Michigan Department of Environmental Quality

Water Division

February 2004

Total Maximum Daily Load for *Escherichia coli* for Mill Creek St. Clair 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 water bodies that are not meeting water quality standards (WQS). The TMDL process establishes the allowable loadings of pollutants for a water body 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 (NPS) 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 Mill Creek, a tributary to the Black River, located in St. Clair County, Michigan.

PROBLEM STATEMENT

This water body was placed on the Section 303(d) list in 2002. This TMDL listing addressed approximately one mile of stream in the vicinity of Yale. The TMDL reach is on the 2002 Section 303(d) list as:

MILL CREEK WBID#: **061503A**
County: St. Clair HUC: 4090001 Size: 1 M
Location: Vicinity of Yale, T7N, R14E, Sec.1.
Problem: **Untreated sewage discharge, pathogens (Rule 100).**
TMDL YEAR(s): 2004 RF3RchID: 4090001 1415.00

Mill Creek (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*.

Monitoring data collected by the Michigan Department of Environmental Quality (MDEQ) in 2002, documented exceedances of the WQS for *E. coli* at various sampling locations during the total body contact recreational season (Tables 1 and 2). In general, *E. coli* concentrations in Mill Creek were highest upstream of Yale at the Jeddo Road station (MC-5A) (Table 1 and Figure 2). Thirty-day geometric mean concentrations upstream of Yale ranged from 52 *E. coli* per 100 milliliters (ml) in August at Arenot Road, to 314 *E. coli* per 100 ml in September at Jeddo Road. Thirty-day geometric mean concentrations in the city limits of Yale and downstream ranged from 38 *E. coli* per 100 ml at Norman Road to 281 *E. coli* per 100 ml at Wilkes Road (Table 2, Figure 3).

The 2002 Section 303(d) listing for Mill Creek was approximately one mile of stream in the vicinity of Yale. Based on a review of the listing and the 2002 monitoring data, the listed TMDL reach will be modified as Arenot Road downstream approximately 11 miles to Norman Road. Mill Creek has moderate flow in this area during the recreational season (Table 3).

NUMERIC TARGET

The impaired designated use addressed by this TMDL is total body contact recreation. Rule 100 of the Michigan WQS requires that this water body 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 five or more sampling events representatively spread over a 30-day period. Each sampling event shall consist of three 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 three 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 ml, based on the geometric mean of all of five or more samples taken over a 30-day period, nor more than 400 fecal coliform bacteria per 100 ml, based on the geometric mean of all of three or more samples taken during any period of discharge not to exceed seven 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). Fecal coliform are substantially higher than *E. coli* (Whitman, 2001) when the wastewater of concern is sewage. It can reasonably be assumed that there are less than 130 *E. coli* per 100 ml in the effluent when the point source discharge is meeting its limit of 200 fecal coliform per 100 ml.

For this TMDL, the WQS of 130 *E. coli* per 100 ml as a 30-day geometric mean and 300 *E. coli* per 100 ml as a daily maximum are the target levels for the TMDL reach from May 1 to October 31. As previously stated, the 2002 monitoring data indicated exceedances of WQS. Stations with the highest concentrations are located upstream of Yale at the Jeddo Road station and downstream at Wilkes Road.

SOURCE ASSESSMENT

The official listed reach of Mill Creek was one mile in the vicinity of Yale. Based on a review of the 2002 data, the modified listed reach covered by this TMDL is Mill Creek from Arenot Road, downstream approximately 11 miles to Norman Road. The TMDL reach is located in Brockway Township in St. Clair County. The municipalities in the modified reach for Mill Creek include

Brockway Township, Speaker Township, Lynn Township, Emmett Township, Maple Valley Township, and the city of Yale (Figure 1). Table 4 shows the distribution of land for each municipality.

The primary pathogen sources for this water body are typical of mixed suburban and agricultural land uses. Agricultural land uses upstream of Yale may be contributing *E. coli* to Mill Creek as indicated by WQS exceedances at Jeddo Road. Exceedances began in July and occurred periodically throughout the remainder of the sampling season. The listing was primarily due to raw sewage discharges from the city of Yale via a combined sanitary sewer system. The system was separated in 1995. The city of Yale reported one Sanitary Sewer Overflow (SSO) prior to the 2002 recreational season. This event resulted in a small amount of partially treated sewage to be discharged to Mill Creek.

