Appendix B

Load Duration Curves and Pollutant Reduction Estimates for Streams in the Lower Meramec Watershed

The following load duration curves and pollutant reduction estimates are being provided for informational purposes to support the development of a nine-element watershed-based plan for the Lower Meramec Watershed, which is funded, in part, by the Environmental Protection Agency, Region 7, through the department under Section 319 of the Clean Water Act. These calculations and analyses are not part of a total maximum daily load (TMDL). Percent reductions were calculated using the load duration curve and available water quality data collected from the water body. Reductions for a given flow range are geometric means and are provided to aid in the selection and placement of best management practices (BMPs). Restoration of beneficial uses will be evaluated through future monitoring and assessment of water quality standards (dnr.mo.gov/env/wpp/waterquality/303d/303d.htm). Load duration curves and load reduction estimates for *E. coli* bacteria are provided for the following six streams:

Stream Name	***Water Body ID Number***
Antire Creek	2188
Fenton Creek	3595
Grand Glaize Creek	2184
Keifer Creek	3592
Mattese Creek	3596
Williams Creek	3594

Text on this page and Figure 1 on page 3 were added in spring 2018 by the Missouri Department of Natural Resources (MoDNR).

The following sections present load duration curves for all water body segments listed as impaired for *E. coli* within the Lower Meramec River Watershed. Therefore, it is important to understand the information presented in a load duration curve.

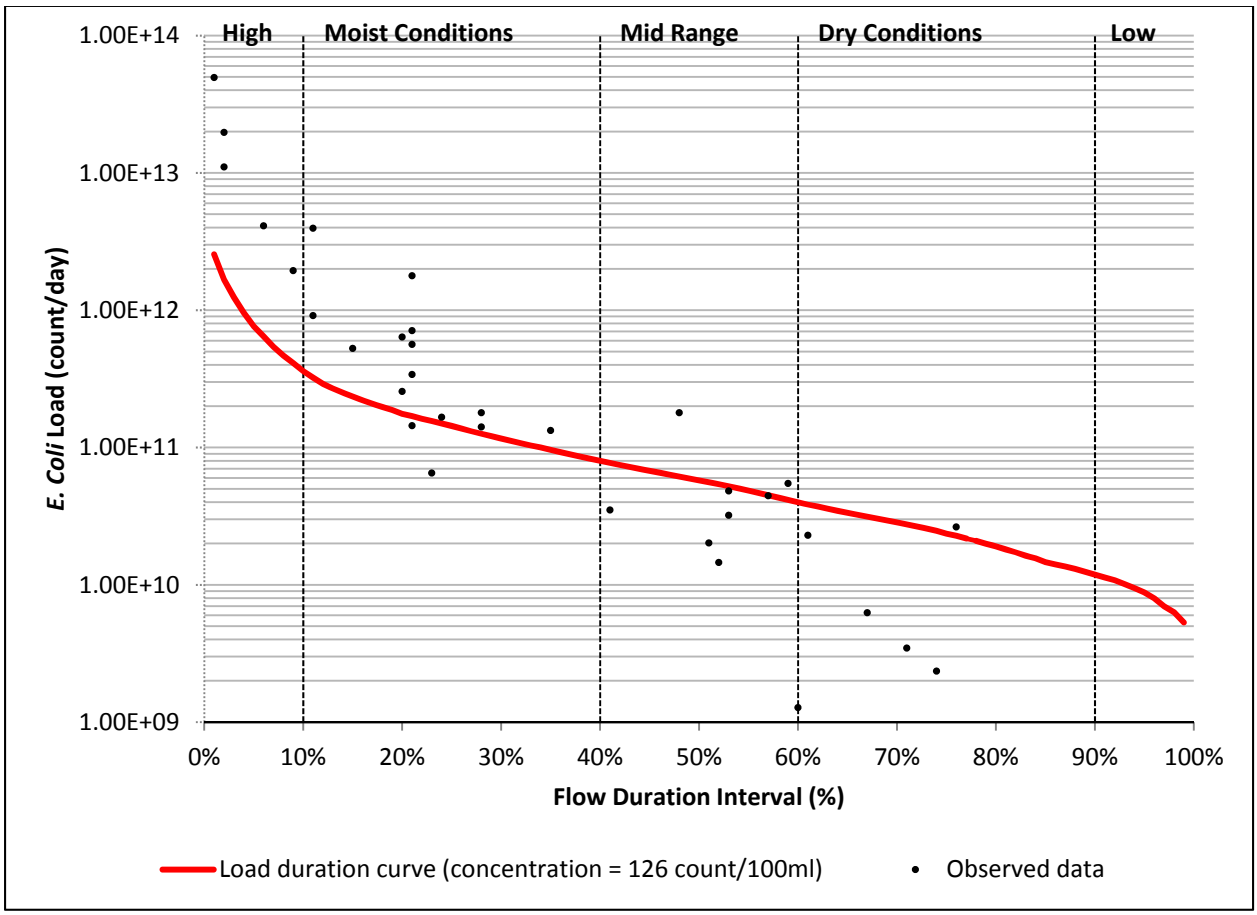
As described by the U.S. Environmental Protection Agency, *"A load duration curve approach allows the characterization of water quality concentrations (or water quality data) at different flow regimes. The method provides a visual display of the relationship between stream flow and loading capacity. Using the duration curve framework, the frequency and magnitude of water quality standard exceedances, allowable loadings, and size of load reductions are easily presented and can be better understood."*

