SHEBOYGAN RIVER REMEDIAL ACTION PLAN
BACTERIOLOGICAL SURVEY - 1990

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INTRODUCTION

The International Joint Commission (IJC) has identified the lower Sheboygan River downstream from the Sheboygan Falls Dam to the harbor and nearshore Lake Michigan as one of 42 Great Lakes Areas Of Concern (AOC) targeted for remedial action. Conventional and toxic pollutants have impaired the lower Sheboygan AOC from being used to its fullest recreational and biological potential. Impairments of the AOC include degradation of fish, wildlife and benthic populations; loss of habitat; dredging restrictions; reduced swimming opportunities; accelerated eutrophication; and the need for waterfowl and fish consumption advisories (WDNR, 1989). The Onion and Mullet River Watersheds are also contributing pollutants to the lower Sheboygan River Basin, Figure 1.

Several efforts have either been completed or are underway to help identify and correct the water quality problems in the lower Sheboygan River Basin. The Sheboygan River Basin Water Quality Management Plan, Priority Watershed Projects for both the Onion (1980) and Sheboygan (1985) Rivers, U.S. EPA Superfund Remedial Investigations and Feasibility Studies being conducted for the Sheboygan River and Harbor, the Kohler Landfill Superfund Project, and the 1989 Sheboygan River Remedial Action Plan are examples of efforts being made to improve and protect water quality in the lower Sheboygan River.

Of these efforts, the 1989 Sheboygan River Remedial Action Plan (RAP) contains the following ecosystem goals: 1) to protect the ecosystem from adverse effects of toxic substances; 2) to maintain diverse communities of aquatic and terrestrial life; 3) to control eutrophication for the protection of Lake Michigan; and 4) to enhance recreational uses of the harbor.

One of the objectives of the Sheboygan River RAP is to describe problems in the AOC associated with contaminants to public health, recreational uses, economic development and the ecosystem. The objectives of Sheboygan River RAP's Ecosystem Goal IV. are to reduce levels of bacterial contamination in the Sheboygan, Mullet and Onion Rivers in order to meet state recreational use standards and to provide adequate public access and recreational facilities (WDNR, 1989).

Since 1977 the DNR has conducted monthly monitoring of several parameters, including fecal coliforms at the STH 28 ambient monitoring station, which corresponds geographically to site SR-7B on the lower Sheboygan River. Monitoring results show that bacterial concentrations at this station have

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[1] *Lakeland College was misidentified in the 1989 Sheboygan Remedial Action Plan as discharging to the lower Sheboygan River Basin, when in fact, it discharges to Fisher Creek in the Pigeon River Watershed, which is part of the upper Sheboygan River Basin. Therefore, Lakeland College is not included in the scope of this study.*

historically been above the state standard. Data from the STH 28 ambientmonitoring station from 1977-1990 are depicted graphically in Figure 2, along with 1990 data for SR-7B.

This bacteriological survey was conducted to satisfy the requirements of the Sheboygan River RAP's Ecosystem Goal IV. Specifically, this report will 1) identify the significance of the point sources of the Hingham, Plymouth, Waldo, Gibbsville, St. Cloud, Mt. Calvary, Kiel, Sheboygan County Health Center, and Belgium Wastewater Treatment Plants (WWTPs)[1], as well as Johnsonville Foods (an industrial point source discharge also treating a portion of Johnsonville's municipal wastewater) on the lower Sheboygan River; 2) compare the results of the bacteriological survey to the bacteriological guidelines set forth by the State of Wisconsin in NR 102; 3) identify other possible sources of contamination; and 4) document the relationship between membrane filter fecal coliform concentrations (MFFCC) and precipitation.

Bacterial contamination of surface water by warm-blooded animals including humans causes potential public health problems, lowers overall water quality and limits recreational use. Several groups of bacteria are especially useful indicators of fecal contamination. Of these, coliform bacteria are constantly present in large numbers in the feces of all warm-blooded animals (WDNR, 1969). The count of fecal bacteria present is assumed to indicate the degree of health risk associated with the use of a waterbody for drinking or body-contact recreation (WDNR, 1980). Existing data on fecal coliform levels in surface waters in Wisconsin indicate that the bacteriological standard in NR 102 is being exceeded at many locations, however, corresponding adverse health effects are not evident (WDNR, 1986).

Assured protection from fecal contamination is the chief criterion used by the State of Wisconsin to make a determination of the suitability of a surface water for recreational use. (Wisconsin Administrative Code Ch. NR 102.04 (5A)). NR 102.04(5A) states:

> "The membrane filter fecal coliform count may not exceed 200 per 100 ml as a geometric mean based on not less than 5 samples per month, nor exceed 400 per 100 ml in more than 10% of all samples during any month."

Fecal coliform bacteria enter surface waters from a combination of sources, including both point sources such as wastewater treatment plants and nonpoint sources such as animal waste runoff from barnyards, feedlots and fields.

STUDY AREA

The Sheboygan River mainstem drains approximately 300 square miles of land into Lake Michigan and consists of a total of 78 stream miles. The Onion River consists of 45 stream miles, while the Mullet River consists of 33 stream miles (WDNR, 1988). Land use in the Sheboygan River Basin is 3.3% residential, 27% natural (including woodlands, wetlands, grasslands, open water and park lands), .6% industrial, .2% commercial, 3.3% transportation, and 65.4% agricultural, with a total acreage of 413,114 (WDNR, 1978).

Both urban and rural land uses contribute to nonpoint source pollution. Pet wastes, failing septic systems, yard wastes, and wildlife (e.g. birds, rodents) may contribute to bacterial loadings from urban areas. Barnyard runoff, animal wastes from livestock, poultry and wildlife, instream pasturing, and landspreading of manure and sewage sludge onto agricultural fields may contribute to bacterial loadings from rural areas. When applied to frozen ground, steep slopes (>6%), on soils with inadequate depth to groundwater, or during periods of high precipitation, bacteria from land application of animal wastes and sewage sludge can contaminate surface and/or ground water.

