Total Suspended Solids, Stable Flow, and Wet Weather Event Monitoring in the Mill Creek Watershed

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Table of Contents

List of Figures ii

List of Tables ii

1. Introduction 1

2. Monitoring Locations and Watershed Description for Mill Creek 1

3. Sampling Methods 1

4. Analytical Methods 4

5. Mill Creek Base Flow Data 4

6. Mill Creek Storm Event Data 4

7. Deviations from the Quality Assurance Project Plan 4

Appendix 1. Mill Creek Watershed Survey Forms for Monitoring Stations 2004 9

Appendix 2. Mill Creek Watershed Monitoring Station and Stormwater Outfall Pictures 2004 16

Appendix 3. Michigan Department of Environmental Quality Rating Curves for Mill Creek 24

List of Figures

Figure 2.1 Mill Creek Watershed..... 2

List of Tables

Table 2.1 Mill Creek Land Use and Cover Statistics..... 3

Table 2.2 Mill Creek Monitoring Stations, Stormwater Outfalls, and Coordinates. 3

Table 5.1 Base Flow TSS Loading Data for Mill Creek 2004..... 5

Table 6.1 Mill Creek TSS Loading Data for the 0.1 Inch Rain Event on 8/25/04 6

Table 6.2 Mill Creek TSS Loading Data for the 1.1 Inch Rain Event on 8/02/04 7

Table 6.3 Mill Creek TSS Loading Data for the 1.4 Inch Rain Event on 8/28/04 8

1. Introduction

An investigation of streams in west Michigan was conducted to monitor the loading of Total Suspended Solids (TSS) and fluctuations in hydrology. The study sites were located in the lower Grand River watershed and included: Bass River, Sand Creek, Strawberry/Mill Creek, York Creek and an unnamed tributary north of Leonard Street and east of East Beltline (M-44). Each of these watersheds is a tributary to the Grand River and is included on Michigan's 2002 303(d) list as requiring a Total Maximum Daily Load (TMDL) because they were identified as not supporting the designated use for biota. The data for each watershed are summarized in individual reports. This report examines the discharge and loading of TSS at 3 locations in Mill Creek under base flow (dry conditions) and during storm events. The data from this project will be used to develop a Biota TMDL for each of the Mill Creek watershed.

2. Monitoring Locations and Watershed Description for Mill Creek

Mill Creek has an 11,103 acre watershed located in Kent County (Figure 2.1). Land use in the watershed is primarily agricultural (61%), forests, fields and wetlands (26%), and residential (8%). A summary of land use/and cover statistics is presented in Table 2.1. Stormwater discharge outfalls were inventoried and three stream locations were selected for flow and TSS monitoring (Figure 2.1). Descriptions and coordinates for the stormwater outfalls and monitoring stations are provided in Table 2.2. Strawberry Creek enters the watershed below Station MS-3. Data for the standard Michigan Department of Natural Resources (MDEQ) Steam Survey Form were collected at each monitoring station. The Steam Survey Forms are included in Appendix 1. Photographs of each monitoring station and stormwater location were taken and included in Appendix 2.

3. Sampling Methods

Dry weather sampling was conducted on 6/28/04, 7/14/04, and 7/28/04. One grab sample was collected from each station. Dry weather sampling was preceded by at least 72 hours without precipitation as measured at the Grand Rapids Airport.

Wet weather sampling was conducted on 8/02/04, 8/25/04, and 8/28/04. The wet weather runoff events were in response to precipitation events of 0.1, 1.1 and 1.4 inches that occurred in a 2 hour time period. Sampling was initiated near the start of each rain event. During the rise and fall of the hydrograph, individual grab samples were collected manually at hourly intervals. Wet weather sampling events lasted from 4-6 hrs. TSS samples were collected at the centroid of each stream transect where approximately 50% of cumulative flow occurred. Samples were collected by immersing a 500 milliliter (ml) polyethylene bottle at mid depth. The sample containers were placed in coolers with ice

Figure 2.1 Mill Creek Watershed.

