APPENDIX A: WATERSHED CHARACTERISTICS

The EFLMR flows southwest from the predominately agricultural regions of Clinton and Highland Counties to the confluence with the Little Miami River at the western border of Clermont County, Ohio. Its watershed spans five counties including Brown, Clermont, Clinton, Highland, and Warren, and covers approximately 500 square miles. Almost half (49 percent) of the EFLMR watershed lies in Clermont County.

A.1 Land use/land cover

The land use/land cover for the EFLMR watershed was extracted from the Ohio Statewide Land Cover Classification. This spatial database was derived from satellite imagery collected from 1999 to 2003 and is the most current detailed land use/land cover data known to be available for the watershed. Each 98-foot by 98-foot pixel contained within the satellite image was classified according to its reflective characteristics and the resulting land use and land cover characteristics of the watershed are presented in Table A-1 and summarized in Figure A-1. The figure and the table show that land use/land cover consists primarily of row crops and forest with developed land concentrated in the most downstream portion of the watershed.

Table A-1. Land Use and Land Cover Characteristics of the EFLMR Watershed.

Land Cover / Land Use	Area (acres)	Area (Sq. Miles)	Percent of Watershed
Row Crops	131,961	206.2	41%
Deciduous Forest	94,729	148	30%
Pasture/Hay	54,080	84.5	17%
Developed, Open Space	17,138	26.8	5%
Low Intensity Residential	7,861	12.3	2%
Open Water	3,036	4.7	1%
Developed, Medium Intensity	2,881	4.5	1%
Evergreen Forest	1,802	2.8	1%
Grassland/Herbaceous	2,543	4	1%
High Intensity Residential	915	1.4	<1%
Commercial/Industrial/Transportation	155	0.2	<1%
Quarries/Strip Mines/Gravel Pits	269	0.4	<1%
Barren Land	69	0.1	<1%
Mixed Forest	356	0.6	<1%
Shrub/Scrub	923	1.4	<1%
Urban/Recreational Grasses	96	0.2	<1%
Woody Wetlands	206	0.3	<1%
Emergent Herbaceous Wetlands	380	0.6	<1%
Total	319,401	499	100%

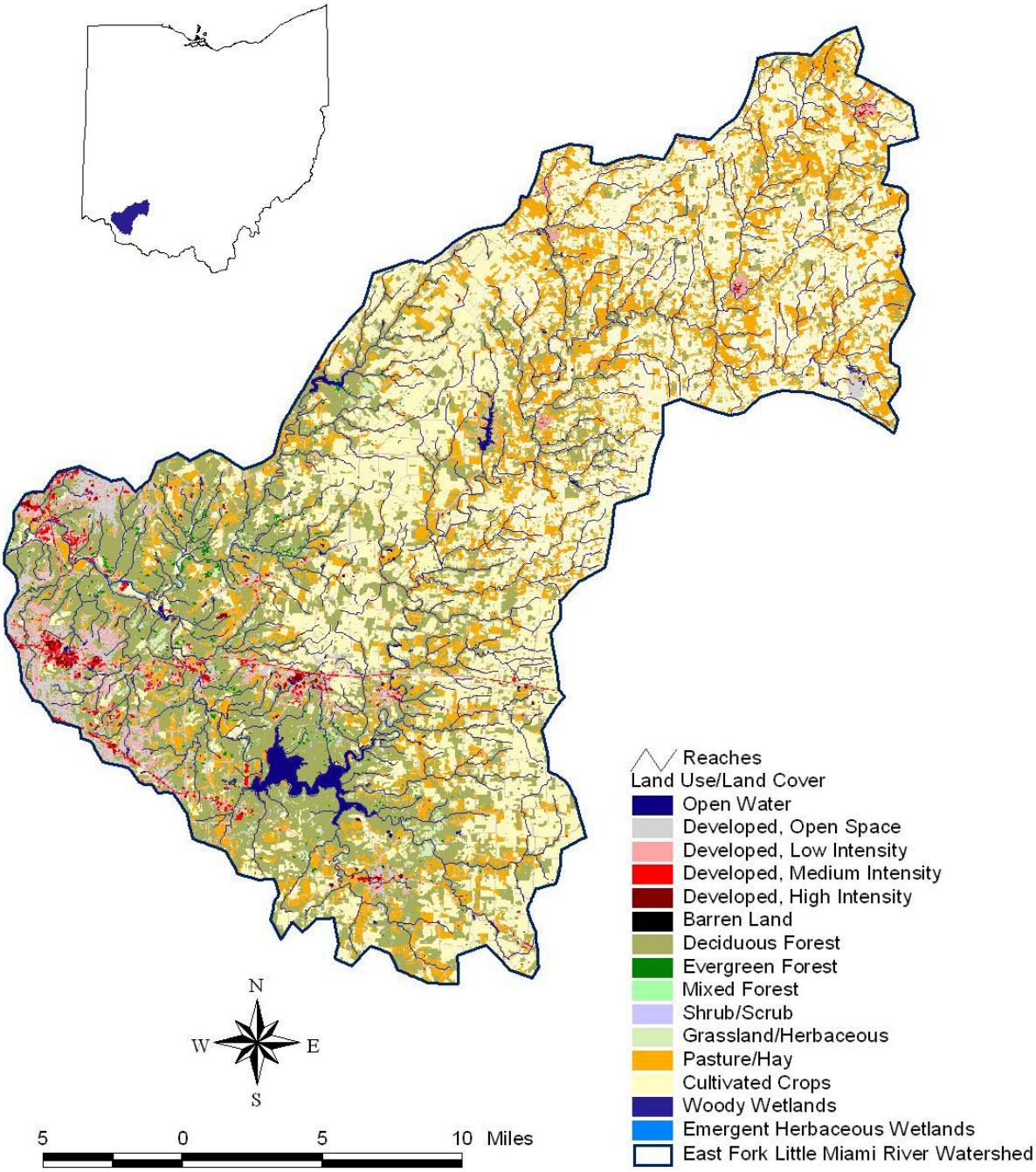

Figure A-1. Land use and land cover within the EFLMR watershed.

A.2 Soils

Soils data and geographic information system (GIS) coverages from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the EFLMR watershed. General soils data and map unit delineations for the United States are provided as part of the State Soil Geographic (STATSGO) database. The STATSGO data set was created to provide a general understanding of soils data to be used with large-scale analyses. Small, site-specific analyses with the STATSGO data are not appropriate. GIS coverages provide accurate locations for the soil map units at a scale of 1:250,000 (USDA, 1995). A map unit is composed of several soil series having similar properties. Identification fields in the GIS coverages can be linked to a database that provides information on chemical and physical soil characteristics.

EFLMR soils were formed from glacial drifts from the Illinoian glacial period. Rivers and streams easily dissect the fertile soils creating deep valleys ranging from 200 to 400 feet deep (Figure A-2). Because of this landscape, soils can be separated into three classes: (1) soils found on the flat, upland areas; (2) soils found on the steep, valley sideslopes and river terraces; (3) soils found on the flat river floodplains. Soils along the floodplains tend to be well drained and comprised of coarser, alluvial sediment. Sideslope soils are generally well drained and shallower than floodplain or upland soils. The upland soils are poorly drained due to the presence of glacial till, loess, and clay loam soil textures. Almost all soils are extremely susceptible to erosion due to silt deposited by glacial activity.

The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have the worst infiltration rates, while sandy soils that are well drained have the best infiltration rates. NRCS has defined four hydrologic groups for soils, and data for the EFLMR watershed were obtained from STATSGO (Table A-2) (NRCS, 2001). Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed in Figure A-3.

Table A-2. Hydrologic soil groups.

Hydrologic Soil Group	Description
A	Soils with high infiltration rates. Usually deep, well-drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well-drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

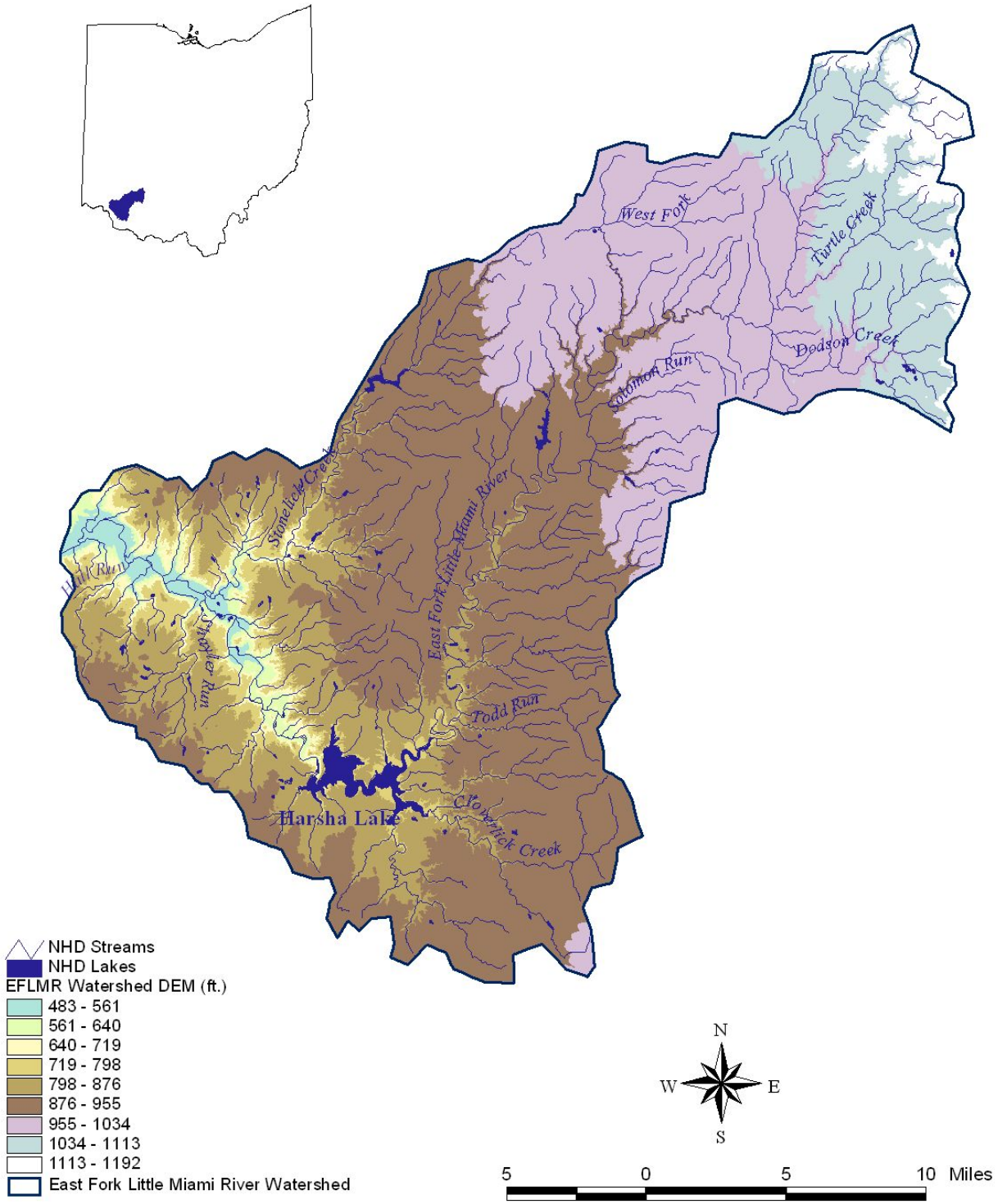

Figure A-2. Elevation within the East Fork Little Miami River Watershed.

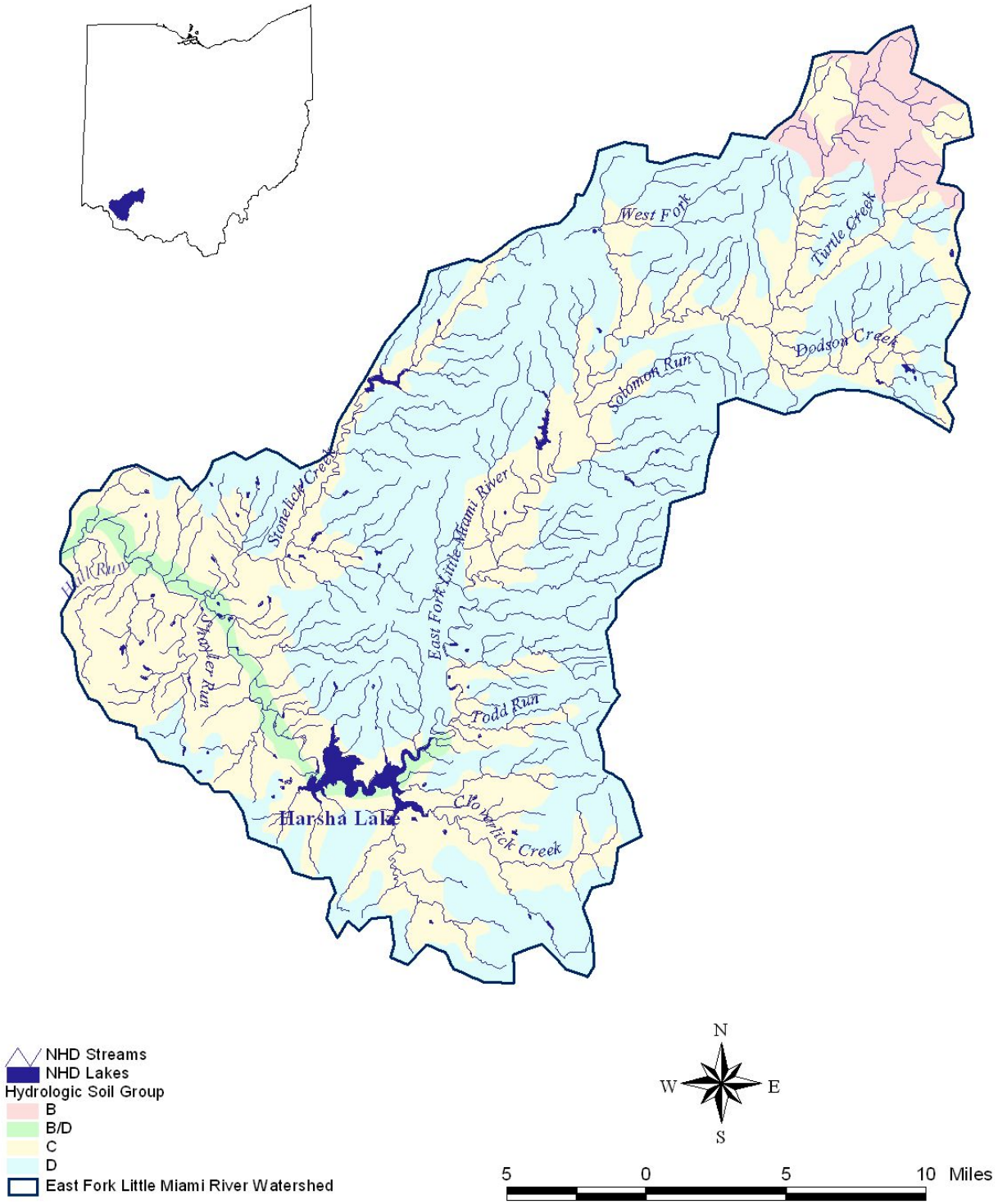

Figure A-3. Distribution of Hydrologic Soil Groups within the East Fork Little Miami River Watershed.

A.3 Population

The US 2000 Census was used to estimate watershed populations within each county and urban area. In 2000 there was approximately 120,000 people within the watershed, half living in urban areas and half rural. Table A-3 and Table A-4 display the estimated 2000 and 2005 populations within the EFLMR watershed.

Table A-3. Population within EFLMR watershed.

County	2000 County Population	2005 Estimated County Population	2000 Estimated Watershed Population	2005 Estimated Watershed Population	2000 Urban Population	2000 Rural Population
Brown County	42,285	44,398	9,212	9,673	3,285	5,927
Clermont County	177,977	190,589	95,171	101,916	48,787	46,384
Clinton County	40,543	42,570	7,614	7,994	6,221	1,393
Hamilton County	845,303	806,652	2,984	2,847	35	2,949
Highland County	40,875	42,818	4,390	4,599	1,348	3,042
Warren County	158,383	196,622	1,245	1,546	0	1,245
Total	**1,305,366**	**1,323,649**	**120,616**	**128,574**	**59,676**	**60,940**

Table A-4. Urban Area Population within EFLMR watershed.

Urban Area	2000 Population
Amelia	2,752
Batavia	1,617
Bethel	2,637
Blanchester	4,220
Day Heights	2,823
Dry Run	6,553
Fayetteville	372
Hamersville	515
Lynchburg	1,350
Martinsville	440
Midland	265
Milford	6,284
Mount Carmel	4,308
Mount Orab	2,307
Mount Repose	4,102
Mulberry	3,139
New Vienna	1,294
Newtonsville	492
Owensville	816
St. Martin	91

Urban Area	2000 Population
Summerside	5,523
Terrace Park	2,273
Williamsburg	2,358
Withamsville	3,145

APPENDIX B: WATER QUALITY STANDARDS

The purpose of developing a TMDL is to identify the pollutant loading that a waterbody can receive and still achieve water quality standards. Under the Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the Clean Water Act's goal of "swimmable/fishable" waters. Water quality standards consist of three components: designated uses, numeric or narrative criteria, and an antidegradation policy. Ohio's water quality standards are summarized in Table B-1 and explained in greater detail below.

Table B-1. Ohio water quality standards.

Component	Description
Designated Use	Designated use reflects how the water can potentially be used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (i.e., they are waterbody specific).*
Numeric Criteria	Chemical criteria represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Biological criteria indicate the health of the in-stream biological community by using one of three indices: • Index of Biotic Integrity (IBI) (measures fish health). • Modified Index of well being (MIwb) (measures fish health). • Invertebrate Community Index (ICI) (measures benthic macroinvertebrate health).
Narrative Criteria	These are the general water quality criteria that apply to all surface waters. These criteria state that all waters must be free from sludge; floating debris; oil and scum; color- and odor-producing materials; substances that are harmful to human, animal or aquatic life; and nutrients in concentrations that may cause algal blooms.
Antidegradation Policy	This policy establishes situations under which OEPA may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to <http://www.epa.state.oh.us/dsw/wqs/wqs.html> for more information.

* According to OAC 3745-1-07(A)(1) each waterbody is assigned a designated use. However, some streams in Ohio are undesignated and receive a default warmwater habitat (WWH) designation for chemical loadings. There is no default protection for recreational use.

B.1 Designated Uses

The East Fork Little Miami River and Dodson Creek are designated by OEPA as exceptional warmwater habitat (EWH). All other streams in the watershed have a warmwater habitat use designation. All of the streams in the East Fork Little Miami River watershed are designated for Primary Contact Recreation (OAC 3745-1-22). William H. Harsha Lake is assigned the exceptional warmwater habitat designated use because all public lakes and reservoirs in the state of Ohio are automatically given this aquatic life designation.

B.2 Numeric Criteria

B.2.1 Biocriteria

Biological criteria are based on aquatic community characteristics that are measured both structurally and functionally. In Ohio, these criteria are used to evaluate the attainment of aquatic life uses. The data collected in these assessments are used to characterize aquatic life impairment and to help diagnose the cause of this impairment.

The principal biological evaluation tools used by Ohio EPA are the Index of Biotic integrity (IBI), the Modified Index of Well-Being (MIWB) and the Invertebrate Community Index (ICI). These three indices are based on species richness, trophic composition, diversity, presence of pollution-tolerant individuals or species, abundance of biomass, and the presence of diseased or abnormal organisms. The IBI and the MIWB apply to fish; the ICI applies to macroinvertebrates. Ohio EPA uses the results of sampling reference sites to set minimum criteria index scores for use designations in water quality standards. The criteria vary based on drainage area, designated use, and ecoregion. For Ohio EPA regulatory purposes[1], the EFLMR falls within both the Eastern Corn Belt Plains and Interior Plateau ecoregions, as shown in Figure B-1. The biological criteria for the Interior Plateau ecoregion are shown in Table B-2 and the criteria for the Eastern Corn Belt Plains ecoregion are shown in Table B-3. Summaries of the available biological data are presented in Appendix CAPPENDIX C:.

[1] It should be noted that a newer Level III ecoregion map locates all of the EFLMR watershed within the Eastern Corn Belt Plains ecoregion. An accompanying Level IV ecoregion maps locates portions of the watershed in the Pre-Wisconsinan Drift Plains subregion with the rest of the watershed in the Loamy High Lime Till Plains subregion. Ohio EPA's use designations, however, are based on the older Level III ecoregion map.

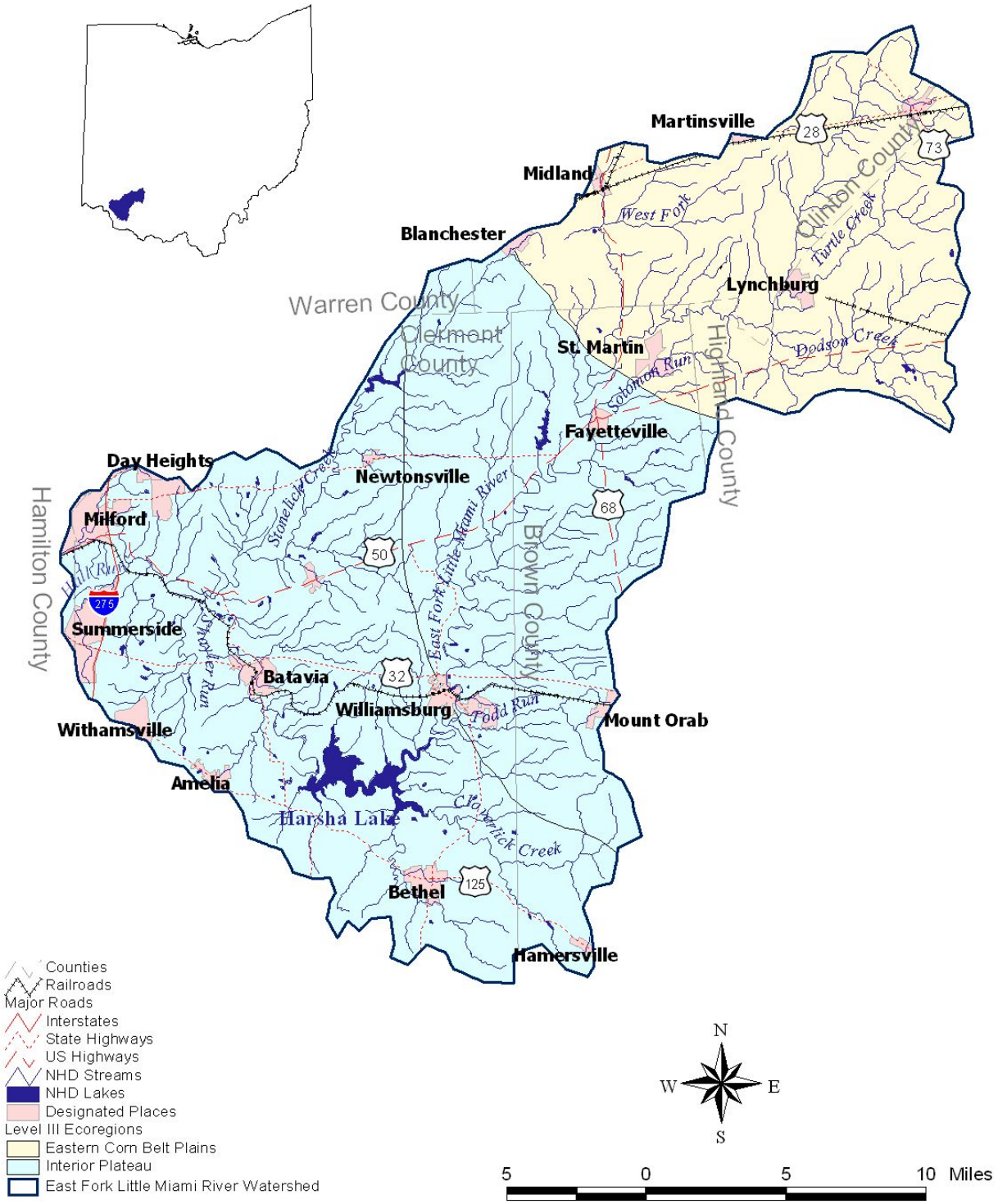

Figure B-1. East Fork Little Miami River watershed ecoregions.

Table B-2. Biological criteria that apply to the Interior Plateau ecoregion.

Index-Site Type	EWH	WWH	MWH
IBI- Headwaters	50	40	24
IBI-Wading	50	40	24
IBI-Boat	48	38	24
MIWB-Wading	9.4	8.1	6.2
MIWB-Boat	9.6	8.7	5.8[1]
ICI	46	30	22

[1]The MIWB for channel modified boat sites is 5.8 and for impounded boat sites it is 6.6

Table B-3. Biological criteria that apply to the Eastern Corn Belt Plains ecoregion.

