Michigan Department of Environmental Quality
Water Bureau
April 2009

Total Maximum Daily Load for *E. coli* for Honey Creek 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, 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 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 Honey Creek, located in Washtenaw County, Michigan.

PROBLEM STATEMENT

This TMDL addresses the listing that appears on the 2008 Section 303(d) list as:

HONEY CREEK **AUID**: 040900050309-05
County: WASHTENAW SIZE: 2.98 M
Location: Honey Creek upstream from Huron River confluence to Wagner Road, including Unnamed Tributary to Honey Creek
Use impairments: Total body contact recreation
Cause: *E. coli*
Source: Industrial point source discharge
TMDL Year(s): 2009

Honey Creek was placed on the 2000 Section 303(d) list due to impairment of recreational uses as indicated by sampling conducted by the Washtenaw County Environmental Health Department (WCEHD) and the Michigan Department of Environmental Quality (MDEQ) (LeSage and Smith, 2008). It is believed that the industrial point source discharge was an erroneous listing because none of the industrial discharges to Honey Creek would be expected to contain *E. coli*. Monitoring data collected by the MDEQ in 2007 documented continuous exceedances of the daily maximum and 30-day geometric mean WQS for *E. coli* during the total body contact (TBC) recreational season of May 1 through October 31, and periodic exceedances of the partial body contact (PBC) WQS (Table 1; Figure 1). Data collected during 2007 indicates that the TMDL reach needs to be extended to the entire Honey Creek watershed, from the confluence with the Huron River upstream to the headwaters including tributaries, for a total of 26 miles. This modification will be included on the 2010 Section 303(d) list. This TMDL addresses the entire 26-mile reach.

Honey Creek flows into the Huron River (Hydrologic Unit Code [HUC] 4090005), and then to Lake Erie (Figure 1). The Honey Creek watershed covers 14,828 acres (about 23 square miles) of Washtenaw County. Glacial topology of this region is flat clay lake plain with soils dominated by silt and clay loams dissected by broad glacial drainageways of sandy soil (Albert, 1995).

Due to the flat terrain, this area was among the first in Michigan to be cleared of its beech-maple and elm-ash forests, drained and farmed by European settlers. Portions of the city of Ann Arbor, and associated suburban housing developments, are located in the Honey Creek watershed. The human population is increasing rapidly in areas surrounding the city of Ann Arbor. From 2000 to 2008, the population in Scio Township increased by 22 percent, and the population of Lodi Township increased by 16 percent (SEMCOG, 2008).

NUMERIC TARGET

The impaired designated uses addressed by this TMDL are TBC and PBC recreation. The designated use rule (Rule 100 [R 323.1100] of the Part 4 rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended) states that this water body be protected for TBC recreation from May 1 through October 31 and PBC recreation year-round. The target levels for these designated uses 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 *E. coli* per 100 milliliters (mL), 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 mL. 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.
>
> (2) All surface waters of the state protected for partial body contact recreation shall not contain more than a maximum of 1,000 *E. coli* per 100 ml. 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.

A sanitary wastewater discharge is considered in compliance with the WQS of 130 *E. coli* per 100 mL if its National Pollutant Discharge Elimination System (NPDES) permit limit of 200 fecal coliform 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 concentrations are substantially higher than *E. coli* concentrations when the wastewater of concern is sewage (Whitman, 2001). Therefore, typically it can 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 to protect the TBC use are the target levels for the TMDL reach from May 1 through October 31, and 1000 *E. coli* per 100 ml as a daily maximum year-round to protect the PBC use. As previously stated, the 2007 monitoring data indicated continuous daily maximum and monthly average TBC WQS exceedances at all stations sampled, and periodic exceedances of the PBC WQS.

DATA DISCUSSION

E. coli data were collected by the MDEQ from four sites in Washtenaw County from August 24 through October 26, 2007 (Figure 1). Precipitation data for the two days prior to each MDEQ

sampling event were obtained from a weather station at Saline, Michigan (Table 1; Weather Underground, 2009). *E. coli* daily maximum and 30-day geometric mean data for 2007 are shown in Table 1 and Figures 2-4. The highest daily maximum *E. coli* concentration of 13,741 *E. coli* per 100 mL was recorded at Station 1 on August 23, 2007. The daily maximum TBC standard (300 *E. coli* per 100 mL) was exceeded at all stations on all sampling dates. The 30-day geometric mean TBC WQS (130 *E. coli* per 100 mL) was exceeded at all stations on all six sampling dates where data was available to calculate the mean. The PBC recreation daily maximum WQS was exceeded on nine dates at Station 1 and three dates at Stations 2-4. Based on the geomeans of all samples at each site, Station 1 had the highest concentrations of *E. coli* while Station 3 had the lowest concentrations (Figure 4). In general, there was a decreasing trend of *E. coli* concentrations from upstream to downstream.

One sample from Station 1 was collected for a qualitative determination of the presence of fecal Bacteroidetes human gene biomarker, also known as bacterial source tracking (BST) technology. The sample for the single BST isolate was collected on October 12, 2007, and the human gene biomarker was not detected. It should be noted that BST testing was only conducted on one sample. A "negative" result does not necessarily mean that human contamination was not present; rather, it wasn't present in that particular sample.

SOURCE ASSESSMENT

Possible sources of *E. coli* include illicit connections to storm sewers and drains, point sources, contaminated (untreated) venting groundwater, manure spreading, pastureland runoff, failing septic systems, illegal dumping and spills, and wildlife and/or pet waste.

There are 11 NPDES permitted discharges in the TMDL watershed, including 3 individual permits, 1 Certificate of Coverage (COC) under the General Petroleum Cleanup Permit, and 7 COCs under the General Industrial Stormwater Permit (Table 2). There is one Wastewater Treatment Plant (WWTP) individual permit, Honey Creek Developments WWTP, which has been issued, but to date the facility has not been constructed.

