

**Michigan Department of Environmental Quality  
Water Division  
October 2002**

**Total Maximum Daily Load for *Escherichia coli* for the Saline River, Near Mooreville,  
Washtenaw County**

**INTRODUCTION**

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a waterbody based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of this TMDL is to identify the allowable levels of *Escherichia coli* (*E. coli*) that will result in the attainment of the applicable WQS in the Saline River, near Mooreville, Washtenaw County, Michigan.

**PROBLEM STATEMENT**

The Saline River was first placed on the Section 303(d) list in 1998. The TMDL reach is on the Section 303(d) list as:

Waterbody:	Saline River	WBID#:	<b>061104A</b>	
County:	Washtenaw	HUC:	4100002	
Location:	Near Mooreville, Section 28, York Township		Size:	1 M
Status:	<b>2</b>	Problem:	<b>Untreated sewage discharge, pathogens (Rule 100).</b>	
TMDL YEAR(s):	<b>2002</b>	RF3RchID:	4100002 2	

The Saline River (Figure 1) was placed on the Section 303(d) list (Creal and Wuycheck, 2002) due to impairment of recreational uses as indicated by the presence of elevated levels of *E. coli*. Historical data collected by the Washtenaw County Health Department document raw sewage discharges into the Saline River in the vicinity of Mooreville since the 1940s (Moore, 2002). Follow-up studies done by the Washtenaw County Environmental Services Department in 1991 again confirmed direct sewage discharges to the Saline River near Dennison and Mooreville Roads (Badics and Dean, 1993). Recent monitoring data (Tables 1-3) collected by the Michigan Department of Environmental Quality (MDEQ) for the 2001 and 2002 monitoring seasons documented exceedances of the WQS for *E. coli* at all three stations sampled during the full body contact recreational season (Tables 1-3 and Figure 2). Thirty-day geometric mean *E. coli* concentrations in 2001 ranged from 94 *E. coli* per 100 milliliters (ml) in August at Platt Road to 830 *E. coli* per 100 ml in September at Dennison Road. Thirty-day geometric mean *E. coli* concentrations in 2002 ranged from 158 *E. coli* per 100 ml in June at Platt Road to 410 *E. coli* per 100 ml in August at Dennison Road. An additional upstream site at Maple Road was sampled in July in 2002, and potential upstream sources of *E. coli* were indicated. The greatest daily geometric mean at this site was 1,649 *E. coli* per 100 ml. The primary data set collected over two years (2001 and 2002) used to develop this TMDL indicates constant exceedances of the WQS at Dennison Road with levels decreasing in a downstream direction. Based on additional data collected in 2002, the upstream boundary of the TMDL reach has been extended to Maple Road (Figure 1).

## NUMERIC TARGET

The impaired designated use for the Saline River at this location is total body contact recreation. Rule 100 of the Michigan WQS requires that this waterbody be protected for total body contact recreation from May 1 to October 31. The target levels for this designated use are the ambient *E. coli* standards established in Rule 62 of the WQS as follows:

R 323.1062 Microorganisms.

Rule 62. (1) All waters of the state protected for total body contact recreation shall not contain more than 130 *Escherichia coli* (*E. coli*) per 100 milliliters, as a 30-day geometric mean. Compliance shall be based on the geometric mean of all individual samples taken during 5 or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of 3 or more samples taken at representative locations within a defined sampling area. At no time shall the waters of the state protected for total body contact recreation contain more than a maximum of 300 *E. coli* per 100 milliliters. Compliance shall be based on the geometric mean of 3 or more samples taken during the same sampling event at representative locations within a defined sampling area.

In addition, sanitary wastewater discharges have an additional target:

Rule 62. (3) Discharges containing treated or untreated human sewage shall not contain more than 200 fecal coliform bacteria per 100 milliliters, based on the geometric mean of all of 5 or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 milliliters, based on the on the geometric mean of all of 3 or more samples taken during any period of discharge not to exceed 7 days. Other indicators of adequate disinfection may be utilized where approved by the department.