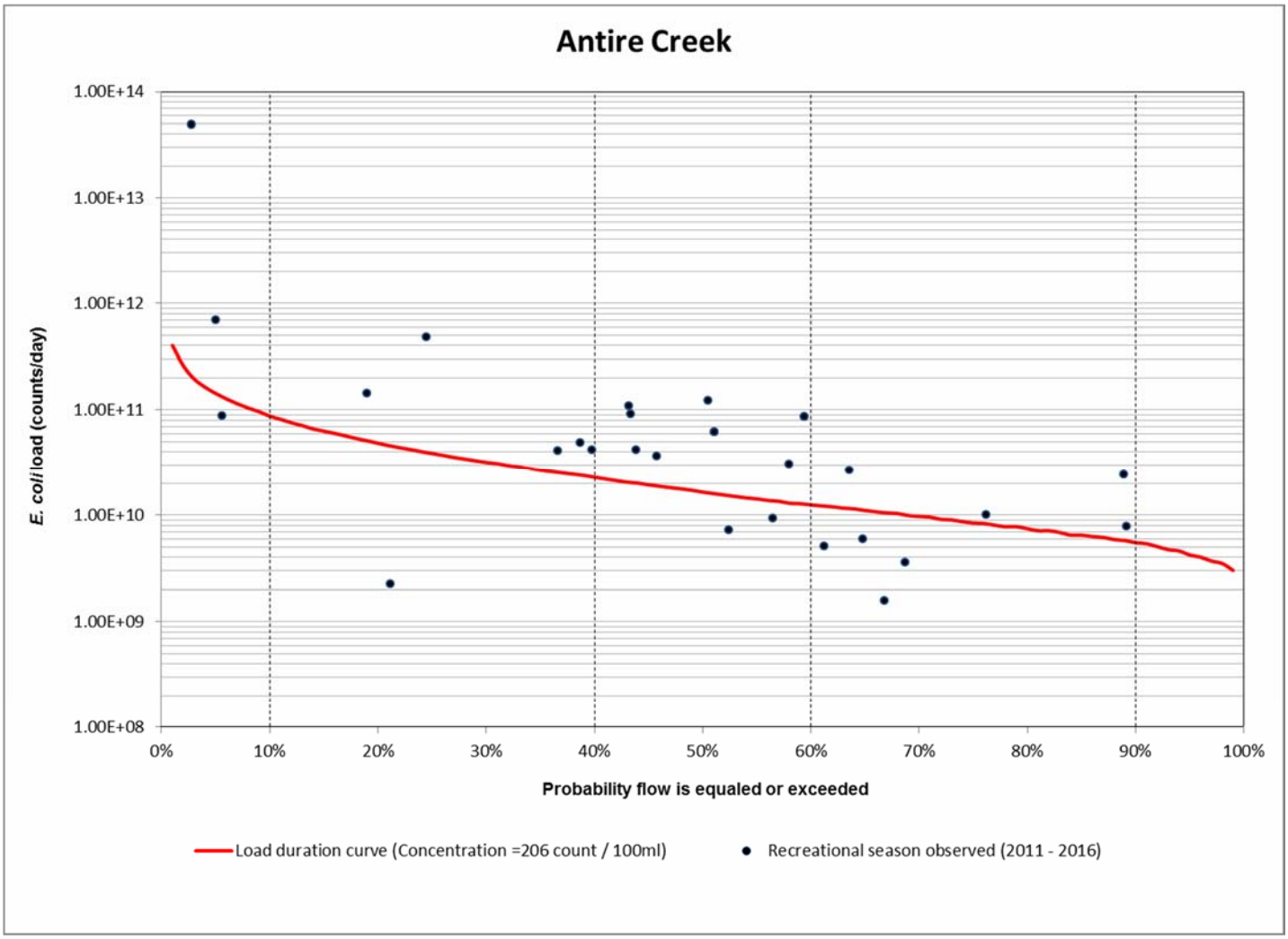
In general, a load duration curve is a visual communication tool that organizes information in a way that is useful for watershed planning. A load duration curve provides: 1) a visual representation of a water quality concern and how it relates to stream flow conditions (e.g. low, medium, and high), 2) indicates if point sources or other continuous input sources (e.g. failing septic systems, livestock access to the stream) are contributing to the concern, and 3) helps determine the types of best management practices that would be most effective.