The lack of a human biomarker in the BST sample collected at Station 1, on October 12, suggests that animals (pets, livestock, and/or wildlife) were a source of *E. coli* to Honey Creek at the time the sample was taken. It should be noted that the lack of a human biomarker in this single isolate does not rule out the potential for human sources at this or other sample locations. There are no permitted Concentrated Animal Feeding Operations in the Honey Creek watershed; however, unregulated livestock manure spreading is likely a nonpoint source of *E. coli* to Honey Creek. Land Cover Data from 2006 shows that 17 percent of the watershed is in cultivated (row) crops and 14 percent is pasture or hay (NOAA, 2008). Additional land coverage includes deciduous forest (21 percent) and wetland (9 percent). Several small operations with horses were noted in areas upstream of Station 1. Generally, it appeared that access to the stream by horses was blocked by fencing; however, in some cases the stables were immediately proximate to Honey Creek, with pastures sloping towards the stream channel. Runoff from these pastures is likely to contribute to *E. coli* in Honey Creek. Urban areas in the downstream portion of Honey Creek (Stations 2-4) may be affecting *E. coli* levels in Honey Creek due to wildlife occupying storm sewer drains, in addition to pets and wildlife congregating near the creek.

Land cover in the watershed is dominated by low to high intensity developed land (33 percent). Generally, with development comes higher amounts of impervious surfaces and the associated flush of storm water following precipitation, which can become contaminated with *E. coli* from litter, human, pet, and wildlife fecal waste. A large manufactured housing community (MHC), Scio Farms, is located just upstream of Staebler Road (Station 1). A tributary of Honey Creek

passes through this high density housing development. About 75 percent of the 913 housing units in this 0.25 square mile area (160 acres) own at least one dog (personal communication with Karen Merchant, property manager of Scio Farms, 2009). Storm water from Scio Farms is collected in six retention ponds that overflow and potentially vent into Honey Creek and an unnamed tributary to Honey Creek. The area around the retention ponds, along with a central community green space located adjacent to the unnamed tributary to Honey Creek, provide the primary area where residents walk their dogs. According to the property manager, cleanup of pet waste by residents is required, but inadequate compliance is a continuing problem. The waste produced by this high density of dogs (approximately four dogs per acre) is a potential source of *E. coli* to Honey Creek, particularly following wet weather. During dry weather, water contaminated by pet waste may be venting continuously into tributaries of Honey Creek from the unregulated storm water retention ponds at Scio Farms Estates. Other housing developments are also present in the watershed, and though none are as densely populated as Scio Farms, all have the potential to contribute pet waste via storm water.

Illegal dumping of trash containing pet wastes (such as kitty litter or dog feces) and human waste (such as soiled diapers) can contribute to *E. coli* in surface water bodies. The Washtenaw County Water Resources Commission (WCWRC) has noted that illegal dumping of trash is a problem upstream of Station 1, at Staebler Road. Litter in that area is so prevalent that it can be seen in aerial photos (Google Earth, 2009).

The Honey Creek watershed has no permitted combined sewer overflows (CSOs). The residential subdivisions in the watershed, including Scio Farms MHC, are connected to the sanitary sewer systems of Scio Township, which transports waste to the Ann Arbor WWTP. Scio Township has had two reported sanitary sewer overflows (SSOs) since 2002. In the most recent incident, on January 26, 2007, raw sewage from a leaking pipe entered the storm sewer and eventually Honey Creek upstream of Station 2 (see Figure 1).

In areas not connected to the sanitary sewer, on-site septic systems are used for sewage disposal. In Washtenaw County, it is estimated that there are 15-30 septic systems per square mile (*E. coli* Work Group, 2008 draft). When they are not functioning properly, or are poorly designed, they are a potential source of *E. coli* contamination. The WCEHD maintains “Time of Sale” septic inspection records, and according to that program approximately eight percent of on-site septic systems in the TMDL watershed are failing or inadequate. Four percent of inspected systems were found to have sewage seeping to above-ground surfaces. When these failures are found during the inspection process, land owners have 180 days to correct the problem.

To assist in determining potential sources of *E. coli* to the Honey Creek, a load duration curve analysis was developed for each sampling station as outlined by Cleland (2002). A load duration curve considers how flow conditions relate to a variety of pollutant sources (point and nonpoint sources). The United States Geological Survey (USGS) stream flow gauge used to determine the load duration curves is located on Mill Creek (HUC 4090005) near Dexter, Michigan (Gauge #04173500). This gauge was chosen due to its proximity to Honey Creek (0.5 miles west). A ratio of the drainage area of Honey Creek to the drainage area of the gauged watershed (defined as the drainage area ratio), was calculated for each of the four sample locations for this TMDL. The load duration curves and associated drainage area ratios for each station sampled on the Honey Creek are included in Figures 5-8. The curves were generated by applying these drainage area ratios to gauged flows for the period of record of 43 years.

The load duration curves indicate that one sampling event occurred in moist (elevated flow) conditions, with the majority of sampling conducted during dry conditions. It should be noted

that the actual annual precipitation (24.46 inches) during 2007, was well below the average annual precipitation of 32.8 inches (Weather Underground, 2009; Weatherbase, 2009). Because of the below average rainfall, stream flows were likely to be low even following a rainfall. The load duration curves and precipitation data indicate that WQS exceedances occurred during both dry and moist conditions (Table 1). However, the highest *E. coli* concentration at Station 1 occurred during moist conditions (elevated flows), on August 23, 2007, following a rainfall event of 0.85 inches (Figure 5). Exceedances during dry conditions generally indicate that sources of *E. coli* are not directly related to precipitation events (i.e., runoff). The most likely sources of *E. coli* during dry weather are constant sources, such as failing septic systems, animals with direct access to the water body, contaminated (untreated) groundwater venting to surface water, and illicit connections of sewage sources to surface water bodies throughout the watershed.

LOADING CAPACITY (LC) DEVELOPMENT

The LC represents the maximum loading that can be assimilated by the water body while still achieving WQS. As indicated in the Numeric Target section, the targets for this pathogen TMDL are the TBC 30-day geometric mean WQS of 130 *E. coli* per 100 mL ,and daily maximum of 300 *E. coli* per 100 mL and the PBC daily maximum WQS of 1000 *E. coli* per 100 ml. Concurrent with the selection of a numeric concentration endpoint, development of the LC requires identification of the critical condition. The “critical condition” is defined as the set of environmental conditions (e.g., flow) used in development of the TMDL that results in attaining WQS and has an acceptably low frequency of occurrence.