Currently, there are three NPDES permitted discharges (Table 5). One of the three permits is for a Wastewater Stabilization Lagoon (WWSL), which contains fecal coliform limits and allows for a seasonal discharge between March through May and October through December. The remaining two permits are for storm water discharges and, due to Best Management Practices contained in the general permit, are not considered to contain treated or untreated human sewage; therefore, they are not considered a source of *E. coli* to the Mill Creek TMDL Watershed. Currently, there are no reported Notice of Coverage permits involving earth work (i.e., construction site activity) in the TMDL watershed.

LINKAGE ANALYSIS

Determining the link between the *E. coli* concentrations in Mill Creek and the potential sources is necessary to develop the TMDL. This link provides the basis for estimating the total assimilative capacity of the creek and any needed load reductions. For this TMDL, the major loadings of pathogens likely enter Mill Creek by both wet and dry weather sources, such as agricultural inputs, unregulated storm water runoff, and to a lesser degree, illicit connections.

The guiding water quality management principle used to develop the TMDL was that compliance with the numeric pathogen target in Mill Creek depends on the control of *E. coli* from agricultural inputs, unregulated storm water runoff, and illicit connections. If the *E. coli* inputs can be controlled to meet the numeric standards, then total body contact recreation in Mill Creek will be protected.

TMDL DEVELOPMENT

The TMDL represents the maximum loading that can be assimilated by the water body 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 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 is equal to the target concentration of 130 *E. coli* per 100 ml as a 30-day geometric mean in all portions of the TMDL reach for each month of the recreational season (May through October). Expressing the TMDL as a concentration equal to the WQS ensures that the WQS

will be met under all flow conditions; therefore, defining a critical condition is unnecessary for this TMDL.

ALLOCATIONS

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

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. 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

There are a total of three permitted point source discharges to the listed reach of Mill Creek. Two permits are for storm water discharges and the remaining permit is for a WWSL. The WWSL is permitted to discharge treated human waste during the months of March through May and October through December. The discharge period overlaps the recreational season in May and October only and 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 is met. The WLA for the WWSL and the storm water permits, is equal to 130 *E. coli* per 100 ml during the recreational season between May 1 and October 31.

LAs

Because this TMDL is concentration-based, the LA is equal to 130 *E. coli* per 100 ml. The determination of individual LAs will be based on the assumption of equal bacteria concentration for all lands in the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions will be determined by the amount of land under the jurisdiction of the local unit of government in the watershed. This TMDL reach is located in Brockway Township, Speaker Township, Lynn Township, Emmett Township, Maple Valley Township, and the city of Yale.

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, including the pollutant decay rate if applicable. The MOS can be either implicit (i.e., incorporated into the WLA or LA 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. The MDEQ has determined that the use of the WQS of 130 *E. coli* per 100 ml is a conservative approach, because pathogen organisms have a limited capability of surviving outside of their hosts and a rate of decay would normally be used. Applying a rate of decay could result in a discharge limit that would be greater than the WQS, thus no rate of decay is applied in order to provide for a greater protection of water quality. Applying the WQS to be met under all flow conditions also adds to the assurance of the MOS.

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 2002, pathogens were monitored weekly at a total of six stations from May through September. Future monitoring will take place as part of the five-year rotating basin monitoring. When these results indicate that the water body may be meeting WQS, sampling will be conducted at the appropriate frequency (as defined in the numeric target section) to determine if the 30-day geometric mean value of 130 *E. coli* per 100 ml is being met.

REASONABLE ASSURANCE ACTIVITIES

The Yale WWSL is responsible for meeting their NPDES permit limits for fecal coliform. Compliance is based on review of Discharge Monitoring Report data by the MDEQ. In addition, the city of Yale completed a sewer separation in 1995. The city had one SSO event prior to the 2002 recreational season that was the result of a faulty valve. The problem has since been corrected.

A local activity in the watershed is the Mill Creek Volunteer Monitoring Project. This project is funded by the MDEQ from a fund to provide seed money to help organizations establish volunteer monitoring activities. The objectives of this program include: Producing quality-assured data that can be used by MDEQ biologists as a screening tool to identify sites where more detailed assessment by the MDEQ is needed, developing and maintaining a database into which volunteer data can be stored and maintained, and generating public awareness, stewardship, and surveillance of Michigan surface waters. Specifically, this group has been involved in an effort to assess the effects of dredging vs. river restoration on several miles of Mill Creek, upstream of Yale. The group is concerned with the potential of increased erosion and sedimentation resulting from dredging activities.