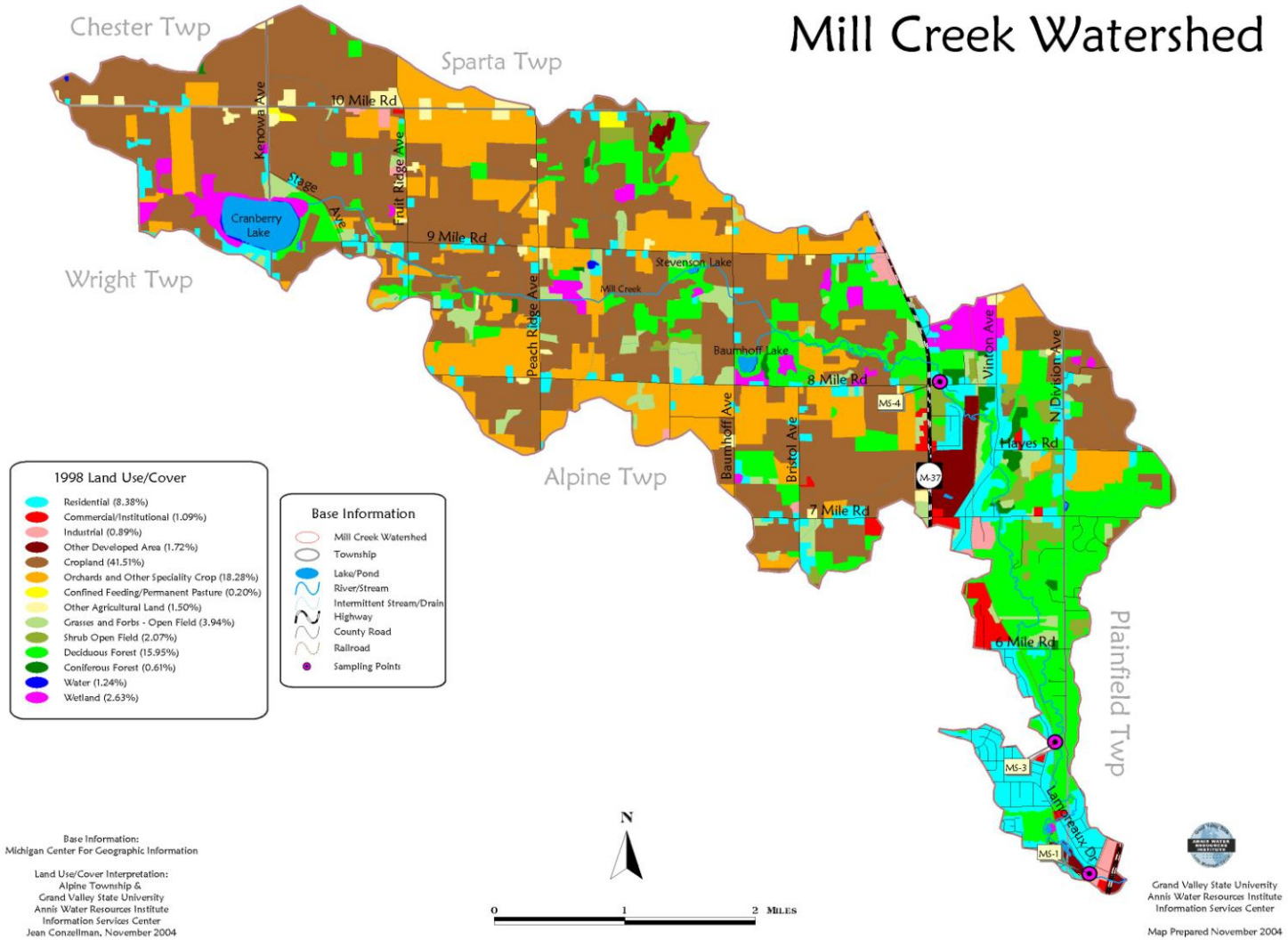


Table 2.1 Mill Creek Land Use and Cover Statistics.

Mill Creek Land Use/Cover		
Map Description	**Acres**	**%**
Commercial/Institutional	121	1
Confined Feeding/Permanent Pasture	22	0
Coniferous Forest	68	1
Cropland	4608	42
Deciduous Forest	1771	16
Grasses and Forbs - Open Field	438	4
Industrial	99	1
Orchards and Other Specialty Crops	2029	18
Other Agricultural Land	166	1
Other Developed Area	190	2
Residential	931	8
Shrub Open Field	230	2
Water	137	1
Wetlands	292	3
Total	11103	100

Table 2.2 Mill Creek Monitoring Stations, Stormwater Outfalls, and Coordinates.

Location and GPS Coordinates				
Type	Location	Site ID	Lat. (N)	Long. (W)
Monitoring	W. River Drive (Downstream)	MS-1	43.0340	-85.6670
Monitoring	Mill Creek Lane off Division (Downstream)	MS-3	43.0487	-85.6710
Monitoring	8 Mile Road E. of M-37 (Downstream)	MS-4	43.0873	-85.6887
Stormwater				

and kept at 4^{o}C. One field blank sample was collected for every 20 investigative samples. One duplicate sample was collected for every 10 investigative samples.

Flow was measured at each location using a Marsh-McBirney Flow Mate 2000 velocity meter according to United States Geological Survey protocols. Transects were established at each location and water depth measurements were collected using a self-leveling rod. The location of each transect was marked by stakes. Depending on stream width, 4 – 12 equally spaced points along the transect were used for depth and flow measurements. Transect locations were selected to minimize interferences from structural anomalies such as debris jams, bridges, and highly eroded areas. Water

elevations were measured at the MDEQ reference point located on each culvert or bridge. Flow measurements were collected during each wet and dry event weather sampling event at 0.6 depth for each transect point.

4. Analytical Methods

Total Suspended Solids was measured gravimetrically by Environmental Protection Agency (EPA) Method 160.2. A complete method description was provided in the Quality Assurance Project Plan (QAPP). One laboratory blank and one laboratory duplicate were analyzed for every ten investigative samples.

5. Mill Creek Base Flow Data

Base flow and TSS loading data for the Mill Creek watershed are summarized in Table 5.1. Rating Curves developed by the MDEQ for each monitoring station and the location of surface elevation reference points are provided in Appendix 3.