Soils in the lower Sheboygan River drainage basin are primarily heavy clay soils exhibiting poor infiltration and percolation, but high fertility. The soils of this area are predominantly of the Kewaunee series including clay loams and silty clay loams with subsoils of mainly clay loam to clay (USDA, 1978). Surface water tends to run off at increased rates from these types of heavy clay surface soils. After rain events streams in the watershed tend to exhibit a reddish color from suspended silts and clays (WDNR, 1990).

METHODS

Eleven sampling stations were selected for the Sheboygan River Bacteriological Study. Seven sampling stations were selected on the mainstem of the Sheboygan River, 3 sites on the Mullet River and 4 sites on the Onion River. The selection of these sites was based on the 1980 Sheboygan River Water Quality Management Plan which reported data from these same sampling locations. Sites were selected for the 1980 Plan that would show influences on water quality from various land uses and from point source discharges. Station locations are listed in Table 1 and depicted in Figure 1 (MAP).

Five samples were collected at each station during a 33 day sampling period from September 14 to October 16, 1990 by DNR staff. Grab samples were collected in sterile plastic bottles and sent to the State Laboratory of Hygiene for analysis. Samples were received within 24 hours of sample collection and analyzed for fecal coliform bacteria using membrane filtration.

Precipitation data from the Plymouth climatological station generated by NOAA for the period of September 10 - October 25, 1990 were used in evaluating the correlation between MFFCC counts and precipitation. These are also listed in the top portion of Table 2. The Plymouth station was chosen because of its central location in relation to the sampling sites.

RESULTS

Monitoring data show that 10 of the 14 lower Sheboygan River watershed sites exceeded the 200/100 mL state standard (as a geometric mean of five samples) during the 1990 sampling period and that 13 of the 14 lower Sheboygan River watershed sites exceeded the 400/100 Ml state standard in more than 10% of all samples taken over the period of roughly a month (September 14-October 16). This data is notable considering that the areas contaminated by these levels

of fecal bacteria, with the exception of Belgium Creek, have been classified as warm water sport fisheries and full body contact recreational use water bodies (based on physical conditions such as depth, width and current) and should therefore be protected for full body contact (WDNR, 1989).

Table 2 lists specific monitoring results and Figure 3 graphically depicts MFFCC counts at all sites. MFFCC counts ranged from highs of 100,000/100 mL at OR-2B, OR-3B and SR-5B on September 14, 1990 to a low of 10/100 mL at SR-2B on October 16, 1990. At the high end are results from September 14. All sites, with the exception of SR-2B were well above 400/100 mL. Results at most sites were above 10,000/100 mL.

Precipitation data for September 14 indicate that 2.2 inches of rain fell at the Plymouth station. This was the only major rain event of the sampling period. MFFCC counts for this date are extremely high at all sites (>90,000/100 mL at 5 sites, >10,000 at another 5 sites), except for SR-1B, SR-2B and SR-3B, near the headwaters of the Sheboygan River, and the most distant from the Plymouth climatological station. There is an obvious relationship between the high amount of rain and the high fecal counts on this date. These results indicate that fecal coliform bacteria concentrations are positively correlated to precipitation. Figure 4 illustrates the relationship between precipitation and MFFCC counts at two sites.

Precipitation for the remaining sampling time was nonexistent or minimal. MFFCC counts at all sites, with the exceptions of OR-3B and MR-2B, during this time were consistently low, remaining within a range of 10 to 1,000/100 mL.

The high dry weather MFFCC counts at MR-2B can be attributed to the point source discharge of the Plymouth WWTP. During the study the wastewater treatment plant at Plymouth did not have a fecal coliform limit but was disinfecting its effluent. Due to difficulties meeting its residual chlorine limit, Plymouth cut back the chlorine feed rate, which severely reduced the fecal coliform bacteria kill. Table 3 shows that the Plymouth WWTP was discharging >13,000/100 mL MFFCCs in September and October of 1990, undoubtedly impacting MR-2B directly downstream.

There is no corresponding point source discharge directly upstream of OR-3B. The Belgium WWTP discharges to Belgium Creek a tributary of the Onion River well upstream of OR-3B (and downstream of OR-2B). Belgium's discharge monitoring data indicate that Belgium was disinfecting during the sampling time. Fecal coliform counts at the Belgium plant were 16 and 25/100 mL for September and October, respectively. Belgium Creek is impacted by surrounding agricultural land uses, which may have caused the dry weather MFFCC spike, but no conclusive evidence is available.

DISCUSSION

Various point and nonpoint sources of pollution affect the water quality within the Sheboygan River watershed. The following sections of this report will discuss possible bacterial contributions by both point and nonpoint sources.

Point Sources

In Wisconsin, point source discharges are regulated through WPDES (Water Pollutant Discharge Elimination System) permits. Permit requirements may include limits and/or monitoring for substances such as fecal coliform bacteria, residual chlorine, BOD, suspended solids, etc. Table 3 lists the point source discharges to the lower Sheboygan River watershed. Five of these 10 point source discharges were disinfecting their effluent for at least a part of the sampling period.

Gibbsville and Sheboygan County Comprehensive Health Center were not required to disinfect their effluents because of long retention times. Gibbsville has been able to show through past plant performance that it is able to meet the state standard for fecal coliforms. Sheboygan County Comprehensive Health Center's WPDES permit will be reevaluated at permit reissuance time for seasonal disinfection (Shuda, pers. comm.).