Index-Site Type	EWH	WWH	MWH
IBI- Headwaters	50	40	24
IBI-Wading	50	40	24
IBI-Boat	48	42	24
MIWB-Wading	9.4	8.3	6.2
MIWB-Boat	9.6	8.5	5.8
ICI	46	36	22

B.2.2 Recreation

Numeric criteria exist in Ohio to protect contact recreation designated uses. However, interpreting Ohio's water quality standards for fecal coliform and *E. coli* is somewhat complex and the state is currently considering changing the standard. Standards have been established to protect three different designated uses:

> Bathing waters: these are waters that, during the recreation season, are suitable for swimming where a lifeguard and/or bathhouse facilities are present, and include any additional such areas where the water quality is approved by the director.
>
> Primary contact: these are waters that, during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as a result of water quality.
>
> Secondary contact: these are waters that, during the recreation season, are suitable for partial body contact recreation such as, but not limited to, wading with minimal threat to public health as a result of water quality.

Table B-4 shows that the primary contact *E. coli* criterion of 126 cfu/100 mL is identical to the bathing water *E. coli* criterion as a geometric mean. However, this is not the case for fecal coliforms. While the primary contact fecal coliform criterion is 1,000 cfu/100 mL, the bathing water fecal coliform criterion is 200/100 mL. For this reason, *E. coli* is not used by itself to determine if there is a violation of the primary contact recreation criteria because Ohio EPA's regulations state that:

"For each designation at least one of the two bacteriological standards (fecal coliform or E. coli*) must be met (OAC 3745-1-07, Table 7-13)."*

Therefore, when both fecal coliform and *E. coli* data are available from the same sample, if at least one of the two standards is met, there is not a human health violation. If only one of the two bacteria groups are available to determine violations of recreational standards, then fecal coliform should be used, not *E. coli*, because it is very rare that a fecal coliform count of 1,000/100 mL would violate the criteria and *E. coli* would not violate the 126/100 mL criteria. For this reason, the load reduction values for the EFLMR watershed are based on meeting the primary contact fecal coliform standard.

Table B-4. Fecal coliform and *E. coli* standards for Ohio. Standards only apply for the period May 1 through October 15.

Parameter	Bathing Waters		Primary Contact		Secondary Contact
	Geometric Mean[1]	Instantaneous[2]	Geometric Mean[1]	Instantaneous[2]	Instantaneous[2]
Fecal Coliform	200/100 mL	400/100 mL	1,000/100 mL	2,000/100 mL	5,000/100 mL
E. coli	126/100 mL	235/100 mL	126/100 mL	298/100 mL	576/100 mL

[1] Geometric mean fecal coliform content should not exceed this standard based on not less than five samples within a thirty-day period.
[2] Fecal coliform content should not exceed this standard in more than ten percent of the samples taken in any thirty-day period.

B.3 Narrative Criteria

Four nutrient-related parameters are available for the EFLMR watershed. These are nitrate and nitrite nitrogen (NN), total Kjeldahl nitrogen (TKN), dissolved phosphorus (DP), and total phosphorus (TP). Common anthropogenic sources of nitrogen and phosphorus include urban runoff, agricultural runoff, sewage treatment plants, septic systems, and livestock operations. Elevated nutrient levels are often observed during storm events.

Nutrient concentrations are rarely high enough to cause direct harm to aquatic life. However, excess nutrients lead to the eutrophication of water bodies and may cause decreased sunlight penetration, a reduction in dissolved oxygen, an increase in nuisance plants, anaerobic conditions, and an increase in detritus (which may cause an increase in ammonia) (Thomann and Mueller, 1987). For the purpose of this report, dissolved oxygen (DO) is included in the nutrient analysis, as it can help identify water bodies that are nutrient impacted.

Total suspended solids and turbidity data are also available for the EFLMR watershed. Both TSS and turbidity measurements can indicate water quality problems due to excess sediment or organic matter (algae and plant overgrowth). Background suspended sediment and turbidity levels vary depending on specific stream characteristics (width, depth, flow, bed material, etc.), and it becomes difficult to compare measurements to statewide or national standards.

Only narrative criteria are available for nutrient and sediment-related causes of impairment. Target values are therefore needed to compare existing water quality conditions to desired water quality conditions and to derive "maximum daily loads". OEPA (OEPA, 1999) has established water quality

targets for nutrients and these were applied for the purposes of developing preliminary load reduction estimates in the East Fork Little Miami River watershed (Table B-5).

Table B-5. Nutrient Target Values for the East Fork Little Miami River Watershed.

Water Quality Parameter	Drainage Area	Designated Use Class	Target Value
Total Phosphorus	Headwaters (< 20 square miles)	EWH	0.05 mg/L
		WWH	0.08 mg/L
	Wadeable (20 < 200 square miles)	EWH	0.05 mg/L
		WWH	0.10 mg/L
	Small Rivers (200 < 1000 square miles)	EWH	0.10 mg/L
		WWH	0.17 mg/L
Nitrate Nitrogen	Headwaters (< 20 square miles)	EWH	0.5 mg/L
		WWH	0.5 mg/L
	Wadeable (20 < 200 square miles)	EWH	0.5 mg/L
		WWH	1 mg/L
	Small Rivers (200 < 1000 square miles)	EWH	1 mg/L
		WWH	1.5 mg/L

OEPA does not have numeric targets for TSS and no statewide recommendations have been published. TSS targets were therefore selected using reference site ranges and the resulting target was 25 mg/L for all streams in the EFLMR watershed.

APPENDIX C: STRESSOR IDENTIFICATION RESULTS

Stressor Candidate Causes and Data to evaluate each
(see column headings on Worksheet = SI chklst by stream - Chem_hab)

Data type	ND=No data ID=insufficient data **bold**=primary data for candidate cause unbold=secondary data Parameter		Nutrients/ DO	Unionized ammonia toxicity	Organic enrichment/ DO	Siltation	Other habitat impacts	Priority metals: Cu, Pb, Zn	Other metals	Other toxics: pesticides, oils, VOCs	Thermal modifications	Flow alteration	Ionic stress: Incr conductance, chlorides, sulfate	pH extremes
wq	Phosphorus, Total		**X**											
wq	Nitrate and Nitrite		**X**											
wq	Dissolved Oxygen		**X**		**X**									
wq	Chlorophyll a		**X**		**X**									
wq	Ammonia			**X**										
wq	Ammonia (Un-ionized)			**X**										
wq	pH			**X**										**X**
wq	Biochemical Oxygen Demand				**X**									
wq	CBOD5				**X**									
wq	Chemical Oxygen Demand (low level)				**X**									
wq	Fecal Coliform				X									
wq	Total Suspended Solid					**X**								
wq	Turbidity, ntu					**X**								
wq	Copper							**X**						
wq	Lead, Total Recoverable							**X**						
wq	Zinc, Total							**X**						
wq	Copper Dissolved							ID						
wq	Lead, Dissolved							ID						
wq	Zinc Dissolved							ID						
wq	Aluminum, Total Recoverable								**X**					
wq	Arsenic, Total Recoverable								**X**					
wq	Cadmium, Total recoverable								**X**					
wq	Chromium, Total recoverable								**X**					
wq	Iron, Total recoverable								**X**					
wq	Nickel, Total recoverable								**X**					
wq	Selenium, Total Recoverable								**X**					
wq	Silver, Total recoverable								**X**					
wq	Arsenic Dissolved								ID					
wq	Cadmium Dissolved								ID					
wq	Chromium Dissolved								ID					
wq	Nickel Dissolved								ID					
wq	Selenium Dissolved								ID					
wq	Atrazine									**X**				
wq	Chlorine (Total residual)									**X**				
wq	Cyanide									**X**				
wq	Phenolic Compounds									**X**				
wq	Oil & Grease, Total, Hexane Extractable									ID				
wq	Oil and Grease (freon extraction)									ND				
wq	Water Temperature										**X**			
wq	Conductivity												**X**	
wq	Chlorides												**X**	
wq	Sulfate Dissolved												**X**	
habitat	QHEI total score					**X**	**X**					X		
habitat	SUBSTRATE					**X**	X							
habitat	SILTCOVER					**X**	X							
habitat	EMBEDDED					**X**	X							
habitat	COVER						X							
habitat	CHANNEL						X					X		
habitat	RIPARIAN						X				X			
habitat	POOL						X							
habitat	RIFFLE						X							
habitat	GRADIENT_S (score)						X							
habitat	GRADIENT_V (feet/mile)													
model	Flow: flashiness stats/parameters											**X**		

				SI Evaluation			
Stressor/ Indicator	**Units**	**Elimination Threshold**	**Comments**	**O unlikely**	**X weak**	**XX possible**	**XXX likely**
Total P	mg/L	OEPA	Use OEPA recommended criteria for des. use, applied conservatively HW: WWH 0.08 mg/l, EWH 0.05 mg/l Wading: WWH 0.1 mg/l, EWH 0.05 mg/l Small River: WWH 0.17 mg/l, EWH 0.10 mg/l	Most obs < criteria/ thresholds	Less than half obs above criteria	More than half obs above criteria	Most/all obs above criteria
Total NO_3+NO_2	mg/L	OEPA	Use OEPA recommended criteria for des. use, applied conservatively HW & Wading, WWH 1.0 mg/l, EWH 0.5 mg/l Small River: WWH 1.5 mg/l, EWH 1.0 mg/l	Most obs < criteria/ thresholds	Less than half obs above criteria	More than half obs above criteria	Most/all obs above criteria
DO	mg/L	all obs. >6 and <10 June-Sep	Supersaturation indicates eutrophication in summer. OEPA thresholds[1]: OMZ min: WWH 4.0 mg/l, EWH 5.0 mg/l OMZ avg: WWH 5.0 mg/l, EWH 6.0 mg/l	Minimum obs > minimum criteria	Majority of obs above criteria	About half of obs below criteria	Majority of obs below criteria
Chlorophyll-A	µg/L	NA	*Little SI data to evaluate.* Wetzel, 2001 (Limnology, 3rd ed): Eutrophic lakes annual mean Chlorophyll-*a* =14.3 ug/l; range 3-78 ug/l (Table 13-18).	Maximum <25 ug/l	Maximum >25 ug/l	Maximum >100 ug/l and multiple obs >25 ug/l	(not used)
Ammonia (NH_4)	mg/L	0.05	EPA chronic at pH = 8.5 and T = 30: 0.4 mg/L	Maximum <0.45 mg/l with pH<8.0	Majority <0.45 mg/l (maximum <0.8 mg/l) with pH<8.0	Multiple obs >0.4 mg/l with pH >8.0 but <8.5	Multiple obs >0.4 mg/l with pH>8.5
Un-ionized Ammonia	mg/L		Toxic at 0.05 mg/l, lethal at 2 mg/l (ref: U.Fla. Extension, Francis-Floyd and Watson, 1990, Document FA-16, http://edis.ifas.ufl.edu/fa031	Maximum <0.05 mg/l	Majority <0.05 mg/l	Multiple >0.05 mg/l and Maximum <2.0 mg/l	Maximum >2.0 mg/l
BOD, 5-day	mg/L	2	Based on reference site ranges and WWH/EWH IBI site ranges per Ed Rankin's memo, Tables 1 and 5.	Maximum >2 and <4	Maximum >6 and <20	Maximum >20	(not used; ID)
cBOD, 5-day	mg/L	2	Based on reference site ranges and WWH/EWH IBI site ranges per Ed Rankin's memo, Tables 2 and 6.	Maximum >2 and <3.5 (ref range)	Maximum >3.5 and <5 (IBI sites range meeting WWH)	Maximum 5-10	Maximum >10
COD	mg/L	10	Based on reference site ranges and WWH/EWH IBI site ranges per Ed Rankin's memo, Tables 3 and 7.	Maximum >10 and <35	Maximum >35	(not used; ID)	(not used; ID)

				SI Evaluation			
Stressor/ Indicator	**Units**	**Elimination Threshold**	**Comments**	**O unlikely**	**X weak**	**XX possible**	**XXX likely**
Fecal coliform	#/100 mL	na	Use in SI is secondary to B/COD in evaluation of organic enrichment. OEPA Primary Contact criteria, May 1 to Oct 15 only: Geometric mean=1000; Instantaneous=2000	Non-outlier maximum <1000	Non-outlier maximum 1000-2000	Non-outlier maximum >2000	(not used)
TSS	mg/L	<19	Based on reference site ranges and WWH/EWH IBI site ranges per Ed Rankin's memo, Tables 4 and 8. Weighted less than other parameters in SI; "…the relationship between TSS and IBI is very weak, with a slight drop in median IBI scores above TSS concentrations of 50 mg/l, but no continuing decrease in IBI above this level.... Data suggest that TSS alone can be a weak indicator where habitat modifications have been widespread, and that used alone could underestimate limitations to aquatic life related to habitat factors."	Non-outlier maximum <25	Maximum >25 and <50	Non-outlier maximum >50	(not used)
Turbidity	ntu	<5	(http://www.water.ncsu.edu/watershedss/info/turbid.html:) Acceptable ranges: Recreation: <5 ntu (AWWA, 1990) ALU: <50 ntu instantaneous or <25 ntu 10-day average (Harvey, 1989) <10 ntu for trout waters or <25 ntu for streams (non-trout) or <50 ntu for lakes/reservoirs (non-trout) (North Carolina Code, 2002)	Non-outlier maximum <25	Maximum >25 and <50	Non-outlier maximum >50	(not used)
QHEI			Per E.Rankin: EWH streams in upper 70s. 9/21/05 - 10/5/05 emails, discussion, consensus among E. Rankin, Clermont Co. staff, Tetra Tech staff. Ref documents: *insert document citation info*	>70	65-70	55-65 HW streams; 60-65 larger streams	<55 HW streams; <60 larger streams
				(Majority obs., with greater weight to more recent data)			
Substrate subscore			range 0-20	>15	>10 to 15	>5 to 10	0-5

				SI Evaluation			
Stressor/ Indicator	**Units**	**Elimination Threshold**	**Comments**	**O unlikely**	**X weak**	**XX possible**	**XXX likely**
Siltcover subscore			1=Heavy; 2=Moderate; 3=Normal; 4=Siltfree	Minimum obs >=3	Obs range 2-4	Obs range 1-4 or 1-3 or 2-3	Obs range 1-2
Embedded subscore			1=Extensive(>75%); 2=Moderate(50-75%); 3=Sparse(25-50%); 4=Low(<25%)	Minimum obs >=3	Obs range 2-4	Obs range 1-4 or 1-3 or 2-3	Obs range 1-2
Cover subscore			range 0-20	>15	>10 to 15	>5 to 10	0-5
Channel subscore			range 0-20	>15	>10 to 15	>5 to 10	0-5
Riparian subscore			range 1-10	Minimum obs >7	Obs range 4-10	Obs range 4-7	Maximum obs <4
Pool subscore			range -1 to 12	>8	Obs range 5-10	Obs range 4-7	Maximum obs <4
Riffle subscore			range -1 to 8	>6	3-6	0-5	Maximum obs <3
Gradient subscore			range 1-10	>7	4-10 or min>6	4-7	Maximum obs <4
Copper (Cu)	µg/L	5	EPA chronic criterion = 9 OEPA OMZ avg 17 ug/l, OMZ max 27 ug/l	Non-outlier max <9	Maximum >9 and most obs <17	Some obs (but not majority) >17, and minimal/few obs >27	Minimum value or most obs, >17; or Multiple/ Maximum >27
Lead (Pb)	µg/L	3	OEPA OMZ avg 16 ug/l OEPA OMZ max 300 ug/l	Non-outlier max <16	Some obs (but not majority) >16, and maximum <300	Some obs (but not majority) >16, and minimal/few obs >300	
Zinc (Zn)	µg/L	18	OEPA OMZ avg or max = 220 at hardness = 200mg/l	Non-outlier max <220	Few/ occasional obs >220		
Aluminum (Al)		any	Aluminum eliminated throughout because pH > 6.5	na	na	na	na
Arsenic (As)	µg/L	2	EPA chronic criterion = 150 OEPA criteria[1]: IMZM=680, OMZM=340; OMZA=150	Non-outlier max <150	not used (all values < 11)		

				SI Evaluation			
Stressor/ Indicator	**Units**	**Elimination Threshold**	**Comments**	**O unlikely**	**X weak**	**XX possible**	**XXX likely**
Cadmium (Cd)	µg/L	0.25	detection limit and chronic criterion. Acute 2.0 ug/l OEPA criteria[2]: Hardness-dependent criteria, based on equations; numeric criteria based on example water hardnesses of 100/200/300/400 mg/L are, respectively: OMZ ave: 2.5, 4.2, 5.8, 7.3 OMZ max: 4.5, 9.9, 16, 22	Non-outlier max <2.5 (all samples except 1980s Back Run and EF2400 (ACOE data)	see graphs: 1980s data at Back Run and EF2400 (ACOE)	not used	not used
Chromium (Cr)	µg/L	15	detection limit; chronic criterion=74. OEPA criteria[2]: Hardness-dependent criteria, based on equations; numeric criteria based on example water hardnesses of 100/200/300/400 mg/L are, respectively: OMZ ave: 86, 150, 210, 270 OMZ max: 1800, 3200, 4400, 5600	Non-outlier max <86	not used (all values < 86 mg/L)		
Iron (Fe)	µg/L	720	EPA chronic criterion = 1000	Non-outlier max <800	Non-outlier max 1000-6000; median <1000	Median 1000-6000	Median >6000
Nickel (Ni)	µg/L	20	EPA chronic criterion=52. OEPA criteria[2]: Hardness-dependent criteria, based on equations; numeric criteria based on example water hardnesses of 100/200/300/400 mg/L are, respectively: OMZ ave: 52, 94, 130, 170 OMZ max: 470, 840, 1200, 1500	Non-outlier max <60	not used (all values < 60 mg/L)		
Selenium (Se)	µg/L	5	EPA chronic criterion OEPA criteria[1]: OMZA=5		not used (all values < =5 mg/L, and not much data)		
Silver (Ag)	µg/L	0.5	EPA acute criterion = 3.2. Little data in database.	Max <3.2	Max >3.2 (little data)	(not used; ID)	(not used; ID)
Atrazine	µg/L		OEPA drinking water limit 3 ug/l. Little data in database.	One site: max<=3.2	(not used)	One site: Most obs 0-2; additional obs 4-12	(not used)
Chlorine, residual	µg/L		EPA chronic criterion =11, acute=19 OEPA criteria for WWH, EWH[1]: OMZM=19, OMZA=11	no data in EFLMR SI samples			

				SI Evaluation			
Stressor/ Indicator	**Units**	**Elimination Threshold**	**Comments**	**O unlikely**	**X weak**	**XX possible**	**XXX likely**
Cyanide (HCN)	µg/L	3	detection limit; EPA chronic criterion = 5.2 OEPA criteria for WWH, EWH[1]: OMZ max=46, OMZ avg=12	no data in EFLMR SI samples			
Phenolics	µg/L	7.5	could be detection limit? Little data in database	no data in EFLMR SI samples			
Temperature	C		OEPA criteria: Variable by month; see OAC 3745-1-07, Table 7-14(A)	tbd	tbd	tbd	tbd
Flow: flashiness			Richards-Baker Index. Range: 0 (absolutely no variability) to 2 (extreme flashiness)	tbd	tbd	tbd	tbd
Conductivity	µ S	600	Geology/soils have naturally high conductivity	Non-outlier max <700	Non-outlier max 700-800	Non-outlier max 800-1000	Non-outlier max >1000
Chloride	mg/L	29	IP had lower number for small rivers. EPA chronic =230	Non-outlier max <100	Non-outlier max 100-200	Non-outlier max 200-230	Non-outlier max >230
Sulfate	mg/L	50	Supplemental ionic SI info; secondary	Non-outlier max <60	Non-outlier max 60-600	Median 60-600	Median >600
pH extremes			Acid dep/ acidity not a problem throughout watershed; a few cases of pH>9				
[1] OAC 3745-1-07, Table 7-1							
[2] OAC 3745-1-07, Table 7-9							

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Description	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26)) 60 pt	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40) 60 pt
OEPA HUC11 Assessment Unit 05090202130						
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 0 - RM 5.5	1-19, 21-22, 30-32	Yes	Multiple IBI <44; see RM plot
1below	Hall Run (headwater size)	OH53 2		23-29	Yes 1998-2003 scores <20	Yes (IBI<40 for n=13 of 15 samps)
1below	Wolfpen Run (headwater size)	OH53 3		33-34, 36	1997 OEPA Qual samps only	ND
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 5.6 - RM 8.5	1, 8-10, 15, 30-32	Yes	Multiple IBI <44; see RM plot
2below	Salt Run (headwater size)	OH53 4		2-3	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=36
2below	UT Salt Run, Nature Center (D Russell) (headwater size)			4	2002 only; questionable scores (8, 6, 10, 12)	ND
2below	UT Salt Run, Circuit City			5-7	ND	ND
2below	Sugarcamp Run (headwater size)	OH53 5		11-13	1994-98 OEPA Qual samps only	1998 Not Impaired; 1994 impaired
2below	East Branch Sugarcamp Run (headwater size)			14	1994 OEPA Qual samps only	Yes (IBI<40) n=1 1994 score=12
2below	Shayler Run (headwater size)	OH53 6		16-22, 26-29	No (ICI>=30) n=2, 1991, scores 30,34	Mixed <40 and >40 in both 1991 and 1998

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Description	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)
					60 pt	60 pt
2below	Shayler Run tributary (headwater size)	OH53 6.1		23-25	ND	Yes (IBI<40 in 1991, 1998)
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8		1-5, 8-9, 11-14, 16-24	n=6 1984-01, scores 30-48 Not impaired	Yes, RM 8.0+
3stonelick	Lick Fork (headwater size)	OH53 9		6-7	No (ICI>=30) n=2, 2001, scores 42,44	No (IBI>40) n=1 1997 score=46
3stonelick	Brushy Fork (headwater size)			10	Yes n=4, 2002, scores <=10	Yes (IBI<40 in 20011, 2003)
3stonelick	Newtonsville Creek (headwater size)			15	ND	ND
OEPA HUC11 Assessment Unit 05090202120						
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	RM 9.0 - RM 20.4	1-8, 10, 12-15, 17-23, 25, 30, 32-35	Yes	Multiple IBI <44; see RM plot
4below	UT, Ross Road (headwater size)			9	2002 only; questionable scores (0, 0, 0)	ND
4below	UT, SR222 @ Filager			11	ND	ND
4below	UT, SR222 @ jail			16	ND	ND
4below	UT, Tillbury Property (D Russell) (headwater size)			24	2002 only; questionable scores (0, 0, 6, 6)	ND
4below	Lucy Run (headwater size)	OH53 18		26-29	Yes (ICI<26) n=1 1996 score=24	Yes above RM 1.5, No < RM 0.5

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Description	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)
					60 pt	60 pt
4below	Fourmile Run (headwater size)	OH53 19		31	1997 OEPA Qual samps only	ND
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)			6, 21	ND	ND
5lakearea	Back Run (all data pre-1993)			2	ND	ND
5lakearea	Ulrey Run (headwater size)	OH53 22		3	1997 OEPA Qual samps only	ND
5lakearea	UT, East Fork State Park (D Russell) (headwater size)			4	2002 only; questionable scores (0, 0, 0, 4)	ND
5lakearea	Slabcamp Run (headwater size)	OH53 23		5	1998 OEPA Qual samps only	Yes (IBI<40) n=2 1998 score=12,34
5lakearea	Barnes Run (headwater size)	OH53 26		7	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=24
5lakearea	Poplar Creek (headwater size)	OH53 27		8-9, 13	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=38
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29		10-12	ND	ND
5lakearea	Cloverlick Creek (wadeable size)	OH53 25		14-16	1997 OEPA Qual samps only	ND
5lakearea	Cabin Run (headwater size)	OH53 24		17-20	1997 OEPA Qual samps only	No (IBI>40) n=2 1998 score=46,48
OEPA HUC11 Assessment Unit 05090202110						