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). Therefore, this pathogen TMDL is concentration-based, consistent with R 323.1062, and the TMDL is equal to the TBC target concentrations of 130 *E. coli* per 100 mL as a 30-day geometric mean and daily maximum of 300 *E. coli* per 100 mL in all portions of the TMDL reach for each month of the recreational season (May through October) and PBC target concentration of 1000 *E. coli* per 100 mL as a daily maximum year-round. Expressing the TMDL as a concentration equal to the WQS ensures that the WQS will be met under all flow and loading conditions for both existing and future sources; therefore, a critical condition is not applicable for this TMDL.

LC

The LC is 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 LC 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. Conceptually, this definition is denoted by the equation:

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

The LC represents the maximum loading that can be assimilated by the receiving water while still achieving WQS. Because this TMDL is concentration-based, the total loading for this TMDL is equal to the TBC 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 during the recreation season and PBC WQS of 1000 *E. coli* per 100 mL as a daily maximum year-round.

WLAs

Table 2 outlines the permitted point source discharges to the watershed surrounding the Honey Creek TMDL reach. The discharges include 3 individual permits, 1 COC under the General Petroleum Cleanup Permit, and 7 COCs under the General Industrial Stormwater Permit. The WLA for the permits in Table 3 is equal to 130 *E. coli* per 100 mL as a 30-day average and 300 *E. coli* per 100 mL as a daily maximum during the recreational season between May 1 and October 31, and 1000 *E. coli* per 100 mL as a daily maximum year-round.

The WLA for industrial storm water includes facilities with a general industrial storm water permit and facilities with an individual permit that authorizes the discharge of industrial storm water to Honey Creek or its tributaries (e.g., Michigan Department of Transportation - Statewide MS4) (See Table 2).

LAs

Because this TMDL is concentration-based, the LA is also equal to 130 *E. coli* per 100 mL as a 30-day geometric mean and 300 *E. coli* per 100 mL as a daily maximum during the recreational season and 1000 *E. coli* per 100 mL as a daily maximum year-round. This LA is based on the assumption that all land, regardless of use, will be required to meet the WQS. 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 (Table 3). Four municipalities have land area within the Honey Creek watershed.

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. Pathogen organisms ordinarily have a limited capability of surviving outside of their hosts and a rate of decay could be developed. However, applying a rate of decay could result in an allocation that would be greater than the WQS, thus no rate of decay is applied to provide for greater protection of water quality. The MDEQ has determined that the use of the TBC 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 during the recreational season, and the PBC WQS of 1000 *E. coli* per 100 mL as a daily maximum year-round, for the WLA and LA is a more conservative approach than developing an explicit MOS. This accounts for the uncertainty in the relationship between pollutant loading and water quality, based on available data, and the assumption to not use a rate of decay. Applying the WQS to be met under all flow conditions also adds to the assurance that an explicit MOS is unnecessary.

SEASONALITY

The WQS for *E. coli* are expressed in terms of seasons (e.g., TBC from May 1 through October 31 and PBC year-round). Allocations and controls developed for the more protective TBC season are also expected to assure attainment of the daily maximum PBC WQS of 1000 *E. coli* per 100 mL, year-round. Because this is a concentration-based TMDL, WQS must be met regardless of flow conditions in the applicable season.

REASONABLE ASSURANCE ACTIVITIES

Illicit discharges and on-site septic system disrepair are potential sources for dry weather exceedances of the WQS. No illicit discharge elimination investigations have been done in Honey Creek or its tributaries. However, the WCWRC has conducted reconnaissance on the portion of Honey Creek between Park and Liberty Roads, which is a designated drain. This stretch of Honey Creek is mainly wetland, and no suspicious outfalls were found (personal communication with Jeff Harms, WCWRC). The "Time of Sale" septic inspection program, operated by the WCEHD, is based on a county regulation and requires inspection and correction of on-site septic inadequacies and failure within 180 days of the inspection. The elimination of any illicit connections or repair of septic system failures may cause a dramatic lowering of *E. coli* concentrations in Honey Creek, and an associated improvement in water quality.

SSOs are illegal events and are required to be reported to the MDEQ and made public knowledge via the Internet at the "CSO and SSO Discharge Information" Web site *(The link provided was broken and has been removed)*. The two reported events that occurred in the Honey Creek watershed do not appear to be due to ongoing maintenance issues, and therefore, are considered isolated occurrences which were corrected in a timely manner.

Pet waste throughout the watershed has been identified as a potential controllable source of *E. coli* to Honey Creek. Contamination of Honey Creek may occur during wet weather via storm run-off (overland flow or storm sewers) and dry weather by contaminating sub-surface flow of groundwater. No township or county ordinance regulates the cleanup of pet waste on private property. If the county receives a complaint of poor animal housekeeping, it is handled as a nuisance complaint by the WCEHD and police, if necessary. The WCWRC coordinates a program called "RiverSafe Home," which encourages homeowners to remove and properly dispose of pet waste from lawns and discourage wildlife from congregating on their property (https://www.washtenaw.org/directory.aspx?did=114). The proper disposal of pet waste throughout the watershed would reduce the E. coli load to Honey Creek.

Permits for the NPDES permitted facilities that may be a source of fecal contamination contain measures to reduce or eliminate the potential for fecal contamination of Honey Creek. Michigan regulates discharges containing treated or untreated human waste (i.e., sanitary wastewater) using fecal coliform. Sanitary wastewater discharges are required to meet 200 fecal coliform per 100 mL as a monthly average and 400 fecal coliform per 100 mL as a maximum. The sanitary discharges are expected to be in compliance with the ambient WQS of 130 *E. coli* per 100 mL and 300 *E. coli* per 100 mL if their NPDES permit limits for fecal coliform are met. The *E. coli* criteria contained in the USEPA's criteria document (1986) were derived to approximate the degree of protection, e.g., no more than 8 illnesses per 1000 swimmers, provided by the fecal coliform indicator level of 200 *E. coli* per 100 mL recommended by the USEPA prior to the adoption of the 1986 criteria. All WWTPs provide year-round disinfection, providing another level of confidence that the WQS for *E. coli* will be met. The individual and general permittees listed in Table 2 with treated human waste discharges are responsible for maintaining compliance with their respective NPDES permit limitations for fecal coliform, and shall continue to monitor their effluent according to their permit requirements. The general industrial storm water permit for the facilities listed in Table 2 states that if there is a TMDL established by the MDEQ for the receiving water that restricts a material that could impair or degrade water quality, then the required storm water pollution prevention plan shall identify the level of control for those materials necessary to comply with the TMDL and an estimate of the current annual load of those materials via storm water discharges to the receiving stream.