Water quality monitoring efforts in the Mill Creek TMDL watershed will continue with an expanded Mill Creek Volunteer Monitoring Project. The expanded Mill Creek Volunteer Monitoring Project began in September 2003, and will end in September 2005. The project will continue to gather and record data from the dredged and non-dredged river restoration sites and will be expanded to include *E. coli* and chemical water testing. The collection of *E. coli* data from Mill Creek during the months of May, June, July, and August by the local group will add to the existing data collected by the MDEQ. It is anticipated that combined efforts will likely result in the identification of specific sources of *E. coli* to Mill Creek, particularly in the vicinity of Jeddo Road and Wilkes Road.

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REFERENCES

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Creal, W. and J. Wuycheck. 2002. Federal Clean Water Act Section 303(d) List – Michigan's Submittal for Year 2002. Michigan Department of Environmental Quality, Surface Water Quality Division, Report Number MI/DEQ/SWQ-02/013.

USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

Whitman, R. Personal Communication. United States Geological Survey, October 2001.

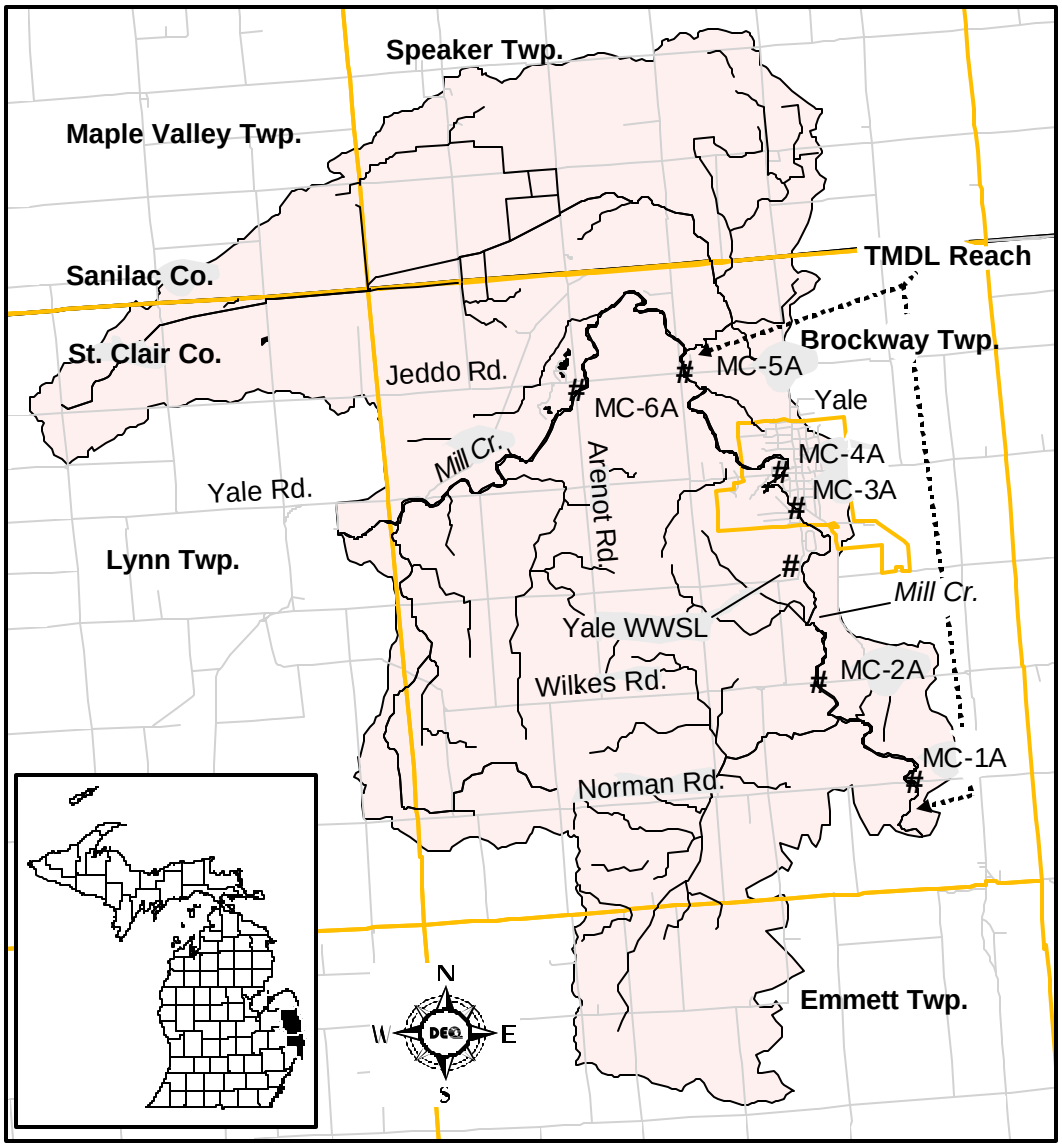

Figure 1. Mill Creek *E. coli* sampling locations, vicinity of Yale, Michigan, 2002.