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Description	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)
					60 pt	60 pt
6above	Kain Run (headwater size)	OH53 35		1, 3	mixed: in 2000 <20; in 2001 >=36	Yes (IBI<40) n=3 1997-2001
6above	UT Kain, Otis Prop. (D Russell) (headwater size)			2	2002 only; questionable scores (12, 0, 0, 0)	ND
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	Todd R to us Harsha Lake	4-6 (RM 30.4-33.9)	Yes	Multiple IBI <44; see RM plot
6above	Todd Run (headwater size)	OH53 37		7	1997 OEPA Qual samps only	Yes (IBI<40) n=2 1998 score=30,32
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	Howard R to Todd R	8-16, 24-25, (rm 34.5-44)	Yes	Multiple IBI <44; see RM plot
6above	Pleasant Run (headwater size)	OH53 41		17-22	Yes (ICI<26) n=1 1996 score=4	Yes > RM 1.5; mixed IBI < RM 1.5
6above	Fivemile Creek (headwater size)	OH53 42		23	1998 OEPA Qual samps only	1982 data only; n=3 scores 28,40,40
6above	Grassy Run (headwater size)			26	ND	ND
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	Solomon to Howard	27-30, 32-34 (rm 48.6-56.2)	mixed: 1982 impaired; 1998+ not	Multiple IBI<46; see RM plot
6above	Glady Run (headwater size)	OH53 48		31	ND	ND

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Description	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)
					60 pt	60 pt
6above	Solomon Run (headwater size)	OH53 53		35-37	1982 OEPA Qual samps only	1982 data only; IBI<40, n=6; scores 22-42
OEPA HUC11 Assessment Unit 05090202100						
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	Dodson to Solomon	1-2, 4-6 (rm 60-70.1)	No (ICI>=42) n=2 1998-00 scores=46,48	1982 multiple IBI<46; 1998 >46; see RM plot
7headwater	West Fork of East Fork (wadeable size)	OH53 56		3	1998 OEPA Qual samps only	mixed; IBI<40 and IBI>40 in 1982 & 1998
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57		7-8	No (ICI>=42) n=1 1998 score=42	Yes (IBI<46)
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	hw to Dodson (RM 70.9-85)	9-10, 13-15	No (ICI>=42) n=3 1982, 1998 scores=42, 44, 46	1982 multiple IBI<46; 1998 >46; see RM plot
7headwater	Turtle Creek (headwater size)	OH53 61		11-12	1998 OEPA Qual samps only	Yes (IBI<40)

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Nutrients/ DO**				*Nutrient Summary*
		Phosphorus	Nitrogen	Oxygen	Chlorophyll	
		TP	NO3NO2	DO	Chl-A	
		mg/l	mg/l	mg/l	ug/l	
					(little data; lesser SI weight)	
OEPA HUC11 Assessment Unit 05090202130						
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XXX	XXX	X	XX	**N & P increase below geo18 wwtp** **XXX**
Hall Run (headwater size)	OH53 2	XX	X	XX	ID n=1	**XX**
Wolfpen Run (headwater size)	OH53 3	XXX	XX	O	O	**XXX**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XXX	XX	O	X	**XXX**
Salt Run (headwater size)	OH53 4	X	O	XX	ID n=1	**X**
UT Salt Run, Nature Center (D Russell) (headwater size)		X	X	O	ND	**X**
UT Salt Run, Circuit City		X	O	ND	ND	**X**
Sugarcamp Run (headwater size)	OH53 5	O	E	ND	ND	**O**
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	ND	**ND**
Shayler Run (headwater size)	OH53 6	XXX	XX	XXX	ND	**XXX**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	ND	**ND**
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	XXX	X	X	ID n=3	**XXX**
Lick Fork (headwater size)	OH53 9	XX	O	X	ID n=1	**XX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Nutrients/ DO**				*Nutrient Summary*
		Phosphorus	Nitrogen	Oxygen	Chlorophyll	
		TP	NO3NO2	DO	Chl-A	
		mg/l	mg/l	mg/l	ug/l	
					(little data; lesser SI weight)	
Brushy Fork (headwater size)		XX	O	ND	ND	**XX**
Newtonsville Creek (headwater size)		XXX	XX	X	ND	**XXX**
OEPA HUC11 Assessment Unit 05090202120						
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	XXX	XX	X	O	**XXX**
UT, Ross Road (headwater size)		XX	X	ND	ND	**XX**
UT, SR222 @ Filager		XX	O	O	ND	**XX**
UT, SR222 @ jail		XX	O	O	ND	**XX**
UT, Tillbury Property (D Russell) (headwater size)		XXX	X	ND	ND	**XXX**
Lucy Run (headwater size)	OH53 18	X	O	O	ND	**X**
Fourmile Run (headwater size)	OH53 19	X	X	O	ID n=2	**X**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		X pre-1993 data only	X pre-1993 data only	ND	ND	**X** **pre-1993 data only**
Back Run (all data pre-1993)		X pre-1993 data only	X pre-1993 data only	ND	ND	**X** **pre-1993 data only**
Ulrey Run (headwater size)	OH53 22	XX	XX	O	ID n=1	**XX**
UT, East Fork State Park (D Russell) (headwater size)		XX	X	O	ND	**XX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Nutrients/ DO**				*Nutrient Summary*
		Phosphorus	Nitrogen	Oxygen	Chlorophyll	
		TP	NO3NO2	DO	Chl-A	
		mg/l	mg/l	mg/l	ug/l	
					(little data; lesser SI weight)	
Slabcamp Run (headwater size)	OH53 23	XX	O	ND	ND	**XX**
Barnes Run (headwater size)	OH53 26	X	ND	XX	ID n=1	**X**
Poplar Creek (headwater size)	OH53 27	XX	O	O	ID n=1	**XX**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	X 1980s data only	O 1980s data only	ND	ND	**X** **1980s data only**
Cloverlick Creek (wadeable size)	OH53 25	X	X	O	ND	**X**
Cabin Run (headwater size)	OH53 24	X	O	O	ID n=2	**X**
OEPA HUC11 Assessment Unit 05090202110						
Kain Run (headwater size)	OH53 35	XXX	X	XX	ID n=1	**XXX**
UT Kain, Otis Prop. (D Russell) (headwater size)		XX	O	O	ND	**XX**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	XXX	ND	O	ND	**XXX**
Todd Run (headwater size)	OH53 37	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	XXX	XX	X	X	**XXX**
Pleasant Run (headwater size)	OH53 41	XXX	X	O	ID n=1	**XXX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Nutrients/ DO**				*Nutrient Summary*
		Phosphorus	Nitrogen	Oxygen	Chlorophyll	
		TP	NO3NO2	DO	Chl-A	
		mg/l	mg/l	mg/l	ug/l	
					(little data; lesser SI weight)	
Fivemile Creek (headwater size)	OH53 42	XXX	O	ND	ND	**XXX**
Grassy Run (headwater size)		XXX	XX	O	ND	**XXX**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	XXX	X	O	ND	**XXX**
Glady Run (headwater size)	OH53 48	XXX	XX	O	ND	**XXX**
Solomon Run (headwater size)	OH53 53	X all data 1982	X all data 1982	ND	ND	**ID**
OEPA HUC11 Assessment Unit 05090202100						
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	XXX	XX	O	ND	**XXX**
West Fork of East Fork (wadeable size)	OH53 56	XXX	X	O	ND	**XXX**
Dodson Creek (EWH, wadeable size)	OH53 57	XXX	O	O	ND	**XXX**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	XXX	XX	O	ND	**XXX**
Turtle Creek (headwater size)	OH53 61	XX	O	O	ND	**XX**

Key to notations:
XXX=likely

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Ammonia Toxicity**			*Ammonia Toxicity Summary*
		ammonia mg/l	unionized amm mg/l	pH-ammonia scatterplot *incr toxicity at ph>8*	
OEPA HUC11 Assessment Unit 05090202130					
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XX	ID (narrow date range)	pH<8 at high ammonia obs	**increasing trend since 1996** **XX**
Hall Run (headwater size)	OH53 2	XX	ID (narrow date range)	pH<8 at high ammonia obs	**XX**
Wolfpen Run (headwater size)	OH53 3	XX @ MHP dschg X in stream	ND	pH<8 at high ammonia obs	**XX @ MHP dschg**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O	pH<8 at high ammonia obs	**O**
Salt Run (headwater size)	OH53 4	O	ND	na	**O**
UT Salt Run, Nature Center (D Russell) (headwater size)		O	ND	na	**O**
UT Salt Run, Circuit City		O	ND	na	**O**
Sugarcamp Run (headwater size)	OH53 5	O	O	na	**O**
East Branch Sugarcamp Run (headwater size)		ND	ND	na	**ND**
Shayler Run (headwater size)	OH53 6	O	O	na	**O**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	na	**ND**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Ammonia Toxicity**			*Ammonia Toxicity Summary*
		ammonia mg/l	unionized amm mg/l	pH-ammonia scatterplot *incr toxicity at ph>8*	
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	X	ID (narrow date range)	pH<8 at high ammonia obs	**X**
Lick Fork (headwater size)	OH53 9	O	ND	na	**O**
Brushy Fork (headwater size)		O	ND	na	**O**
Newtonsville Creek (headwater size)		XX	ND	pH<8 at high ammonia obs	**XX**
OEPA HUC11 Assessment Unit 05090202120					
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	X	ID (narrow date range)	pH<8 at high ammonia obs	**X**
UT, Ross Road (headwater size)		ND	ND	na	**ND**
UT, SR222 @ Filager		O	ND	na	**O**
UT, SR222 @ jail		O	ND	na	**O**
UT, Tillbury Property (D Russell) (headwater size)		O	ND	na	**O**
Lucy Run (headwater size)	OH53 18	O	ID (narrow date range)	na	**O**
Fourmile Run (headwater size)	OH53 19	O	ND	pH<8 at high ammonia obs	**O**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		XX pre-1993 data only	ND	pH<8 at high ammonia obs	**XX/ID pre-1993 data only**
Back Run (all data pre-1993)		XX pre-1993 data only	ND	pH<8.5 at high ammonia obs	**XX/ID pre-1993 data only**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Ammonia Toxicity**			*Ammonia Toxicity Summary*
		ammonia mg/l	unionized amm mg/l	pH-ammonia scatterplot *incr toxicity at ph>8*	
Ulrey Run (headwater size)	OH53 22	O	ND	na	**O**
UT, East Fork State Park (D Russell) (headwater size)		X few obs	ND	pH<8 at high ammonia obs	**X/ID**
Slabcamp Run (headwater size)	OH53 23	X few obs	ND	no pH data	**X/ID**
Barnes Run (headwater size)	OH53 26	O	ND	na	**O**
Poplar Creek (headwater size)	OH53 27	XX upstream only, 1980s data only	ND	pH<8 at high ammonia obs	**XX/ID 1980s upstream data only**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	X 1980s data only	ND	little pH data	**X/ID 1980s data only**
Cloverlick Creek (wadeable size)	OH53 25	XX pre-1993 data only	ND	pH<8.5 at high ammonia obs	**XX/ID pre-1993 data only**
Cabin Run (headwater size)	OH53 24	O	ND	na	**O**
OEPA HUC11 Assessment Unit 05090202110					
Kain Run (headwater size)	OH53 35	X	ND	pH<8 at high ammonia obs	**X**
UT Kain, Otis Prop. (D Russell) (headwater size)		O	ND	na	**O**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	X 1985 data only	ND	pH<8 at high ammonia obs	**X/ID 1985 data only**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Ammonia Toxicity			*Ammonia Toxicity Summary*
		ammonia mg/l	unionized amm mg/l	pH-ammonia scatterplot *incr toxicity at ph>8*	
Todd Run (headwater size)	OH53 37	ND	ND	na	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	X	O	pH<8 at high ammonia obs	**X**
Pleasant Run (headwater size)	OH53 41	X	O	pH<8 at high ammonia obs	**X**
Fivemile Creek (headwater size)	OH53 42	O	O	na	**O**
Grassy Run (headwater size)		O	ND	na	**O**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	O	O	pH<8 at high ammonia obs	**O**
Glady Run (headwater size)	OH53 48	O	ND	na	**O**
Solomon Run (headwater size)	OH53 53	ID (1982 data only)	ID (1982 data only)	ID (1982 data only)	**ID**
OEPA HUC11 Assessment Unit 05090202100					
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	O	ID (narrow date range)	na	**O**
West Fork of East Fork (wadeable size)	OH53 56	O	ID (narrow date range)	na	**O**
Dodson Creek (EWH, wadeable size)	OH53 57	O	ID (narrow date range)	na	**O**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	O	ID (narrow date range)	na	**O**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Ammonia Toxicity**			*Ammonia Toxicity Summary*
		ammonia	unionized amm	pH-ammonia	
		mg/l	mg/l	scatterplot	
				incr toxicity at ph>8	
Turtle Creek (headwater size)	OH53 61	O	ID (narrow date range)	na	**O**

Key to notations:
XXX=likely

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Organic Enrichment/ DO**						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*
		BOD mg/l	CBOD5 mg/l	COD low mg/l	Chl-A ug/l	DO mg/l	Fecal #/100ml	
		N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.						
OEPA HUC11 Assessment Unit 05090202130								
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	X	XX	X	XX	X	XX	**nutrients high, bod low, chlA high, occasional DO stress.**
Hall Run (headwater size)	OH53 2	ID	XXX	O	ID n=1	XX	XX	**XXX**
Wolfpen Run (headwater size)	OH53 3	ND	X	ND	O	O	XX	**X**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	X most data 1982 only	X	O	X	O	X	**X**
Salt Run (headwater size)	OH53 4	ND	X	ND	ID n=1	XX	XX	**X-XX**
UT Salt Run, Nature Center (D Russell) (headwater size)		ND	X	ND	ND	O	ND	**X**
UT Salt Run, Circuit City		ND	X	ND	ND	ND	ND	**X**
Sugarcamp Run (headwater size)	OH53 5	O	ND	O	ND	ND	O	**O/ID**
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	ND	ND	ND	**ND**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Organic Enrichment/ DO**						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*
		BOD mg/l	CBOD5 mg/l	COD low mg/l	Chl-A ug/l	DO mg/l	Fecal #/100ml	
		N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.						
Shayler Run (headwater size)	OH53 6	O	XX	O	ND	XXX	XX	**XX-XXX**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	ND	ND	ND	**ND**
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O most data 1982 only	XX	X	ID n=3	X	XX	**XX**
Lick Fork (headwater size)	OH53 9	ND	O	ND	ID n=1	X	XX	**O-X**
Brushy Fork (headwater size)		ND	O	ND	ND	ND	ND	**O/ID**
Newtonsville Creek (headwater size)		ND	XXX	ND	ND	X	XX	**XXX**
OEPA HUC11 Assessment Unit 05090202120								
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O most data 1982 only	XX	O	O	X	XX	**XX**
UT, Ross Road (headwater size)		ND	O	ND	ND	ND	ND	**O/ID**
UT, SR222 @ Filager		ND	O	ND	ND	O	ND	**O**
UT, SR222 @ jail		ND	O	ND	ND	O	ND	**O**
UT, Tillbury Property (D Russell) (headwater size)		ND	XX	ND	ND	ND	ND	**XX**
Lucy Run (headwater size)	OH53 18	O	XX	O	ND	O	XX	**XX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Organic Enrichment/ DO**						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*
		BOD mg/l	CBOD5 mg/l	COD low mg/l	Chl-A ug/l	DO mg/l	Fecal #/100ml	
		N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.						
Fourmile Run (headwater size)	OH53 19	ND	X	ND	ID n=2	O	O	**X**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		XX pre-1993 data only	O pre-1993 data only	ND	ND	ND	XX pre-1993 data only	**X pre-1993 data only**
Back Run (all data pre-1993)		XX pre-1993 data only	O pre-1993 data only	ND	ND	ND	XX pre-1993 data only	**XX pre-1993 data only**
Ulrey Run (headwater size)	OH53 22	ND	XX	ND	ID n=1	O	XX	**XX**
UT, East Fork State Park (D Russell) (headwater size)		ND	X	ND	ND	O	ND	**X**
Slabcamp Run (headwater size)	OH53 23	ID n=2	ND	ID n=2	ND	ND	XX	**ID**
Barnes Run (headwater size)	OH53 26	ND	XXX	ND	ID n=1	XX	XX	**XXX**
Poplar Creek (headwater size)	OH53 27	XX upstream only, 1980s data only	XX	ND	ID n=1	O	XX	**XX**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	XX wwtp only, 1980s data only	ND	ND	ND	ND	ND	**XX wwtp only; 1980s data only**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Organic Enrichment/ DO**						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*
		BOD mg/l	CBOD5 mg/l	COD low mg/l	Chl-A ug/l	DO mg/l	Fecal #/100ml	
		N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.						
Cloverlick Creek (wadeable size)	OH53 25	O	O	ND	ND	O	XX	**O**
Cabin Run (headwater size)	OH53 24	ND	O	ND	ID n=2	O	XX	**O**
OEPA HUC11 Assessment Unit 05090202110								
Kain Run (headwater size)	OH53 35	ND	XXX	ND	ID n=1	XX	XX	**XXX**
UT Kain, Otis Prop. (D Russell) (headwater size)		ND	XX	ND	ND	O	ND	**X**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	O	X	O	ND	O	X	**O**
Todd Run (headwater size)	OH53 37	ND	ND	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	O	XX	X	X	X	XX	**XX**
Pleasant Run (headwater size)	OH53 41	X	XX	X	ID n=1	O	XX	**XX**
Fivemile Creek (headwater size)	OH53 42	X	ND	O	ND	ND	XX	**X**
Grassy Run (headwater size)		ND	X	ND	ND	O	ND	**X**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Organic Enrichment/ DO**						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*
		BOD mg/l	CBOD5 mg/l	COD low mg/l	Chl-A ug/l	DO mg/l	Fecal #/100ml	
		N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.						
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	O	O	O	ND	O	X	**O**
Glady Run (headwater size)	OH53 48	ND	O	ND	ND	O	ND	**O**
Solomon Run (headwater size)	OH53 53	ID (1982 data only)	ND	ID (1982 data only)	ND	ND	ND	**ID**
OEPA HUC11 Assessment Unit 05090202100								
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	O	XX	O	ND	O	O	**X**
West Fork of East Fork (wadeable size)	OH53 56	O	X	O	ND	O	O	**O**
Dodson Creek (EWH, wadeable size)	OH53 57	O	XX	O	ND	O	O	**X**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	O	XX	O	ND	O	X	**X**
Turtle Creek (headwater size)	OH53 61	O	O	O	ND	O	O	**O**

Key to notations:

Stream		**Organic Enrichment/ DO**						
		BOD	CBOD5	COD low	Chl-A	DO	Fecal	
		mg/l	mg/l	mg/l	ug/l	mg/l	#/100ml	
EWH: East Fork and Dodson Creek **WWH: all other tributaries**	**OH WBID segment**	*N obs CBOD5 greater than BOD and CODlow throughout. BOD and CODlow data in narrow date ranges only.*						*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*

XXX=likely

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Siltation/Sedimentation						Siltation/ Sedimentation Summary
		SS/Turbidity		Habitat				
		TSS	Turbidity	QHEI	Substrate	Siltcover	Embedded	
		mg/l	ntu	100pt	20pt	4pt	4pt	
OEPA HUC11 Assessment Unit 05090202130								
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XX	X (decreasing trend)	O above geo 17 (rm 4); X-XX below	X	O	O	**O-X**
Hall Run (headwater size)	OH53 2	XX	X	XX-XXX	O	XX	X	**X-XX**
Wolfpen Run (headwater size)	OH53 3	XX	X	XXX n=1 1997	O n=1 1997	XXX n=1 1997	XXX n=1 1997	**XX**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XX	XX	O	O	X	X	**X**
Salt Run (headwater size)	OH53 4	XX	X	XX n=1 1997	XX n=1 1997	X n=1 1997	O n=1 1997	**XX**
UT Salt Run, Nature Center (D Russell) (headwater size)		XX	X	ND	ND	ND	ND	**X**
UT Salt Run, Circuit City		X	O	ND	ND	ND	ND	**X**
Sugarcamp Run (headwater size)	OH53 5	O	ND	X-XX	O	X	XXX	**X**
East Branch Sugarcamp Run (headwater size)		ND	ND	XX n=1 1994	O	X	XX	**X**
Shayler Run (headwater size)	OH53 6	XX	XX	XX-XXX	X	XX	O	**XX**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	X	X	XX	X	**XX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Siltation/Sedimentation**						*Siltation/ Sedimentation Summary*
		SS/Turbidity		Habitat				
		TSS	Turbidity	QHEI	Substrate	Siltcover	Embedded	
		mg/l	ntu	100pt	20pt	4pt	4pt	
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	XX	XX	O below Lick Fork; declining to XX upstream	X	XX	XX	**XX**
Lick Fork (headwater size)	OH53 9	X	O	X-XX	O	XXX	XXX	**XXX**
Brushy Fork (headwater size)		O	O	XXX	X	ND	ND	**O/ID**
Newtonsville Creek (headwater size)		XX	XX	ND	ND	ND	ND	**X**
OEPA HUC11 Assessment Unit 05090202120								
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	XX	XX	O	O	XX	XX	**XX**
UT, Ross Road (headwater size)		X	X	ND	ND	ND	ND	**X**
UT, SR222 @ Filager		O	O	ND	ND	ND	ND	**O/ID**
UT, SR222 @ jail		O	O	ND	ND	ND	ND	**O/ID**
UT, Tillbury Property (D Russell) (headwater size)		XX	XX	ND	ND	ND	ND	**X**
Lucy Run (headwater size)	OH53 18	XX	XX	XX ds to XXX us	O	O	X	**X**
Fourmile Run (headwater size)	OH53 19	XX	X	O-X n=1 1997	O n=1 1997	O n=1 1997	O n=1 1997	**X**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		XX pre-1993 data only	ND	ND	ND	ND	ND	**X pre-1993 data only**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Siltation/Sedimentation**						*Siltation/ Sedimentation Summary*
		SS/Turbidity		Habitat				
		TSS	Turbidity	QHEI	Substrate	Siltcover	Embedded	
		mg/l	ntu	100pt	20pt	4pt	4pt	
Back Run (all data pre-1993)		XX pre-1993 data only	ND	ND	ND	ND	ND	**X pre-1993 data only**
Ulrey Run (headwater size)	OH53 22	XX	X	XX n=1 1997	O n=1	XXX n=1	XXX n=1	**XXX**
UT, East Fork State Park (D Russell) (headwater size)		X	X	ND	ND	ND	ND	**X**
Slabcamp Run (headwater size)	OH53 23	X	ND	XXX n=1 1998	X n=1	XXX n=1	XX n=1	**XXX**
Barnes Run (headwater size)	OH53 26	XX	ND	X n=1 1997	O n=1	XXX n=1	XXX n=1	**XXX**
Poplar Creek (headwater size)	OH53 27	XX	O	XX n=1 1997	O n=1	XXX n=1	XXX n=1	**XXX**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	X 1980s data only	ND	ND	ND	ND	ND	**X 1980s data only**
Cloverlick Creek (wadeable size)	OH53 25	XX	O	ND	ND	ND	ND	**X**
Cabin Run (headwater size)	OH53 24	XX	XX Hosea wwtp	O n=1 1998	O n=1	XXX n=1	XXX n=1	**XXX**
OEPA HUC11 Assessment Unit 05090202110								
Kain Run (headwater size)	OH53 35	XX	XX	X-XX	O	XX	XX	**X**
UT Kain, Otis Prop. (D Russell) (headwater size)		XX	XX	ND	ND	ND	ND	**X**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Siltation/Sedimentation						Siltation/ Sedimentation Summary
		SS/Turbidity		Habitat				
		TSS	Turbidity	QHEI	Substrate	Siltcover	Embedded	
		mg/l	ntu	100pt	20pt	4pt	4pt	
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	XX	ND	O n=1, 1998	O	O	XX	**O**
Todd Run (headwater size)	OH53 37	ND	ND	XX n=1, 1998	O n=1, 1998	O n=1, 1998	XX n=1, 1998	**X**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	XX	XX	O	O	X	XX	**X**
Pleasant Run (headwater size)	OH53 41	XX	XX	X-XX	X upstream; O downstream	X	X	**X**
Fivemile Creek (headwater size)	OH53 42	O	ND	XX	O	X	XX	**X**
Grassy Run (headwater size)		X	O	ND	ND	ND	ND	**X**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	XX	XX	O	O	XX	XX	**XX**
Glady Run (headwater size)	OH53 48	O	ND	ND	ND	ND	ND	**ID**
Solomon Run (headwater size)	OH53 53	ID (1982 data only)	ND	ND	ND	ND	ND	**ID**
OEPA HUC11 Assessment Unit 05090202100								
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	XX	ND	O	O	X	O	**X**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Siltation/Sedimentation**						*Siltation/ Sedimentation Summary*
		SS/Turbidity		Habitat				
		TSS	Turbidity	QHEI	Substrate	Siltcover	Embedded	
		mg/l	ntu	100pt	20pt	4pt	4pt	
West Fork of East Fork (wadeable size)	OH53 56	XX	ND	O	O	XX	XX	**XX**
Dodson Creek (EWH, wadeable size)	OH53 57	XX	ND	XXX	O-X	X	X	**X**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	XX	ND	O overall to X upstream	X	O	O	**X**
Turtle Creek (headwater size)	OH53 61	O	ND	XX	X	O	O	**X**