The 2008 Huron River Watershed Management Plan identifies management priorities within the watershed, and though a management plan specific to Honey Creek does not exist at this time, creation of a plan is a listed goal for the future. Along with the 2008 Huron River Watershed Management Plan, the Honey Creek Stormwater Modeling Project was completed by the WCWRC, analyzing the flow and water quality of Honey Creek. A study of the imperviousness of the Honey Creek watershed was also completed by the WCWRC, and the Ann Arbor, Scio, and Superior Townships. The aim of this study was to model impervious surfaces and to predict how changing the distribution of these surfaces would affect the hydrology of the creek. The result of this study was a document titled, "Impervious Surface Reduction Study," which was distributed to local communities and was intended to aid in developing and changing local ordinances. The existence of the 2008 Huron River Watershed Management Plan improves accessibility to grants and funding should an organization choose to apply for watershed improvement/management funding for Honey Creek.

Honey Creek is part of the Adopt-A-Stream program, implemented by the Huron River Watershed Council. The Adopt-A-Stream program monitors water quality throughout the Huron River watershed. Other volunteer actions include promoting proper lawn care, pet waste cleanup, investigating pollution sources, education, and land use planning. This program does not specifically monitor for *E. coli*, but distributes educational materials and promotes a sense of public and personal responsibility to maintain water quality.

Future monitoring will take place as part of the five-year rotating basin monitoring, as resources allow, once actions have occurred to address sources of *E. coli.* When these results indicate that the water body 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 and daily maximum values of 300 *E. coli* per 100 ml and 1000 *E. coli* per 100 ml are being met.

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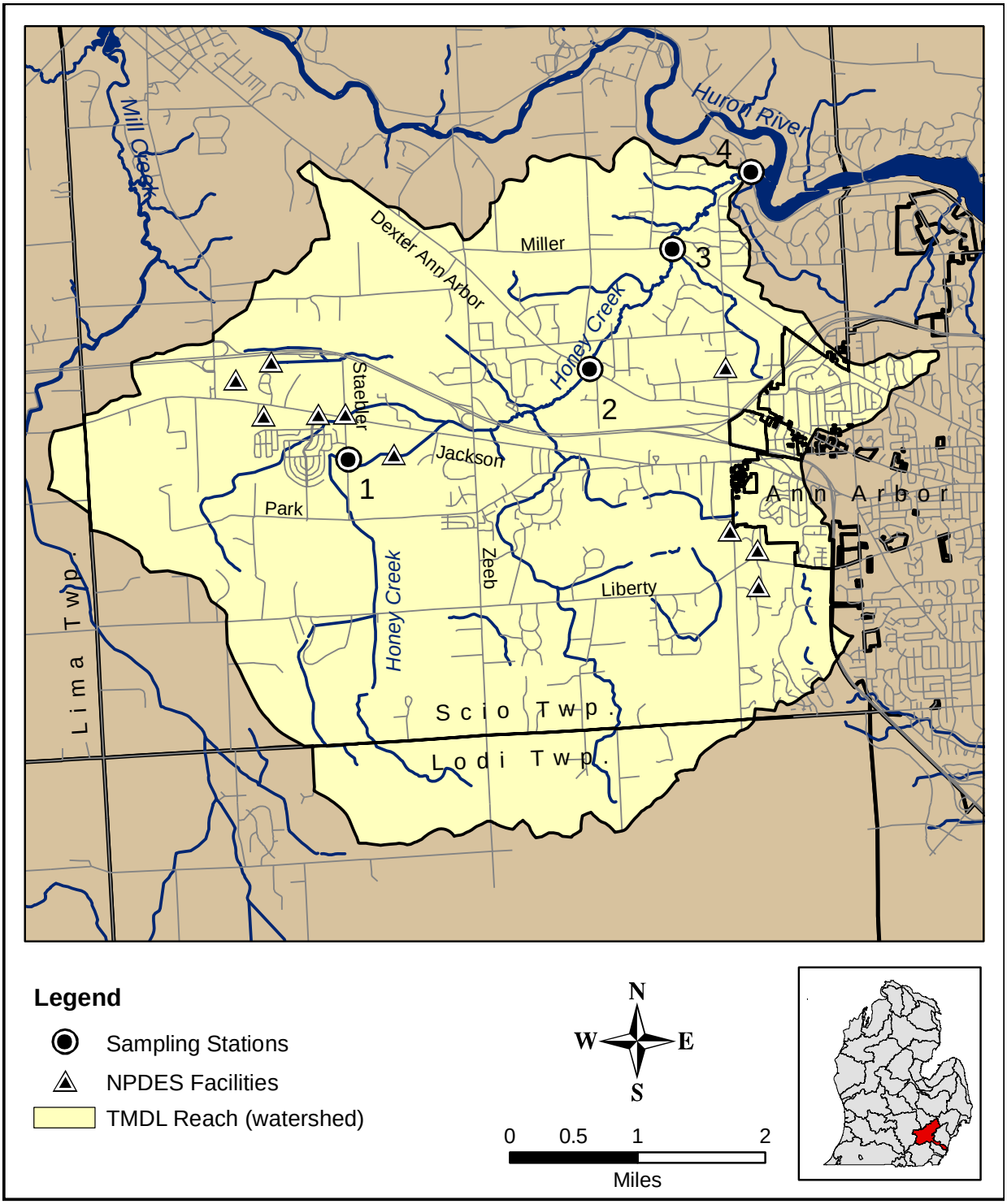

Figure 1. Location of sampling stations 1-4 and NPDES permits within the Honey Creek watershed, Washtenaw County. The map inset shows the location of the Huron River.