Figure 1 provides an example of a load duration curve for *E. coli*. The x-axis, the flow duration interval, illustrates the full range of stream flow conditions for the water body segment (≤ 10 represents the percent of time the stream is at the highest flow conditions (flood), and ≥ 90 represents the percent of time the stream is at the lowest flow conditions (drought)). The x-axis represents the frequency for which a particular flow is met or exceeded. Whereas, lower flows are equaled or exceeded more frequently than higher flows. The y-axis describes bacteria loading as counts per day. Individually measured data have been converted to instantaneous loads and are plotted as points on the graph. The solid line represents the maximum pollutant loading across the different flow scenarios in which the water body can still meet the state's water quality standards. This line also corresponds to the water quality criterion concentration applicable for attaining the water body's designated whole body contact recreational use. Any data point above the solid line reflects a water quality excursion and possible exceedance.

The information provided in Figure 1 below indicates the frequency of *E. coli* excursions, which start occurring at the mid-range flow conditions (2 of 8 observations occur above the red line) and become more frequent through moist and high flow conditions (18 of 20 observations above the red line). The goal of a watershed management plan is to implement land management practices to address excursions or exceedances occurring during moist and mid-range conditions (runoff conditions), and dry and low flow conditions (non-runoff conditions) in an effort to decrease the frequency and magnitude of the water quality excursions. Decreasing the frequency and magnitude of excursions would aid in bringing the water body back into compliance and allow it to meet its designated recreational use(s) (e.g. whole body contact A or B recreation; and secondary contact recreation).