Key to notations:
XXX=likely

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Habitat Alterations									Habitat Summary
		QHEI	Substrate	Siltcover	Cover	Channel	Riparian	Pool	Riffle	Gradient	
		100pt	20pt	4pt	20pt	20pt	10pt	12pt	8pt	10pt	
OEPA HUC11 Assessment Unit 05090202130											
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O above geo 17 (rm 4); X-XX below	X	O	X	O	XX	O	XX	O	**X-XX**
Hall Run (headwater size)	OH53 2	XX-XXX	O	XX	XX	X	X	XX	XX	X	**XX-XXX**
Wolfpen Run (headwater size)	OH53 3	XXX n=1 1997	O n=1 1997	XXX n=1 1997	XX n=1 1997	O n=1 1997	XX n=1 1997	XX n=1 1997	XX n=1 1997	X n=1 1997	**XXX**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O	X	O	O	XX	O	O	O	**O**
Salt Run (headwater size)	OH53 4	XX n=1 1997	XX n=1 1997	X n=1 1997	O n=1 1997	X n=1 1997	XX n=1 1997	X n=1 1997	XX n=1 1997	O n=1 1997	**XX**
UT Salt Run, Nature Center (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT Salt Run, Circuit City		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Sugarcamp Run (headwater size)	OH53 5	X-XX	O	X	X	O	X	X	X	XX	**X-XX**
East Branch Sugarcamp Run (headwater size)		XX n=1 1994	O	X	XX	O	O	XX	X	XX	**XX**
Shayler Run (headwater size)	OH53 6	XX-XXX	X	XX	XX	X	X	X	XX	X	**XX-XXX**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	**Other Habitat Alterations**									*Habitat Summary*
		QHEI	Substrate	Siltcover	Cover	Channel	Riparian	Pool	Riffle	Gradient	
		100pt	20pt	4pt	20pt	20pt	10pt	12pt	8pt	10pt	
Shayler Run tributary (headwater size)	OH53 6.1	X	X	XX	X	O	X	X	X	O	**X**
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O below Lick Fork; declining to XX upstream	X	XX	X	O	X	X downstream; declining upstream	X downstream; declining upstream	O	**X downstream; declining TO XX upstream**
Lick Fork (headwater size)	OH53 9	X-XX	O	XXX	X	O	O	X	X	O	**X-XX**
Brushy Fork (headwater size)		XXX	X	ND	XX	X	X	X	XXX	XX	**XXX**
Newtonsville Creek (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
OEPA HUC11 Assessment Unit 05090202120											
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O	O	XX	O	O	X	O	O	O	**O**
UT, Ross Road (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT, SR222 @ Filager		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT, SR222 @ jail		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT, Tillbury Property (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Lucy Run (headwater size)	OH53 18	XX ds to XXX us	O	O	X	X	XX	X	XX	X	**XXX**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Habitat Alterations									Habitat Summary
		QHEI	Substrate	Siltcover	Cover	Channel	Riparian	Pool	Riffle	Gradient	
		100pt	20pt	4pt	20pt	20pt	10pt	12pt	8pt	10pt	
Fourmile Run (headwater size)	OH53 19	O-X n=1 1997	O n=1 1997	O n=1 1997	O n=1 1997	O n=1 1997	XX n=1 1997	X n=1 1997	XXX n=1 1997	O n=1 1997	**X**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Back Run (all data pre-1993)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Ulrey Run (headwater size)	OH53 22	XX n=1 1997	O n=1	XXX n=1	X n=1	O n=1	XX n=1	XX n=1	X n=1	XX n=1	**XX**
UT, East Fork State Park (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Slabcamp Run (headwater size)	OH53 23	XXX n=1 1998	X n=1	XXX n=1	XX n=1	O n=1	O n=1	XXX n=1	XXX n=1	O	**XXX**
Barnes Run (headwater size)	OH53 26	X n=1 1997	O n=1	XXX n=1	O n=1	O n=1	XX n=1	XX n=1	XXX n=1	O	**X**
Poplar Creek (headwater size)	OH53 27	XX n=1 1997	O n=1	XXX n=1	X n=1	O n=1	X n=1	XX n=1	XXX n=1	O	**XX**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Cloverlick Creek (wadeable size)	OH53 25	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Habitat Alterations									Habitat Summary
		QHEI	Substrate	Siltcover	Cover	Channel	Riparian	Pool	Riffle	Gradient	
		100pt	20pt	4pt	20pt	20pt	10pt	12pt	8pt	10pt	
Cabin Run (headwater size)	OH53 24	O n=1 1998	O n=1	XXX n=1	X n=1	O n=1	O n=1	XX n=1	XXX n=1	XX n=1	**O**
OEPA HUC11 Assessment Unit 05090202110											
Kain Run (headwater size)	OH53 35	X-XX	O	XX	X	O	O	O	XX	XX	**X-XX**
UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	O n=1, 1998	O	O	O	O	O	O	O	O	**O**
Todd Run (headwater size)	OH53 37	XX n=1, 1998	O n=1, 1998	O n=1, 1998	XX n=1, 1998	O n=1, 1998	O n=1, 1998	XX n=1, 1998	XXX n=1, 1998	XX n=1, 1998	**XX**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	O	O	X	O-X	O	X	O	X	O	**O**
Pleasant Run (headwater size)	OH53 41	X-XX	X upstream; O downstream	X	X	X	XX	XX	XXX	O	**X-XX**
Fivemile Creek (headwater size)	OH53 42	XX	O	X	X	O	XX	XX	XX	X	**XX**
Grassy Run (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Habitat Alterations									Habitat Summary
		QHEI	Substrate	Siltcover	Cover	Channel	Riparian	Pool	Riffle	Gradient	
		100pt	20pt	4pt	20pt	20pt	10pt	12pt	8pt	10pt	
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	O	O	XX	O	O	X	O	O	O	**O**
Glady Run (headwater size)	OH53 48	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Solomon Run (headwater size)	OH53 53	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
OEPA HUC11 Assessment Unit 05090202100											
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	O	O	X	O	O	X	O	O	O	**O**
West Fork of East Fork (wadeable size)	OH53 56	O	O	XX	X	O	X	X	X	O	**O**
Dodson Creek (EWH, wadeable size)	OH53 57	XXX	O-X	X	X	X	X	X	XX	X	**XXX**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	O overall to X upstream	X	O	O	O	XX	O	X	X	**X**
Turtle Creek (headwater size)	OH53 61	XX	X	O	X	X	XX	XX	XX	O	**XX**

Key to notations:
XXX=likely

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Priority Metals: copper lead, zinc**			**Other Metals**								*Metals Summary*
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
OEPA HUC11 Assessment Unit 05090202130													
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XX at geo 2	X	O	E	O	O	O	X	O	ID n=1 1982	X at geo 2, O elsewhere	**Metals observations associated w TSS. Summary: unlikely to be bioavailable X**
Hall Run (headwater size)	OH53 2	X	X	O	E	O	O	O	O	O	ND	O	**O**
Wolfpen Run (headwater size)	OH53 3	ID n=1	ID n=1	ND	ND	ND	ID n=1	ND	ND	O	ND	ND	**ID**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O	O	E	O	O	O	X	O	ND	n=7, all appear mdl	**O**
Salt Run (headwater size)	OH53 4	O N=1	O	ND	ND	ND	O	O	ND	O	ND	ND	**O**
UT Salt Run, Nature Center (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT Salt Run, Circuit City		O	O	O	ND	ND	ND	ND	ND	ND	ND	ND	**ID**
Sugarcamp Run (headwater size)	OH53 5	O	O	O	E	O	O	O	O	O	ND	ND	**O**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Priority Metals: copper lead, zinc			Other Metals								Metals Summary
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Shayler Run (headwater size)	OH53 6	XXX	X	O	E	O	O	O	X	O	ND	ND	**XX**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	XX	X	O	E	O	O	O	X	O	ND	O	**Possible Cu; other metals unlikely**
Lick Fork (headwater size)	OH53 9	X	X	ND	ND	ND	O	O	ND	O	ND	O	**O**
Brushy Fork (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Newtonsville Creek (headwater size)		XX	X	O	ND	ND	O	O	O	O	ND	O	**Possible Cu; other metals unlikely**
OEPA HUC11 Assessment Unit 05090202120													
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	X	O	O	E	O	O	O	X	O	ND	O	**O**
UT, Ross Road (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
UT, SR222 @ Filager		O n=1	O	ND	ND	ND	ND	ND	ND	ND	ND	ND	**O/ND**

Stream **EWH: East Fork and Dodson Creek** **WWH: all other tributaries**	**OH WBID segment**	**Priority Metals: copper lead, zinc**			**Other Metals**								*Metals Summary*
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
UT, SR222 @ jail		O n=1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**O/ND**
UT, Tillbury Property (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Lucy Run (headwater size)	OH53 18	X	O	O	E	O	O	O	X	O	ND	ND	**O**
Fourmile Run (headwater size)	OH53 19	X	O	ND	ND	ND	O	O	ND	O	ND	O	**O/ND**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		X pre-1993 data only	O pre-1993 data only	O pre-1993 data only	ND	O pre-1993 data only	XX 1980s ACOE data only	O pre-1993 data only	XX but 1980's data only	O pre-1993 data only	O pre-1993 data only	ND	**O/ID**
Back Run (all data pre-1993)		X pre-1993 data only	X pre-1993 data only	X (1984 obs)	ND	O pre-1993 data only	XX 1980s data only	O pre-1993 data only	XX but 1980's data only	O pre-1993 data only	O pre-1993 data only	ND	**O/ID**
Ulrey Run (headwater size)	OH53 22	O	O	ND	ND	ND	O	O	ND	O	ND	ID	**O/ND**
UT, East Fork State Park (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Slabcamp Run (headwater size)	OH53 23	O n=1	O	O	E	O	O	O	XX 1998 data only	O	ND	ND	**O/ID**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Priority Metals: copper lead, zinc			Other Metals								Metals Summary
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
Barnes Run (headwater size)	OH53 26	O	O	ND	ND	ND	O	O	ND	O	ND	ID	**O/ND**
Poplar Creek (headwater size)	OH53 27	O	O	O	ND	O	O	O	XX but 1980's data only	O	ND	ND	**O/ID**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Cloverlick Creek (wadeable size)	OH53 25	O	O	O	ND	O	O	O	XX but 1980's data only	O	O	ND	**O/ID**
Cabin Run (headwater size)	OH53 24	O	O	O except XXX dschg	ND	ND	O	O	X	O	ND	ID	**O/ID, except Hosea discharge**
OEPA HUC11 Assessment Unit 05090202110													
Kain Run (headwater size)	OH53 35	XXX	X	O	ND	ND	O	O	O	O	ND	O	**Possible Cu; other metals unlikely**
UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	O	O	O	ND	ND	O	O	ND	O	ND	X but little data	**O/ID**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Priority Metals: copper lead, zinc			Other Metals								Metals Summary
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
Todd Run (headwater size)	OH53 37	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	XX	X	O	E	O	O	O	X	O	ID	X but little data	**Possible Cu; other metals unlikely**
Pleasant Run (headwater size)	OH53 41	X	O	O	E	O	O	O	X	O	ND	ID n=1	**O**
Fivemile Creek (headwater size)	OH53 42	O	O	O	E	O	O	O	O	O	ND	ND	**O**
Grassy Run (headwater size)		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	O	O	O	E	O	O	O	X	O	ND	ND	**O**
Glady Run (headwater size)	OH53 48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**
Solomon Run (headwater size)	OH53 53	ID (1982 data only)	ID (1982 data only)	ID (1982 data only)	ND	ND	ID (1982 data only)	ID (1982 data only)	ID (1982 data only)	ND	ND	ND	**ID (1982 data only)**
OEPA HUC11 Assessment Unit 05090202100													
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	O	O	O	E	O	O	O	O	O	ND	ND	**O**

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Priority Metals: copper lead, zinc			Other Metals								Metals Summary
		Cu, T	Pb, T	Zn, T	Al	As	Cd	Cr	Fe	Ni	Se	Ag	
		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	
West Fork of East Fork (wadeable size)	OH53 56	O	O	O	E	O	O	O	O	O	ND	ND	**O**
Dodson Creek (EWH, wadeable size)	OH53 57	O	O	O	E	O	O	O	X	O	n=1 1982 ID	ND	**O**
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	O	O	O	E	O	O	O	X	O	ND	ND	**O**
Turtle Creek (headwater size)	OH53 61	O	O	O	E	O	O	O	X	O	ND	ND	**O**

Key to notations:
XXX=likely

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Toxics: organics, pesticides, oils, VOCs				Toxics Summary
		Atrazine	chlorine (residual)	cyanide	phenols	
		ug/l	mg/l	mg/l	ug/l	
OEPA HUC11 Assessment Unit 05090202130						
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	ND	O N=6, ID	O N=6, ID	O N=6, ID	**ID**
Hall Run (headwater size)	OH53 2	ND	ND	ND	ND	**ND**
Wolfpen Run (headwater size)	OH53 3	ND	ND	ND	ND	**ND**
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	ND	ND	ND	ND	**ND**
Salt Run (headwater size)	OH53 4	ND	ND	ND	ND	**ND**
UT Salt Run, Nature Center (D Russell) (headwater size)		ND	ND	ND	ND	**ND**
UT Salt Run, Circuit City		ND	ND	ND	ND	**ND**
Sugarcamp Run (headwater size)	OH53 5	ND	ND	ND	ND	**ND**
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	ND	**ND**
Shayler Run (headwater size)	OH53 6	ND	ND	ND	ND	**ND**
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Toxics: organics, pesticides, oils, VOCs				Toxics Summary
		Atrazine	chlorine (residual)	cyanide	phenols	
		ug/l	mg/l	mg/l	ug/l	
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	ND	ND	ND	ND	**ND**
Lick Fork (headwater size)	OH53 9	ND	ND	ND	ND	**ND**
Brushy Fork (headwater size)		ND	ND	ND	ND	**ND**
Newtonsville Creek (headwater size)		ND	ND	ND	ND	**ND**
OEPA HUC11 Assessment Unit 05090202120						
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	one site; 1998; max=3.2	ND	ND	ND	**ID**
UT, Ross Road (headwater size)		ND	ND	ND	ND	**ND**
UT, SR222 @ Filager		ND	ND	ND	ND	**ND**
UT, SR222 @ jail		ND	ND	ND	ND	**ND**
UT, Tillbury Property (D Russell) (headwater size)		ND	ND	ND	ND	**ND**
Lucy Run (headwater size)	OH53 18	ND	ND	ND	ND	**ND**
Fourmile Run (headwater size)	OH53 19	ND	ND	ND	ND	**ND**
East Fork LMR (EWH, Small River sites) (all data pre-1993)		ND	ND	ND	ND	**ND**
Back Run (all data pre-1993)		ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Toxics: organics, pesticides, oils, VOCs				Toxics Summary
		Atrazine	chlorine (residual)	cyanide	phenols	
		ug/l	mg/l	mg/l	ug/l	
Ulrey Run (headwater size)	OH53 22	ND	ND	ND	ND	**ND**
UT, East Fork State Park (D Russell) (headwater size)		ND	ND	ND	ND	**ND**
Slabcamp Run (headwater size)	OH53 23	ND	ND	ND	ND	**ND**
Barnes Run (headwater size)	OH53 26	ND	ND	ND	ND	**ND**
Poplar Creek (headwater size)	OH53 27	ND	ND	ND	ND	**ND**
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND	ND	ND	ND	**ND**
Cloverlick Creek (wadeable size)	OH53 25	ND	ND	ND	ND	**ND**
Cabin Run (headwater size)	OH53 24	ND	ND	ND	ND	**ND**
OEPA HUC11 Assessment Unit 05090202110						
Kain Run (headwater size)	OH53 35	ND	ND	ND	ND	**ND**
UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	ND	ND	ND	ND	**ND**
Todd Run (headwater size)	OH53 37	ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Toxics: organics, pesticides, oils, VOCs				Toxics Summary
		Atrazine	chlorine (residual)	cyanide	phenols	
		ug/l	mg/l	mg/l	ug/l	
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	XX one site	ND	ND	ND	**X/ND**
Pleasant Run (headwater size)	OH53 41	ND	ND	ND	ND	**ND**
Fivemile Creek (headwater size)	OH53 42	ND	ND	ND	ND	**ND**
Grassy Run (headwater size)		ND	ND	ND	ND	**ND**
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	ND	ND	ND	ND	**ND**
Glady Run (headwater size)	OH53 48	ND	ND	ND	ND	**ND**
Solomon Run (headwater size)	OH53 53	ND	ND	ND	ND	**ND**
OEPA HUC11 Assessment Unit 05090202100						
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	ND	ND	ND	ND	**ND**
West Fork of East Fork (wadeable size)	OH53 56	ND	ND	ND	ND	**ND**
Dodson Creek (EWH, wadeable size)	OH53 57	ND	ND	ND	ND	**ND**

Stream EWH: East Fork and Dodson Creek WWH: all other	OH WBID segment	Other Toxics: organics, pesticides, oils, VOCs				*Toxics Summary*
		Atrazine	chlorine (residual)	cyanide	phenols	
		ug/l	mg/l	mg/l	ug/l	
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	ND	ND	ND	ND	**ND**
Turtle Creek (headwater size)	OH53 61	ND	ND	ND	ND	**ND**

Key to notations:
XXX=likely

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Flow Alteration			*Flow Alteration Summary*
		Channel	QHEI	Flashiness	
		20pt	100pt	t.b.d.	
OEPA HUC11 Assessment Unit 05090202130					
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O above geo 17 (rm 4); X-XX below		**Richards-Baker flashiness index inconclusive for all**
Hall Run (headwater size)	OH53 2	X	XX-XXX		
Wolfpen Run (headwater size)	OH53 3	O n=1 1997	XXX n=1 1997		
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O		
Salt Run (headwater size)	OH53 4	X n=1 1997	XX n=1 1997		
UT Salt Run, Nature Center (D Russell) (headwater size)		ND	ND		
UT Salt Run, Circuit City		ND	ND		
Sugarcamp Run (headwater size)	OH53 5	O	X-XX		
East Branch Sugarcamp Run (headwater size)		O	XX n=1 1994		
Shayler Run (headwater size)	OH53 6	X	XX-XXX		
Shayler Run tributary (headwater size)	OH53 6.1	O	X		
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O	O below Lick Fork; declining to XX upstream		
Lick Fork (headwater size)	OH53 9	O	X-XX		

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Flow Alteration			*Flow Alteration Summary*
		Channel	QHEI	Flashiness	
		20pt	100pt	t.b.d.	
Brushy Fork (headwater size)		X	XXX		
Newtonsville Creek (headwater size)		ND	ND		
OEPA HUC11 Assessment Unit 05090202120					
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O	O		
UT, Ross Road (headwater size)		ND	ND		
UT, SR222 @ Filager		ND	ND		
UT, SR222 @ jail		ND	ND		
UT, Tillbury Property (D Russell) (headwater size)		ND	ND		
Lucy Run (headwater size)	OH53 18	X	XX ds to XXX us		
Fourmile Run (headwater size)	OH53 19	O n=1 1997	O-X n=1 1997		
East Fork LMR (EWH, Small River sites) (all data pre-1993)		ND	ND		
Back Run (all data pre-1993)		ND	ND		
Ulrey Run (headwater size)	OH53 22	O n=1	XX n=1 1997		
UT, East Fork State Park (D Russell) (headwater size)		ND	ND		
Slabcamp Run (headwater size)	OH53 23	O n=1	XXX n=1 1998		

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Flow Alteration			*Flow Alteration Summary*
		Channel	QHEI	Flashiness	
		20pt	100pt	t.b.d.	
Barnes Run (headwater size)	OH53 26	O n=1	X n=1 1997		
Poplar Creek (headwater size)	OH53 27	O n=1	XX n=1 1997		
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND	ND		
Cloverlick Creek (wadeable size)	OH53 25	ND	ND		
Cabin Run (headwater size)	OH53 24	O n=1	O n=1 1998		
OEPA HUC11 Assessment Unit 05090202110					
Kain Run (headwater size)	OH53 35	O	X-XX		
UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND		
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	O	O n=1, 1998		
Todd Run (headwater size)	OH53 37	O n=1, 1998	XX n=1, 1998		
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	O	O		
Pleasant Run (headwater size)	OH53 41	X	X-XX		
Fivemile Creek (headwater size)	OH53 42	O	XX		
Grassy Run (headwater size)		ND	ND		

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Flow Alteration			*Flow Alteration Summary*
		Channel	QHEI	Flashiness	
		20pt	100pt	t.b.d.	
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	O	O		
Glady Run (headwater size)	OH53 48	ND	ND		
Solomon Run (headwater size)	OH53 53	ND	ND		
OEPA HUC11 Assessment Unit 05090202100					
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	O	O		
West Fork of East Fork (wadeable size)	OH53 56	O	O		
Dodson Creek (EWH, wadeable size)	OH53 57	X	XXX		
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	O	O overall to X upstream		
Turtle Creek (headwater size)	OH53 61	X	XX		

Key to notations:
XXX=likely

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Ionic Stress: Conductance, TDS, chlorides			*Ionic Stress Summary*	pH Extremes
		Conductivity umhos/cm	Chlorides mg/l	Sulfate mg/l		pH
OEPA HUC11 Assessment Unit 05090202130						
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O, except X at geo 18 below wwtp	O	O	**O**	E
Hall Run (headwater size)	OH53 2	XX	X	X	**X**	E
Wolfpen Run (headwater size)	OH53 3	XX	O	ND	**X**	E
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O	O	O	**O**	E
Salt Run (headwater size)	OH53 4	XX	XX	ND	**XX**	
UT Salt Run, Nature Center (D Russell) (headwater size)		XX	O	ND	**X**	E
UT Salt Run, Circuit City		O	O	ND	**O**	ND
Sugarcamp Run (headwater size)	OH53 5	O	O	O	**O**	E
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	**ND**	ND
Shayler Run (headwater size)	OH53 6	X	O	X	**X**	E
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	**ND**	ND
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O	X upstream	O little data	**O**	E
Lick Fork (headwater size)	OH53 9	O	ND	ND	**O**	E

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Ionic Stress: Conductance, TDS, chlorides			*Ionic Stress Summary*	pH Extremes
		Conductivity	Chlorides	Sulfate		
		umhos/cm	mg/l	mg/l		pH
Brushy Fork (headwater size)		XXX	ND	ND	**XXX increasing trend, unknown chloride**	ND
Newtonsville Creek (headwater size)		XXX	X	ND	**XXX some chloride effects**	E
OEPA HUC11 Assessment Unit 05090202120						
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O	O	O	**O**	
UT, Ross Road (headwater size)		XXX	ND	ND	**XXX**	ND
UT, SR222 @ Filager		XX	X	ND	**XX**	E
UT, SR222 @ jail		O	O	ND	**O**	E
UT, Tillbury Property (D Russell) (headwater size)		XXX	ND	ND	**XXX**	ND
Lucy Run (headwater size)	OH53 18	O	O	O	**O**	E
Fourmile Run (headwater size)	OH53 19	O	O	ND	**O**	E
East Fork LMR (EWH, Small River sites) (all data pre-1993)		X 1980s data only	O pre-1993 data only	ND	**X**	some>9 1980s data only
Back Run (all data pre-1993)		O pre-1993 data only	O pre-1993 data only	ND	**O**	some>9 1980s data only
Ulrey Run (headwater size)	OH53 22	XX	O	ND	**X**	some>9

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Ionic Stress: Conductance, TDS, chlorides			*Ionic Stress Summary*	pH Extremes
		Conductivity umhos/cm	Chlorides mg/l	Sulfate mg/l		pH
UT, East Fork State Park (D Russell) (headwater size)		XXX	O	ND	**XXX**	E
Slabcamp Run (headwater size)	OH53 23	O	O	ID n=2	**O**	ND
Barnes Run (headwater size)	OH53 26	O	ND	ND	**O/ND**	E
Poplar Creek (headwater size)	OH53 27	O	X	ND	**X**	E
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND	ND	ND	**ND**	n=1 pH=7.3
Cloverlick Creek (wadeable size)	OH53 25	O	O	ND	**O**	some>9
Cabin Run (headwater size)	OH53 24	X	O	ND	**X**	E
OEPA HUC11 Assessment Unit 05090202110						
Kain Run (headwater size)	OH53 35	XX	XX	ND	**XX**	E
UT Kain, Otis Prop. (D Russell) (headwater size)		XXX	O	ND	**XXX increasing trend, low chloride**	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	O	ND	ND	**O**	E
Todd Run (headwater size)	OH53 37	ND	ND	ND	**ND**	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	O	O	O	**O**	E

Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Ionic Stress: Conductance, TDS, chlorides			Ionic Stress Summary	pH Extremes
		Conductivity umhos/cm	Chlorides mg/l	Sulfate mg/l		pH
Pleasant Run (headwater size)	OH53 41	X	O	O	**O**	E
Fivemile Creek (headwater size)	OH53 42	O	O	O	**O**	E
Grassy Run (headwater size)		O	ND	ND	**O**	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	X	O	O	**O**	E
Glady Run (headwater size)	OH53 48	XX	ND	ND	**XX**	E
Solomon Run (headwater size)	OH53 53	ID (1982 data only)	ID (1982 data only)	ID (1982 data only)	**ID**	ID (1982 data only)
OEPA HUC11 Assessment Unit 05090202100						
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	X 1998, 2002 data only	O 1998 data only	O 1998 data only	**XX**	E
West Fork of East Fork (wadeable size)	OH53 56	X 1998, 2002 data only	O 1998 data only	O 1998 data only	**X**	E
Dodson Creek (EWH, wadeable size)	OH53 57	X 1998, 2002 data only	O 1998 data only	X	**X**	E
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	X 1998, 2002 data only	O 1998 data only	O 1998 data only	**X**	E
Turtle Creek (headwater size)	OH53 61	X 1998, 2002 data only	X 1998 data only	X 1998 data only	**XX**	E

Key to notations:

Stream		Ionic Stress: Conductance, TDS, chlorides				pH Extremes
EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID segment	Conductivity umhos/cm	Chlorides mg/l	Sulfate mg/l	*Ionic Stress Summary*	pH

XXX=likely

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	*Nutrient Summary*	*Ammonia Toxicity Summary*	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*	*Siltation/ Sedimenta-tion Summary*	*Habitat Summary*	*Metals Summary*	*Toxics Summary*	*Ionic Stress Summary*	*pH Extremes*
OEPA HUC11 Assessment Unit 05090202130										
East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	N & P increase below geo18 wwtp XXX	increasing trend since 1996 XX	nutrients high, bod low, chlA high, occasional DO stress.	O-X	X-XX	Metals observations associated w TSS. Summary: unlikely to be bioavailable X	ID	O	E
Hall Run (headwater size)	OH53 2	XX	XX	XXX	X-XX	XX-XXX	O	ND	X	E
Wolfpen Run (headwater size)	OH53 3	XXX	XX @ MHP dschg	X	XX	XXX	ID	ND	X	E
East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XXX	O	X	X	O	O	ND	O	E
Salt Run (headwater size)	OH53 4	X	O	X-XX	XX	XX	O	ND	XX	0
UT Salt Run, Nature Center (D Russell) (headwater size)		X	O	X	X	ND	ND	ND	X	E
UT Salt Run, Circuit City		X	O	X	X	ND	ID	ND	O	ND
Sugarcamp Run (headwater size)	OH53 5	O	O	O/ID	X	X-XX	O	ND	O	E
East Branch Sugarcamp Run (headwater size)		ND	ND	ND	X	XX	ND	ND	ND	ND
Shayler Run (headwater size)	OH53 6	XXX	O	XX-XXX	XX	XX-XXX	XX	ND	X	E

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	*Nutrient Summary*	*Ammonia Toxicity Summary*	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*	*Siltation/ Sedimenta-tion Summary*	*Habitat Summary*	*Metals Summary*	*Toxics Summary*	*Ionic Stress Summary*	*pH Extremes*
Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND	XX	X	ND	ND	ND	ND
Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	XXX	X	XX	XX	X downstream; declining TO XX upstream	Possible Cu; other metals unlikely	ND	O	E
Lick Fork (headwater size)	OH53 9	XX	O	O-X	XXX	X-XX	O	ND	O	E
Brushy Fork (headwater size)		XX	O	O/ID	O/ID	XXX	ND	ND	XXX increasing trend, unknown chloride	ND
Newtonsville Creek (headwater size)		XXX	XX	XXX	X	ND	Possible Cu; other metals unlikely	ND	XXX some chloride effects	E
OEPA HUC11 Assessment Unit 05090202120										
East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	XXX	X	XX	XX	O	O	ID	O	0
UT, Ross Road (headwater size)		XX	ND	O/ID	X	ND	ND	ND	XXX	ND
UT, SR222 @ Filager		XX	O	O	O/ID	ND	O/ND	ND	XX	E
UT, SR222 @ jail		XX	O	O	O/ID	ND	O/ND	ND	O	E
UT, Tillbury Property (D Russell) (headwater size)		XXX	O	XX	X	ND	ND	ND	XXX	ND

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	*Nutrient Summary*	*Ammonia Toxicity Summary*	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*	*Siltation/ Sedimenta-tion Summary*	*Habitat Summary*	*Metals Summary*	*Toxics Summary*	*Ionic Stress Summary*	*pH Extremes*
Lucy Run (headwater size)	OH53 18	X	O	XX	X	XXX	O	ND	O	E
Fourmile Run (headwater size)	OH53 19	X	O	X	X	X	O/ND	ND	O	E
East Fork LMR (EWH, Small River sites) (all data pre-1993)		X pre-1993 data only	XX/ID pre-1993 data only	X pre-1993 data only	X pre-1993 data only	ND	O/ID	ND	X	some>9 1980s data only
Back Run (all data pre-1993)		X pre-1993 data only	XX/ID pre-1993 data only	XX pre-1993 data only	X pre-1993 data only	ND	O/ID	ND	O	some>9 1980s data only
Ulrey Run (headwater size)	OH53 22	XX	O	XX	XXX	XX	O/ND	ND	X	some>9
UT, East Fork State Park (D Russell) (headwater size)		XX	X/ID	X	X	ND	ND	ND	XXX	E
Slabcamp Run (headwater size)	OH53 23	XX	X/ID	ID	XXX	XXX	O/ID	ND	O	ND
Barnes Run (headwater size)	OH53 26	X	O	XXX	XXX	X	O/ND	ND	O/ND	E
Poplar Creek (headwater size)	OH53 27	XX	XX/ID 1980s upstream data only	XX	XXX	XX	O/ID	ND	X	E
Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	X 1980s data only	X/ID 1980s data only	XX wwtp only; 1980s data only	X 1980s data only	ND	ND	ND	ND	n=1 pH=7.3
Cloverlick Creek (wadeable size)	OH53 25	X	XX/ID pre-1993 data only	O	X	ND	O/ID	ND	O	some>9
Cabin Run (headwater size)	OH53 24	X	O	O	XXX	O	O/ID, except Hosea discharge	ND	X	E

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	*Nutrient Summary*	*Ammonia Toxicity Summary*	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*	*Siltation/ Sedimenta-tion Summary*	*Habitat Summary*	*Metals Summary*	*Toxics Summary*	*Ionic Stress Summary*	*pH Extremes*
OEPA HUC11 Assessment Unit 05090202110										
Kain Run (headwater size)	OH53 35	XXX	X	XXX	X	X-XX	Possible Cu; other metals unlikely	ND	XX	E
UT Kain, Otis Prop. (D Russell) (headwater size)		XX	O	X	X	ND	ND	ND	XXX increasing trend, low chloride	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	XXX	X/ID 1985 data only	O	O	O	O/ID	ND	O	E
Todd Run (headwater size)	OH53 37	ND	ND	ND	X	XX	ND	ND	ND	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	XXX	X	XX	X	O	Possible Cu; other metals unlikely	X/ND	O	E
Pleasant Run (headwater size)	OH53 41	XXX	X	XX	X	X-XX	O	ND	O	E
Fivemile Creek (headwater size)	OH53 42	XXX	O	X	X	XX	O	ND	O	E
Grassy Run (headwater size)		XXX	O	X	X	ND	ND	ND	O	E
East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	XXX	O	O	XX	O	O	ND	O	E
Glady Run (headwater size)	OH53 48	XXX	O	O	ID	ND	ND	ND	XX	E

Stream **EWH: East Fork and Dodson Creek** **WWH: all other**	**OH WBID segment**	*Nutrient Summary*	*Ammonia Toxicity Summary*	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*	*Siltation/ Sedimenta-tion Summary*	*Habitat Summary*	*Metals Summary*	*Toxics Summary*	*Ionic Stress Summary*	*pH Extremes*
Solomon Run (headwater size)	OH53 53									
OEPA HUC11 Assessment Unit 05090202100										
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 52	XXX	O	X	X	O	O	ND	XX	E
West Fork of East Fork (wadeable size)	OH53 56	XXX	O	O	XX	O	O	ND	X	E
Dodson Creek (EWH, wadeable size)	OH53 57	XXX	O	X	X	XXX	O	ND	X	E
East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH53 60	XXX	O	X	X	X	O	ND	X	E
Turtle Creek (headwater size)	OH53 61	XX	O	O	X	XX	O	ND	XX	E

Key to notations:
XXX=likely

Other data/information (descriptive/qualitative) based on permits, point source discharges, land use activities, specific events (e.g., spills), first-hand knowledge, etc., including information about other unsampled contributing tributaries and their watershed conditions. Include references to specific locations or time periods when possible. Information that may apply more generally to a subwatershed area and not just to a specific tributary or segment can be added into the most applicable row with a notation about how widely the condition(s) apply.

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
OEPA HUC11 Assessment Unit 05090202**130**							
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 0 - RM 5.5	1-19, 21-22, 30-32	Yes	Yes (IBI<48)	Some sediment flushing from Hall Run into EFLMR
							Stream channel runs under highways and through Tech-50 center and other increasingly suburbanized/developed areas
							Two WWTP's in area
							Numbers of ballfields and parks
							Field obs: much bank erosion and downcutting; "Rivers Edge" development (and other) since 1998, high TSS
1below	Hall Run (headwater size)	OH53 2		23-29	ND	Yes (IBI<40)	Bad sewerline breaks; aerobic treatment systems
							BZAK Landscape company: large mulch piles and other runoff
							OEPA field notes: high bank erosion, with high flushing of sediment from upstream (higher gradient) to downstream (lower gradient) Hall Run, and some sediment flushing into EFLMR
1below	Wolfpen Run (headwater size)	OH53 3		33-34, 36	ND	ND	Mobile Home treatment plant, and failing onsite systems
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 5.6 - RM 8.5	1, 8-10, 15, 30-32	Yes	Yes (IBI<48)	Gravel mining in river channel (Shenkle and others) from just upstream of the Stonelick Creek confluence upstream to below MEF treatment plant in Batavia

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
2below	Salt Run (headwater size)	OH53 4		2-3	ND	Yes (IBI<40) n=1 1997 score=36	Highly variable land use, from Eastgate Mall area's increasing suburbanization, to low intensity State Park; some downcutting and erosion in State Park area apparently from increasing flashiness in the streamflow
2below	UT Salt Run, Nature Center (D Russell) (headwater size)			4	2002 only; questionable scores	ND	
2below	UT Salt Run, Circuit City			5-7	ND	ND	
2below	Sugarcamp Run (headwater size)	OH53 5		11-13	ND	1998 Not Impaired; 1994 impaired	Treatment plant lift station at Route 131 sometimes fails Increased downcutting and erosion in upstream State Park area apparently from increasing flashiness in the streamflow
2below	East Branch Sugarcamp Run (headwater size)			14	ND	Yes (IBI<40) n=1 1994 score=12	
2below	Shayler Run (headwater size)	OH53 6		16-22, 26-29	No (ICI>=30) n=2, 1991, scores 30,34	Yes (IBI<40)	Increasing small industrial development (Buxton Road and elsewhere); red dye and blue dye from plant spills (Sun Chemical and others); copper sulfate used to treat algae in Bristol Lake, Route 125 Sewer line in streambed Increasing residential construction and development; residential brush clearing for views Sewer overflows and spillage from sewer line in streambed; manhole covers missing (behind Amelia High School)
2below	Shayler Run tributary (headwater size)	OH53 6.1		23-25	ND	Yes (IBI<40)	
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8		1-5, 8-9, 11 14, 16-24	n=6 1984-01, scores 30-48 Not impaired	Yes, RM 8.0+	Upstream: higher gradient, with decent oxygenation and riffles & pools Upstream: more failing septics and horse farms; sporadic new construction, but slower than around Batavia Poor habitat in the reach from dam (Stonelick reservoir, river mile ~14) downstream to Route 131 (approx Newtonsville Cr confluence, river mile ~10.6) Downstream: more bank erosion

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
3stonelick	Lick Fork (headwater size)	OH53 9		6-7	ND	No (IBI>40) n=1 1997 score=46	
3stonelick	Brushy Fork (headwater size)			10	2002 only; questionable scores	ND	Toxicity testing showed no harmful levels; decent habitat but very low fish scores for unknown reason. Habitat includes bedrock substrate without good pools.
3stonelick	Newtonsville Creek (headwater size)			15	ND	ND	Failing septics and onsite systems; increasing number of horse farms
OEPA HUC11 Assessment Unit 05090202**120**							
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	RM 9.0 - RM 20.4	1-8, 10, 12-15, 17-23, 25, 30, 32-35	Yes	Yes (IBI<48)	Two WWTP's (Middle East Fork, and Batavia), and village of Batavia are located in this segment of EFLMR
4below	UT, Ross Road (headwater size)			9	2002 only; questionable scores	ND	
4below	UT, SR222 @ Filager			11	ND	ND	
4below	UT, SR222 @ jail			16	ND	ND	
4below	UT, Tillbury Property (D Russell) (headwater size)			24	2002 only; questionable scores	ND	
4below	Lucy Run (headwater size)	OH53 18		26-29	Yes (ICI<26) n=1 1996 score=24	Yes above RM 1.5, No @ RM 0.2	Aquatic life use scores OK in 1998, but increasing recent development since then. Some but not many failing septics and horse farms; no package plants; yet, possible leakage from sewer line in middle portion of stream channel (Routes 125, 132); student volunteers noted "manhole covers coming off, visible toilet paper and other trash"

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
4below	Fourmile Run (headwater size)	OH53 19		31	ND	ND	OEPA field notes (1997): newly constructed golf course has no effective sediment controls in place; heavy bedload of silt and sand in stream Increasing development with construction runoff Backwash to WWTP
5lakearea	East Fork LMR (EWH, Small River sites)			6, 21		ND	
5lakearea	East Fork Lake (Harsha Reservoir)			1		ND	
5lakearea	Back Run			2	ND	ND	Package plant at mobile home park; pond with spillway by package plant; trailer park off Route 125 and a bowling alley next to the trailer park.
5lakearea	Ulrey Run (headwater size)	OH53 22		3	ND	ND	Increasing development; package plant(s)
5lakearea	UT, East Fork State Park (D Russell) (headwater size)			4	2002 only; questionable scores	ND	
5lakearea	Slabcamp Run (headwater size)	OH53 23		5	ND	Yes (IBI<40) n=2 1998 score=12,34	OEPA notes: high bacteria observations Large mobile home park Major industrial development in the drainage (e.g., four transmission plants) Increased sediment runoff from construction in this growing industrial area
5lakearea	Barnes Run (headwater size)	OH53 26		7	ND	Yes (IBI<40) n=1 1997 score=24	From Hamersville north to Route 32: Barnes R, Cloverlick Cr, and Todd R affected by high rural development, including many small road front lots with septics. Land disposal of septic waste mentioned as possible, although illegal. Sediment impact from soybeans/agriculture
5lakearea	Poplar Creek (headwater size)	OH53 27		8-9, 13	ND	Yes (IBI<40) n=1 1997 score=38	Increasing sediment runoff associated with increasing construction/development in the area
5lakearea	Town Run (headwater size)	OH53 29		10-12	ND	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
5lakearea	Cloverlick Creek (wadeable size)	OH53 25		14-16	ND	ND	Yankeetown onsite septic
							Hogs and hog waste pond, now gone, may have affected fecal and ammonia conditions before 1998.
							From Hamersville north to Route 32: Barnes R, Cloverlick Cr, and Todd R affected by high rural development, including many small road front lots with septics.
							Possible dewatering due to dam (Bethel drinking water supply) upstream of State Park
5lakearea	Cabin Run (headwater size)	OH53 24		17-20	ND	No (IBI>40) n=2 1998 score=46,48	Attained aquatic life use scores; possibly some sedimentation from horse trails.
OEPA HUC11 Assessment Unit 05090202**110**							
6above	Kain Run (headwater size)	OH53 35		1, 3	ND	Yes (IBI<40) n=1 1997 score=30	Most landuse in watershed is agricultural.
							OEPA field notes: significant algal production; spikes of nitrate and TP (wet-weather spikes)
							Copper observations may be related to road runoff (sample site is next to roads)
6above	UT Kain, Otis Prop. (D Russell) (headwater size)			2	2002 only; questionable scores	ND	
6above	Todd Run (headwater size)	OH53 37		7	ND	Yes (IBI<40) n=2 1998 score=30,32	From Hamersville north to Route 32: Barnes R, Cloverlick Cr, and Todd R affected by high rural development, including many small road front lots with septics.
6above	Pleasant Run (headwater size)	OH53 41		17-22	Yes (ICI<26) n=1 1996 score=4	Yes	Some roadfront lots with septics; OEPA high bacteria and low DO observations.
							Closed hazardous waste landfill (SECOS *sp?*) is in this watershed.

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
6above	Fivemile Creek (headwater size)	OH53 42		23	ND	1982 data only; n=3, IBI scores 28,40,40	Failing onsite septics. "Bacteria exceedances" noted in OEPA field notes. Little livestock except for small number cattle possibly in upper parts in some tributaries. 50-100 head cattle; 50-100 head hogs Agriculture is mostly soybeans in upper part of stream (75% soy; 25% corn)
6above	Grassy Run (headwater size)			26	ND	ND	Phosphorus spikes at predictable periods; could be due to wet weather events or ChemLawn applications
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20	Todd R to us Harsha Lake	4-6 (RM 30.4-33.9)	Yes	Yes (IBI<48); 1982 data only	
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36	Howard R to Todd R (Clermont Co)	8-16, 24-25, (rm 34.5-44)	Yes	Yes (IBI<48)	Town of Marathon waste disposal… *(incomplete notes……)*
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45	Solomon to Howard (Brown Co)	27-30, 32-34 (rm 48.6 56.2)	mixed: 1982 impaired; 1998+ not	Yes (IBI<50)	Some cattle in watershed, mostly in feedlots; some hogs. Less impact from septics, but 100 "Holiday Homes" manufactured housing constructed in 1998 Erosion impact from Metzgers and others; streambank erosion; levee'd banks prevent sediment deposits onto flood plain OEPA field notes: downstream site near Glady Run had heavy sediment and embeddedness and high bedload ATVs currently causing problems. Fayetteville sewer had continuous impact, dumping into river, between 1982-1998.
6above	Glady Run (headwater size)	OH53 48		31	ND	ND	
6above	Solomon Run (headwater size)	OH53 53		35-37	ND	Yes (IBI<40) n=6 1982 scores 22-42	Possible livestock impact (also in Sycamore Creek, no WQ data).

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
OEPA HUC11 Assessment Unit 05090202**100**							
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5352	Dodson to Solomon (rm 60-70.1)	1-2, 4-6	No (ICI>=42) n=2 1998-00 scores=46,48	Yes (IBI<50)	EFLMR upstream of Solomon Run: mostly Ag (soybeans) with some livestock; not many septic systems.
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5360	hw to Dodson (RM 70.9-85)	9-10, 13-15	No (ICI>=42) n=3 1982, 1998 scores=42, 44, 46	Yes (IBI<50)	EFLMR upstream of Solomon Run: mostly Ag (soybeans) with some livestock; not many septic systems.
7headwater	West Fork of East Fork (wadeable size)	OH5356		3	ND	mixed (some IBI<40)	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip- tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	Notes/Comments from Local Experts meetings, June 15, 2005
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57		7-8	No (ICI>=42) n=1 1998 score=42	Yes (IBI<50)	Bedload sand in stream is mostly natural rather than result of runoff/erosion; however, extensive bedload sand aggravated due to road crossing.
							Two quarries in headwaters, with buffering; downstream substrate is more clay than sand.
							Possible impact from unfenced beef cattle - Anderson Road.
							Route 50 - eroded high banks.
							Increase in no-till agriculture from 1982 to 1998, and since 1998, resulting in increased flashiness in hydrograph; no-till practices can harden soil surface, increase crustiness; lead to more erosion and increased stream energy.
							Natural soils are mostly clay; not much sand. *(possible contradiction to statement above about bedload?) Yes. Not sure where the sand is coming from. We should ask Paul or Jay.*
							Ag is mostly soybeans; soybeans are fertilized more with P than with N. Trend toward continuous soybeans rather than crop rotation.
							QHEI score dropped from 1982 to 1998; Riparian and Cover subscores main contributors to drop.
							In EFLMR upstream of Solomon Run, Highland County: not as many septics, EXCEPT in Dodson.
7headwater	Turtle Creek (headwater size)	OH53 61		11-12	ND	Yes (IBI<40)	Sediment/silt downstream of Quarry on Sharpsville Road (Ed Moore).
							Few cattle historically but just built 2400 sow operation in headwaters.

Stressor ID Candidate Causes:

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
OEPA HUC11 Assessment Unit 05090202**130**										
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)				xx				
						x		x?		x?
			x? check reports	x? check reports	x? check reports					
			x (fertilizers?)			x				
						x	x			
1below	Hall Run (headwater size)	OH53 2		x	x					
						xx				
						xx	x			
1below	Wolfpen Run (headwater size)	OH53 3		x	x					
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)				x	x			

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
2below	Salt Run (headwater size)	OH53 4				xx				
2below	UT Salt Run, Nature Center (D Russell) (headwater size)									
2below	UT Salt Run, Circuit City									
2below	Sugarcamp Run (headwater size)	OH53 5		x	x					
						xx				
2below	East Branch Sugarcamp Run (headwater size)									
2below	Shayler Run (headwater size)	OH53 6				x		x	x?	x?
				x	x		x			
			x (lawn fertilizer?)			xx	x			
					x					
2below	Shayler Run tributary (headwater size)	OH53 6.1								
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8								
				x	x					
							x			
						x	x			

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
3stonelick	Lick Fork (headwater size)	OH53 9								
3stonelick	Brushy Fork (headwater size)									
3stonelick	Newtonsville Creek (headwater size)			x	x	x				
OEPA HUC11 Assessment Unit 05090202**120**										
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	x? check reports	x? check reports	x? check reports					
4below	UT, Ross Road (headwater size)									
4below	UT, SR222 @ Filager									
4below	UT, SR222 @ jail									
4below	UT, Tillbury Property (D Russell) (headwater size)									
4below	Lucy Run (headwater size)	OH53 18								
				x	x					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
4below	Fourmile Run (headwater size)	OH53 19	fertilizers?			xx				
						xx	x			
			x?	x						
5lakearea	East Fork LMR (EWH, Small River sites)									
5lakearea	East Fork Lake (Harsha Reservoir)									
5lakearea	Back Run			x	x	x				
5lakearea	Ulrey Run (headwater size)	OH53 22		x	x	x				
5lakearea	UT, East Fork State Park (D Russell) (headwater size)									
5lakearea	Slabcamp Run (headwater size)	OH53 23			x					
						x		x?	x?	x?
						xx				
5lakearea	Barnes Run (headwater size)	OH53 26		x	x					
			x		x					
						xx				
5lakearea	Poplar Creek (headwater size)	OH53 27				xx	x			
5lakearea	Town Run (headwater size)	OH53 29								

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
5lakearea	Cloverlick Creek (wadeable size)	OH5325		x	x					
				x	x					
				x	x					
							x			
5lakearea	Cabin Run (headwater size)	OH5324				x?				
OEPA HUC11 Assessment Unit 05090202**110**										
6above	Kain Run (headwater size)	OH5335	x			x	x			
			x							
								x		x?
6above	UT Kain, Otis Prop. (D Russell) (headwater size)									
6above	Todd Run (headwater size)	OH5337		x	x					
6above	Pleasant Run (headwater size)	OH5341			x					
								x?	x?	x?