Sanitary wastewater discharges are considered in compliance with the WQS of 130 *E. coli* per 100 ml if their National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliforms per 100 ml as a monthly average is met. This is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source dischargers are meeting their limit of 200 fecal coliform per 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent.

For this TMDL, the WQS of 130 per 100 ml as a 30-day geometric mean is the target level for the TMDL reach from May 1 to October 31. As previously stated, the 2001 and 2002 monitoring data indicated exceedances of WQS at all stations with the highest concentrations at Dennison Road and Maple Road.

## SOURCE ASSESSMENT

The modified TMDL reach for the Saline River is Maple Road (upstream boundary) to Platt Road (downstream boundary) (Figure 1). The modified TMDL reach is downstream of Saline, in the vicinity of Mooreville, York Township, Washtenaw County (Figure 1). There are two permitted point source discharges just upstream of the TMDL reach, the Saline Wastewater Treatment Plant (WWTP) (MI0024023), which discharges to the Saline River, and River Ridge Mobile Home Park (MHP) WWTP (MI0055034), which discharges to an unnamed tributary of the Saline River.

Potential pathogen sources for this waterbody include illicit sewer connections in the Mooreville area. Dye tests, as well as site observations, have confirmed that several homes have been discharging sewage to the Saline River for decades (Badics and Dean, 1993). Monitoring data for 2001 indicated the highest exceedances at Mooreville (Dennison Road), where the homes are located. In-stream levels of *E. coli* decreased in a downstream direction at Petersburg and Platt Roads (Figure 2). However, additional data collected in 2002 indicated potential sources of *E. coli* upstream of the Mooreville area. The Saline River has moderate flows at this location (Table 4).

As stated above, there are two permitted point source discharges to the Saline River above the listed reach, the Saline WWTP and the River Ridge MHP WWTP. The Saline WWTP has a continuous discharge of 1.8 million gallons per day (MGD) and has a limit of 200 fecal coliform per 100 ml as a monthly average. The River Ridge MHP WWTP has a continuous discharge of 0.074 MGD and also has a limit of 200 fecal coliform per 100 ml as a monthly average. Both WWTPs will be considered in compliance with the WQS of 130 *E. coli* per 100 ml if their NPDES permit limit of 200 fecal coliform per 100 ml as a monthly average are met. As previously discussed, this is assumed because *E. coli* are a subset of fecal coliform (American Public Health Association, 1995). When the wastewater of concern is sewage, fecal coliform is substantially higher than *E. coli* (Whitman, 2001). When the point source is meeting its limit of 200 fecal coliform per 100 ml, it can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent. In addition, the area of Mooreville will be sewered beginning in 2002. Sanitary lines will tie into existing infrastructure of the Milan WWTP (MI0021571) for treatment. It is anticipated that residential hook-ups will be completed by winter 2003.

## **LINKAGE ANALYSIS**

The link between the *E. coli* concentration in the Saline River and the potential sources is the basis for the development of the TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. This provides the basis for estimating the total assimilative capacity of the river and any needed load reductions. For this TMDL, a significant amount of the pathogen load likely enters the Saline River by illicit connections and raw sewage inputs from homes in the vicinity of Dennison Road. Based on 2002 monitoring data, the concentrations of *E. coli* at Maple Road were found to exceed the WQS, indicating unknown sources above this site.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in the Saline River depends on the control of *E. coli* from illicit connections and continued compliance by the permitted point source discharges. Additionally, the sources of *E. coli* upstream of Maple Road need to be identified and controlled. If the *E. coli* inputs can be controlled, then total body contact recreation in the Saline River will be protected.