Both Plymouth and Waldo WWTPs were disinfecting for the entire sampling period, but were not required to meet the state standard for fecal coliforms in their WPDES permits. Plymouth and Waldo were, however, required to meet a daily maximum residual chlorine limit of .2 mg/L. In their attempts to meet this limit, chlorine feed was lowered to a level that was ineffective at killing fecal coliform bacteria (Shuda, per. comm.). Resulting MFFCC counts in the plants' effluents were very high.

The high counts from the point sources at Plymouth and Waldo likely influenced results at sampling sites downstream (MR-2B near Plymouth and possibly OR-2B near Waldo, see Figure 4.1). Where available, all other point source discharge monthly monitoring records show fecal coliform concentrations to be well below the state standard.

Nonpoint Sources

Located in Sheboygan County in the Maple Corner Subwatershed, Schuett Creek joins the Sheboygan River approximately .1 miles downstream of CTH MM. Schuett Creek is almost entirely bordered by state-owned land and is classified as a Class I trout stream (WDNR, 1990). Schuett Creek was chosen as an unimpacted stream for comparison of bacteriological data.

Schuett Creek was sampled 12 times in the Fall of 1991 and 10 times in the Spring of 1992. The fall MFFCC minimum, maximum, and geometric mean values were 40/100 mL, 15,000/100 mL and 231/100 mL, respectively. Spring minimum, maximum, and geometric mean values were <10/100 mL, 1200/100 mL, and 118/100 mL, respectively.

Bacteria levels (MFFCC counts) in Schuett Creek are similar, but slightly lower than those from the 1990 sampling results of the Onion, Mullet and lower Sheboygan Rivers (See Table 2). This is a small stream with very little dilution of surface runoff, but does show the degree to which natural sources influence bacterial concentrations in surface waters.

The lower Sheboygan River watershed consists mainly of heavy clay and sandy soils. These particular soil types do not act as good buffers of nonpoint source pollutants in periods of heavy rainfall.

Rainfall causes runoff carrying bacteria from nonpoint sources, such as streets, residential areas, farm fields, barnyards and urban areas, into lakes and streams. In the fall, it is likely that farmers in the watershed were landspreading manure onto their cleared fields. As flow rates increased, water may have bypassed overloaded sewage treatment systems and water mixing in streams may have returned bacteria previously deposited in river sediment to the water column.

Table 2 lists precipitation values, MFFCC values and sampling dates. Total average precipitation for the months of September and October of 1990 were 4.01 inches at the Plymouth climatological station. The largest amount of rainfall occurred on September 14, leaving 2.2 inches of precipitation. The extremely high MFFCC counts throughout the basin for the first sample are suspected of being largely due to stormwater runoff from nonpoint sources, as well as overloading of some point source discharges caused by the September 14 rain event. Figure 4.1 and 4.2 show the relationship between precipitation and MFFCC concentration.

Onion River Sub-basin

The Onion River sub-basin is the most seriously contaminated of the streams in the lower Sheboygan River watershed study area. The geometric means of fecal coliform counts ranged from 344 to 4305 per 100 mL.

Contributing bacterial loadings to the Onion are the tributaries of Belgium Creek, Ben Nutt Creek and Mill Creek. Mill Creek and Ben Nutt Creek, along with the headwaters of the Onion, rise from cold water springs in the Kettle Moraine area. These reaches exhibit the best water quality along the Onion River sub-basin. Both Mill and Ben Nutt Creeks support trout populations (WDNR, 1978). However, agricultural nonpoint sources of pollution, including unrestricted stream access by cattle and cropping and winter spreading of manure on steep slopes are affecting the upper reaches of the Onion (WDNR, 1978). The site along this stretch is OR-1B which had the lowest geometric mean for the Onion River sub-basin. There are no point source contributions to bacteria loading until the Waldo WWTP. Waldo, along with the Hingham WWTP impact the Onion River further downstream at site OR-2B.

Belgium Creek is impacted by the point source discharge of the Belgium WWTP. Impoundments, lack of groundwater contribution and heavy clay soils limit the lower Onion River's streamflow to mostly surface runoff, effluent and flow from the headwaters. Agricultural ditching and runoff have also degraded this tributary. OR-4B may be impacted by the point source discharge of the

Gibbsville WWTP. OR-3B had the overall highest geometric mean for fecal coliforms of 4,305/100 Ml and violated the 400/100 mL state standard in 100% of all samples.

Mullet River Sub-basin

Geometric means for the Mullet River sampling sites ranged from a low of 151 to a high of 3,699 per 100 mL. The highest fecal bacteria counts were recorded at MR-2B, probably as a result of the Plymouth WWTP discharge (see Table 3), as well as stormwater runoff.

Upstream of Highway 67 the Mullet River and its tributaries meet assigned water quality standards. No point source discharges occur along this segment. Bacterial levels for this stretch of the river were measured at site MR-1B. Except for counts measured after heavy rain, contamination here was low.

Urban and rural nonpoint sources along with point source discharges at Plymouth, contribute to bacteria counts at MR-2B, where contamination was high even in dry weather. Clay soils, lower gradients and modifications to streamflow (impoundments) impact the lower reaches of the Mullet River (WDNR, 1978). MR-2B exceeded the 400/100 mL state standard 100% of the sampling period.

Sheboygan River Sub-basin

Sites along the Sheboygan River fall into two distinct groups. From the headwaters to the Rockville impoundment (sites SR-1B, SR-2B, and SR-3B) bacterial contamination is low to moderate, while downstream from the Rockville impoundment to the confluence with the Mullet River contamination is high. Geometric means for the Sheboygan River sites ranged from an overall low of 48/100 mL to a high of 704/100 mL.

Land uses surrounding the upper reaches of the Sheboygan River are primarily undeveloped wetland and dairy agriculture (WDNR, 1990). Agricultural nonpoint source pollution from streambank pasturing and manure spreading are probable causes of nonpoint contamination along this stretch.