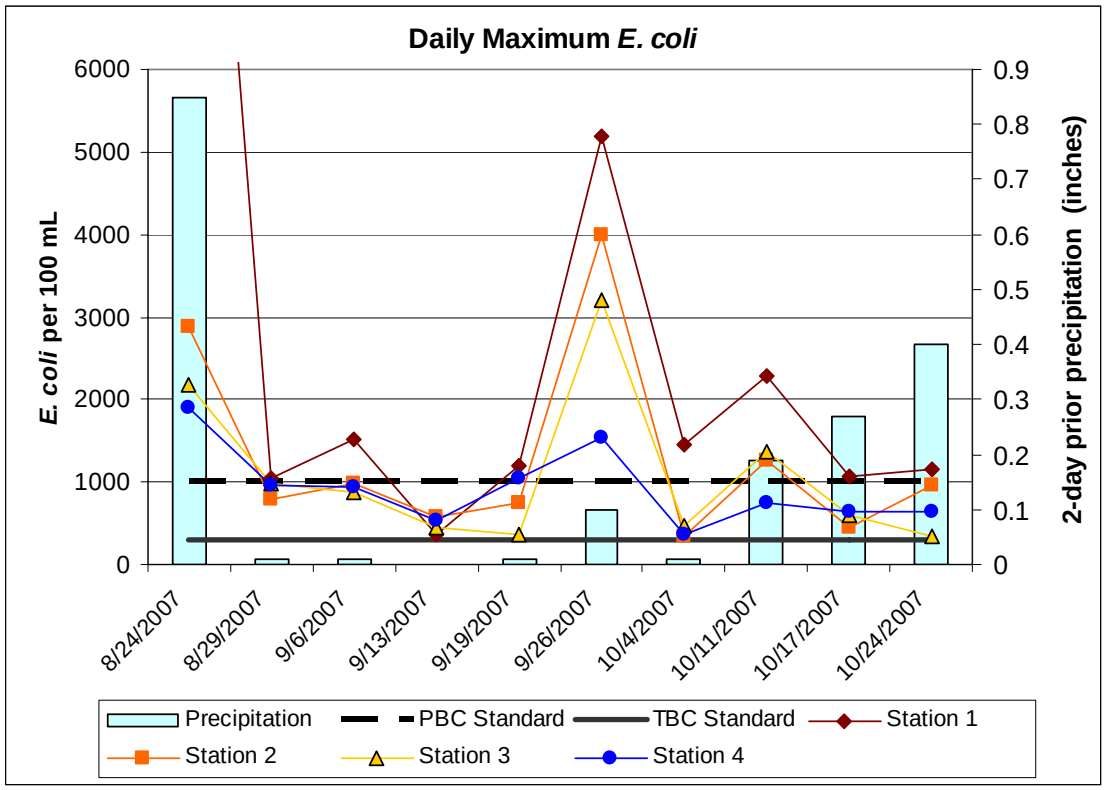

Figure 2. Daily Maximum *E. coli* sampling results from Honey Creek (Stations 1-4).

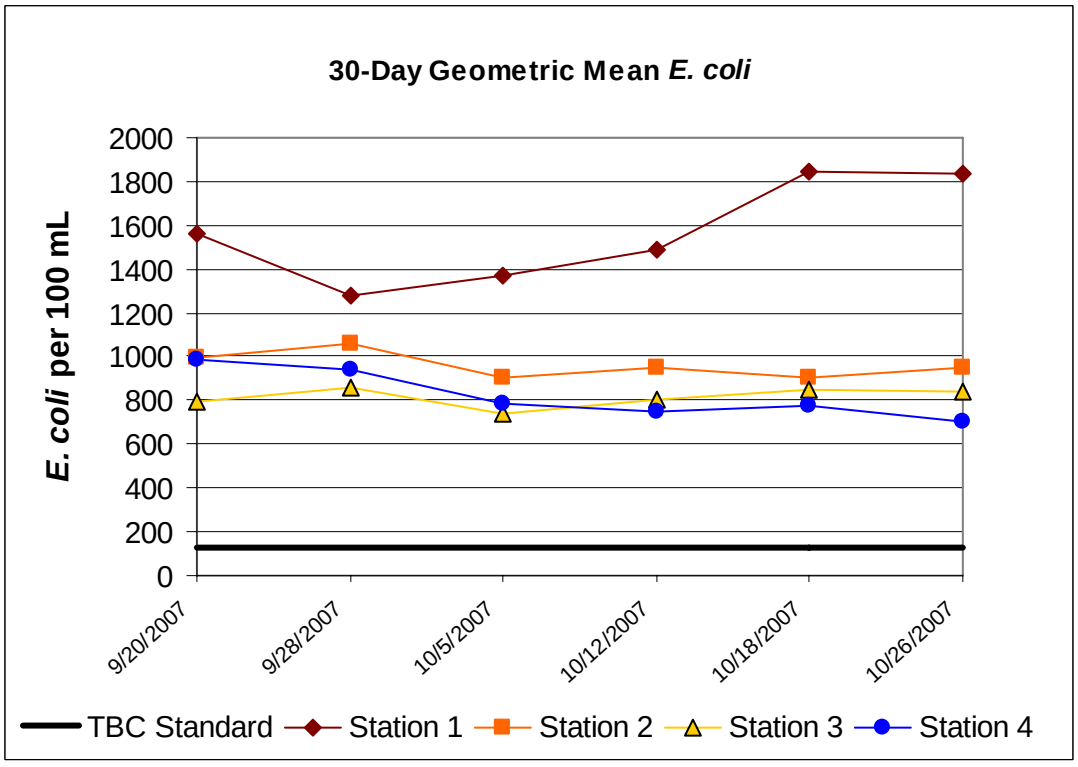

Figure 3. 30-day geometric mean *E. coli* sampling results from Honey Creek (Stations 1-4).