6. Mill Creek Storm Event Data

Storm flow and TSS loading data for the Mill Creek watershed are summarized in Tables 6.1, 6.2, and 6.3 for the 0.1, 1.1, and 1.4 inch rainfall events, respectively.

7. Deviations from the Quality Assurance Project Plan

Some of the field and laboratory duplicates with low suspended solids (<10 mg/l) exceeded the RPD limits. The difference between duplicates ranged from 1-3 mg/l. The small relative difference between duplicates reflects normal variations associated with sampling and analysis at low concentration levels. Based on professional judgment, the data was not qualified. The results of field and laboratory duplicates and blanks were submitted in a separate Quality Assurance report.

Table 5.1 Base Flow TSS Loading Data for Mill Creek 2004.

Mill Creek Base Flow Data							
Site ID:	**Name**	**Discharge m^3/ sec**	**Discharge cfs**	**TSS mg/l**	**Loading lb/d**	**Surface ft**	**Method**
June 29, 2004							
MS-1	West River Drive	0.37	13.06	4	281	6.96	Meter
MS-3	Mill Creek Lane off Division Ave	0.30	10.59	4	228	5.58	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.16	5.65	6	182	7.99	Meter
July 14, 2004							
MS-1	West River Drive	0.30	10.59	3	171	6.96	Meter
MS-3	Mill Creek Lane off Division Ave	0.26	9.18	1	49	5.68	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.12	4.24	3	68	8.09	Meter
July 28, 2004							
MS-1	West River Drive	0.30	10.52	4	227	7.10	Meter
MS-3	Mill Creek Lane off Division Ave	0.21	7.42	2	80	5.78	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.07	2.47	1	13	8.12	Meter

Table 6.1. Mill Creek TSS Loading Data for the 0.1 Inch Rain Event on 8/25/04.

Site ID:	Name	Discharge m^3/ sec	Discharge cfs	TSS mg/l	Loading lb/d	Loading lb/hr	Surface ft	Method
		16:00						
MS-1	West River Drive	0.20	7.06	3	114	5	7.05	Meter
MS-3	Mill Creek Lane off Division Avenue	0.11	3.88	2	42	2	5.85	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.05	1.77	4	38	2	8.10	Meter
		17:00						
MS-1	West River Drive	0.22	7.77	10	418	17	6.99	Meter
MS-3	Mill Creek Lane off Division Avenue	0.11	3.88	11	230	10	5.85	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.06	2.12	6	68	3	8.05	Meter
		18:00						
MS-1	West River Drive	0.26	9.18	17	840	35	6.90	Meter
MS-3	Mill Creek Lane off Division Avenue	0.13	4.59	10	247	10	5.68	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.06	2.12	9	103	4	8.00	Meter
		19:00						
MS-1	West River Drive	0.22	7.77	10	418	17	7.00	Meter
MS-3	Mill Creek Lane off Division Avenue	0.11	3.88	11	230	10	5.86	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.05	1.77	8	76	3	8.08	Meter

Table 6.2. Mill Creek TSS Loading Data for the 1.1 Inch Rain Event on 8/02/04.

Site ID:	Name	Discharge m^3/ sec	Discharge cfs	TSS mg/l	Loading lb/d	Loading lb/hr	Water Elevation (ft)	Method
			15:00					
MS-1	West River Drive	0.28	9.89	3	160	7	7.05	Meter
MS-3	Mill Creek Lane off Division Ave	0.18	6.36	2	68	3	5.84	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.07	2.47	1	13	1	8.07	Meter
			16:00					
MS-1	West River Drive	0.60	21.19	78	8896	371	6.66	Meter
MS-3	Mill Creek Lane off Division Avenue	0.27	9.53	25	1283	53	5.71	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.07	2.47	11	146	6	8.07	Meter
			17:00					
MS-1	West River Drive	0.62	21.89	155	18267	761	6.69	Meter
MS-3	Mill Creek Lane off Division Avenue	0.30	10.59	31	1768	74	5.64	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.08	2.82	14	213	9	8.00	Meter
			18:00					
MS-1	West River Drive	0.63	22.25	224	26824	1118	6.72	Meter
MS-3	Mill Creek Lane off Division Avenue	0.31	10.95	29	1709	71	5.64	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.08	2.82	16	243	10	7.97	Meter
			19:00					
MS-1	West River Drive	0.53	18.71	78	7858	327	6.79	Meter
MS-3	Mill Creek Lane off Division Avenue	0.30	10.59	25	1426	59	5.67	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.07	2.47	11	146	6	8.04	Meter
			20:00					
MS-1	West River Drive	0.40	14.12	66	5018	209	6.82	Meter
MS-3	Mill Creek Lane off Division Avenue	0.25	8.83	22	1045	44	5.70	Meter
MS-4	8-Mile Road East of M-37 (Alpine Ave)	0.08	2.82	10	152	6	8.07	Meter

Table 6.3. Mill Creek TSS Loading Data for 1.4 Inch Rain Event 8/28/04.