The segment of the Sheboygan River prior to SR-1B, just south of St. Cloud, runs through about 4.5 miles of wetland and is not directly impacted by any point source discharge. The 9.7 stream miles between SR-1B and SR-2B run mostly through wetland and Sheboygan Lake. The Sheboygan River continues through about four more miles of wetlands and the City of Kiel before reaching site SR-3B at the Rockwell impoundment. Impacting the river at SR-3B is the continued buffering effect of the wetland, however, urbanized land use and the point source discharge of the Kiel WWTP influence the site.

Exhibiting the greatest effect on these sites are the Sheboygan and Kiel Marshes. Wetlands tend to act as pollution filters because they slow down the flow of water, allowing for the deposition of sediment and the natural breakdown of fecal coliform bacteria.

From the Rockville Dam to Sheboygan Falls land uses gradually change from agricultural to developing residential and urban. Soils here are clayey with low permeability and low gradient (WDNR, 1990). One point source discharge on this stretch is Johnsonville Foods, which discharges upstream of SR-5B and may be contributing to the high MFFCC counts at that site.

From the confluence with the Mullet River to the its mouth, the Sheboygan River is impacted by approximately 20 permitted point source discharges (WDNR, 1988). This area roughly corresponds to the lower Sheboygan River Area Of Concern. Ambient monitoring data from the STH 28 station from 1977-1990 show that bacterial concentrations have averaged above the state standard of 200/100 mL even in years of low flows (see Figure 2). These high levels of bacterial concentrations have historically been a cause for concern.

Clayey soils and urban land uses along this stretch result in very high runoff characteristics. Bacteria counts at STH 28 (site SR-7B) are the combined result of agricultural nonpoint sources upstream, contributions from the Mullet and Onion Rivers, impacts of surrounding urbanized land use and point source discharges.

CONCLUSION

The results from the sampling period of September 14, 1990 through October 16, 1990 along with ambient monitoring data from the STH 28 station and 1991 sampling data from Schuett Creek demonstrate that:

1) All three of the streams sampled during the 1990 study were in violation of the State of Wisconsin Recreational Standards. With the exception of SR-2B, every site violated the state standard of no more than 10% of all samples to exceed 400/100 mL during any month. With the exceptions of Sheboygan and Mullet River headwater sites SR-1B, SR-2B, SR-3B, and MR-1B, every site exceeded the state standard of 200/100 mL as a geometric mean based on no less than 5 samples.
2) The point source discharge from the Plymouth WWTP was most likely responsible for the high dry weather bacterial concentrations at MR-2B.
3) Rainfall in concert with land uses in the basin affect rural and urban nonpoint source pollutant loadings to the streams in the study area, as evidenced by wet weather MFFCC counts.
4) Even a 'pristine' stream such as Schuett Creek has naturally occurring sources of bacterial contamination.

RECOMMENDATIONS

Since the time of sampling in 1990, several events have occurred that may have already improved the water quality of the study area. In May 1993 Waldo's WWTP completed the installation of a chlorination - dechlorination system (Shuda, pers. comm.). This should insure that Waldo will be effectively reducing bacteria loadings from its plant.

Recommendation: monitoring downstream of the Waldo WWTP should be done to determine the results of this change.

The Plymouth WWTP is currently being upgraded to satisfy its WPDES permit compliance schedule. Because of previous difficulties in meeting residual chlorine limits, Plymouth chose to install an ultraviolet disinfection system. This system should go on line in 1994 and significantly improve the water quality at MR-2B (Shuda, pers. comm.).

Recommendation: monitoring downstream of the Plymouth WWTP should be done after construction is completed to determine the results of this change.

Due to a lack of conclusive evidence, the high dry weather results at OR-3B remain largely unexplained.

Recommendation: further monitoring should be done upstream and downstream of the site to attempt to determine the sources of fecal contamination at OR-3B.

As far as nonpoint source pollution is concerned, Best Management Practices (BMP'S) such as conservation tillage, elimination of cattle access to streams, barnyard runoff management, installation of manure storage facilities, elimination of winter spreading of manure on critical slopes, adoption and enforcement of construction erosion control ordinances, stormwater detention, urban housekeeping, and adoption and enforcement of pet and yard waste ordinances should reduce sediment, nutrient and bacteria loading to streams. Personnel and financial assistance to implement various rural and urban practices are available from the Department of Natural Resources and the Land Conservation Departments in the Sheboygan River watershed. These programs can work to significantly improve the quality of the Sheboygan River.

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TABLE 1.
FECAL BACTERIA SAMPLE STATIONS
IN THE SHEBOYGAN RIVER BASIN

ONION RIVER

STREAM SITE	SITE LOCATION	STREAM MILE
OR-1B	CTH AC	29.78
OR-2B	CTH W	22.35
OR-3B	Eernisse Road	14.34
OR-4B	Ourtown Road	3.72

MULLET RIVER

STREAM SITE	SITE LOCATION	STREAM MILE
MR-1B	STH 67 (Plymouth)	17.30
MR-2B	CTH AC (Plymouth)	12.21
MR-3B	CTH PP (Sheb. Falls)	0.13

SHEBOYGAN RIVER

STREAM SITE	SITE LOCATION	STREAM MILE
SR-1B	CTH G. (St.Cloud)	63.09
SR-2B	CTH MM	53.40
SR-3B	CTH AA (Kiel)	44.15
SR-4B	CTH A (Franklin)	34.04
SR-5B	Woodland Road	28.19
SR-6B	Meadowlark Road	17.60
SR-7B	STH 28 (Sheboygan)	3.46

TABLE 2.
Lower Sheboygan River
Precipitation and Membrane Filter Fecal Coliform Concentration Data from 1990