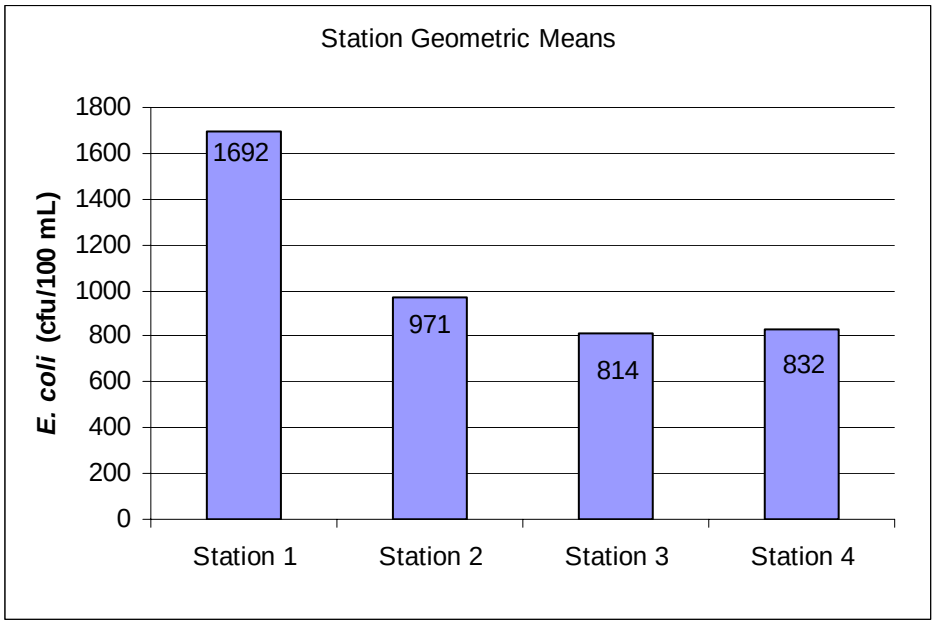

Figure 4. Geometric mean concentrations of all *E. coli* samples for each station (*E. coli*/100 mL).

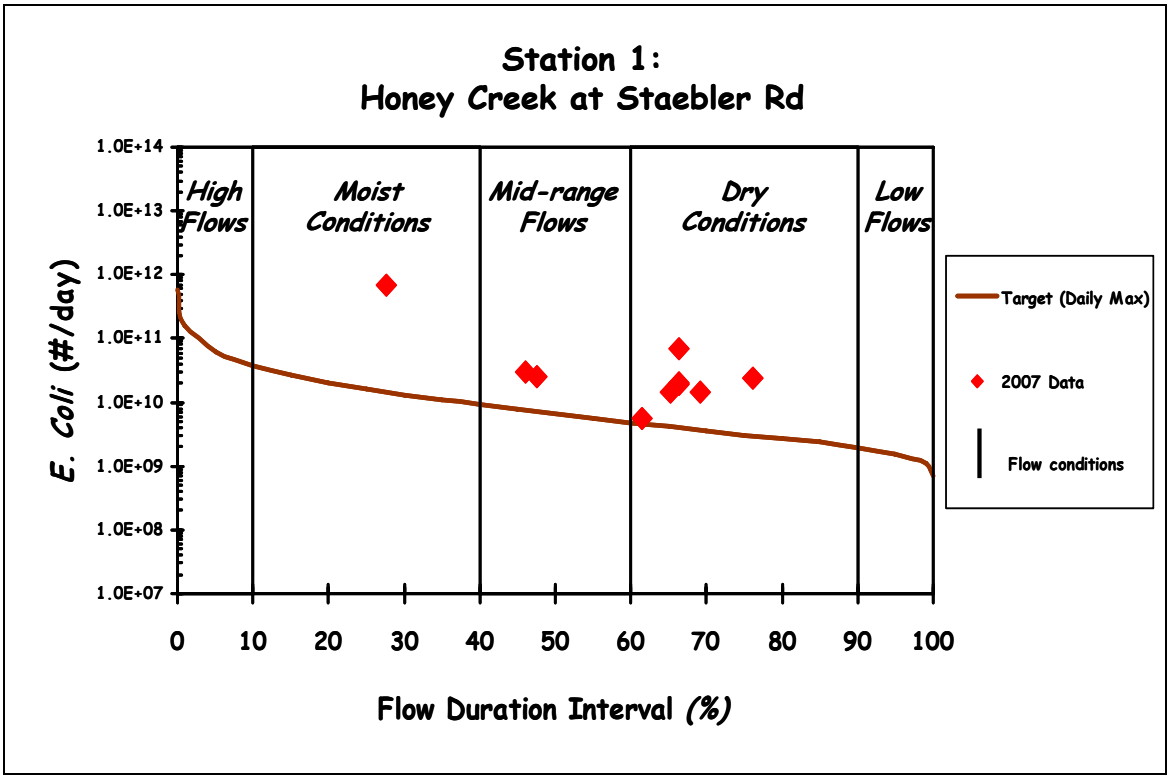

Figure 5. Flow duration curve for Honey Creek at Staeber Road (Station 1). Curve is based on *E. coli* Data and USGS Gage Duration Interval 04173500, and a drainage area of 5.1 square miles.