Site ID:	Name	Discharge m^3/ sec	Discharge cfs	TSS mg/l	Loading lb/d	Loading lb/hr	Surface ft	Method
			5:00					
MS-1	West River Drive	0.23	8.12	3	131	5	7.03	Meter
MS-3	Mill Creek Lane off Division Avenue	0.04	1.41	2	15	1	5.85	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.06	2.12	4	46	2	8.09	Meter
			6:00					
MS-1	West River Drive	0.77	27.19	164	24003	1000	6.02	Meter
MS-3	Mill Creek Lane off Division Avenue	0.27	9.53	27	1386	58	5.70	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.10	3.53	15	285	12	8.00	Meter
			7:00					
MS-1	West River Drive	0.52	18.36	112	11070	461	6.70	Meter
MS-3	Mill Creek Lane off Division Avenue	0.32	11.30	21	1277	53	5.58	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.15	5.30	10	285	12	7.92	Meter
			8:00					
MS-1	West River Drive	0.51	18.01	80	7755	323	6.73	Meter
MS-3	Mill Creek Lane off Division Avenue	0.26	9.18	22	1087	45	5.66	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.12	4.24	9	205	9	7.95	Meter
			9:00					
MS-1	West River Drive	0.46	16.24	63	5509	230	6.79	Meter
MS-3	Mill Creek Lane off Division Avenue	0.26	9.18	22	1087	45	5.63	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.10	3.53	9	171	7	7.98	Meter
			10:00					
MS-1	West River Drive	0.42	14.83	34	2714	113	6.80	Meter
MS-3	Mill Creek Lane off Division Avenue	0.24	8.47	24	1095	46	5.68	Meter
MS-4	8-Mile Road East of M-37 (Alpine Avenue)	0.10	3.53	11	209	9	7.98	Meter

Appendix 1

Mill Creek Watershed Survey Forms for Monitoring Stations 2004

Date: 6/29/2004 **Single Site Watershed Survey Data Sheet** Time: 14:40

Waterbody Name: Mill/StrawberryCreek County: Kent Station #: 1

Location: MS-1 Township: Plainfield Sec 31 T8N R11W NW ¼ SW ¼

Investigator: BTS, MB Lat: 43.03398 Long: -85.667

Coordinate Determination Method (check the one that applies):

_X_ GPS ___ GPS w/ DBR ___ Digital mapping software ___ Topographic map ___ Other (describe _____)

Map Scale (if known _____)

Upstream Side

PHYSICAL HABITAT

BACKGROUND INFORMATION - pg. 18

Event Conditions noted at site	None				
Days since Rain			>3		
Water Temp./D.O./pH *					
Water Color	Clear				
Waterbody Type-u/s	Stream				
Waterbody Type-d/s	Stream				
Stream Width (ft.)		10-25			
Avg. Stream Depth (ft.)		1-3			
Water Velocity (ft./sec) *					
Stream Flow Type				M	

PHYSICAL APPEARANCE - pg. 20

(Check all that apply)

Aquatic Plants		
Floating Algae		
Filamentous Algae		
Bacterial Sheen/Slimes		
Turbidity		
Oil Sheen		
Foam		
Trash		

SUBSTRATE (%) – pg. 22

(add to 100%)

Boulder – 10 in. diam.	20%
Cobble/Gravel –10 to .08 in. diam.	10%
Sand – coarse grain	40%
Silt/Detritus/Muck - fine grain/organic matter	
Hardpan/Bedrock – solid clay/rock surface	
Artificial – manmade	30%
Unknown	

INSTREAM COVER – pg. 23

(check all that apply)

Undercut Banks	
Overhanging Vegetation	yes
Deep Pools	
Boulders	yes
Aquatic Plants	
Logs or Woody Debris	yes

RIVER MORPHOLOGY – pg. 23

Riffle			
Pool			
Channel			Maintained
Designated Drain	?		

STREAM CORRIDOR – pg. 26

Riparian Veg. Width ft.(L)	<10			
Riparian Veg. Width ft.(R)	<10			
Bank Erosion		L		
Streamside Land Cover		Grass	Shrub	Trees
Stream Canopy %		25-50		

Highest Water Mark (ft.)	?					

Stream Cross Section

Adjacent Land Uses

Wetlands		
Shrub or Old Field		
Forest		
Pasture		
Crop Residue		
Rowcrop		
Residential Lawns, Parks	L	R
Impervious Surface	L	R
Disturbed Ground		
No Vegetation		

* Optional Data Item

Data Sheet Version 4/27/00

Single Site Watershed Survey Data Sheet (page 2)

Date: 6/29/2004 **Station #: 1**

Upstream Side

POTENTIAL SOURCES (Severity: S – slight; M – moderate; H – high) – pg. 28							
Crop Related Sources				Land Disposal			
Grazing Related Sources				On-site Wastewater Systems			
Intensive Animal Feeding Operations				Silviculture (Forestry NPS)			
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)				Resource Extraction (Mining NPS)			
Channelization				Recreational/Tourism Activities (general)			
Dredging				• Golf Courses			
Removal of Riparian Vegetation				• Marinas/Recr. Boating (water releases)			
Bank and Shoreline Erosion/ Modification/Destruction				• Marinas/Recr. Boating (bank or shoreline erosion)			
Flow Regulation/ Modification (Hydrology)				Debris in Water			
Upstream Impoundment				Industrial Pt. Source			
Construction:Highway/Road /Bridge/Culvert				Municipal Pt. Source			
Construction: Land Development				Natural Sources		M	
Urban Runoff (Residential/ Urban NPS)		M		Source(s) Unknown		M	

SITE SUMMARY INFORMATION – pg. 33			
SURVEY DIRECTION	N/A	U/S	D/S
SITE SIMILARITY	?	Y	N
OVERALL SITE RANKING	L	M	H
SITE FOLLOW-UP RANK	L	M	H

COMMENTS: Sample sites upstream of bridge.