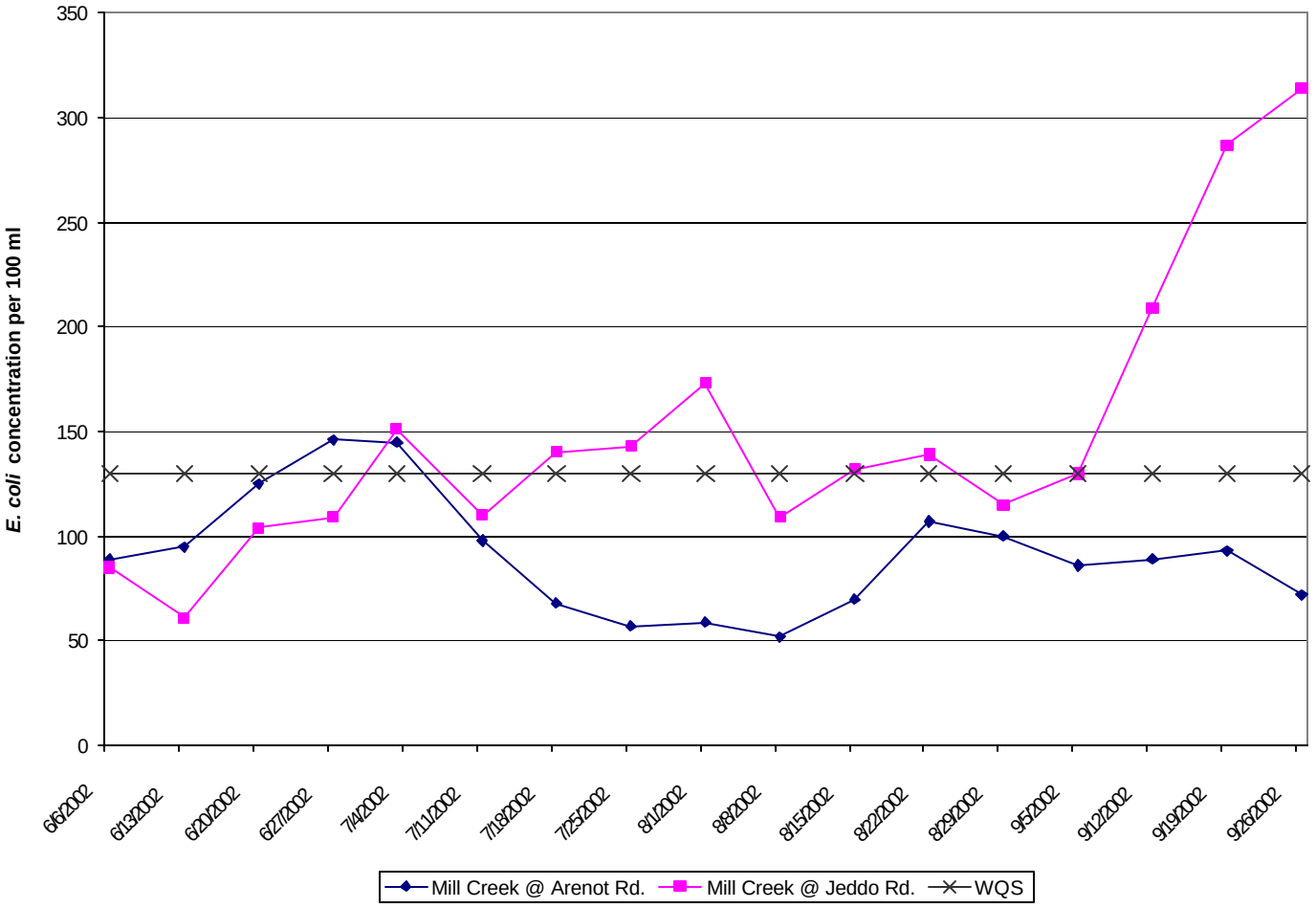

Figure 2. Thirty-day Geometric mean for *E. coli* in Mill Creek, upstream of Yale, St. Clair County, Michigan, 2002.