## **TMDL DEVELOPMENT**

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving WQS. As indicated in the Numeric Target section, the target for this pathogen TMDL is the WQS of 130 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the environmental conditions that will be used when defining allowable levels. Many TMDLs are designed around the concept of a "critical condition." The "critical condition" is defined as the set of environmental conditions that, if controls are designed to protect, will ensure attainment of objectives for all other conditions. For example, the critical conditions for the control of point sources in Michigan are given in R 323.1082 and R 323.1090. In general, the lowest monthly 95% exceedance flow for streams is used as a design condition for point source discharges. However, for pathogens in point source discharges of treated or untreated human sewage, levels are restricted to a monthly

average limit of 200 per 100 ml for fecal coliform regardless of stream flow. Therefore, the design stream flow is not a critical condition for determining the allowable loading of pathogens for WWTPs. In addition, other *E. coli* sources to the Saline River arise from a mixture of wet and dry weather-driven nonpoint sources, and there is no single critical condition that is protective for all other conditions. For these sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g., pounds per day). For *E. coli*, however, mass is not an appropriate measure, and the USEPA allows pathogen TMDLs to be expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). Therefore, this pathogen TMDL is concentration-based consistent with R 323.1062, and the TMDL at Platt Road is equal to the target concentration of 130 *E. coli* per 100 ml for each month of the recreational season (May through October).

## **ALLOCATIONS**

TMDLs are comprised of the sum of individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relation between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. As previously indicated, this pathogen TMDL will not be expressed on a mass loading basis and is concentration-based consistent with USEPA regulations in 40 CFR, Section 130.2(i).

### WLAs

The Saline WWTP has a permitted discharge to the Saline River just upstream of the listed reach. This facility has a design flow of 1.8 MGD and has a limit of 200 fecal coliform per 100 ml as a monthly average. The River Ridge MHP WWTP also has a permitted discharge to an unnamed tributary to the Saline River upstream from the TMDL reach. This facility has a design flow of 0.074 MGD and has a limit of 200 fecal coliform per 100 ml as a monthly average. Therefore, the WLA will be equal to 130 *E. coli* per 100 ml. As previously stated, when the WWTPs are meeting their permit limit, it is assumed the WQS will be met in the discharge.

### LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml. As indicated in the Source Assessment section, one of the primary sources of *E. coli* is homes illicitly discharging to the Saline River in the vicinity of Mooreville. It is anticipated that this problem will be corrected when the area is sewered. Recent data has indicated an additional source of *E. coli* upstream of Maple Road. This source must be identified and controlled to meet the LA of 130 *E. coli* per 100 ml.

## MOS

This section addresses the incorporation of an MOS in the TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS because no rate of decay was used.

## **SEASONALITY**

Seasonality in the TMDL is addressed by expressing the TMDL in terms of a total body contact recreation season that is defined as May 1 through October 31 by R 323.1100 of the WQS. There is no total body contact during the remainder of the year primarily due to cold weather. In addition, because this is a concentration-based TMDL, WQS will be met regardless of flow conditions in the applicable season.

## **MONITORING**

In 2001, pathogens were monitored at three stations from May through September (Figure 1). In 2002, pathogens were monitored at the same three stations from May through June. Sampling resumed again in July, 2002 at all stations with an additional site located at Maple Road. Due to exceedances upstream of the TMDL reach, future monitoring will be oriented to determining the source of *E. coli* upstream of Maple Road. To aid in that effort, two stations were added to the last month of the 2002 sampling. Those locations included one station in the city of Saline and one station upstream of Saline (Table 5).

Additional sampling will take place after the area of Mooreville has been sewered. When these results indicate that the waterbody may be meeting WQS, sampling will be conducted at the appropriate frequency to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

## **REASONABLE ASSURANCE ACTIVITIES**

Under the NPDES permit program, the two WWTP dischargers are responsible for meeting their effluent limits for fecal coliform. Compliance is determined based on review of Discharge Monitoring Report data by the MDEQ. As previously stated, the WWTP discharges in the watershed are presently disinfecting their effluent well below their permitted limits.

The area of Mooreville will be sewered beginning in 2002. Sanitary lines will tie into existing infrastructure of the Milan WWTP (MI0021571) for treatment. It is anticipated that residential hook-ups will be completed by winter 2003.