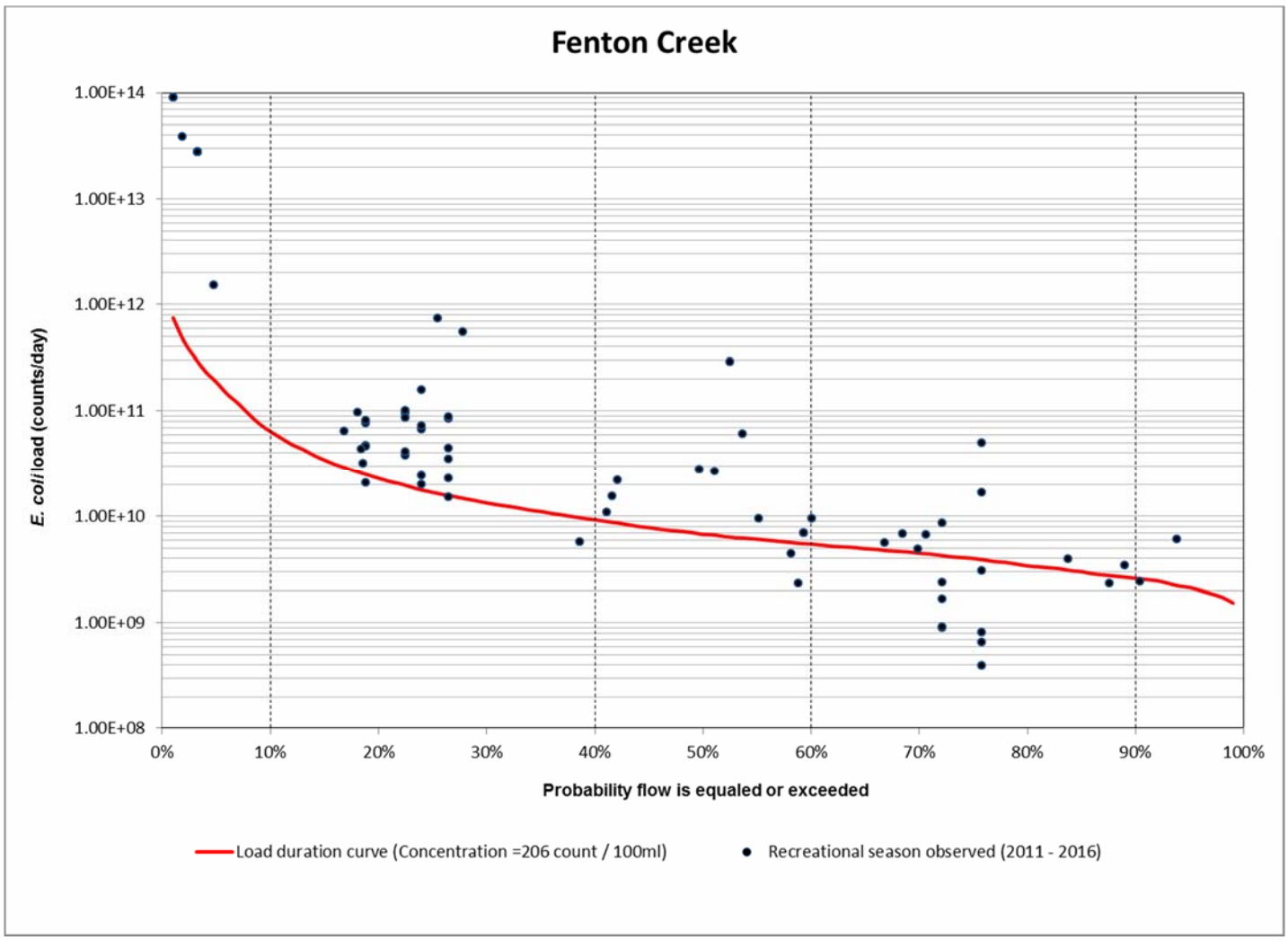
Figure 1. Example Load Duration Curve





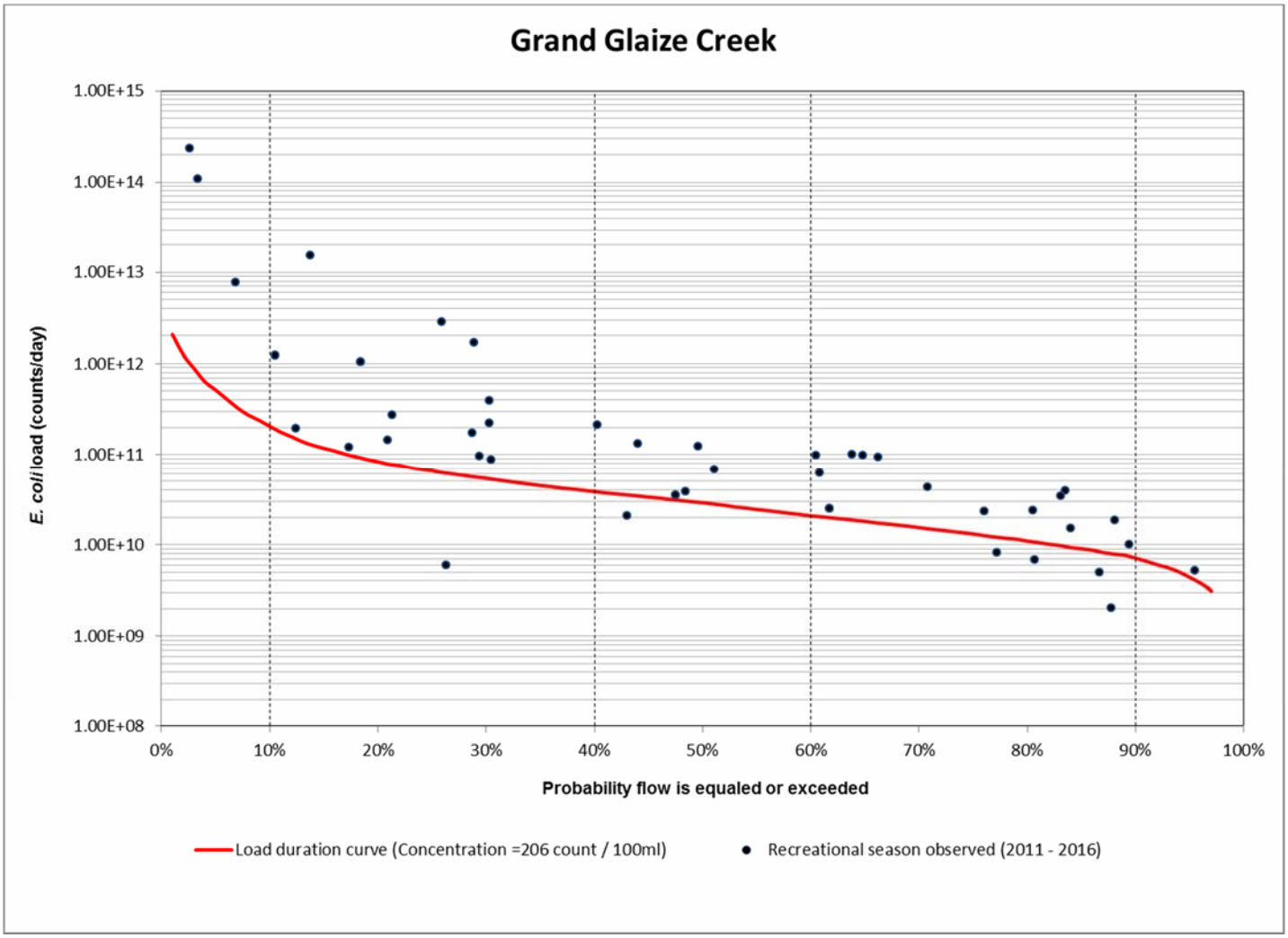
Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Antire Creek					
Percent of Time Flow is Equaled or	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
95	0.84	4.22E+09	No data	No data	No data
75	1.67	8.43E+09	7.38E+09	None	0.0%
50	3.28	1.65E+10	4.69E+10	3.04E+10	64.7%
25	7.71	3.89E+10	4.84E+10	9.57E+09	19.8%
10	17.38	8.76E+10	1.44E+12	1.35E+12	93.9%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range