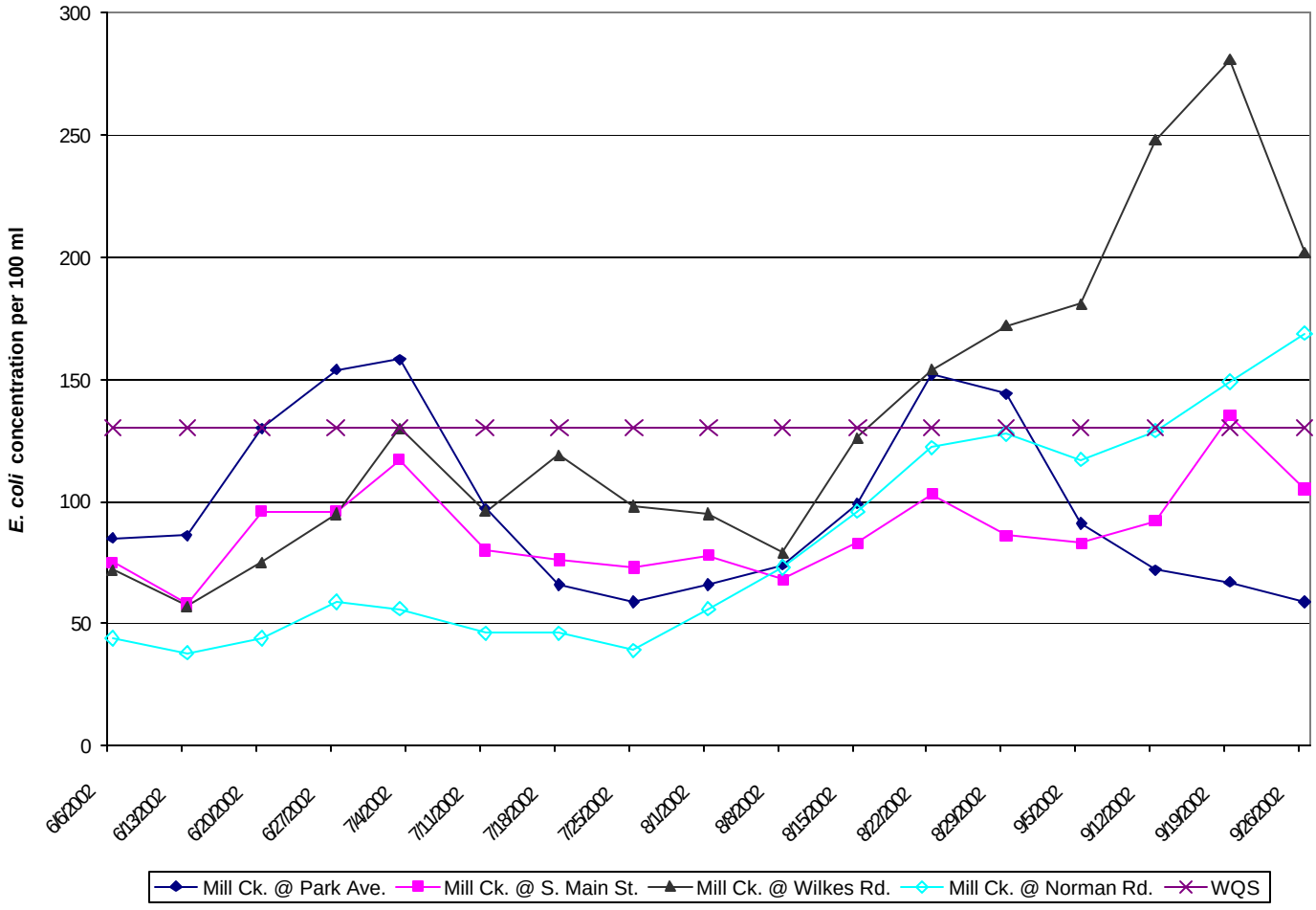

Figure 3. Thirty-day Geometric mean for *E. coli* in Mill Creek, vicinity of Yale and downstream, St. Clair County, Michigan, 2002.