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
6above	Fivemile Creek (headwater size)	OH53 42		x	x					
					x					
				minor?	minor?					
			x			x				
6above	Grassy Run (headwater size)		x							
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20								
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36			x?					
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45		x	x					
					x	x				
						x	x			
						x	x			
						x	x			x?
			x	x	x					
6above	Glady Run (headwater size)	OH53 48								
6above	Solomon Run (headwater size)	OH53 53		x	x	x	x			

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
OEPA HUC11 Assessment Unit 05090202**100**										
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5352	x			x				
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5360	x			x				
7headwater	West Fork of East Fork (wadeable size)	OH5356								

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrients/ DO (incl. nuisance algal growth)	Ammonia toxicity	Organic enrichment/ DO	Siltation/ Sedimen-tation	Other habitat alteration	Priority metals: copper, lead, zinc	Other metals	Other toxics: organics, pesticides, oils, VOCs
7headwater	Dodson Creek (EWH, wadeable size)	OH5357				x				
						x				
				x	x	x	x			
						x	x			
						x	x			
						x				
			x							
							x			
					x					
7headwater	Turtle Creek (headwater size)	OH5361				x				
				x	x	x	x			

Stressor ID Candidate Causes:

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
OEPA HUC11 Assessment Unit 05090202**130**						
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)				
						x? increased runoff from pavements
						x? check reports
			x			
1below	Hall Run (headwater size)	OH53 2				
						x?
			x			
1below	Wolfpen Run (headwater size)	OH53 3				
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
2below	Salt Run (headwater size)	OH53 4	x			road/pavement runoff?
2below	UT Salt Run, Nature Center (D Russell) (headwater size)					
2below	UT Salt Run, Circuit City					
2below	Sugarcamp Run (headwater size)	OH53 5				
			x			
2below	East Branch Sugarcamp Run (headwater size)					
2below	Shayler Run (headwater size)	OH53 6				x?
						x?
2below	Shayler Run tributary (headwater size)	OH53 6.1				
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
3stonelick	Lick Fork (headwater size)	OH53 9				
3stonelick	Brushy Fork (headwater size)					
3stonelick	Newtonsville Creek (headwater size)					
OEPA HUC11 Assessment Unit 05090202**120**						
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16				x? check reports
4below	UT, Ross Road (headwater size)					
4below	UT, SR222 @ Filager					
4below	UT, SR222 @ jail					
4below	UT, Tillbury Property (D Russell) (headwater size)					
4below	Lucy Run (headwater size)	OH53 18				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
4below	Fourmile Run (headwater size)	OH53 19				
5lakearea	East Fork LMR (EWH, Small River sites)					
5lakearea	East Fork Lake (Harsha Reservoir)					
5lakearea	Back Run					
5lakearea	Ulrey Run (headwater size)	OH53 22				
5lakearea	UT, East Fork State Park (D Russell) (headwater size)					
5lakearea	Slabcamp Run (headwater size)	OH53 23				
						x?
5lakearea	Barnes Run (headwater size)	OH53 26				
5lakearea	Poplar Creek (headwater size)	OH53 27				
5lakearea	Town Run (headwater size)	OH53 29				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
5lakearea	Cloverlick Creek (wadeable size)	OH5325				
			x			
5lakearea	Cabin Run (headwater size)	OH5324				
OEPA HUC11 Assessment Unit 05090202**110**						
6above	Kain Run (headwater size)	OH5335				
6above	UT Kain, Otis Prop. (D Russell) (headwater size)					
6above	Todd Run (headwater size)	OH5337				
6above	Pleasant Run (headwater size)	OH5341				
						x?

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
6above	Fivemile Creek (headwater size)	OH53 42				
6above	Grassy Run (headwater size)					
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 20				
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Small River sites)	OH53 36				x?
6above	East Fork, Solomon R to upst Cloverlick Creek (EWH, Wadeable sites)	OH53 45				
						x
6above	Glady Run (headwater size)	OH53 48				
6above	Solomon Run (headwater size)	OH53 53				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
OEPA HUC11 Assessment Unit 05090202**100**						
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5352				
7headwater	East Fork, hw to upst Solomon Run (EWH, Wadeable sites)	OH5360				
7headwater	West Fork of East Fork (wadeable size)	OH5356				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Flow alteration	Ionic stress: conductance, TDS, chlorides	pH extremes	Other potential impacts, not easily categorized in previous columns
7headwater	Dodson Creek (EWH, wadeable size)	OH5357				
			x			
						x
7headwater	Turtle Creek (headwater size)	OH5361				

Statistical Tolerance Value Model Results:

	TV	TV	TV		
BenSampID	NOx	Habitat	Conductivity	InEFLMR	Geo_groupSI
4157	7	5	5	in	1below
4160	7	5	5	in	1below
4162	7	5	5	in	1below
4164	7	5	5	in	1below
4168	6	6	5	in	1below
4170	7	5	5	in	1below
4172	7	5	5	in	1below
4174	7	5	5	in	1below
4176	7	5	5	in	1below
4180	6	6	5	in	1below
414	6	4	4	in	1below
4182	7	5	5	in	1below
	6.75	5.08	4.92	average Stressor TV (tolerance value) score	
4184	7	5	5	in	2below
4186	7	5	5	in	2below
4188	7	5	5	in	2below
4460	6	5	5	in	2below
4477	7	5	5	in	2below
4503	7	4	5	in	2below
4346	7	5	5	in	2below
4378	6	4	5	in	2below
	6.75	4.75	5.00	average Stressor TV (tolerance value) score	
4409	5	7	7	in	2below
4410	4	6	7	in	2below
4411	5	6	7	in	2below
4412	5	7	8	in	2below

	TV	TV	TV		
BenSampID	NOx	Habitat	Conductivity	InEFLMR	Geo_groupSI
	4.75	6.50	7.25	average Stressor TV (tolerance value) score	
4282	5	7	5	in	3stonelick
4284	5	6	5	in	3stonelick
4369	6	5	5	in	3stonelick
4396	6	5	5	in	3stonelick
4287	6	6	6	in	3stonelick
	5.60	5.80	5.20	average Stressor TV (tolerance value) score	
4401	5	5	5	in	3stonelick
4402	5	5	6	in	3stonelick
4403	2	7	6	in	3stonelick
4404	4	8	9	in	3stonelick
	4.00	6.25	6.50	average Stressor TV (tolerance value) score	
4190	7	5	5	in	4below
4192	7	5	5	in	4below
4462	7	4	4	in	4below
4194	7	5	5	in	4below
4479	7	5	5	in	4below
4505	7	4	5	in	4below
4348	7	4	5	in	4below
4380	6	4	4	in	4below
4507	7	4	5	in	4below
4350	6	4	4	in	4below
4196	7	5	5	in	4below
4198	6	6	5	in	4below
4200	7	4	4	in	4below
4204	7	5	5	in	4below
4206	7	5	5	in	4below
4464	7	4	4	in	4below
4208	7	5	5	in	4below
4481	7	4	4	in	4below
4212	7	4	5	in	4below
4483	7	5	5	in	4below

	TV	TV	TV		
BenSampID	NOx	Habitat	Conductivity	InEFLMR	Geo_groupSI
4509	7	5	5	in	4below
4352	6	5	5	in	4below
4382	6	4	4	in	4below
4214	6	5	5	in	4below
4216	7	5	5	in	4below
4218	7	4	4	in	4below
4466	6	5	4	in	4below
4220	7	5	5	in	4below
4222	7	4	4	in	4below
	6.76	4.59	4.66	average Stressor TV (tolerance value) score	
4432	5	7	8	in	4below
4434	4	8	8	in	4below
	4.50	7.50	8.00	average Stressor TV (tolerance value) score	
4439	4	8	9	in	4below
4440	6	7	7	in	4below
4441	4	7	7	in	4below
4442	4	5	4	in	4below
	4.50	6.75	6.75	average Stressor TV (tolerance value) score	
4417	5	5	5	in	5lakearea
4418	4	7	7	in	5lakearea
4419	4	6	4	in	5lakearea
4420	4	8	9	in	5lakearea
	4.25	6.50	6.25	average Stressor TV (tolerance value) score	
4425	5	7	7	in	6above
4426	1	7	2	in	6above
4427	4	8	7	in	6above
4428	4	7	7	in	6above
	3.50	7.25	5.75	average Stressor TV (tolerance value) score	
390	4	4	4	in	6above
4456	4	4	4	in	6above

	TV	TV	TV		
BenSampID	NOx	Habitat	Conductivity	InEFLMR	Geo_groupSI
	4.00	4.00	4.00	average Stressor TV (tolerance value) score	
397	5	6	5	in	6above
4473	5	5	5	in	6above
	5.00	5.50	5.00	average Stressor TV (tolerance value) score	
4226	5	6	5	in	6above
4228	6	5	5	in	6above
4231	6	5	5	in	6above
399	6	5	5	in	6above
4475	6	5	5	in	6above
4233	6	5	5	in	6above
4235	6	5	5	in	6above
4237	6	5	5	in	6above
4239	5	6	5	in	6above
4241	7	5	5	in	6above
4513	6	5	5	in	6above
4356	6	5	5	in	6above
4386	7	5	5	in	6above
	6.00	5.15	5.00	average Stressor TV (tolerance value) score	
4244	6	6	5	in	6above
4246	6	5	5	in	6above
4248	6	5	5	in	6above
4250	6	6	5	in	6above
	6.00	5.50	5.00	average Stressor TV (tolerance value) score	
4252	6	5	5	in	7headwater
	6.00	5.00	5.00	average Stressor TV (tolerance value) score	
4254	6	5	5	in	7headwater
4256	5	6	5	in	7headwater
4259	5	6	6	in	7headwater
	5.33	5.67	5.33	average Stressor TV (tolerance value) score	

	TV	TV	TV		
BenSampID	NOx	Habitat	Conductivity	lnEFLMR	Geo_groupSI
4314	6	6	5	in	7headwater
	6.00	6.00	5.00	average Stressor TV (tolerance value) score	

BenSampID	WaterbodyName	PSiteID	Geo_Huc11AU	SUBBASINIDLUT	BugCollDate	StaidOwner
4157	E Fork L Miami	EF0080	3	2	02-Sep-82	OEPA
4160	E Fork L Miami	EF0080	3	2	02-Sep-93	OEPA
4162	E Fork L Miami	EF0080	3	2	28-Aug-98	OEPA
4164	E Fork L Miami	EF0170	8	10	02-Sep-82	OEPA
4168	E Fork L Miami	EF0220	11	11	27-Aug-98	OEPA
4170	E Fork L Miami	EF0400	17	17	28-Aug-98	OEPA
4172	E Fork L Miami	EF0470	18	19A	01-Sep-82	OEPA
4174	E Fork L Miami	EF0470	18	19A	02-Sep-93	OEPA
4176	E Fork L Miami	EF0470	18	19A	27-Aug-98	OEPA
4180	E Fork L Miami	EF0510	22	20	27-Aug-98	OEPA
414	E Fork L Miami	EF0540	30	21	06-Sep-99	Clermont
4182	E Fork L Miami	EF0550	31	21	26-Aug-98	OEPA
4184	E Fork L Miami	EF0660	8	27	01-Sep-82	OEPA
4186	E Fork L Miami	EF0660	8	27	01-Sep-93	OEPA
4188	E Fork L Miami	EF0660	8	27	26-Aug-98	OEPA
4460	E Fork L Miami	EF0662	10	27	17-Sep-97	Clermont
4477	E Fork L Miami	EF0662	10	27	27-Aug-98	Clermont
4503	E Fork L Miami	EF0662	10	27	06-Sep-99	Clermont
4346	E Fork L Miami	EF0662	10	27	22-Sep-00	Clermont
4378	E Fork L Miami	EF0662	10	27	14-Sep-01	Clermont
4409	LMR UT1 Salt Run LMR - Dave Russell	SALT_UT1	4	39	23-May-02	Clermont
4410	LMR UT1 Salt Run LMR - Dave Russell	SALT_UT1	4	39	01-Jul-02	Clermont
4411	LMR UT1 Salt Run LMR - Dave Russell	SALT_UT1	4	39	15-Aug-02	Clermont
4412	LMR UT1 Salt Run LMR - Dave Russell	SALT_UT1	4	39	22-Sep-02	Clermont

BenSampID	WaterbodyName	PSiteID	Geo_Huc11AU	SUBBASINIDLUT	BugCollDate	StaidOwner
4282	Stonelick Creek	ST0100	3	59	22-Aug-84	OEPA
4284	Stonelick Creek	ST0100	3	59	01-Sep-93	OEPA
4369	Stonelick Creek	ST0200	4	59	23-Sep-00	Clermont
4396	Stonelick Creek	ST0200	4	59	01-Oct-01	Clermont
4287	Stonelick Creek	ST0310	5	59	01-Sep-93	OEPA
4401	Brushy Fork	BRUSH2.4	10	76	22-May-02	Clermont
4402	Brushy Fork	BRUSH2.4	10	76	01-Jul-02	Clermont
4403	Brushy Fork	BRUSH2.4	10	76	15-Aug-02	Clermont
4404	Brushy Fork	BRUSH2.4	10	76	22-Sep-02	Clermont
4190	E Fork L Miami	EF0910	1	62	01-Sep-82	OEPA
4192	E Fork L Miami	EF0910	1	62	01-Sep-93	OEPA
4462	E Fork L Miami	EF0910	1	62	17-Sep-97	Clermont
4194	E Fork L Miami	EF0910	1	62	25-Aug-98	OEPA
4479	E Fork L Miami	EF0910	1	62	27-Aug-98	Clermont
4505	E Fork L Miami	EF0910	1	62	06-Sep-99	Clermont
4348	E Fork L Miami	EF0910	1	62	22-Sep-00	Clermont
4380	E Fork L Miami	EF0910	1	62	14-Sep-01	Clermont
4507	E Fork L Miami	EF1130	6	82	06-Sep-99	Clermont
4350	E Fork L Miami	EF1130	6	82	22-Sep-00	Clermont
4196	E Fork L Miami	EF1150	7	82	01-Sep-82	OEPA
4198	E Fork L Miami	EF1150	7	82	25-Aug-98	OEPA
4200	E Fork L Miami	EF1250	13	104A	25-Aug-98	OEPA
4204	E Fork L Miami	EF1270	17	104A	01-Sep-82	OEPA
4206	E Fork L Miami	EF1270	17	104A	01-Sep-93	OEPA
4464	E Fork L Miami	EF1270	17	104A	17-Sep-97	Clermont
4208	E Fork L Miami	EF1270	17	104A	25-Aug-98	OEPA
4481	E Fork L Miami	EF1270	17	104A	27-Aug-98	Clermont
4212	E Fork L Miami	EF1370	22	116	24-Aug-98	OEPA
4483	E Fork L Miami	EF1370	22	116	27-Aug-98	Clermont

BenSampID	WaterbodyName	PSiteID	Geo_Huc11AU	SUBBASINIDLUT	BugCollDate	StaidOwner
4509	E Fork L Miami	EF1370	22	116	06-Sep-99	Clermont
4352	E Fork L Miami	EF1370	22	116	22-Sep-00	Clermont
4382	E Fork L Miami	EF1370	22	116	14-Sep-01	Clermont
4214	E Fork L Miami	EF1550	25	122	31-Aug-82	OEPA
4216	E Fork L Miami	EF1550	25	122	31-Aug-93	OEPA
4218	E Fork L Miami	EF1550	25	122	24-Aug-98	OEPA
4466	E Fork L Miami	EF1560	30	131	17-Sep-97	Clermont
4220	E Fork L Miami	EF1970	34	152	31-Aug-82	OEPA
4222	E Fork L Miami	EF1970	34	152	24-Aug-98	OEPA
4432	LMR - Dave Russell, Ross Road	RR	9	108	23-May-02	Clermont
4434	LMR - Dave Russell, Ross Road	RR	9	108	28-Oct-02	Clermont
4439	LMR - Dave Russell, Tillbury property/Crosspointe	TP	24	117	23-May-02	Clermont
4440	LMR - Dave Russell, Tillbury property/Crosspointe	TP	24	117	01-Jul-02	Clermont
4441	LMR - Dave Russell, Tillbury property/Crosspointe	TP	24	117	15-Aug-02	Clermont
4442	LMR - Dave Russell, Tillbury property/Crosspointe	TP	24	117	22-Sep-02	Clermont
4417	LMR - Dave Russell, East Fork State Park	SP	4	159A	23-May-02	Clermont
4418	LMR - Dave Russell, East Fork State Park	SP	4	159A	01-Jul-02	Clermont
4419	LMR - Dave Russell, East Fork State Park	SP	4	159A	15-Aug-02	Clermont
4420	LMR - Dave Russell, East Fork State Park	SP	4	159A	22-Sep-02	Clermont
4425	LMR - Dave Russell, Otis Property	OP	2	240	23-May-02	Clermont
4426	LMR - Dave Russell, Otis Property	OP	2	240	01-Jul-02	Clermont
4427	LMR - Dave Russell, Otis Property	OP	2	240	15-Aug-02	Clermont
4428	LMR - Dave Russell, Otis Property	OP	2	240	22-Sep-02	Clermont
390	Pleasant Run	PLEAS02	17	223	16-Nov-96	Clermont
4456	Pleasant Run	PLEAS02	17	223	16-Nov-96	Clermont

BenSampID	WaterbodyName	PSiteID	Geo_Huc11AU	SUBBASINIDLUT	BugCollDate	StaidOwner
397	E Fork L Miami	EF3070	5	217A	18-Sep-97	Clermont
4473	E Fork L Miami	EF3070	5	217A	18-Sep-97	Clermont
4226	E Fork L Miami	EF3470	8	217B	31-Aug-82	OEPA
4228	E Fork L Miami	EF3470	8	217B	26-Aug-98	OEPA
4231	E Fork L Miami	EF3560	12	218B	26-Aug-98	OEPA
399	E Fork L Miami	EF3620	14	218B	18-Sep-97	Clermont
4475	E Fork L Miami	EF3620	14	218B	18-Sep-97	Clermont
4233	E Fork L Miami	EF4110	15	222A	31-Aug-82	OEPA
4235	E Fork L Miami	EF4110	15	222A	22-Aug-84	OEPA
4237	E Fork L Miami	EF4110	15	222A	26-Aug-98	OEPA
4239	E Fork L Miami	EF4420	24	226	30-Aug-82	OEPA
4241	E Fork L Miami	EF4420	24	226	25-Aug-98	OEPA
4513	E Fork L Miami	EF4420	24	226	05-Sep-99	Clermont
4356	E Fork L Miami	EF4420	24	226	13-Oct-00	Clermont
4386	E Fork L Miami	EF4420	24	226	14-Sep-01	Clermont
4244	E Fork L Miami	EF5420	32	231A	30-Aug-82	OEPA
4246	E Fork L Miami	EF5420	32	231A	25-Aug-83	OEPA
4248	E Fork L Miami	EF5420	32	231A	28-Aug-98	OEPA
4250	E Fork L Miami	EF5620	34	231B	30-Aug-82	OEPA
4252	E Fork L Miami	EF6210	4	235A	25-Aug-98	OEPA
4254	E Fork L Miami	EF7090	9	235B	30-Aug-82	OEPA
4256	E Fork L Miami	EF7090	9	235B	24-Aug-98	OEPA
4259	E Fork L Miami	EF7530	13	238A	24-Aug-98	OEPA

BenSampID	WaterbodyName	PSiteID	Geo_Huc11AU	SUBBASINIDLUT	BugCollDate	StaidOwner
4314	Dodson Creek	DODSON02	7	237	24-Aug-98	OEPA

BenSampID	StationID	SiteType	Location	UseClassID	Catchment Area
4157	S11100 0.77	stream		Exceptional Warmwater Habitat	498
4160	S11100 0.77	stream		Exceptional Warmwater Habitat	498
4162	S11100 0.77	stream		Exceptional Warmwater Habitat	498
4164	S11100 1.70	stream		Exceptional Warmwater Habitat	495
4168	S11100 2.20	stream		Exceptional Warmwater Habitat	495
4170	S11100 4.00	stream		Exceptional Warmwater Habitat	492
4172	S11100 4.70	wwtp-mix		Exceptional Warmwater Habitat	491
4174	S11100 4.70	wwtp-mix		Exceptional Warmwater Habitat	491
4176	S11100 4.70	wwtp-mix		Exceptional Warmwater Habitat	491
4180	S11100 5.10	stream		Exceptional Warmwater Habitat	490
414	EFRM5.4	stream	P&G pump station, u/s LEF WWTP	Exceptional Warmwater Habitat	484
4182	S11100 5.50	stream		Exceptional Warmwater Habitat	484
4184	S11100 6.60	stream		Exceptional Warmwater Habitat	476
4186	S11100 6.60	stream		Exceptional Warmwater Habitat	476
4188	S11100 6.60	stream		Exceptional Warmwater Habitat	476
4460	EFRM6.6	stream	Roundbottom Rd bridge @ Perintown	Exceptional Warmwater Habitat	500
4477	EFRM6.6	stream	Roundbottom Rd bridge @ Perintown	Exceptional Warmwater Habitat	500
4503	EFRM6.6	stream	Roundbottom Rd bridge @ Perintown	Exceptional Warmwater Habitat	500
4346	EFRM6.6	stream	Roundbottom Rd bridge @ Perintown	Exceptional Warmwater Habitat	500
4378	EFRM6.6	stream	Roundbottom Rd bridge @ Perintown	Exceptional Warmwater Habitat	500
4409	NC	stream	Cincinnati Nature Center, UT to Salt Run		2
4410	NC	stream	Cincinnati Nature Center, UT to Salt Run		2
4411	NC	stream	Cincinnati Nature Center, UT to Salt Run		2
4412	NC	stream	Cincinnati Nature Center, UT to Salt Run		2

BenSampID	StationID	SiteType	Location	UseClassID	Catchment Area
4282	S11107 1.00	stream		Warmwater Habitat	80
4284	S11107 1.00	stream		Warmwater Habitat	80
4369	ST2.0	stream	Steel Bridge @ Stonelick-Wms Corner	Warmwater Habitat	65
4396	ST2.0	stream	Steel Bridge @ Stonelick-Wms Corner	Warmwater Habitat	65
4287	S11107 3.10	stream		Warmwater Habitat	71
4401	BRUSH2.4	stream	Private Dr N. of Quail Ridge Road	Warmwater Habitat	4.91
4402	BRUSH2.4	stream	Private Dr N. of Quail Ridge Road	Warmwater Habitat	4.91
4403	BRUSH2.4	stream	Private Dr N. of Quail Ridge Road	Warmwater Habitat	4.91
4404	BRUSH2.4	stream	Private Dr N. of Quail Ridge Road	Warmwater Habitat	4.91
4190	S11100 9.10	stream		Exceptional Warmwater Habitat	380
4192	S11100 9.10	stream		Exceptional Warmwater Habitat	380
4462	EFRM9.1	stream	Stonelick-Olive Branch bridge	Exceptional Warmwater Habitat	380
4194	S11100 9.10	stream		Exceptional Warmwater Habitat	380
4479	EFRM9.1	stream	Stonelick-Olive Branch bridge	Exceptional Warmwater Habitat	380
4505	EFRM9.1	stream	Stonelick-Olive Branch bridge	Exceptional Warmwater Habitat	380
4348	EFRM9.1	stream	Stonelick-Olive Branch bridge	Exceptional Warmwater Habitat	380
4380	EFRM9.1	stream	Stonelick-Olive Branch bridge	Exceptional Warmwater Habitat	380
4507	EFRM11.3	stream	4610 State Route 222	Exceptional Warmwater Habitat	383
4350	EFRM11.3	stream	4610 State Route 222	Exceptional Warmwater Habitat	383
4196	S11100 11.50	stream		Exceptional Warmwater Habitat	375
4198	S11100 11.50	stream		Exceptional Warmwater Habitat	375
4200	S11100 12.50	stream		Exceptional Warmwater Habitat	373
4204	S11100 12.70	stream		Exceptional Warmwater Habitat	373
4206	S11100 12.70	stream		Exceptional Warmwater Habitat	373
4464	EFRM12.7	stream	Park Maint facility, u/s MEF WWTP	Exceptional Warmwater Habitat	373
4208	S11100 12.70	stream		Exceptional Warmwater Habitat	373
4481	EFRM12.7	stream	Park Maint facility, u/s MEF WWTP	Exceptional Warmwater Habitat	373
4212	S11100 13.70	stream		Exceptional Warmwater Habitat	364
4483	EFRM13.7	stream	1st bend @ Haskell, u/s/ Batavia WWTP	Exceptional Warmwater Habitat	364