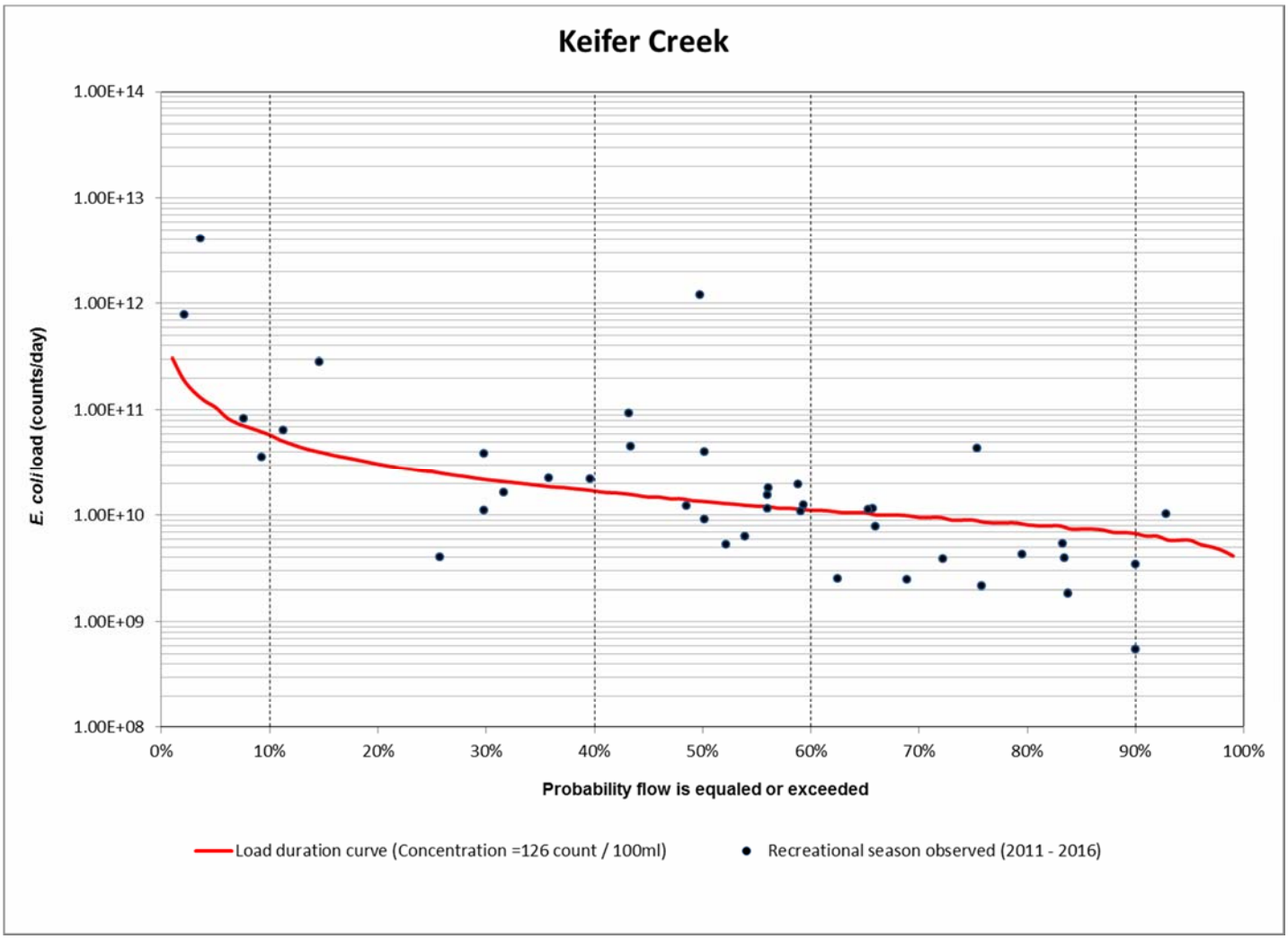
Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Fenton Creek					
Percent of Time Flow is Equaled or Exceeded	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
95	0.42	2.14E+09	3.82E+09	1.68E+09	44.0%
75	0.80	4.01E+09	2.72E+09	None	0.0%
50	1.34	6.75E+09	1.65E+10	9.70E+09	59.0%
25	3.34	1.68E+10	5.64E+10	3.96E+10	70.1%
10	12.72	6.41E+10	2.73E+13	2.72E+13	99.8%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range