Illicit discharges, agricultural inputs and to a lesser degree, storm water inputs, are likely the dominant source of *E. coli* to the Saline River. Implementation activities to meet the TMDL require measures to reduce *E. coli* sources. Activities in Washtenaw county requiring certification of properly functioning septic systems at the time of home sale will aid in reducing the number of failing septic systems/illicit connections that are currently in place. In addition, the city of Saline is included in the Phase II storm water permit urban area. This permit will require activities that reduce *E. coli* inputs through the public education, storm water management plans and illicit connections identification and elimination requirements.

Finally, in an effort to identify sources of *E. coli* upstream of the TMDL reach, three stations were added to the sampling. Results indicate exceedances of the daily geometric mean at Maple Road as well as upstream of the city of Saline at Dell Road (Figure 1, Table 5). Considerably

lower concentrations were found in the city of Saline at the Macon/Monroe Street station. This data indicate further source investigation is necessary. After the source is identified, appropriate corrective measures will be taken.

Prepared by: Christine Thelen, Aquatic Biologist  
Surface Water Quality Assessment Section  
Water Division  
Michigan Department of Environmental Quality  
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## REFERENCES

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- Moore, L. Personal Communication. Washtenaw County Health Department, June 2002.
- Whitman, R. Personal Communication. United States Geological Survey, October 2001.
- USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