BenSampID	StationID	SiteType	Location	UseClassID	Catchment Area
4509	EFRM13.7	stream	1st bend @ Haskell, u/s/ Batavia WWTP	Exceptional Warmwater Habitat	364
4352	EFRM13.7	stream	1st bend @ Haskell, u/s/ Batavia WWTP	Exceptional Warmwater Habitat	364
4382	EFRM13.7	stream	1st bend @ Haskell, u/s/ Batavia WWTP	Exceptional Warmwater Habitat	364
4214	S11100 15.50	stream		Exceptional Warmwater Habitat	359
4216	S11100 15.50	stream		Exceptional Warmwater Habitat	359
4218	S11100 15.50	stream		Exceptional Warmwater Habitat	359
4466	EFRM15.6	stream	Sportsmans Park @ SR 222	Exceptional Warmwater Habitat	359
4220	S11100 19.70	stream		Exceptional Warmwater Habitat	343
4222	S11100 19.70	stream		Exceptional Warmwater Habitat	343
4432	RR	stream	Ross Road, UT to UT to EFLMR, NE of Batavia		2
4434	RR	stream	Ross Road, UT to UT to EFLMR, NE of Batavia		2
4439	TP	stream	Tillbury property/Crosspointe, UT to EFLMR nr Batavia		2
4440	TP	stream	Tillbury property/Crosspointe, UT to EFLMR nr Batavia		2
4441	TP	stream	Tillbury property/Crosspointe, UT to EFLMR nr Batavia		2
4442	TP	stream	Tillbury property/Crosspointe, UT to EFLMR nr Batavia		2
4417	SP	stream	East Fork State Park, UT to Harsha Lake	Warmwater Habitat	2
4418	SP	stream	East Fork State Park, UT to Harsha Lake	Warmwater Habitat	2
4419	SP	stream	East Fork State Park, UT to Harsha Lake	Warmwater Habitat	2
4420	SP	stream	East Fork State Park, UT to Harsha Lake	Warmwater Habitat	2
4425	OP	stream	Otis Property, small unnamed trib to Kain Run		2
4426	OP	stream	Otis Property, small unnamed trib to Kain Run		2
4427	OP	stream	Otis Property, small unnamed trib to Kain Run		2
4428	OP	stream	Otis Property, small unnamed trib to Kain Run		2
390	PLEAS0.2	stream	Hutchinson Rd off SR 133	Warmwater Habitat	8.2
4456	PLEAS0.2	stream	Hutchinson Rd off SR 133	Warmwater Habitat	8.2

BenSampID	StationID	SiteType	Location	UseClassID	Catchment Area
397	EFRM30.7	stream	Upstream Harsha Lake	Exceptional Warmwater Habitat	254
4473	EFRM30.7	stream	Upstream Harsha Lake	Exceptional Warmwater Habitat	254
4226	S11100 34.70	stream		Exceptional Warmwater Habitat	237
4228	S11100 34.70	stream		Exceptional Warmwater Habitat	237
4231	S11100 35.60	stream		Exceptional Warmwater Habitat	235
399	EFRM36.2	stream	Downstream of Williamsburg Dam	Exceptional Warmwater Habitat	240
4475	EFRM36.2	stream	Downstream of Williamsburg Dam	Exceptional Warmwater Habitat	240
4233	S11100 41.10	stream		Exceptional Warmwater Habitat	222
4235	S11100 41.10	stream		Exceptional Warmwater Habitat	222
4237	S11100 41.10	stream		Exceptional Warmwater Habitat	222
4239	S11100 44.20	stream		Exceptional Warmwater Habitat	195
4241	S11100 44.20	stream		Exceptional Warmwater Habitat	195
4513	EFRM44.1	stream	upstream Blue Sky Pkwy bridge	Exceptional Warmwater Habitat	195
4356	EFRM44.1	stream	upstream Blue Sky Pkwy bridge	Exceptional Warmwater Habitat	195
4386	EFRM44.1	stream	upstream Blue Sky Pkwy bridge	Exceptional Warmwater Habitat	195
4244	S11100 54.20	stream		Exceptional Warmwater Habitat	164
4246	S11100 54.20	stream		Exceptional Warmwater Habitat	164
4248	S11100 54.20	stream		Exceptional Warmwater Habitat	164
4250	S11100 56.20	stream		Exceptional Warmwater Habitat	151
4252	S11100 62.10	stream		Exceptional Warmwater Habitat	101
4254	S11100 70.90	stream		Exceptional Warmwater Habitat	54
4256	S11100 70.90	stream		Exceptional Warmwater Habitat	54
4259	S11100 75.30	stream		Exceptional Warmwater Habitat	26

BenSampID	StationID	SiteType	Location	UseClassID	Catchment Area
4314	S11151 0.20	stream		Exceptional Warmwater Habitat	32.4

BenSampID	SiteTypeOEPA	RiverMile	Ecoregion	Eco_four	Huc11	OH_WBID	BenRepNum	ICI_Num
4157	Small Rivers	0.77	2	55d	130	OH53 1	1	42
4160	Small Rivers	0.77	2	55d	130	OH53 1	1	40
4162	Small Rivers	0.77	2	55d	130	OH53 1	1	42
4164	Small Rivers	1.7	2	55d	130	OH53 1	1	40
4168	Small Rivers	2.2	2	55d	130	OH53 1	1	36
4170	Small Rivers	4	2	55d	130	OH53 1	1	44
4172	Small Rivers	4.7	2	55d	130	OH53 1	1	40
4174	Small Rivers	4.7	2	55d	130	OH53 1	1	44
4176	Small Rivers	4.7	2	55d	130	OH53 1	1	40
4180	Small Rivers	5.1	2	55d	130	OH53 1	1	40
414	Small Rivers	5.4	2	55d	130	OH53 1	1	44
4182	Small Rivers	5.5	2	55d	130	OH53 1	1	46
4184	Small Rivers	6.6	2	55d	130	OH53 1	1	42
4186	Small Rivers	6.6	2	55d	130	OH53 1	1	42
4188	Small Rivers	6.6	2	55d	130	OH53 1	1	46
4460	Small Rivers	6.6	2	55d	130	OH53 1	1	36
4477	Small Rivers	6.6	2	55d	130	OH53 1	1	40
4503	Small Rivers	6.6	2	55d	130	OH53 1	1	46
4346	Small Rivers	6.6	2	55d	130	OH53 1	1	48
4378	Small Rivers	6.6	2	55d	130	OH53 1	1	42
4409	Headwaters			55d	130		1	12
4410	Headwaters			55d	130		1	10
4411	Headwaters			55d	130		1	8
4412	Headwaters			55d	130		1	6

BenSampID	SiteTypeOEPA	RiverMile	Ecoregion	Eco_four	Huc11	OH_WBID	BenRepNum	ICI_Num
4282	Wadeable	1	2	55d	130	OH53 8	1	44
4284	Wadeable	1	2	55d	130	OH53 8	1	32
4369	Wadeable	2	2	55d	130	OH53 8	1	48
4396	Wadeable	2	2	55d	130	OH53 8	1	36
4287	Wadeable	3.1	2	55d	130	OH53 8	1	38
4401	Headwaters	2.4	2	55d	130		1	10
4402	Headwaters	2.4	2	55d	130		1	2
4403	Headwaters	2.4	2	55d	130		1	0
4404	Headwaters	2.4	2	55d	130		1	0
4190	Small Rivers	9.1	2	55d	120	OH53 16	1	42
4192	Small Rivers	9.1	2	55d	120	OH53 16	1	42
4462	Small Rivers	9.1	2	55d	120	OH53 16	1	38
4194	Small Rivers	9.1	2	55d	120	OH53 16	1	48
4479	Small Rivers	9.1	2	55d	120	OH53 16	1	42
4505	Small Rivers	9.1	2	55d	120	OH53 16	1	40
4348	Small Rivers	9.1	2	55d	120	OH53 16	1	44
4380	Small Rivers	9.1	2	55d	120	OH53 16	1	40
4507	Small Rivers	11.3	2	55d	120	OH53 16	1	32
4350	Small Rivers	11.3	2	55d	120	OH53 16	1	48
4196	Small Rivers	11.5	2	55d	120	OH53 16	1	42
4198	Small Rivers	11.5	2	55d	120	OH53 16	1	40
4200	Small Rivers	12.5	2	55d	120	OH53 16	1	34
4204	Small Rivers	12.7	2	55d	120	OH53 16	1	42
4206	Small Rivers	12.7	2	55d	120	OH53 16	1	44
4464	Small Rivers	12.7	2	55d	120	OH53 16	1	34
4208	Small Rivers	12.7	2	55d	120	OH53 16	1	44
4481	Small Rivers	12.7	2	55d	120	OH53 16	1	32
4212	Small Rivers	13.7	2	55d	120	OH53 16	1	44
4483	Small Rivers	13.7	2	55d	120	OH53 16	1	38

BenSampID	SiteTypeOEPA	RiverMile	Ecoregion	Eco_four	Huc11	OH_WBID	BenRepNum	ICI_Num
4509	Small Rivers	13.7	2	55d	120	OH53 16	1	44
4352	Small Rivers	13.7	2	55d	120	OH53 16	1	38
4382	Small Rivers	13.7	2	55d	120	OH53 16	1	38
4214	Small Rivers	15.5	2	55d	120	OH53 16	1	42
4216	Small Rivers	15.5	2	55d	120	OH53 16	1	44
4218	Small Rivers	15.5	2	55d	120	OH53 16	1	42
4466	Small Rivers	15.6	2	55d	120	OH53 16	1	36
4220	Small Rivers	19.7	2	55d	120	OH53 16	1	36
4222	Small Rivers	19.7	2	55d	120	OH53 16	1	34
4432	Headwaters			55d	120		1	0
4434	Headwaters			55d	120		1	0
4439	Headwaters			55d	120		1	6
4440	Headwaters			55d	120		1	6
4441	Headwaters			55d	120		1	0
4442	Headwaters			55d	120		1	0
4417	Headwaters			55d	120		1	4
4418	Headwaters			55d	120		1	0
4419	Headwaters			55d	120		1	0
4420	Headwaters			55d	120		1	0
4425	Headwaters			55d	110		1	12
4426	Headwaters			55d	110		1	0
4427	Headwaters			55d	110		1	0
4428	Headwaters			55d	110		1	0
390	Headwaters	0.2	2	55d	110	OH53 41	1	4
4456	Headwaters	0.2	2	55d	110	OH53 41	1	4

BenSampID	SiteTypeOEPA	RiverMile	Ecoregion	Eco_four	Huc11	OH_WBID	BenRepNum	ICI_Num
397	Small Rivers	30.7	2	55d	110	OH53 20	1	42
4473	Small Rivers	30.7	2	55d	110	OH53 20	1	42
4226	Small Rivers	34.7	2	55d	110	OH53 36	1	32
4228	Small Rivers	34.7	2	55d	110	OH53 36	1	46
4231	Small Rivers	35.6	2	55d	110	OH53 36	1	40
399	Small Rivers	36.2	2	55d	110	OH53 36	1	44
4475	Small Rivers	36.2	2	55d	110	OH53 36	1	44
4233	Small Rivers	41.1	2	55d	110	OH53 36	1	42
4235	Small Rivers	41.1	2	55d	110	OH53 36	1	48
4237	Small Rivers	41.1	2	55d	110	OH53 36	1	48
4239	Wadeable	44.2	2	55d	110	OH53 36	1	28
4241	Wadeable	44.2	2	55d	110	OH53 36	1	38
4513	Wadeable	44.1	2	55d	110	OH53 36	1	26
4356	Wadeable	44.1	2	55d	110	OH53 36	1	40
4386	Wadeable	44.1	2	55d	110	OH53 36	1	42
4244	Wadeable	54.2	2	55d	110	OH53 45	1	38
4246	Wadeable	54.2	2	55d	110	OH53 45	1	46
4248	Wadeable	54.2	2	55d	110	OH53 45	1	50
4250	Wadeable	56.2	2	55d	110	OH53 45	1	40
4252	Wadeable	62.1	2	55d	100	OH53 52	1	46
4254	Wadeable	70.9	5	55d	100	OH53 60	1	42
4256	Wadeable	70.9	5	55d	100	OH53 60	1	46
4259	Wadeable	75.3	5	55d	100	OH53 60	1	44

BenSampID	SiteTypeOEPA	RiverMile	Ecoregion	Eco_four	Huc11	OH_WBID	BenRepNum	ICI_Num
4314	Wadeable	0.2	2	55d	100	OH53 57	1	42

BenSampID	Comments2
4157	
4160	
4162	
4164	
4168	
4170	
4172	
4174	
4176	
4180	lat/long not on stream per ArcView plot. Adjust P-Long to long from OEPA StationID S11101 0.20 (by ArcView review).
414	lat/long too far downstream (~rm4.8 at OldID). Should be between Hall (conf mi 5.2) and Wolfpen (conf mi 5.9). Adj Plat/Plong to estimates upstr Hall confl
4182	
4184	
4186	
4188	
4460	Could be same loc as OEPA StationID M04S02 and S11100 6.60, but lat/longs plot upstream; keep separate for now
4477	Could be same loc as OEPA StationID M04S02 and S11100 6.60, but lat/longs plot upstream; keep separate for now
4503	Could be same loc as OEPA StationID M04S02 and S11100 6.60, but lat/longs plot upstream; keep separate for now
4346	Could be same loc as OEPA StationID M04S02 and S11100 6.60, but lat/longs plot upstream; keep separate for now
4378	Could be same loc as OEPA StationID M04S02 and S11100 6.60, but lat/longs plot upstream; keep separate for now
4409	Add WaterbodyName and TribTo per ArcView. Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4410	Add WaterbodyName and TribTo per ArcView. Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4411	Add WaterbodyName and TribTo per ArcView. Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4412	Add WaterbodyName and TribTo per ArcView. Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.

BenSampID	Comments2
4282	
4284	
4369	
4396	
4287	
4401	
4402	
4403	
4404	
4190	
4192	
4462	
4194	
4479	
4505	
4348	
4380	
4507	
4350	
4196	
4198	
4200	
4204	
4206	
4464	
4208	
4481	
4212	
4483	

BenSampID	Comments2
4509	
4352	
4382	
4214	
4216	
4218	
4466	
4220	
4222	
4432	Lat/long provided from D Russell per J. McManus email 1/4/05
4434	Lat/long provided from D Russell per J. McManus email 1/4/05
4439	Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4440	Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4441	Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4442	Lat/long puts this in EFLMR not LMR. Coords are correct per J.McManus email 11/10/04 and 1/4/05.
4417	lat/long puts this in EFLMR not LMR. Lat/longs are correct per J.McManus email 1/4/05.
4418	lat/long puts this in EFLMR not LMR. Lat/longs are correct per J.McManus email 1/4/05.
4419	lat/long puts this in EFLMR not LMR. Lat/longs are correct per J.McManus email 1/4/05.
4420	lat/long puts this in EFLMR not LMR. Lat/longs are correct per J.McManus email 1/4/05.
4425	Lat/long puts this in EFLMR not LMR. Coords corrected in Plat/long per J.McManus email 1/4/05; site on UT to Kain Run.
4426	Lat/long puts this in EFLMR not LMR. Coords corrected in Plat/long per J.McManus email 1/4/05; site on UT to Kain Run.
4427	Lat/long puts this in EFLMR not LMR. Coords corrected in Plat/long per J.McManus email 1/4/05; site on UT to Kain Run.
4428	Lat/long puts this in EFLMR not LMR. Coords corrected in Plat/long per J.McManus email 1/4/05; site on UT to Kain Run.
390	
4456	

BenSampID	Comments2
397	lat/long WAY OFF per ArcView plot Adjust Plat/Plong to those of StationID 383081 as approx.
4473	lat/long WAY OFF per ArcView plot Adjust Plat/Plong to those of StationID 383081 as approx.
4226	
4228	
4231	
399	
4475	
4233	
4235	
4237	
4239	
4241	
4513	
4356	
4386	
4244	
4246	
4248	
4250	
4252	
4254	
4256	
4259	

BenSampID	Comments2
4314	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
OEPA HUC11 Assessment Unit 05090202**130**							
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 0 - RM 5.5	1-19, 21-22, 30-32	Yes	Multiple IBI <44; see RM plot	nutrients; ammonia? Sediment
1below	Hall Run (headwater size)	OH53 2		23-29	Yes 1998-2003 scores <20	Yes (IBI<40 for n=13 of 15 samps)	organic; sediment; habitat
1below	Wolfpen Run (headwater size)	OH53 3		33-34, 36	1997 OEPA Qual samps only	ND	nutrients; habitat
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	RM 5.6 - RM 8.5	1, 8-10, 15, 30-32	Yes	Multiple IBI <44; see RM plot	nutrients
2below	Salt Run (headwater size)	OH53 4		2-3	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=36	sediment; habitat
2below	UT Salt Run, Nature Center (D Russell) (headwater size)			4	2002 only; questionable scores (8, 6, 10, 12)	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
2below	UT Salt Run, Circuit City			5-7	ND	ND	
2below	Sugarcamp Run (headwater size)	OH53 5		11-13	1994-98 OEPA Qual samps only	1998 Not Impaired; 1994 impaired	habitat
2below	East Branch Sugarcamp Run (headwater size)			14	1994 OEPA Qual samps only	Yes (IBI<40) n=1 1994 score=12	habitat
2below	Shayler Run (headwater size)	OH53 6		16-22, 26-29	No (ICI>=30) n=2, 1991, scores 30,34	Mixed <40 and >40 in both 1991 and 1998	nutrients; organic; sediment; habitat
2below	Shayler Run tributary (headwater size)	OH53 6.1		23-25	ND	Yes (IBI<40 in 1991, 1998)	
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8		1-5, 8-9, 11 14, 16-24	n=6 1984-01, scores 30-48 Not impaired	Yes, RM 8.0+	nutrients; habitat upstream
3stonelick	Lick Fork (headwater size)	OH53 9		6-7	No (ICI>=30) n=2, 2001, scores 42,44	No (IBI>40) n=1 1997 score=46	possible nutrients, habitat
3stonelick	Brushy Fork (headwater size)			10	Yes n=4, 2002, scores <=10	Yes (IBI<40 in 20011, 2003)	ionic stress? Habitat

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
3stonelick	Newtonsville Creek (headwater size)			15	ND	ND	nutrients; organic; conductivity?
OEPA HUC11 Assessment Unit 05090202**120**							
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	RM 9.0 - RM 20.4	1-8, 10, 12-15, 17-23, 25, 30, 32-35	Yes	Multiple IBI <44; see RM plot	nutrients
4below	UT, Ross Road (headwater size)			9	2002 only; questionable scores (0, 0, 0)	ND	ionic stress or natural?
4below	UT, SR222 @ Filager			11	ND	ND	
4below	UT, SR222 @ jail			16	ND	ND	
4below	UT, Tillbury Property (D Russell) (headwater size)			24	2002 only; questionable scores (0, 0, 6, 6)	ND	nutrients; ionic stress or natural?
4below	Lucy Run (headwater size)	OH53 18		26-29	Yes (ICI<26) n=1 1996 score=24	Yes above RM 1.5, No < RM 0.5	habitat declining upstream
4below	Fourmile Run (headwater size)	OH53 19		31	1997 OEPA Qual samps only	ND	sediment

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)			6, 21	ND	ND	
5lakearea	Back Run (all data pre-1993)			2	ND	ND	
5lakearea	Ulrey Run (headwater size)	OH53 22		3	1997 OEPA Qual samps only	ND	sediment; habitat
5lakearea	UT, East Fork State Park (D Russell) (headwater size)			4	2002 only; questionable scores (0, 0, 0, 4)	ND	ionic stress or natural?
5lakearea	Slabcamp Run (headwater size)	OH53 23		5	1998 OEPA Qual samps only	Yes (IBI<40) n=2 1998 score=12,34	sediment; habitat
5lakearea	Barnes Run (headwater size)	OH53 26		7	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=24	organic; sediment
5lakearea	Poplar Creek (headwater size)	OH53 27		8-9, 13	1997 OEPA Qual samps only	Yes (IBI<40) n=1 1997 score=38	sediment; habitat
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29		10-12	ND	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
5lakearea	Cloverlick Creek (wadeable size)	OH53 25		14-16	1997 OEPA Qual samps only	ND	
5lakearea	Cabin Run (headwater size)	OH53 24		17-20	1997 OEPA Qual samps only	No (IBI>40) n=2 1998 score=46,48	sediment
OEPA HUC11 Assessment Unit 05090202**110**							
6above	Kain Run (headwater size)	OH53 35		1, 3	mixed: in 2000 <20; in 2001 >=36	Yes (IBI<40) n=3 1997-2001	nutrients; organic; habitat
6above	UT Kain, Otis Prop. (D Russell) (headwater size)			2	2002 only; questionable scores (12, 0, 0, 0)	ND	ionic stress or natural?
6above	Todd Run (headwater size)	OH53 37		7	1997 OEPA Qual samps only	Yes (IBI<40) n=2 1998 score=30,32	possible habitat
6above	Pleasant Run (headwater size)	OH53 41		17-22	Yes (ICI<26) n=1 1996 score=4	Yes > RM 1.5; mixed IBI < RM 1.5	nutrients; possible habitat
6above	Fivemile Creek (headwater size)	OH53 42		23	1998 OEPA Qual samps only	1982 data only; n=3 scores 28,40,40	nutrients; habitat
6above	Grassy Run (headwater size)			26	ND	ND	nutrients

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	Todd R to us Harsha Lake	4-6 (RM 30.4-33.9)	Yes	Multiple IBI <44; see RM plot	nutrients
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	Howard R to Todd R	8-16, 24-25, (rm 34.5-44)	Yes	Multiple IBI <44; see RM plot	nutrients
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	Solomon to Howard	27-30, 32-34 (rm 48.6-56.2)	mixed: 1982 impaired; 1998+ not	Multiple IBI<46; see RM plot	nutrients; sediment?
6above	Glady Run (headwater size)	OH53 48		31	ND	ND	nutrients
6above	Solomon Run (headwater size)	OH53 53		35-37	1982 OEPA Qual samps only	1982 data only; IBI<40, n=6; scores 22-42	
OEPA HUC11 Assessment Unit 05090202**100**							
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	Dodson to Solomon	1-2, 4-6 (rm 60-70.1)	No (ICI>=42) n=2 1998-00 scores=46,48	1982 multiple IBI<46; 1998 >46; see RM plot	nutrients

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Descrip-tion	Geo-order site #s (within SI/AU)	ICI impaired (EWH <46 (42); WWH <30 (26))	IBI impaired (East Fork: see plots for EWH criteria. Tribs: WWH habitat, hw or wading, IBI<40)	SUMMARY: Proposed/draft stressor calls
					60 pt	60 pt	
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	hw to Dodson (RM 70.9-85)	9-10, 13-15	No (ICI>=42) n=3 1982, 1998 scores=42, 44, 46	1982 multiple IBI<46; 1998 >46; see RM plot	nutrients
7headwater	West Fork of East Fork (wadeable size)	OH53 56		3	1998 OEPA Qual samps only	mixed; IBI<40 and IBI>40 in 1982 & 1998	nutrients
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57		7-8	No (ICI>=42) n=1 1998 score=42	Yes (IBI<46)	nutrients; sediment? Habitat
7headwater	Turtle Creek (headwater size)	OH53 61		11-12	1998 OEPA Qual samps only	Yes (IBI<40)	habitat