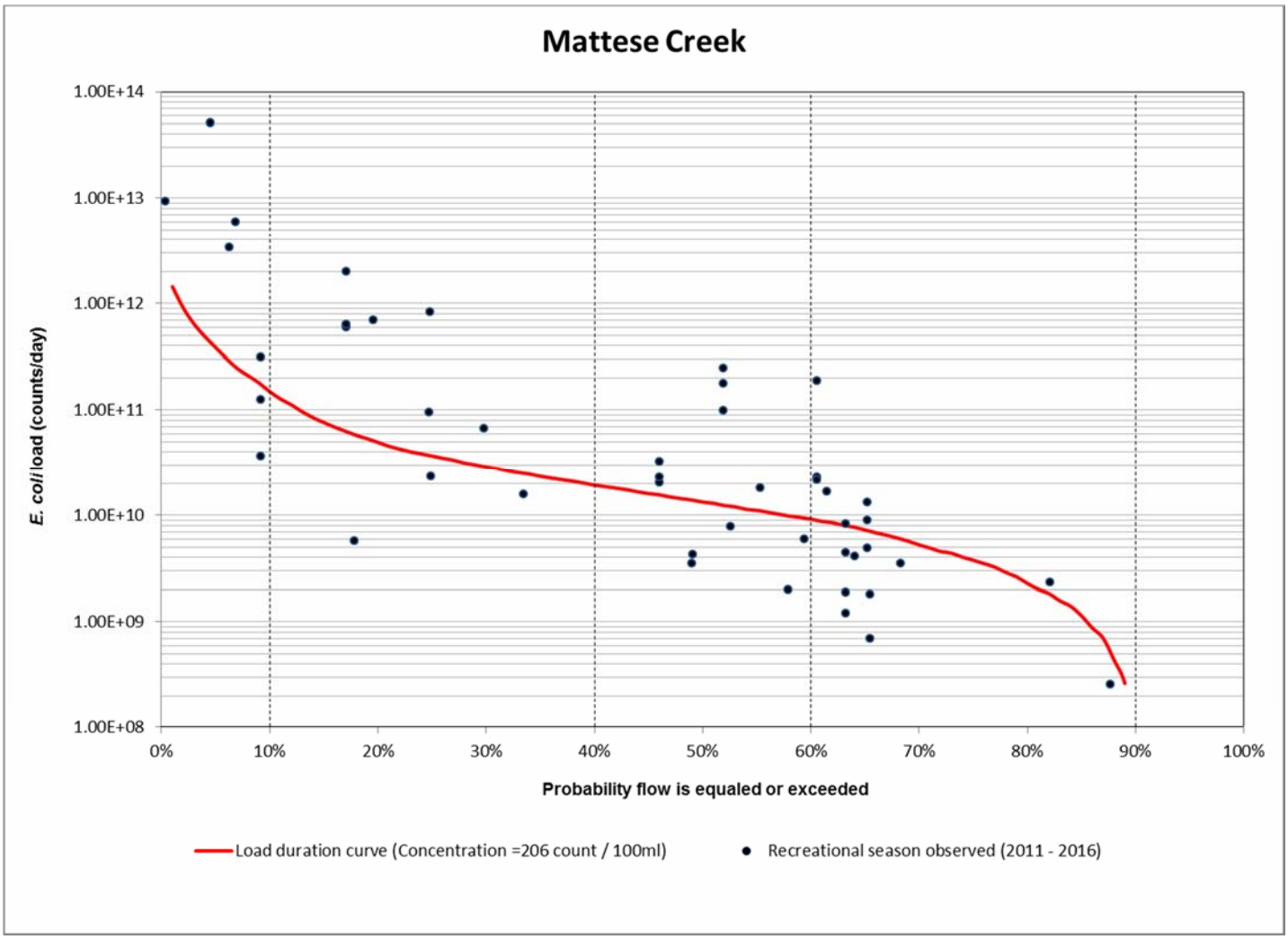
Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Grand Glaize Creek					
Percent of Time Flow is Equaled or Exceeded	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
95	0.87	4.37E+09	5.23E+09	8.58E+08	16.4%
75	2.60	1.31E+10	2.40E+10	1.09E+10	45.3%
50	5.75	2.90E+10	6.22E+10	3.32E+10	53.4%
25	13.02	6.56E+10	3.55E+11	2.90E+11	81.5%
10	40.68	2.05E+11	5.83E+13	5.81E+13	99.6%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range