SITE DATE	9/14	9/24	10/01	10/15	10/16	COMPARISON TO STANDARD		
PRECIPITATION								
Plymouth	2.20	0	.06	.09	0	GEOM MEAN	% THAT GEOM MEAN > 200 / 100 ML	% OF TOT SAMPLES > 400 / 100 ML
MFFCC (/100 mL)								
OR-1B	12,000	310	270	80	60	344	72% (<1x)	20%
OR-2B	100,000	300	160	160	90	586	193% (2x)	20%
OR-3B	100,000	2,300	2,800	4,100	560	4,305	2053% (20x)	100%
OR-4B	90,000	1,700	210	670	470	1,589	695% (7x)	80%
MR-1B	18,000	100	110	20	20	151	0	20%
MR-2B	25,000	520	2,900	680	27,000	3,699	1750% (17.5x)	100%
MR-3B	95,000	430	1,100	240	170	1,129	465% (4.7x)	60%
SR-1B	700	60	110	110	150	150	0	20%
SR-2B	330	40	40	50	10	48	0	0
SR-3B	1,300	240	60	60	80	155	0	20%
SR-4B	45,000	240	290	140	360	691	246% (2.5x)	20%
SR-5B	100,000	330	140	110	340	704	252% (2.5x)	20%
SR-6B	62,000	400	90	80	540	626	213% (2x)	40%
SR-7B	41,000	800	210	120	140	650	225% (2x)	40%

TABLE 3.
Point Source Data on
the Sheboygan, Mullet and Onion Rivers from 1990

POINT SOURCE DISCHARGE	RECEIVING WATER NAME	DISINFECTING		MFFCC GEOM MEAN /100ML		FLOW DAILY MAX MGD		DESIGN FLOW MGD
		SEPT	OCT	SEPT	OCT	SEPT	OCT	
WALDO WWTP	ONION RIVER	Y	Y	13732	13366	.108	.049	.1
HINGHAM WWTP	ONION RIVER	Y	N	72	NA	.0476	.0341	.05
BELGIUM WWTP	ONION RIVER	Y	Y	16	25	.343	.233	.192
GIBBSVILLE WWTP	ONION RIVER	N	N[1]	106.5	NA	.041	.028	.04
SHEB CO HEALTH CENTER	ONION RIVER	N	N[2]	NA	NA	.0187	.0158	.0674
PLYMOUTH WWTP	MULLET RIVER	Y	Y	27724	30520	2.25	1.48	1.65
ST. CLOUD WWTP	SHEBOYGAN RIVER	N	N	NA	NA	.031	.028	.044
KIEL WWTP	SHEBOYGAN RIVER	N	N	16	NA	1.1	.914	.862
MT. CALVARY WWTP	SHEBOYGAN RIVER	N	N	103	155	.26	.135	.174
JOHNSONVILLE FOODS	SHEBOYGAN RIVER	Y	N	0	NA	.0045	.0045	.05

Source: 1990 Discharge Monitoring Report Summary Data

1 Gibbsville is not required to disinfect because it has an adequatly long retention time. Past plant performance has shown that Gibbsville is able to meet the state standard for fecal coliform bacteria without disinfection.

2 Disinfection was not required at the Sheboygan County Comprehensive Health Center during the sampling time. Seasonal disinfection will be considered at the next permit reissuance, however.