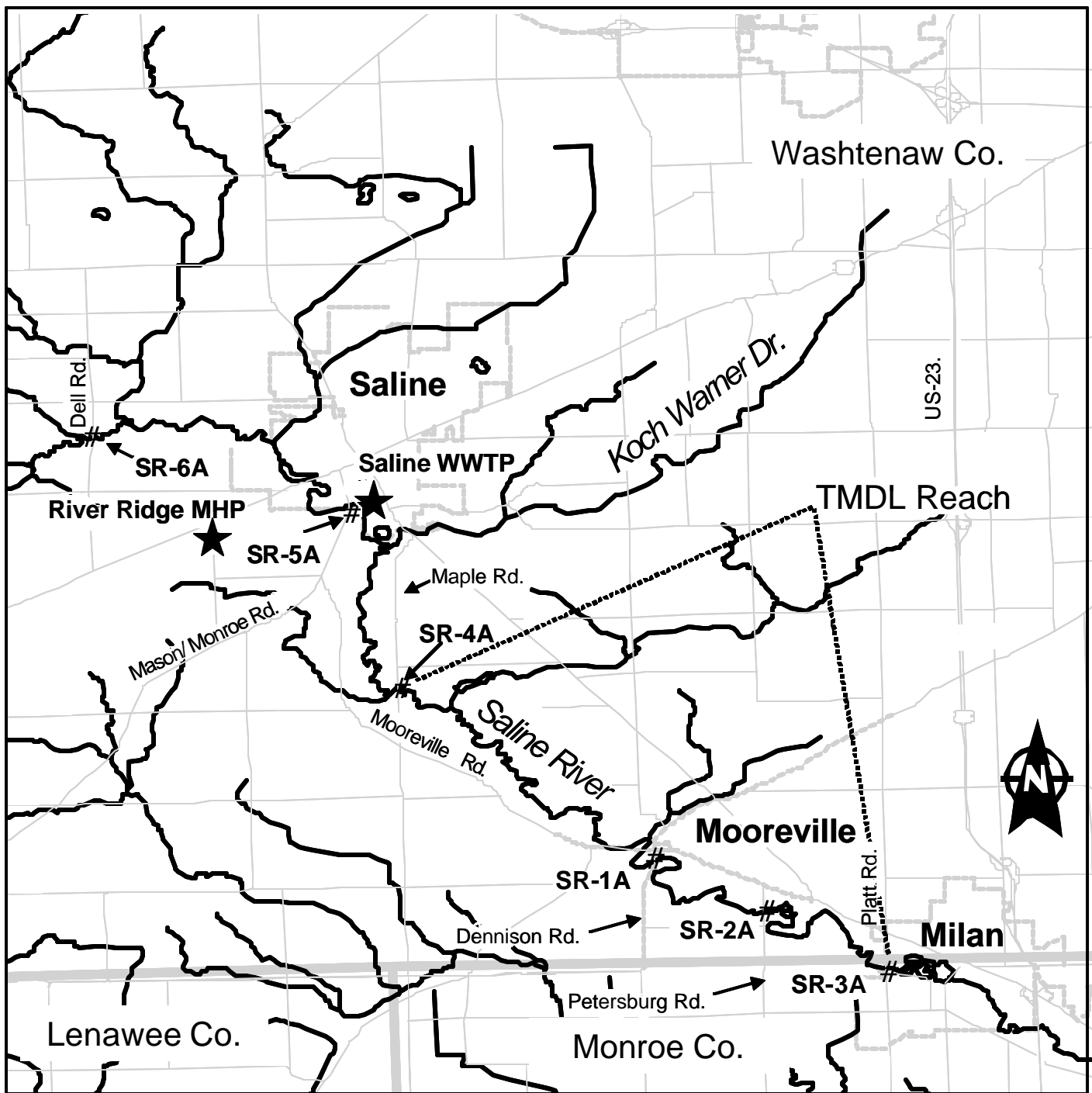


Figure 1. The Saline River *E. coli* sampling locations, York Township, Michigan, 2001-2002.



