments:

_____

_____

_____

_____

_____