The Sheboygan River Basin

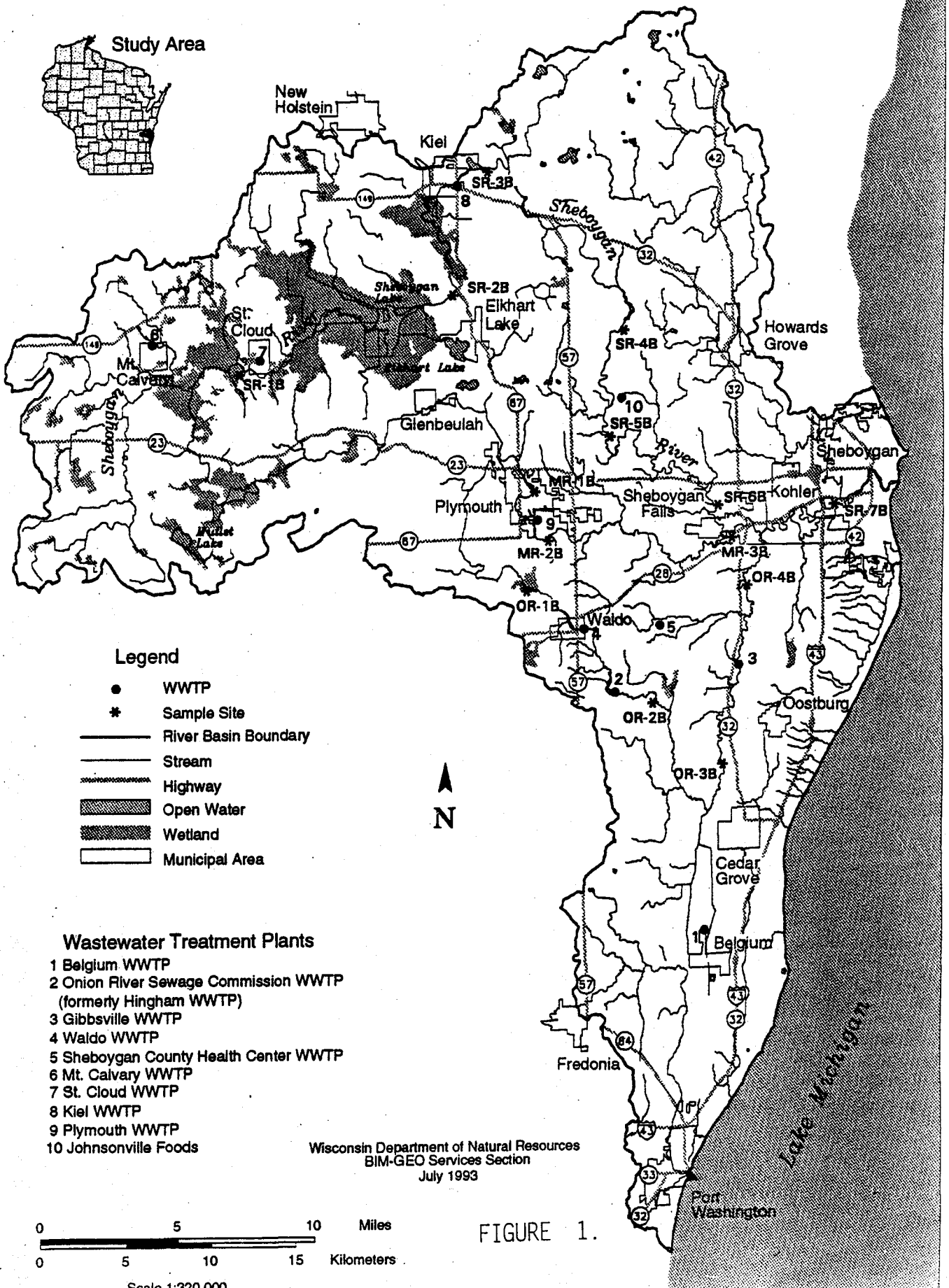


FIGURE 1.

STH 28 MONITORING STATION DATA