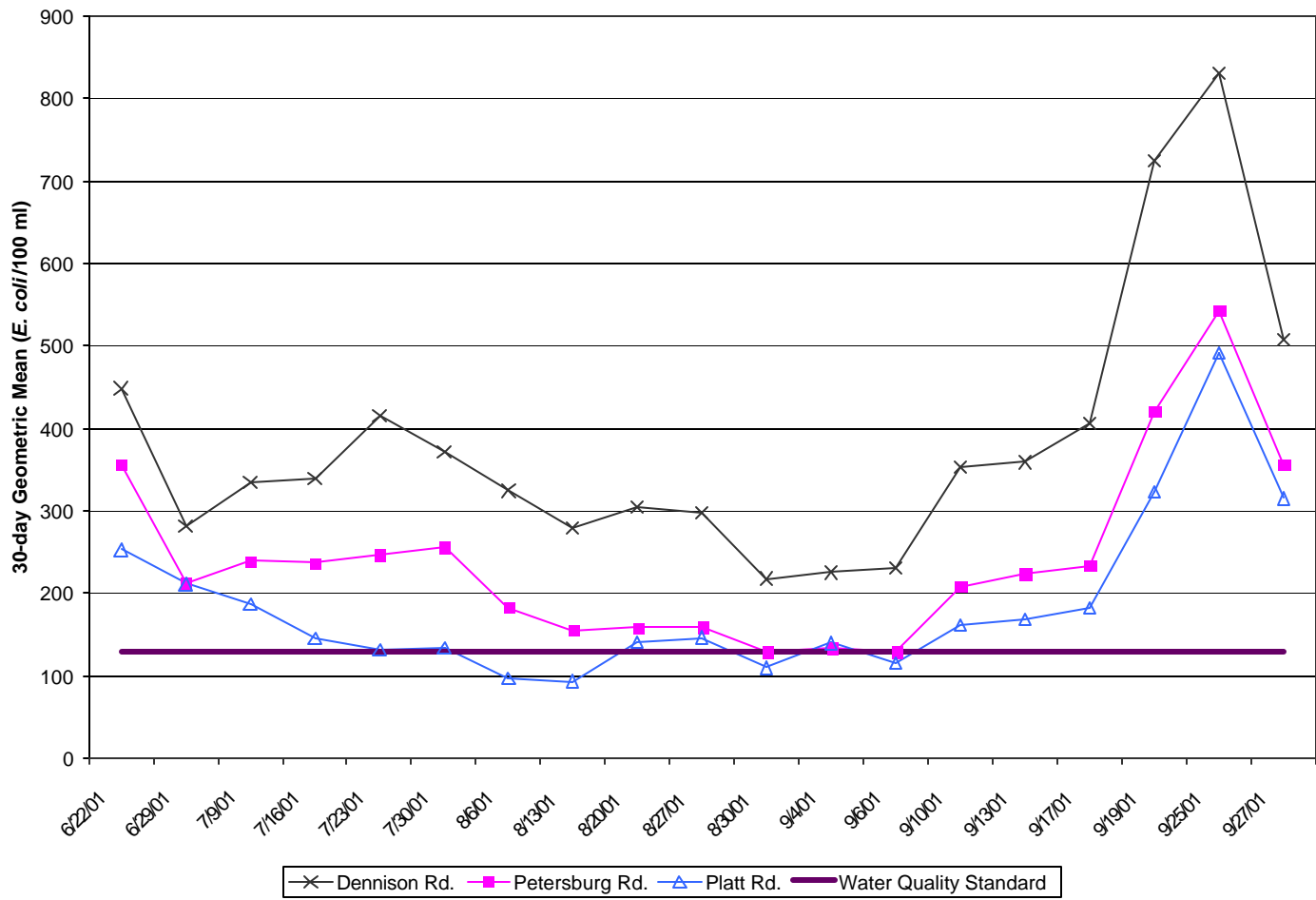


Figure 2. Thirty-day Geometric mean for *E. coli* in the Saline River at all sampling locations for 2001.

**Table 1. MDEQ 2001 *E. coli* monitoring data for the Saline River (*E. coli*/100 ml). Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.**

	Dennison Rd. SR-1A			Petersburg Rd. SR-2A			Platt Rd. SR-3A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
5/22/2001	2700	2990	---	3100	3264	---	440	423	---	overcast, cool
	3000			3300			420			
	3300			3400			410			
6/1/2001	200	184	---	160	173	---	290	252	---	rain, cool
	240			170			220			
	130			190			250			
6/8/2001	210	195	---	220	185	---	150	181	---	sunny, mild
	160			130			180			
	220			220			220			
6/15/2001	140	100	---	90	113	---	100	134	---	partly cloudy, hot and muggy
	120			100			120			
	60			160			200			
6/22/2001	1700	1686	448	490	487	356	380	403	253	overcast, mild
	1650			470			410			
	1710			500			420			
6/29/2001	320	291	281	280	245	212	190	172	212	sunny, hot and humid
	220			220			150			
	350			240			180			
7/9/2001	460	439	335	340	316	239	110	138	188	partly cloudy, warm and humid
	460			310			160			
	400			300			150			
7/16/2001	190	206	339	180	174	237	40	50	145	sunny, warm and humid
	210			210			80			
	220			140			40			
7/23/2001	270	280	416	170	138	247	110	83	132	cloudy, hot and humid
	290			130			40			
	280			120			130			

Table 1 continued (*E. coli*/100 ml).

	Dennison Rd. SR-1A			Petersburg Rd. SR-2A			Platt Rd. SR-3A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
7/30/2001	920	965	372	530	588	256	290	428	134	sunny, hot and humid
	1040			620			1080			
	940			620			250			
8/6/2001	120	147	325	40	46	183	70	35	97	clear, sunny and hot
	140			40			60			
	190			60			10			
8/13/2001	250	204	279	120	139	155	90	117	94	partly cloudy, mild
	190			150			160			
	180			150			110			
8/20/2001	390	323	305	120	195	159	230	381	141	overcast, mild
	270			200			470			
	320			310			510			
8/27/2001	250	251	298	190	142	160	150	103	147	clear, mild
	350			100			180			
	180			150			40			
8/30/2001	190	203	218	170	204	129	100	103	110	partly cloud, mild
	220			310			220			
	200			160			50			
9/4/2001	190	173	225	20	55	134	130	115	140	clear, mild
	170			90			90			
	160			90			130			
9/6/2001	260	232	231	110	118	129	90	45	116	clear, mild
	200			100			100			
	240			150			10			
9/10/2001	2800	2696	353	2200	2133	209	3100	2005	161	clear, mild
	2800			2100			1300			
	2500			2100			2000			

Table 1 continued (*E. coli*/100 ml).