Table 1. MDEQ 2002 *E. coli* monitoring data for Mill Creek (*E. coli*/100 ml) upstream of Yale. Shaded areas indicate exceedances of the Water Quality Standard. Data are presented upstream to downstream.

	Mill Creek @ Arenot Road MC-6A			Mill Creek @ Jeddo Road MC-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
5/9/2002	60	87	---	400	274	---	thunderstorms, 60°
	180			320			
	60			160			
5/16/2002	140	82	---	20	20	---	rain, 65°
	200			20			
	20			20			
5/23/2002	40	43	---	120	76	---	sunny, 65°
	20			60			
	100			60			
5/30/2002	140	104	---	160	58	---	sunny, 75°
	100			20			
	80			60			
6/6/2002	200	178	89	160	188	85	clear, 70°
	280			160			
	100			260			
6/13/2002	180	120	95	60	52	61	overcast, 70°
	60			120			
	160			20			
6/20/2002	380	320	125	160	284	104	hazy, 80°
	240			420			
	360			340			
6/27/2002	140	92	146	280	96	109	partly sunny, 75°
	140			160			
	40			20			

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

	Mill Creek @ Arenot Road MC-6A			Mill Creek @ Jeddo Road MC-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
7/3/2002	160	101	145	400	288	151	sunny, 85°
	160			500			
	40			120			
7/11/2002	40	25	98	20	38	110	sunny, 75°
	20			140			
	20			20			
7/18/2002	20	20	68	220	179	140	hazy, 80°
	20			100			
	20			260			
7/25/2002	120	124	57	300	319	143	partly sunny, 75°
	160			600			
	100			180			
8/1/2002	160	115	59	320	249	173	humid, 85°
	60			200			
	160			240			
8/8/2002	60	52	52	60	29	109	sunny, 70°
	60			20			
	40			20			
8/15/2002	120	113	70	40	99	132	mostly cloudy, 75°
	100			120			
	120			200			
8/22/2002	120	163	107	260	229	139	rain, 75°
	200			100			
	180			460			

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

	Mill Creek @ Arenot Road MC-6A			Mill Creek @ Jeddo Road MC-5A			
DATE	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**SAMPLE RESULTS**	**DAILY G. MEAN**	**30-day G. MEAN**	**Weather data**
8/29/2002	80	92	100	140	125	115	sunny, 70°
	60			140			
	160			100			
9/5/2002	120	52	86	400	458	130	sunny, 70°
	60			480			
	20			500			
9/12/2002	20	62	89	420	312	209	sunny, 70°
	100			240			
	120			300			
9/19/2002	220	145	93	520	474	287	sunny, 70°
	100			540			
	140			380			
9/26/2002	120	46	72	240	362	314	sunny, 60°
	40			620			
	20			320			

Table 2. MDEQ 2002 *E. coli* data for Mill Creek (*E. coli*/100 ml) in the vicinity of Yale and downstream. Shaded areas indicated exceedances of the WQS. Data are presented upstream to downstream.