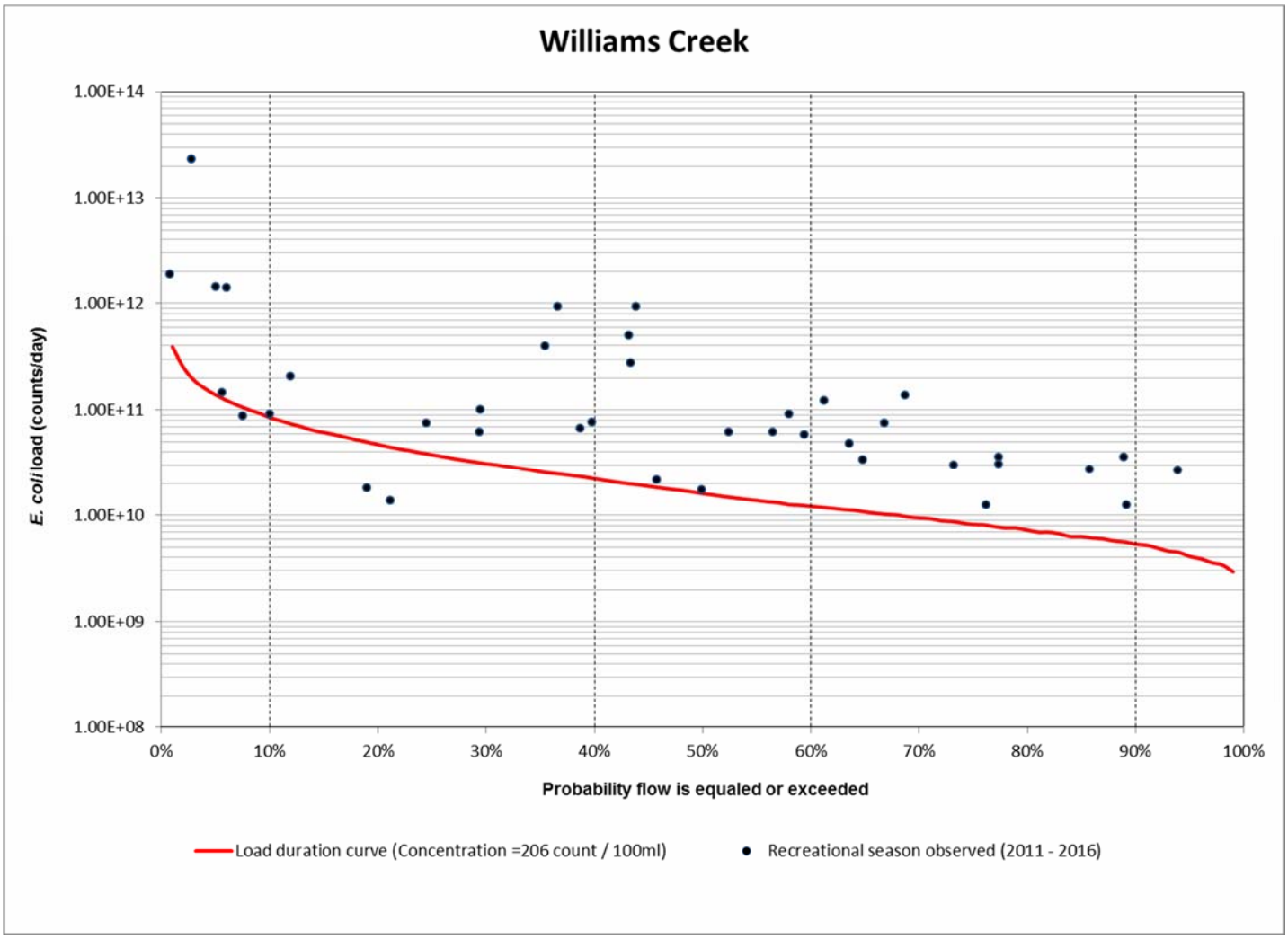
Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Keifer Creek					
Percent of Time Flow is Equaled or Exceeded	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
95	1.89	5.83E+09	2.69E+09	None	0.0%
75	2.92	9.01E+09	5.19E+09	None	0.0%
50	4.39	1.35E+10	2.21E+10	8.58E+09	38.8%
25	8.43	2.60E+10	2.66E+10	6.18E+08	2.3%
10	18.92	5.83E+10	3.14E+11	2.55E+11	81.4%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range



Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Mattese Creek					
Percent of Time Flow is Equaled or Exceeded	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
90	0.02	8.77E+07	6.81E+07	None	0.0%
75	0.75	3.77E+09	5.02E+09	1.25E+09	24.9%
50	2.64	1.33E+10	1.86E+10	5.25E+09	28.3%
25	7.31	3.68E+10	1.71E+11	1.34E+11	78.5%
10	29.58	1.49E+11	1.46E+12	1.31E+12	89.8%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range



Estimate of Bacteria Load Reductions Needed to Attain Water Quality Standards in Williams Creek					
Percent of Time Flow is Equaled or Exceeded	**Flow (cfs)**	**Loading Capacity (counts/day)**	**Existing Loading (counts/day)**	**Reduction Needed (counts/day)**	**Reduction Needed (%)**
95	0.81	4.10E+09	2.68E+10	2.27E+10	84.7%
75	1.63	8.19E+09	3.84E+10	3.02E+10	78.7%
50	3.19	1.61E+10	1.00E+11	8.40E+10	83.9%
25	7.49	3.78E+10	9.26E+10	5.48E+10	59.2%
10	16.88	8.51E+10	7.25E+11	6.40E+11	88.3%

Existing Loading = Estimated as the geometric mean of all observed *E. coli* loads within a specific flow range