	Dennison Rd. SR-1A			Petersburg Rd. SR-2A			Platt Rd. SR-3A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
9/13/2001	260	271	359	200	203	224	160	131	169	overcast, cool
	480			150			100			
	160			280			140			
9/17/2001	360	376	406	300	250	234	110	149	182	clear, cool
	390			200			200			
	380			260			150			
9/19/2001	3200	3133	725	1100	1029	421	3000	2021	323	mild, rain
	3100			1100			1100			
	3100			900			2500			
9/25/2001	560	457	830	560	424	543	240	362	491	cool, light rain
	370			400			300			
	460			340			660			
9/27/2001	270	232	508	210	259	356	190	219	315	overcast, cool
	140			330			220			
	330			250			250			

**Table 2. MDEQ 2002 *E. coli* monitoring data for the Saline River (*E. coli*/100 ml), May through June. Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.**

	Dennison Rd. SR-1A			Petersburg Rd. SR-2A			Platt Rd. SR-3A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
5/9/2002	20	20	---	200	43	---	40	25	---	storms, 60°
	20			20			20			
	20			20			20			
5/14/2002	1400	1290	---	1440	1349	---	2600	3017	---	sunny, 50°
	1080			1040			4400			
	1420			1640			2400			
5/21/2002	80	63	---	60	105	---	60	60	---	sunny, 45°
	160			120			60			
	20			160			60			
5/28/2002	100	152	---	200	58	---	100	79	---	sunny, 65°
	350			20			100			
	100			50			50			
6/4/2002	400	654	175	600	620	186	240	272	158	overcast, 60°
	760			640			200			
	920			620			420			
6/11/2002	160	131	254	20	32	175	400	205	240	hazy, 80°
	100			80			120			
	140			20			180			

**Table 3. MDEQ 2002 *E. coli* monitoring data for the Saline River (*E. coli*/100 ml), July through September. Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.**

	Maple Rd. SR-4A			Dennison Rd. SR-1 A			Petersburg Rd. SR-2A			Platt Rd. SR-3A			
DATE	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	Weather data
7/31/2002	2000	1649	---	540	671	---	600	480	---	140	---	---	hazy, 90°
	1400			350			400			460			
	1600			1600			460			#			
8/7/2002	680	1070	---	400	544	---	480	556	---	260	167	---	sunny, 65°
	1000			560			560			180			
	1800			720			640			100			
8/13/2002	4800	793	---	760	462	---	360	285	---	320	1390	---	humid, 75°
	5200			360			160			2800			
	20			360			400			3000			
8/21/2002	500	323	---	320	132	---	400	284	---	180	224	---	sunny, 70°
	140			20			260			260			
	480			360			220			240			
8/28/2002	580	504	744	560	521	410	240	337	374	180	105	---	sunny, 70°
	480			600			400			320			
	460			420			400			20			
9/4/2002	500	552	598	280	367	363	140	136	290	40	58	199	sunny, 65°
	800			400			180			80			
	420			440			100			60			
9/11/2002	760	656	542	280	326	328	320	352	265	180	151	195	sunny, 70°
	580			440			380			120			
	640			280			360			160			

# sample not analyzed.

**Table 4. Saline River average flows (cfs) at Platt Road, vicinity of Mooreville, Michigan.**

<b>May</b>	<b>June</b>	<b>July</b>	<b>August</b>	<b>September</b>	<b>October</b>
54	38	25	18	19	19

**Table 5. MDEQ 2002 Additional *E. coli* monitoring data for the Saline River (*E. coli*/100 ml) upstream of the TMDL reach, mid-August through September. Shaded areas indicate exceedances of the Water Quality Standard.**

DATE	Dell Rd. SR-6A			Macon/Monroe Rd. SR-5A			Weather data
	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	SAMPLE RESULTS	DAILY G. MEAN	30-day G. MEAN	
8/21/2002	840	911	---	20	66	---	sunny, 70°
	900			120			
	1000			120			
8/28/2002	1800	1361	---	240	219	---	sunny, 70°
	1400			200			
	1000			220			
9/4/2002	2000	2194	---	160	109	---	sunny, 65°
	2200			100			
	2400			80			
9/11/2002	1600	1702	---	100	145	---	sunny, 70°
	2200			220			
	1400			140			