Date: 6/29/04 **Single Site Watershed Survey Data Sheet** Time: 15:55

Waterbody Name: Mill / Strawberry County: Kent Station #: 3

Location: MS-3 Township : Alpine Sec. 25 T 8N R 12W ¼: NE ¼: SW

Investigator: MB, BTS Lat: 43.04872 Long: 85.67097

Coordinate Determination Method (check the one that applies):

_X GPS ___ GPS w/ DBR ___ Digital mapping software ___ Topographic map ___ Other (describe _____)

Map Scale (if known _____)

/Downstream Side

PHYSICAL HABITAT

BACKGROUND INFORMATION - pg. 18

Event Conditions noted at site	None				
Days since Rain					Unknown
Water Temp./D.O./pH *					
Water Color	Clear				
Waterbody Type-u/s	Stream				
Waterbody Type-d/s	Stream				
Stream Width (ft.)		10-25			
Avg. Stream Depth (ft.)		1-3			
Water Velocity (ft./sec) *					
Stream Flow Type			L		

PHYSICAL APPEARANCE - pg. 20
(Check all that apply)

Aquatic Plants		
Floating Algae		
Filamentous Algae		
Bacterial Sheen/Slimes		
Turbidity		
Oil Sheen		
Foam		
Trash		

SUBSTRATE (%) – pg. 22
(add to 100%)

Boulder – 10 in. diam.	X 10%
Cobble/Gravel –10 to .08 in. diam.	X 80%
Sand – coarse grain	X 10%
Silt/Detritus/Muck - fine grain/organic matter	
Hardpan/Bedrock – solid clay/rock surface	
Artificial – manmade	
Unknown	

INSTREAM COVER – pg. 23
(check all that apply)

Undercut Banks	Yes
Overhanging Vegetation	Yes
Deep Pools	
Boulders	Yes
Aquatic Plants	
Logs or Woody Debris	Yes

RIVER MORPHOLOGY – pg. 23

Riffle		Abundant	
Pool			
Channel	Natural		Maintained
Designated Drain	?		

Highest Water Mark (ft.)	?				

STREAM CORRIDOR – pg. 26

Riparian Veg. Width ft.(L)	< 10			
Riparian Veg. Width ft.(R)			30-100	
Bank Erosion		L		
Streamside Land Cover			Shrub	Trees
Stream Canopy %				>50

Stream Cross Section

Adjacent Land Uses

Wetlands		
Shrub or Old Field		
Forest		R
Pasture		
Crop Residue		
Rowcrop		
Residential Lawns, Parks	L	
Impervious Surface	L	
Disturbed Ground		
No Vegetation		

* Optional Data Item

Data Sheet Version 4/27/00

Single Site Watershed Survey Data Sheet (page 2)

Date: 6/29/04 **Station #: 3**
/Downstream Side

POTENTIAL SOURCES (Severity: S – slight; M – moderate; H – high) – pg. 28							
Crop Related Sources				Land Disposal			
Grazing Related Sources				On-site Wastewater Systems			
Intensive Animal Feeding Operations				Silviculture (Forestry NPS)			
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)				Resource Extraction (Mining NPS)			
Channelization	S			Recreational/Tourism Activities (general)			
Dredging				• Golf Courses			
Removal of Riparian Vegetation				• Marinas/Recr. Boating (water releases)			
Bank and Shoreline Erosion/ Modification/Destruction				• Marinas/Recr. Boating (bank or shoreline erosion)			
Flow Regulation/ Modification (Hydrology)				Debris in Water			
Upstream Impoundment				Industrial Pt. Source			
Construction:Highway/Road /Bridge/Culvert				Municipal Pt. Source			
Construction: Land Development				Natural Sources		M	
Urban Runoff (Residential/ Urban NPS)	S			Source(s) Unknown		M	

SITE SUMMARY INFORMATION – pg. 33			
SURVEY DIRECTION	N/A	U/S	D/S
SITE SIMILARITY	?	Y	N
OVERALL SITE RANKING	L	M	H
SITE FOLLOW-UP RANK	L	M	H

COMMENTS: Sample site downstream of bridge.