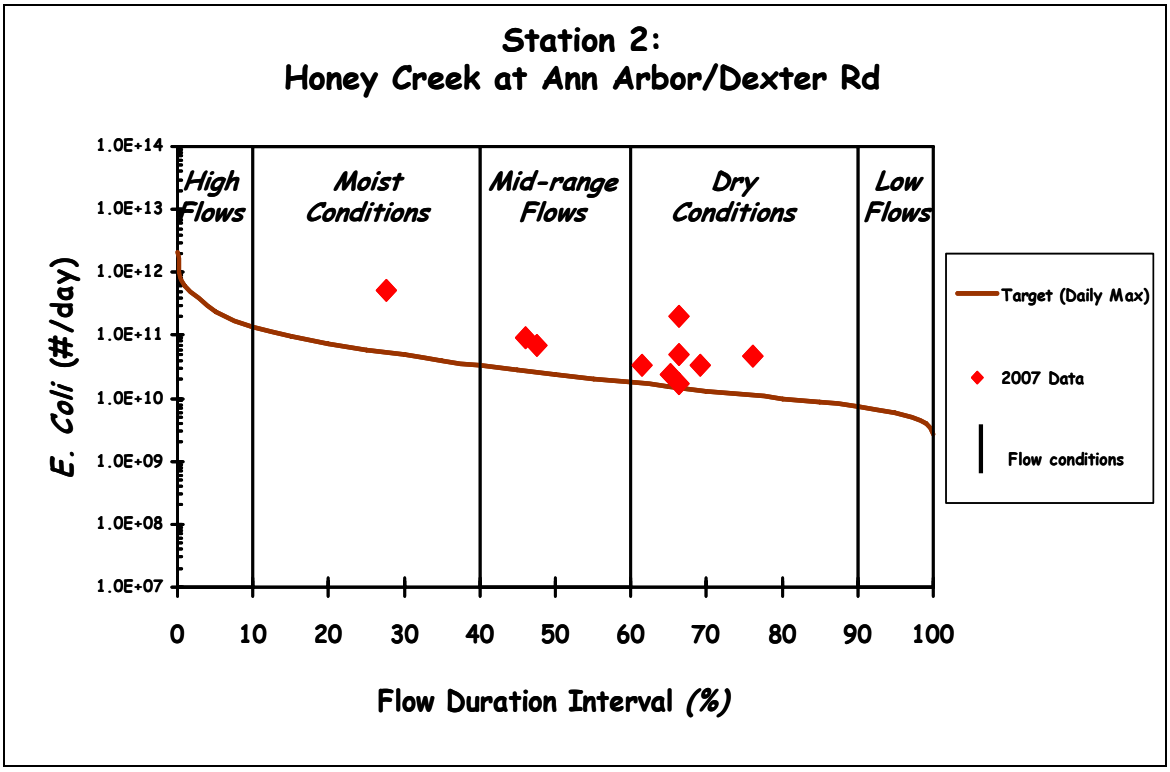

Figure 6. Flow duration curve for Honey Creek at Ann Arbor/Dexter Road (Station 2). Curve is based on *E. coli* Data and USGS Gage Duration Interval 04173500, and a drainage area of 18.8 square miles.

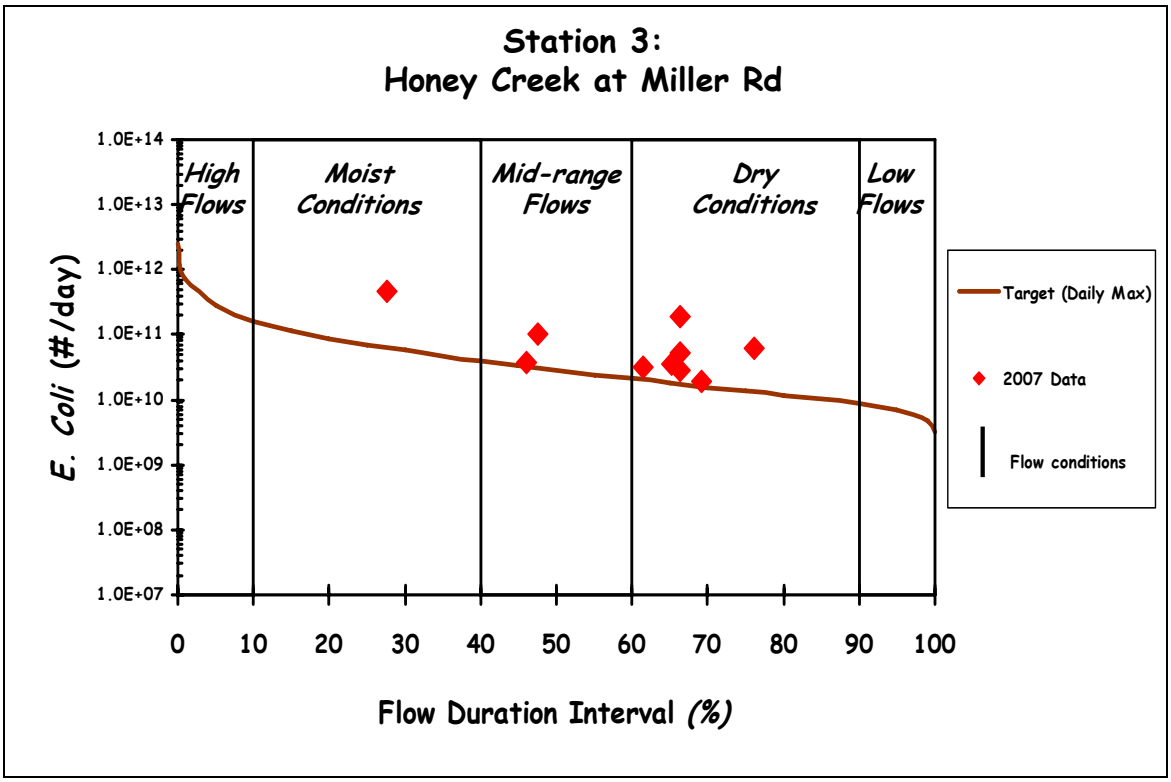

Figure 7. Flow duration curve for Honey Creek at Miller Road (Station 3). Curve is based on *E. coli* Data and USGS Gage Duration Interval 04173500, and a drainage area of 22.3 square miles.