DATE	Mill Creek @ Park Ave. MC-4A			Mill Creek @ S. Main St. MC-3A			Mill Creek @ Wilkes Rd. MC-2A			Mill Creek @ Norman Rd. MC-1A			Weather data
	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	
5/9/2002	320	127	---	260	246	---	140	90	---	60	52	---	storms,
	20			240			260			120			60o
	320			240			20			20			
5/16/2002	140	38	---	20	20	---	40	68	---	160	40	---	rain, 65^{o}
	20			20			40			20			
	20			20			200			20			
5/23/2002	20	49	---	20	54	---	40	52	---	40	32	---	sunny, 65^{o}
	100			400			60			20			
	60			20			60			40			
5/30/2002	120	83	---	60	66	---	20	52	---	60	36	---	sunny, 75^{o}
	80			80			120			20			
	60			60			60			40			
6/6/2002	240	226	85	160	137	75	160	115	72	60	66	44	clear, 70^{o}
	220			100			80			120			
	220			160			120			40			
6/13/2002	180	136	86	120	66	58	60	29	57	20	27	38	overcast, 70^{o}
	100			20			20			100			
	140			120			20			10			
6/20/2002	320	297	130	200	246	96	220	264	75	280	82	44	hazy, 80^{o}
	340			220			160			100			
	240			340			520			20			
6/27/2002	20	112	154	40	56	96	60	166	95	140	131	59	partly sunny,
	320			20			240			200			75o
	220			220			320			80			

Table 2 continued (*E. coli*/100 ml).

	Mill Creek @ Park Ave. MC-4A			Mill Creek @ S. Main St. MC-3A			Mill Creek @ Wilkes Rd. MC-2A			Mill Creek @ Norman Rd. MC-1A			
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**
7/3/2002	40	96	158	20	179	117	200	256	130	20	29	56	sunny, 85°
	140			360			300			60			
	160			800			280			20			
7/11/2002	20	20	97	20	20	80	20	25	96	20	25	46	sunny, 75°
	20			20			40			40			
	20			20			20			20			
7/18/2002	20	20	66	80	50	76	20	85	119	40	25	46	hazy, 80°
	20			80			80			20			
	20			20			380			20			
7/25/2002	100	164	59	200	206	73	100	100	98	180	155	39	partly sunny,
	220			200			100			260			75o
	200			220			100			80			
8/1/2002	200	197	66	60	78	78	180	145	95	120	190	56	humid, 85°
	160			40			280			240			
	240			200			60			240			
8/8/2002	220	174	74	180	90	68	20	98	79	22	111	73	sunny, 70°
	120			20			260			220			
	200			200			180			280			
8/15/2002	200	86	99	20	52	83	140	267	126	60	99	96	cloudy, 75°
	80			120			400			100			
	40			60			340			160			
8/22/2002	280	165	152	240	151	103	220	226	154	20	83	122	rain, 75°
	100			240			240			80			
	160			60			220			360			

Table 2 continued (*E. coli*/100 ml).

	Mill Creek @ Park Ave. MC-4A			Mill Creek @ S. Main St. MC-3A			Mill Creek @ Wilkes Rd. MC-2A			Mill Creek @ Norman Rd. MC-1A			
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**
8/29/2002	440	128	144	160	86	86	140	176	172	220	199	128	sunny, 70°
	120			100			140			200			
	40			40			280			180			
9/5/2002	20	20	91	120	66	83	120	186	181	80	121	117	sunny, 70°
	20			60			300			160			
	20			40			180			140			
9/12/2002	80	54	72	240	142	92	560	476	248	120	182	129	sunny, 70°
	20			120			480			360			
	100			100			400			140			
9/19/2002	20	58	67	620	373	135	160	498	281	820	199	149	sunny, 70°
	80			220			920			20			
	120			380			840			480			
9/26/2002	140	92	59	20	42	105	20	43	202	300	158	169	sunny, 60°
	140			180			100			220			
	40			20			40			60			

Table 3. Mill Creek average flows (cfs) at Yale Road, St. Clair County, Michigan.

May	June	July	August	September	October
42	22	12	9.2	7.9	8.4

Table 4. Distribution of land for each municipality in the Mill Creek TMDL reach.

Municipality	Square Miles	Percent
Brockway Township	24	59
Speaker Township	8	20
Lynn Township	4	10
Emmett Township	3	7
Maple Valley Township	1	2
City of Yale	1	2
TOTAL	**41**	**100**

Table 5. Permitted outfalls to the Mill Creek TMDL Watershed in the vicinity of Yale.
Source: MDEQ/WD's NPDES Permit Management System

Facility	Permit Number	Receiving Water	Latitude	Longitude
Yale WWSL	MIG580325	Mill Creek	43.1166	-82.8000
Yale Steel*	MIS410411	Mill Creek	43.1425	-82.8703
Yale Industries*	MIS410399	Mill Creek	43.1167	-82.7988

*denotes Industrial Storm Water permit