Date: 6/29/04 **Single Site Watershed Survey Data Sheet** Time: 16:35

Waterbody Name: Mill / Strawberry County: Kent Station #: 4

Location: MS-4 Township : Alpine Sec. 13 T8N R12W ¼ NW ¼ NW

Investigator: MB, BTS Lat: 43.08725 Long: 85.6887

Coordinate Determination Method (check the one that applies):

_X GPS ___ GPS w/ DBR ___ Digital mapping software ___ Topographic map ___ Other (describe _____)

Map Scale (if known _____)

/Downstream Side

PHYSICAL HABITAT

BACKGROUND INFORMATION - pg. 18

Event Conditions noted at site	None				
Days since Rain					Unknown
Water Temp./D.O./pH *					
Water Color	Clear				
Waterbody Type-u/s	Stream				
Waterbody Type-d/s	Stream				
Stream Width (ft.)	< 10				
Avg. Stream Depth (ft.)	< 1				
Water Velocity (ft./sec) *					
Stream Flow Type			L		

PHYSICAL APPEARANCE - pg. 20
(Check all that apply)

Aquatic Plants		
Floating Algae		
Filamentous Algae		
Bacterial Sheen/Slimes		
Turbidity		
Oil Sheen		
Foam		
Trash		

SUBSTRATE (%) – pg. 22
(add to 100%)

Boulder – 10 in. diam.	
Cobble/Gravel –10 to .08 in. diam.	X 80%
Sand – coarse grain	X 20%
Silt/Detritus/Muck - fine grain/organic matter	
Hardpan/Bedrock – solid clay/rock surface	
Artificial – manmade	
Unknown	

INSTREAM COVER – pg. 23
(check all that apply)

Undercut Banks	yes
Overhanging Vegetation	yes
Deep Pools	
Boulders	
Aquatic Plants	
Logs or Woody Debris	yes

RIVER MORPHOLOGY – pg. 23

Riffle	Present		
Pool	Present		
Channel	Natural		
Designated Drain	?		

Highest Water Mark (ft.)	?				

STREAM CORRIDOR – pg. 26

Riparian Veg. Width ft.(L)	< 10			
Riparian Veg. Width ft.(R)		10-30		
Bank Erosion		L		
Streamside Land Cover		Grass	Shrub	Trees
Stream Canopy %				>50

Stream Cross Section

Adjacent Land Uses

Wetlands		
Shrub or Old Field		R
Forest		
Pasture		
Crop Residue		
Rowcrop		
Residential Lawns, Parks	L	
Impervious Surface		
Disturbed Ground		
No Vegetation		

* Optional Data Item

Data Sheet Version 4/27/00

Single Site Watershed Survey Data Sheet (page 2)

Date: 6/29/04 **Station #: 4**
/Downstream Side

POTENTIAL SOURCES (Severity: S – slight; M – moderate; H – high) – pg. 28							
Crop Related Sources				Land Disposal			
Grazing Related Sources				On-site Wastewater Systems			
Intensive Animal Feeding Operations				Silviculture (Forestry NPS)			
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)				Resource Extraction (Mining NPS)			
Channelization				Recreational/Tourism Activities (general)			
Dredging				• Golf Courses			
Removal of Riparian Vegetation				• Marinas/Recr. Boating (water releases)			
Bank and Shoreline Erosion/ Modification/Destruction				• Marinas/Recr. Boating (bank or shoreline erosion)			
Flow Regulation/ Modification (Hydrology)				Debris in Water			
Upstream Impoundment				Industrial Pt. Source			
Construction:Highway/Road /Bridge/Culvert				Municipal Pt. Source			
Construction: Land Development				Natural Sources		M	
Urban Runoff (Residential/ Urban NPS)	S			Source(s) Unknown		M	

SITE SUMMARY INFORMATION – pg. 33			
SURVEY DIRECTION	N/A	U/S	D/S
SITE SIMILARITY	?	Y	N
OVERALL SITE RANKING	L	M	H
SITE FOLLOW-UP RANK	L	M	H

COMMENTS: Bright, pink root, like aquatic plant. Sample site downstream of bridge.