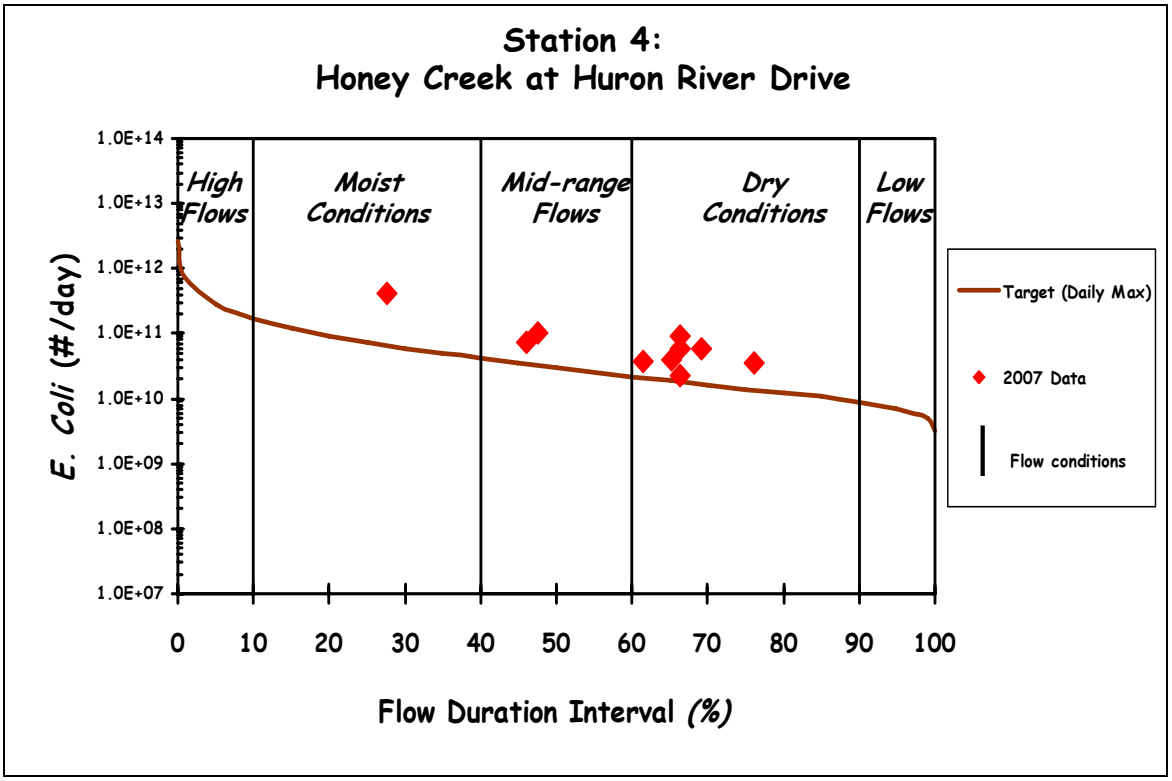

Figure 8. Flow duration curve for Honey Creek at Huron River Drive (Station 4). Curve is based on *E. coli* Data and USGS Gage Duration Interval 04173500, and a drainage area of 23.3 square miles.

Table 1. Weekly *E. coli* sampling results (counts per 100 mL) from the Honey Creek (Stations 1-4), August 24-October 26, 2007. Exceedances of the TBC WQS are shaded gray and PBC exceedances are outlined in bold. Precipitation data from Ann Arbor weather station (Weather Underground, 2009).

	Station 1			Station 2			Station 3			Station 4			
	Honey Creek, Staebler Rd (north crossing)			Honey Creek, Ann Arbor/Dexter Rd.			Honey Creek, Miller Rd.			Honey Creek, Huron River Dr.			**Prior 2-Day Precipitation (inches)**
Date	**Sample Results**	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	Sample Results	Daily Max.	30-day Geomean	
8/23/2007	**8,500**			**3,400**			**2,600**			**2,600**			
	18,500			**2,000**			**2,000**			**1,200**			
	16,500	13741		**3,500**	2876		**2,000**	2183		**2,200**	1900		0.85
8/29/2007	**1,600**			**1,000**			**1,200**			**1,200**			
	1,200			**800**			**800**			**1,200**			
	600	1048		**600**	783		**1,000**	986		**600**	952		0.01
9/6/2007	**1,600**			**800**			**800**			**600**			
	1,800			**1,200**			**600**			**1,400**			
	1,200	1512		**1,000**	986		**1,400**	876		**1,000**	944		0.01
9/13/2007	**800**			**600**			**400**			**400**			
	140			**1,600**			**600**			**600**			
	400	355		**200**	577		**400**	458		**600**	524		0
9/19/2007	**1,200**			**600**			**400**			**1,000**			
	1,000			**600**			**600**			**800**			
	1,400	1189	1559	**1,200**	756	994	**200**	363	793	**1,400**	1038	986	0.01
9/26/2007	**5,000**			**4,400**			**3,400**			**1,000**			
	5,800			**4,000**			**3,000**			**2,600**			
	4,800	5183	1282	**3,600**	3987	1061	**3,200**	3196	856	**1,400**	1538	945	0.1
10/4/2007	**940**			**320**			**560**			**500**			
	2,000			**540**			**520**			**620**			
	1,600	1444	1367	**240**	346	901	**360**	472	738	**160**	367	781	0.01
10/11/2007	**1,800**			**2,000**			**2,000**			**1,200**			
	2,200			**640**			**1,600**			**600**			
	3,000	2282	1484	**1,600**	1270	948	**800**	1368	807	**600**	756	747	0.19
10/17/2007	**1,500**			**480**			**680**			**560**			
	1,200			**580**			**460**			**620**			
	660	1059	1847	**340**	456	904	**680**	597	851	**740**	636	776	0.27
10/24/2007	**800**			**540**			**380**			**480**			
	1,200			**360**			**300**			**620**			
	1,600	1154	1836	**4,600**	963	949	**320**	332	836	**840**	630	703	0.4

Table 2. Individual and General Permits and COCs in the Honey Creek watershed. Source: MDEQ, Water Bureau's NPDES Permit Management System.

Facility Name	Permit	Township	Latitude	Longitude
MI000000 - Individual Permit				
MDOT-Statewide MS4	MI0057364	Statewide	na	na
Honey Creek Development WWTP	MI0058169	Scio	42.2862	-83.85417
Pall Life Sciences Inc	MI0048453	Scio	42.27722	-83.80000
MIG080000 General Permit - Wastewater from Petroleum Cleanup				
Wolverine Truck Plaza	MIG080754	Scio	42.29583	-83.87500
MIS410000 General Permit - Storm Water Discharges from Industrial Activities				
Dexter Stamping Co-Ann Arbor	MIS410016	Scio	42.29778	-83.86944
Sheridan Books-Ann Arbor	MIS410027	Scio	42.29167	-83.85833
Barrett Paving Mtls-Ann Arbor	MIS410054	Scio	42.29583	-83.80000
Fendt Builders-Ann Arbor	MIS410059	Scio	42.27500	-83.79583
Terumo Medical Corp-Ann Arbor	MIS410082	Scio	42.29167	-83.86250
Thetford Corp-Ann Arbor	MIS410357	Scio	42.29167	-83.87083
Superior Materials Plt 38	MIS410484	Scio	42.27083	-83.79583

Table 3. Percent of land area in Honey Creek watershed located within each municipality.

Civil Division	Percent of Watershed
Lima Township	1%
Scio Township	85%
Lodi Township	9%
City of Ann Arbor	5%