MFFCC CONCENTRATION AND FLOW, YEARLY AVERAGES

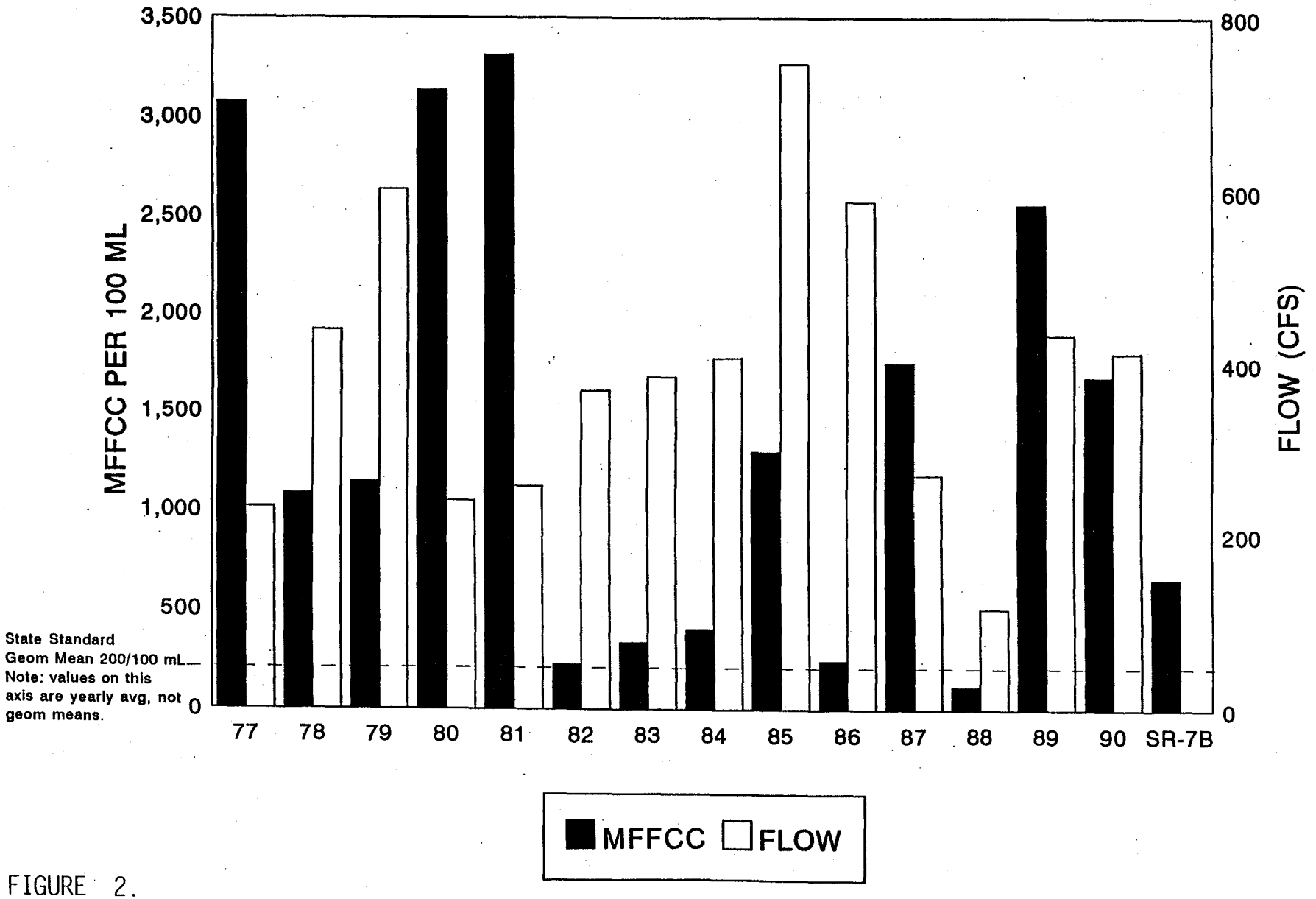
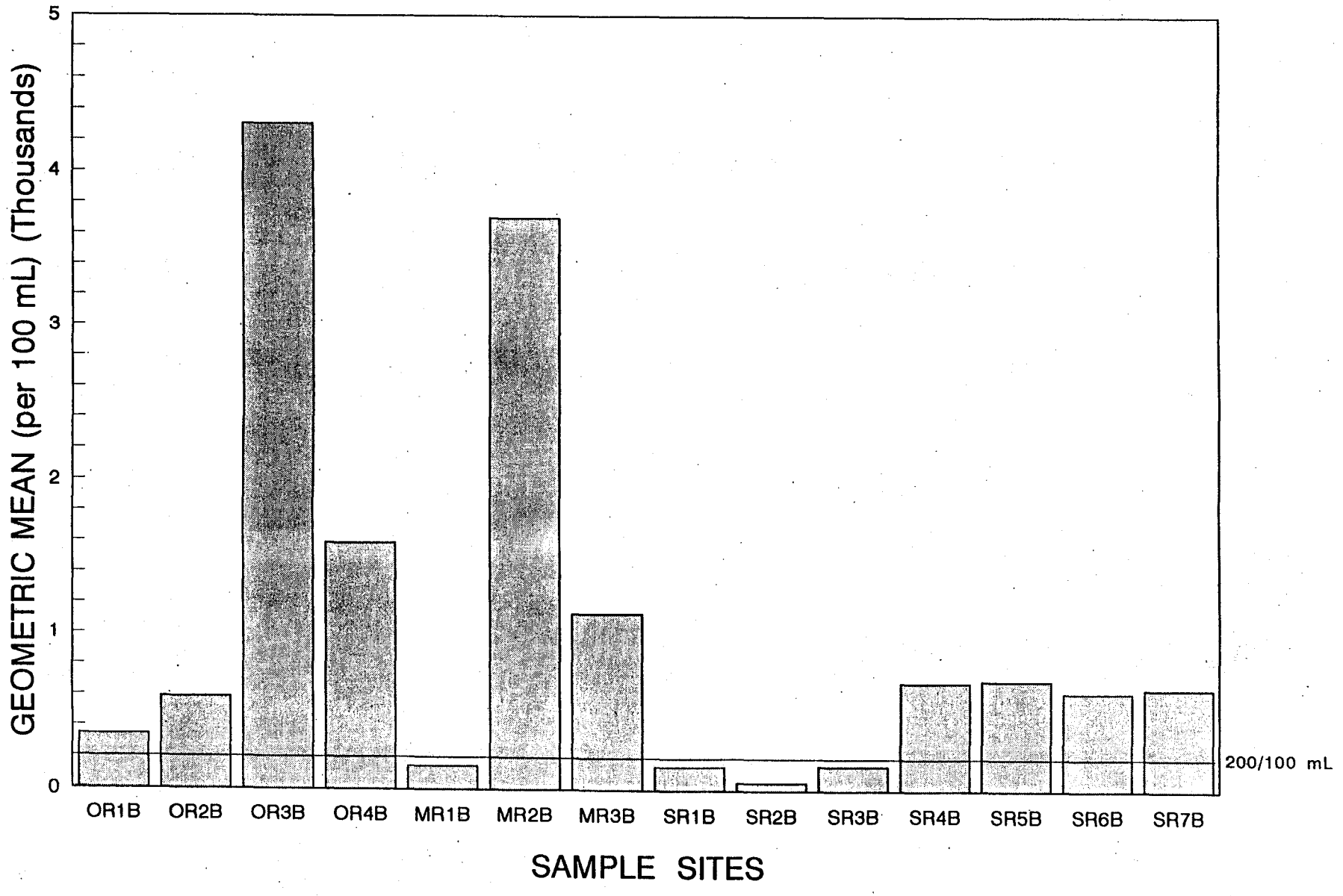