Appendix 2

Mill Creek Watershed Monitoring Station and Stormwater Outfall Pictures 2004

MS-1 Downstream

MS-1 Upstream

MS-3 Downstream

MS-3 Upstream

MS-4 Downstream

MS-4 Culvert

MS-4 Downstream

Appendix 3

Mill Creek Watershed

MDEQ Rating Curves 2004

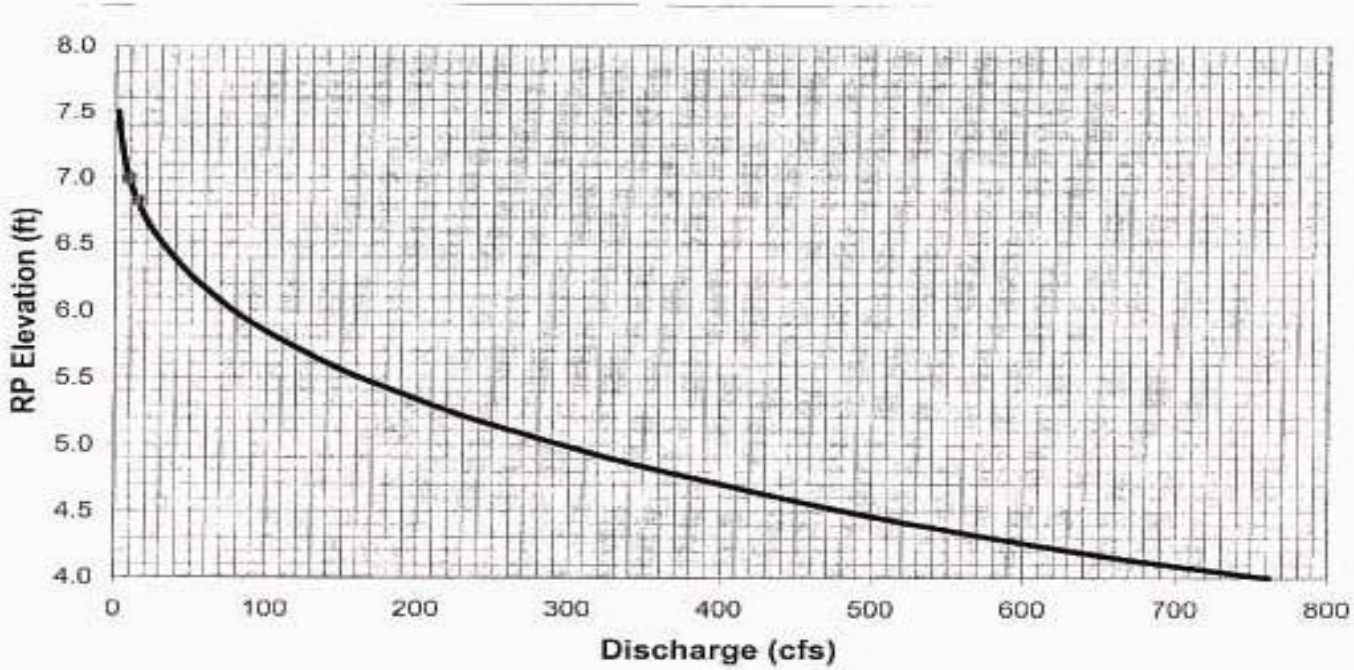
DEQ Michigan Department of Environmental Quality - Land and Water Management Division
Stage-Discharge Rating Curve

Station: MC-01, Mill Creek at West River Drive

RP: Downstream side of foot bridge a V notched on the deck of the bridge between the 7th and 8th railing support from the LEW.

R.P. (ft)	Discharge (cfs)
7.50	1.85
7.33	3.38
7.15	5.72
6.97	9.60
6.80	15.35
6.62	23.74
6.45	34.99
6.27	49.34
6.10	67.18
5.92	88.90
5.75	115.53
5.57	147.86
5.40	185.69
5.22	229.49
5.05	279.68
4.87	336.74
4.70	401.14
4.52	473.34
4.35	553.83
4.17	649.25
4.00	761.99

Measurements		
Date	Discharge	RP
4/28/2004	14.6	6.82
7/29/2004	9.19	6.99



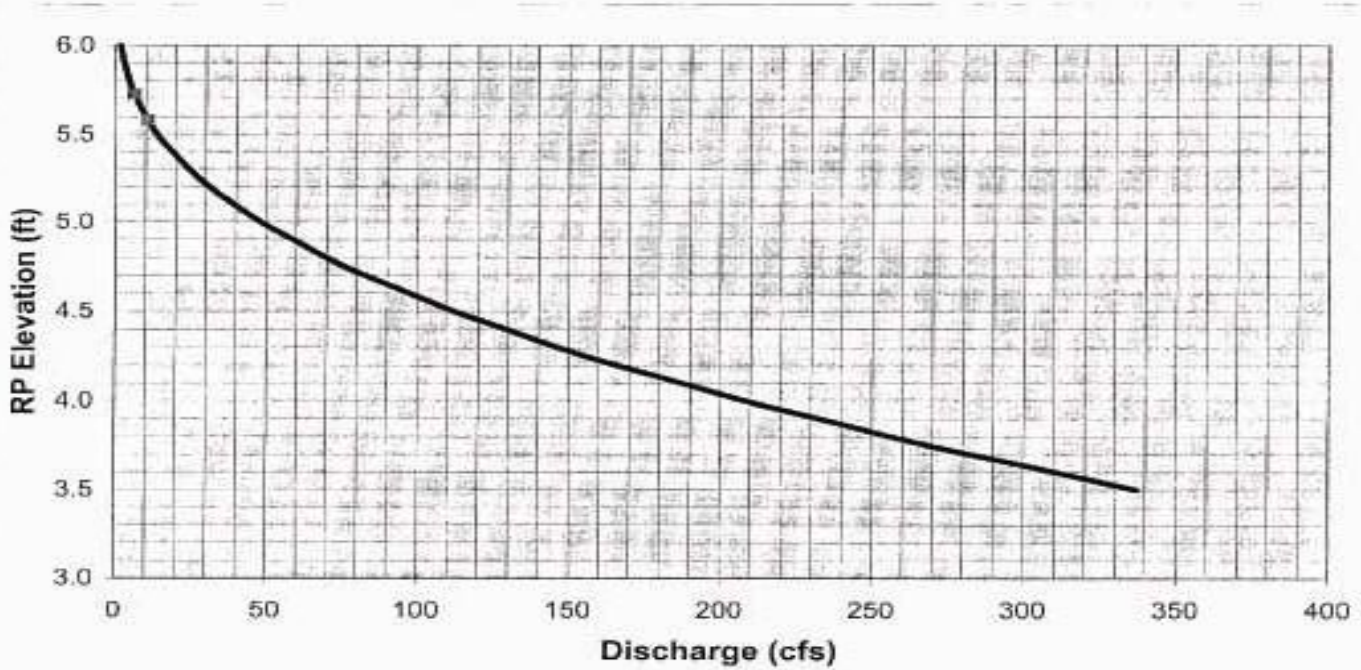
10/20/2004

DEQ Michigan Department of Environmental Quality - Land and Water Management Division
Stage-Discharge Rating Curve

Station: MC-03, Mill Creek off Division Road at Maranatha Campground
RP: Downstream side of foot bridge about 10 feet from the left edge of water.

R.P. (ft)	Discharge (cfs)
6	1.58
5.88	3.14
5.75	5.57
5.63	9.05
5.5	13.78
5.38	19.9
5.25	27.58
5.13	36.93
5	48.06
4.88	61.06
4.75	75.99
4.63	92.9
4.5	111.83
4.38	132.82
4.25	155.86
4.13	180.98
4	208.16
3.88	237.4
3.75	268.68
3.63	301.97
3.5	337.26
3.38	374.52

Measurements		
Date	Discharge	RP
4/28/2004	10.6	5.58
7/29/2004	6.3	5.72



10/21/2004

DEQ Michigan Department of Environmental Quality - Land and Water Management Division

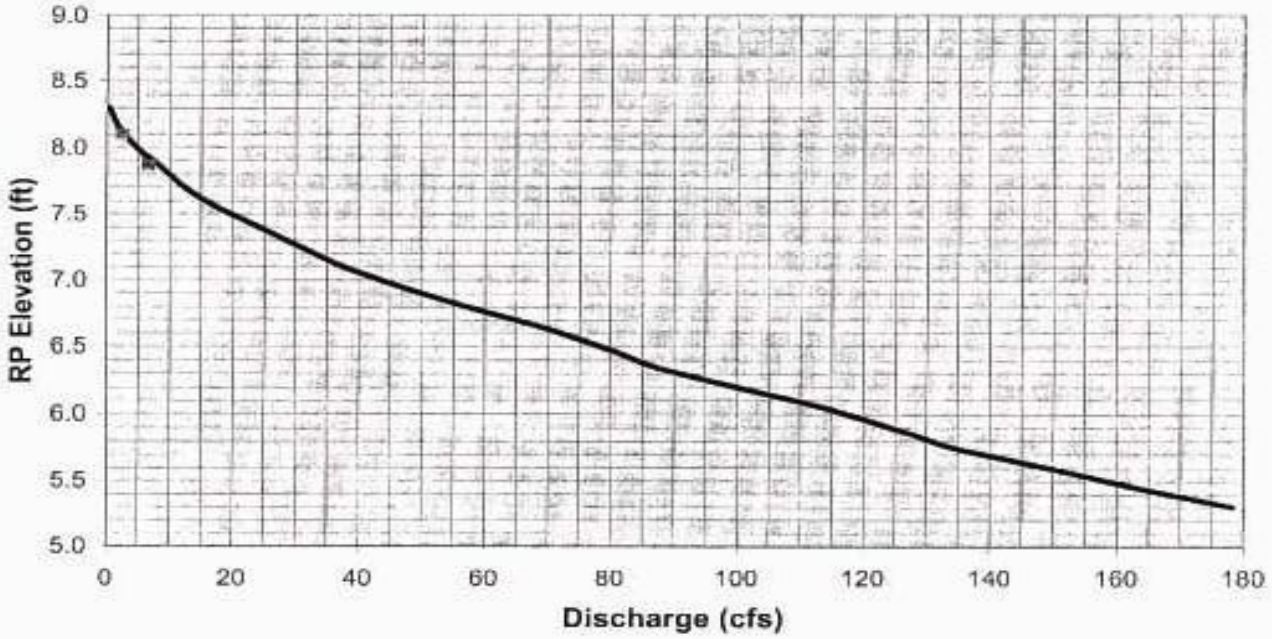
Stage-Discharge Rating Curve

Station: MC-04, Mill Creek at 8 Mile Road

RP: Downstream side of twin culverts a notched on bend on top of left culvert.

R.P. (ft)	Discharge (cfs)
8.30	0.40
8.15	1.96
8.00	4.78
7.85	8.74
7.70	12.40
7.56	17.08
7.40	24.18
7.21	32.50
7.10	37.50
6.95	46.72
6.80	57.06
6.65	68.62
6.46	80.68
6.35	87.00
6.20	99.84
6.05	113.36
5.86	127.18
5.75	134.30
5.60	149.00
5.45	162.92
5.30	178.26

Measurements		
Date	Discharge	RP
4/28/2004	6.70	7.87
7/29/2004	2.42	8.10



10/22/2004