FIGURE 2.

FIGURE 3.

MEMBRANE FILTER FECAL COLIFORM COUNT (MFFCC), ALL SITES



DATA BASED ON 5 SAMPLES FROM 9/14/90 - 10/16/90

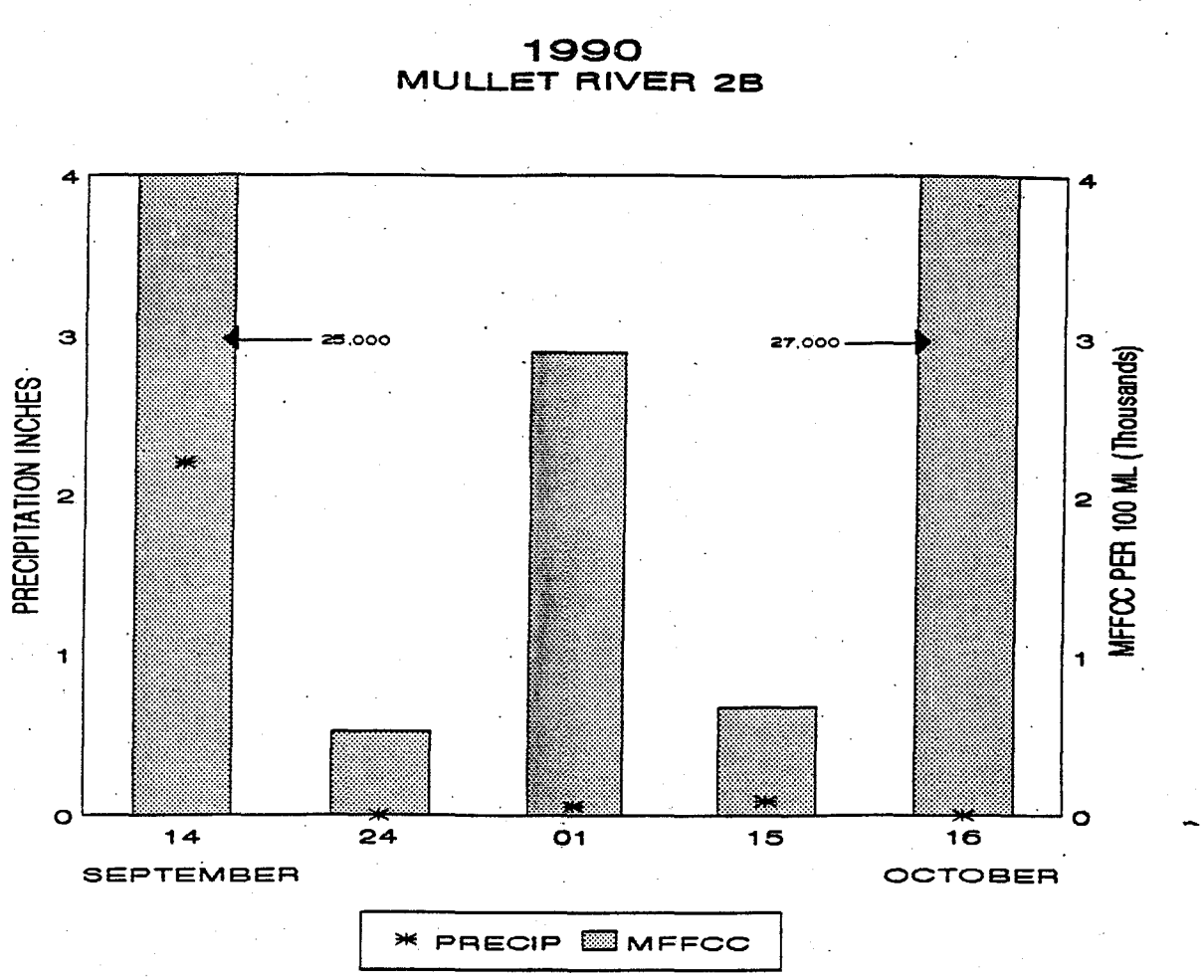


FIGURE 4.1

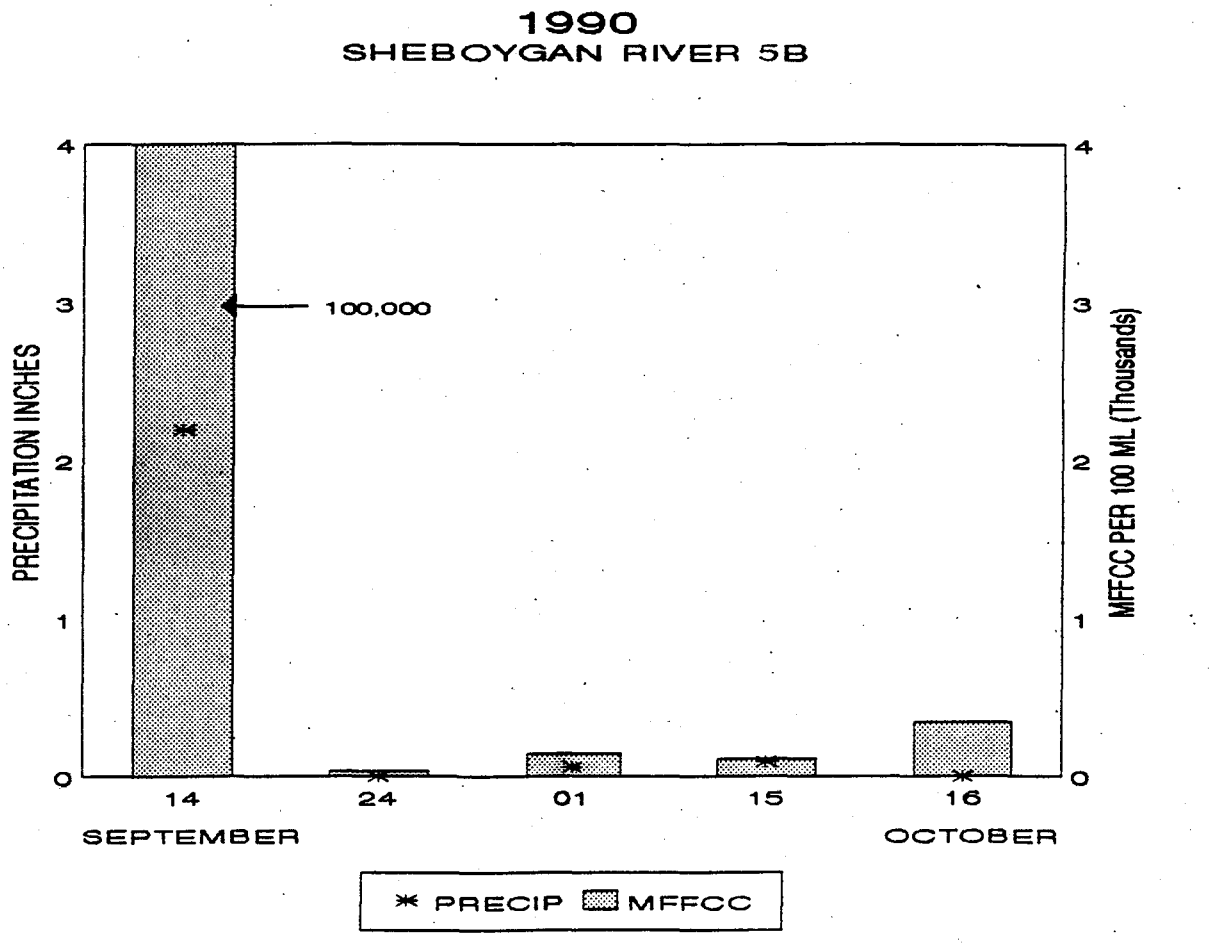


FIGURE 4.2