SI Summary Assessments by Candidate Cause

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrient Summary				Ammonia Toxicity Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
OEPA HUC11 Assessment Unit 05090202**130**									
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	N & P increase below geo18 wwtp XXX	x	mean score = 6.75; slight stress indicator	XXX	increasing trend since 1996 XX	x	XXX
1below	Hall Run (headwater size)	OH53 2	XX		ND		XX	x	
1below	Wolfpen Run (headwater size)	OH53 3	XXX		ND	XXX	XX @ MHP dschg	x	
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XXX		mean score = 6.75; slight stress indicator	XXX	O		
2below	Salt Run (headwater size)	OH53 4	X		ND		O		
2below	UT Salt Run, Nature Center (D Russell) (headwater size)		X	ND	mean score = 4.75; incon-clusive		O	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Nutrient Summary*				*Ammonia Toxicity Summary*		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
2below	UT Salt Run, Circuit City		X	ND	ND		O	ND	
2below	Sugarcamp Run (headwater size)	OH53 5	O		ND		O	x	
2below	East Branch Sugarcamp Run (headwater size)		ND	ND	ND		ND	ND	
2below	Shayler Run (headwater size)	OH53 6	XXX	x		XXX	O	x	
2below	Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND		ND	ND	
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	XXX		mean score = 5.6; incon-clusive	XXX	X	x	
3stonelick	Lick Fork (headwater size)	OH53 9	XX	ND	ND		O	ND	
3stonelick	Brushy Fork (headwater size)		XX		mean score = 4; weak non-stress result		O		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrient Summary				Ammonia Toxicity Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
3stonelick	Newtonsville Creek (headwater size)		XXX		ND	XXX	XX	x	
OEPA HUC11 Assessment Unit 05090202**120**									
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	XXX	x	mean score = 6.76; slight stress indicator	XXX	X	x	
4below	UT, Ross Road (headwater size)		XX	ND	mean score = 4.5; in-conclusive		ND	ND	
4below	UT, SR222 @ Filager		XX	ND	ND		O	ND	
4below	UT, SR222 @ jail		XX	ND	ND		O	ND	
4below	UT, Tillbury Property (D Russell) (headwater size)		XXX	ND	mean score = 4.5; in-conclusive	XXX	O	ND	
4below	Lucy Run (headwater size)	OH53 18	X				O	x	
4below	Fourmile Run (headwater size)	OH53 19	X	x	ND		O	x	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Nutrient Summary*				*Ammonia Toxicity Summary*		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)		X pre-1993 data only	ND	ND		XX/ID pre-1993 data only		
5lakearea	Back Run (all data pre-1993)		X pre-1993 data only		ND		XX/ID pre-1993 data only	x	
5lakearea	Ulrey Run (headwater size)	OH53 22	XX		ND		O	x	
5lakearea	UT, East Fork State Park (D Russell) (headwater size)		XX	ND	mean score = 4.25; weak non-stress result		X/ID	ND	
5lakearea	Slabcamp Run (headwater size)	OH53 23	XX		ND		X/ID		
5lakearea	Barnes Run (headwater size)	OH53 26	X	x	ND		O	x	
5lakearea	Poplar Creek (headwater size)	OH53 27	XX		ND		XX/ID 1980s upstream data only		
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	X 1980s data only	ND	ND		X/ID 1980s data only		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrient Summary				Ammonia Toxicity Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
5lakearea	Cloverlick Creek (wadeable size)	OH53 25	X		ND		XX/ID pre-1993 data only	xx	
5lakearea	Cabin Run (headwater size)	OH53 24	X		ND		O		
OEPA HUC11 Assessment Unit 05090202**110**									
6above	Kain Run (headwater size)	OH53 35	XXX	x	ND	XXX	X		
6above	UT Kain, Otis Prop. (D Russell) (headwater size)		XX	ND	mean score = 3.5; weak non-stress result		O	ND	
6above	Todd Run (headwater size)	OH53 37	ND		ND		ND	x	
6above	Pleasant Run (headwater size)	OH53 41	XXX		mean score = 4; weak to in-conclusive	XXX	X		
6above	Fivemile Creek (headwater size)	OH53 42	XXX	x	ND	XXX	O	x	
6above	Grassy Run (headwater size)		XXX	x	ND	XXX	O		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrient Summary				Ammonia Toxicity Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	XXX		mean score = 5; in-conclusive	XXX	X/ID 1985 data only		
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	XXX		mean score = 6; in-conclusive	XXX	X		
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	XXX	x	mean score = 6; in-conclusive	XXX	O	x	
6above	Glady Run (headwater size)	OH53 48	XXX	ND	ND	XXX	O	ND	
6above	Solomon Run (headwater size)	OH53 53	ID		ND			x	
OEPA HUC11 Assessment Unit 05090202**100**									
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	XXX	x	mean score = 6; in-conclusive	XXX	O		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Nutrient Summary				Ammonia Toxicity Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	XXX	x	mean score = 5.3; in-conclusive	XXX	O		
7headwater	West Fork of East Fork (wadeable size)	OH53 56	XXX		ND	XXX	O		
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57	XXX	x	mean score = 6; in-conclusive	XXX	O	x	
7headwater	Turtle Creek (headwater size)	OH53 61	XX		ND		O	x	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
OEPA HUC11 Assessment Unit 05090202**130**								
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	XX	x		O-X	xx	
1below	Hall Run (headwater size)	OH53 2	XXX	x	XXX	X-XX	xx	XXX
1below	Wolfpen Run (headwater size)	OH53 3	X	x		XX		
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	X			X	x	
2below	Salt Run (headwater size)	OH53 4	X-XX			XX	xx	XXX
2below	UT Salt Run, Nature Center (D Russell) (headwater size)		X	ND		X	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
2below	UT Salt Run, Circuit City		**X**	ND		**X**	ND	
2below	Sugarcamp Run (headwater size)	OH53 5	**O/ID**	x		**X**	xx	
2below	East Branch Sugarcamp Run (headwater size)		**ND**	ND		**X**	ND	
2below	Shayler Run (headwater size)	OH53 6	**XX-XXX**	xx	**XXX**	**XX**	XX	**XXX**
2below	Shayler Run tributary (headwater size)	OH53 6.1	**ND**	ND		**XX**	ND	
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	**XX**	x		**XX**	x	
3stonelick	Lick Fork (headwater size)	OH53 9	**O-X**	ND		**XXX**	ND	
3stonelick	Brushy Fork (headwater size)		**O/ID**			**O/ID**		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
3stonelick	Newtonsville Creek (headwater size)		**XXX**	x	**XXX**	**X**	x	
OEPA HUC11 Assessment Unit 05090202**120**								
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	**XX**	x		**XX**		
4below	UT, Ross Road (headwater size)		**O/ID**	ND		**X**	ND	
4below	UT, SR222 @ Filager		**O**	ND		**O/ID**	ND	
4below	UT, SR222 @ jail		**O**	ND		**O/ID**	ND	
4below	UT, Tillbury Property (D Russell) (headwater size)		**XX**	ND		**X**	ND	
4below	Lucy Run (headwater size)	OH53 18	**XX**	x		**X**		
4below	Fourmile Run (headwater size)	OH53 19	**X**			**X**	xxx	**XXX**

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)		**X pre-1993 data only**			**X pre-1993 data only**		
5lakearea	Back Run (all data pre-1993)		**XX pre-1993 data only**	x		**X pre-1993 data only**	x	
5lakearea	Ulrey Run (headwater size)	OH53 22	**XX**	x		**XXX**	x	**XXX**
5lakearea	UT, East Fork State Park (D Russell) (headwater size)		**X**	ND		**X**	ND	
5lakearea	Slabcamp Run (headwater size)	OH53 23	**ID**	x		**XXX**	xx	**XXX**
5lakearea	Barnes Run (headwater size)	OH53 26	**XXX**	xx	**XXX**	**XXX**	xx	**XXX**
5lakearea	Poplar Creek (headwater size)	OH53 27	**XX**			**XXX**	xx	**XXX**
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	**XX wwtp only; 1980s data only**			**X 1980s data only**		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
5lakearea	Cloverlick Creek (wadeable size)	OH53 25	**O**	xx		**X**		
5lakearea	Cabin Run (headwater size)	OH53 24	**O**			**XXX**	x	**XXX**
OEPA HUC11 Assessment Unit 05090202**110**								
6above	Kain Run (headwater size)	OH53 35	**XXX**		**XXX**	**X**	x	
6above	UT Kain, Otis Prop. (D Russell) (headwater size)		**X**	ND		**X**	ND	
6above	Todd Run (headwater size)	OH53 37	**ND**	x		**X**		
6above	Pleasant Run (headwater size)	OH53 41	**XX**	x		**X**		
6above	Fivemile Creek (headwater size)	OH53 42	**X**	xx		**X**	x	
6above	Grassy Run (headwater size)		**X**			**X**		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	**O**			**O**		
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	**XX**	x		**X**		
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	**O**	x		**XX**	xx	**XXX?**
6above	Glady Run (headwater size)	OH53 48	**O**	ND		**ID**	ND	
6above	Solomon Run (headwater size)	OH53 53		x			x	
OEPA HUC11 Assessment Unit 05090202**100**								
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	**X**			**X**	x	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Organic Enrichment/ DO Summary: (B/COD outweigh fecal)*			*Siltation/ Sedimentation Summary*		
			WQ-SI	BPJ-local	**Summary**	WQ-SI	BPJ-local	**Summary**
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	**X**			**X**	x	
7headwater	West Fork of East Fork (wadeable size)	OH53 56	**O**			**XX**		
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57	**X**	x		**X**	xx	**XXX?**
7headwater	Turtle Creek (headwater size)	OH53 61	**O**	x		**X**	xx	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
OEPA HUC11 Assessment Unit 05090202**130**									
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	**O above geo 17 (rm 4); X-XX below**	x	mean score = 5.1; incon-clusive		**Metals observations associated w TSS. Summary: unlikely to be bioavailable X**	x	
1below	Hall Run (headwater size)	OH53 2	**XX-XXX**	x	ND	**XX-XXX**	**O**		
1below	Wolfpen Run (headwater size)	OH53 3	**XXX** n=1 1997		ND	**XXX**	**ID**		
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	**O**	x	mean score = 4.75; incon-clusive		**O**		
2below	Salt Run (headwater size)	OH53 4	**XX** **n=1 1997**		ND	**XX**	**O**		
2below	UT Salt Run, Nature Center (D Russell) (headwater size)		**ND**	ND	mean score = 6.5; slight stress indicator		**ND**	ND	

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
2below	UT Salt Run, Circuit City		ND	ND	ND		ID	ND	
2below	Sugarcamp Run (headwater size)	OH53 5	X-XX		ND	X-XX	O		
2below	East Branch Sugarcamp Run (headwater size)		XX n=1 1994	ND	ND	XX	ND	ND	
2below	Shayler Run (headwater size)	OH53 6	XX-XXX	xx		XX-XXX	XX	x	
2below	Shayler Run tributary (headwater size)	OH53 6.1	X	ND	ND		ND	ND	
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O below Lick Fork; declining to XX upstream	xx	mean score = 5.8; incon-clusive	XX	Possible Cu; other metals unlikely		
3stonelick	Lick Fork (headwater size)	OH53 9	X-XX	ND	ND	X-XX	O	ND	
3stonelick	Brushy Fork (headwater size)		XXX		mean score = 6.25; incon-clusive	XXX	ND		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
3stonelick	Newtonsville Creek (headwater size)		ND		ND		Possible Cu; other metals unlikely		
OEPA HUC11 Assessment Unit 05090202**120**									
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O		mean score = 4.59; in-conclusive		O		
4below	UT, Ross Road (headwater size)		ND	ND	mean score = 7.5; moderate stress indicator		ND	ND	
4below	UT, SR222 @ Filager		ND	ND	ND		O/ND	ND	
4below	UT, SR222 @ jail		ND	ND	ND		O/ND	ND	
4below	UT, Tillbury Property (D Russell) (headwater size)		ND	ND	mean score = 6.75; slight stress indicator		ND	ND	
4below	Lucy Run (headwater size)	OH53 18	XX ds to XXX us			XXX	O		
4below	Fourmile Run (headwater size)	OH53 19	O-X n=1 1997	x	ND		O/ND		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)		ND		ND		O/ID		
5lakearea	Back Run (all data pre-1993)		ND		ND		O/ID		
5lakearea	Ulrey Run (headwater size)	OH53 22	XX n=1 1997		ND	XX	O/ND		
5lakearea	UT, East Fork State Park (D Russell) (headwater size)		ND	ND	mean score = 6.5; in-conclusive		ND	ND	
5lakearea	Slabcamp Run (headwater size)	OH53 23	XXX n=1 1998		ND	XXX	O/ID	x	
5lakearea	Barnes Run (headwater size)	OH53 26	X n=1 1997		ND		O/ND		
5lakearea	Poplar Creek (headwater size)	OH53 27	XX n=1 1997	x	ND	XX	O/ID		
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND		ND		ND		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
5lakearea	Cloverlick Creek (wadeable size)	OH53 25	ND	x	ND		O/ID		
5lakearea	Cabin Run (headwater size)	OH53 24	O n=1 1998		ND		O/ID, except Hosea discharge		
OEPA HUC11 Assessment Unit 05090202**110**									
6above	Kain Run (headwater size)	OH53 35	X-XX	x	ND	XX	Possible Cu; other metals unlikely	x	x?
6above	UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND	mean score = 7.25; moderate stress indicator		ND	ND	
6above	Todd Run (headwater size)	OH53 37	XX n=1, 1998		ND	XX	ND		
6above	Pleasant Run (headwater size)	OH53 41	X-XX		mean score = 4; weak to in-conclusive	X-XX	O	x	
6above	Fivemile Creek (headwater size)	OH53 42	XX		ND	XX	O		
6above	Grassy Run (headwater size)		ND		ND		ND		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	**O** **n=1, 1998**		mean score = 5.5; in-conclusive		**O/ID**		
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	**O**		mean score = 5.15; in-conclusive		**Possible Cu; other metals unlikely**		
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	**O**	xx	mean score = 5.5; in-conclusive		**O**		
6above	Glady Run (headwater size)	OH53 48	**ND**	ND	ND		**ND**	ND	
6above	Solomon Run (headwater size)	OH53 53	**ND**	x	ND				
OEPA HUC11 Assessment Unit 05090202**100**									
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	**O**		mean score = 5; in-conclusive		**O**		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Habitat Summary				Metals Summary		
			WQ-SI	BPJ-local	TV model	Summary	WQ-SI	BPJ-local	Summary
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	O overall to X upstream		mean score = 5.7; in-conclusive		O		
7headwater	West Fork of East Fork (wadeable size)	OH53 56	O		ND		O		
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57	XXX	x	mean score = 6; in-conclusive	XXX	O		
7headwater	Turtle Creek (headwater size)	OH53 61	XX	x	ND	XX	O		

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
OEPA HUC11 Assessment Unit 05090202**130**								
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	**ID**	x?		**Richards-Baker flashiness index inconclusive for all**	x	
1below	Hall Run (headwater size)	OH53 2	**ND**				x	
1below	Wolfpen Run (headwater size)	OH53 3	**ND**					
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	**ND**					
2below	Salt Run (headwater size)	OH53 4	**ND**				x	
2below	UT Salt Run, Nature Center (D Russell) (headwater size)		**ND**	ND				

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
2below	UT Salt Run, Circuit City		ND	ND				
2below	Sugarcamp Run (headwater size)	OH53 5	ND				x	
2below	East Branch Sugarcamp Run (headwater size)		ND	ND				
2below	Shayler Run (headwater size)	OH53 6	ND	x?				
2below	Shayler Run tributary (headwater size)	OH53 6.1	ND	ND				
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	ND					
3stonelick	Lick Fork (headwater size)	OH53 9	ND	ND				
3stonelick	Brushy Fork (headwater size)		ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
3stonelick	Newtonsville Creek (headwater size)		ND					
OEPA HUC11 Assessment Unit 05090202**120**								
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	ID					
4below	UT, Ross Road (headwater size)		ND	ND				
4below	UT, SR222 @ Filager		ND	ND				
4below	UT, SR222 @ jail		ND	ND				
4below	UT, Tillbury Property (D Russell) (headwater size)		ND	ND				
4below	Lucy Run (headwater size)	OH53 18	ND					
4below	Fourmile Run (headwater size)	OH53 19	ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)		ND					
5lakearea	Back Run (all data pre-1993)		ND					
5lakearea	Ulrey Run (headwater size)	OH53 22	ND					
5lakearea	UT, East Fork State Park (D Russell) (headwater size)		ND	ND				
5lakearea	Slabcamp Run (headwater size)	OH53 23	ND	x?				
5lakearea	Barnes Run (headwater size)	OH53 26	ND					
5lakearea	Poplar Creek (headwater size)	OH53 27	ND					
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
5lakearea	Cloverlick Creek (wadeable size)	OH53 25	ND				x	
5lakearea	Cabin Run (headwater size)	OH53 24	ND					
OEPA HUC11 Assessment Unit 05090202**110**								
6above	Kain Run (headwater size)	OH53 35	ND	x?				
6above	UT Kain, Otis Prop. (D Russell) (headwater size)		ND	ND				
6above	Todd Run (headwater size)	OH53 37	ND					
6above	Pleasant Run (headwater size)	OH53 41	ND	x?				
6above	Fivemile Creek (headwater size)	OH53 42	ND					
6above	Grassy Run (headwater size)		ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	ND					
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	X/ND					
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	ND	x?				
6above	Glady Run (headwater size)	OH53 48	ND	ND				
6above	Solomon Run (headwater size)	OH53 53						
OEPA HUC11 Assessment Unit 05090202**100**								
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Toxics Summary			Flow Alteration Summary		
			WQ-SI	BPJ-local	Summary	WQ-SI	BPJ-local	Summary
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	ND					
7headwater	West Fork of East Fork (wadeable size)	OH53 56	ND					
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57	ND				x	
7headwater	Turtle Creek (headwater size)	OH53 61	ND					

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Ionic Stress Summary				pH Extremes
			WQ-SI	BPJ-local	TV model	Summary	
OEPA HUC11 Assessment Unit 05090202**130**							
1below	East Fork, mouth to Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O		mean score = 4.9; incon-clusive		E
1below	Hall Run (headwater size)	OH53 2	X		ND		E
1below	Wolfpen Run (headwater size)	OH53 3	X		ND		E
2below	East Fork, Stonelick Cr to upst Wolfpen Run (EWH, Small River sites)	OH53 1 (part)	O		mean score = 5; incon-clusive		E
2below	Salt Run (headwater size)	OH53 4	XX		ND	?	0
2below	UT Salt Run, Nature Center (D Russell) (headwater size)		X	ND	mean score = 7.25; moderate stress indicator	?	E

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	Ionic Stress Summary				pH Extremes
			WQ-SI	BPJ-local	TV model	Summary	
2below	UT Salt Run, Circuit City		O	ND	ND		ND
2below	Sugarcamp Run (headwater size)	OH53 5	O		ND		E
2below	East Branch Sugarcamp Run (headwater size)		ND	ND	ND		ND
2below	Shayler Run (headwater size)	OH53 6	X				E
2below	Shayler Run tributary (headwater size)	OH53 6.1	ND	ND	ND		ND
3stonelick	Stonelick Creek (wadeable below rm11, geo16; headwater above rm16 geo20)	OH53 8	O		mean score = 5.2; incon-clusive		E
3stonelick	Lick Fork (headwater size)	OH53 9	O	ND	ND		E
3stonelick	Brushy Fork (headwater size)		XXX increasing trend, unknown chloride		mean score = 6.5; slight stress indicator	XXX	ND

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Ionic Stress Summary*				*pH Extremes*
			WQ-SI	BPJ-local	TV model	Summary	
3stonelick	Newtonsville Creek (headwater size)		XXX some chloride effects		ND	XXX	E
OEPA HUC11 Assessment Unit 05090202**120**							
4below	East Fork, below dam to Stonelick (EWH, Small River sites)	OH53 16	O		mean score = 4.66; in-conclusive		0
4below	UT, Ross Road (headwater size)		XXX	ND	mean score = 8; positive stress indicator	XXX	ND
4below	UT, SR222 @ Filager		XX	ND	ND		E
4below	UT, SR222 @ jail		O	ND	ND		E
4below	UT, Tillbury Property (D Russell) (headwater size)		XXX	ND	mean score = 6.75; slight stress indicator	xxx?	ND
4below	Lucy Run (headwater size)	OH53 18	O				E
4below	Fourmile Run (headwater size)	OH53 19	O		ND		E

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Ionic Stress Summary*				*pH Extremes*
			WQ-SI	BPJ-local	TV model	Summary	
5lakearea	East Fork LMR (EWH, Small River sites) (all data pre-1993)		X		ND		some>9 1980s data only
5lakearea	Back Run (all data pre-1993)		O		ND		some>9 1980s data only
5lakearea	Ulrey Run (headwater size)	OH53 22	X		ND		some>9
5lakearea	UT, East Fork State Park (D Russell) (headwater size)		XXX	ND	mean score = 6.25; in-conclusive	xxx?	E
5lakearea	Slabcamp Run (headwater size)	OH53 23	O		ND		ND
5lakearea	Barnes Run (headwater size)	OH53 26	O/ND		ND		E
5lakearea	Poplar Creek (headwater size)	OH53 27	X		ND		E
5lakearea	Town Run (headwater size) (all data 1983, 1987 only)	OH53 29	ND		ND		n=1 pH=7.3

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Ionic Stress Summary*				*pH Extremes*
			WQ-SI	BPJ-local	TV model	Summary	
5lakearea	Cloverlick Creek (wadeable size)	OH53 25	O		ND		some>9
5lakearea	Cabin Run (headwater size)	OH53 24	X		ND		E
OEPA HUC11 Assessment Unit 05090202**110**							
6above	Kain Run (headwater size)	OH53 35	XX	ND			E
6above	UT Kain, Otis Prop. (D Russell) (headwater size)		XXX increasing trend, low chloride	ND	mean score = 5.75; in-conclusive	xxx?	E
6above	Todd Run (headwater size)	OH53 37	ND	ND			E
6above	Pleasant Run (headwater size)	OH53 41	O		mean score = 4; weak to in-conclusive		E
6above	Fivemile Creek (headwater size)	OH53 42	O		ND		E
6above	Grassy Run (headwater size)		O		ND		E

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Ionic Stress Summary*				*pH Extremes*
			WQ-SI	BPJ-local	TV model	Summary	
6above	East Fork, Solomon R to upst Cloverlick Creek: Todd R to Harsha Lake (EWH, Small River sites)	OH53 20	O		mean score = 5; in-conclusive		E
6above	East Fork, Solomon R to upst Cloverlick Creek: Howard R to Todd R (EWH, Small River sites)	OH53 36	O		mean score = 5; in-conclusive		E
6above	East Fork, Solomon R to upst Cloverlick Creek: Solomon R to Howard R (EWH, Wadeable sites)	OH53 45	O		mean score = 5; in-conclusive		E
6above	Glady Run (headwater size)	OH53 48	XX	ND	ND		E
6above	Solomon Run (headwater size)	OH53 53			ND		
OEPA HUC11 Assessment Unit 05090202**100**							
7headwater	East Fork, hw to upst Solomon Run: Dodson to Solomon (EWH, Wadeable sites)	OH53 52	XX		mean score = 5; in-conclusive		E

SI Assessment group	Stream EWH: East Fork and Dodson Creek WWH: all other tributaries	OH WBID seg-ment	*Ionic Stress Summary*				*pH Extremes*
			WQ-SI	BPJ-local	TV model	Summary	
7headwater	East Fork, hw to upst Solomon Run: hw to Dodson (EWH, Wadeable sites)	OH53 60	X		mean score = 5.3; in-conclusive		E
7headwater	West Fork of East Fork (wadeable size)	OH53 56	X		ND		E
7headwater	Dodson Creek (EWH, wadeable size)	OH53 57	X		mean score = 5; in-conclusive		E
7headwater	Turtle Creek (headwater size)	OH53 61	XX		ND		E

Type	SI Subshed/ geoorder group	Geoorder position (within subgroup)	Project Site ID (PSiteID)	River Mile	Location description	Data Owners' Original (multiple) Site IDs
wwtp	1	6	EF0153	1.53	Milford WWTP effluent d/c to East Fork L Miami R	M04W43
wwtp	1	18	EF0470	4.7	E. Fk. L. Miami R. dst Lower East Fork WWTP	M04S30 and S11100 4.70
wwtp	1	34-35	WLFP150/155		Wolfpen mobile home effluent (155) and downstream eff (150)	WLFPN1.5 and WOLFMHEF
wwtp	2	5-6-7	SALT_UT2.1, SALT_UT2.2, SALT_UT2.3		Circuit City stormwater basin (UNT Salt Run), Eastgate Blvd inflows (N/S) and outflow	CCITYINN, CCITYINS, CCITYOUT
autosamp	2	18	SHAYLR17	1.7	Shayler Run, above Baldwin Rd bridge @ autosampler	SHYLR1.7; SHAYLER1-3; SHAYLERa-f; SHAYLERT
autosamp	3	3	ST0100	1	Stonelick Creek, US 50 autosampler station	S11107 1.00; STEFLMR, STEFLMR1-3, STEFLMRT
autosamp	3	15	NEWTON03	0.9	Newtonsville Creek, Cedarville Rd @ autosampler station	NEWTN0.9; NEWTCOMP; NEWTON1-3; NEWTONT
wwtp	4	14-15	EF1259/60	12.59-12.6	EFLMR at Middle E Fk WWTP mixing zone; Amelia-Batavia effluent d/c to EFLMR	S11100 12.59; M04S26; M04W21
wwtp	4	19-20	EF1340/50	13.4-13.5	Batavia wwtp mix zone; Batavia wwtp effluent d/c to EFLMR	M04S27, M04W19
wwtp	5	11	Town2	1.34	Town Run (just) dst Bethel wwtp	S11125 1.34; M04S24
wwtp	5	19-20	Hosea In/out		Cabin Run; SW basin inflow/discharge	HOSEAIN; HOSEAOUT
autosamp	6	3	KAIN18	1.8	Kain Run, SR 276 @ autosample	KAIN1.8; KAINRUN1-3; KAINRUN
autosamp	6	9	EF3480	34.8	Main Street, Williamsburg	2EFR10002; EFRM34.8; EFRM3481-3; EFRM348T; M04S08
wwtp	6	10	EF3526	35.26	Williamsburg wwtp effluent d/c to EFLMR	M04W47

APPENDIX D: BIOSTATISTICAL MEMO

D.1 Background

The assessment of biological condition is a highly effective means of evaluating cumulative impacts of nonpoint and point source pollution and the Ohio EPA utilizes three measures to calculate use attainment: the Invertebrate Community Index (ICI), the fish Index of Biological Integrity (IBI), and the Modified Index of Well-Being (mIWB). Although these indices are very effective at determining if streams are not meeting their aquatic life use designation, they do not identify the cause of impairment. If an effective management plan is to be developed, there must be a thorough understanding of the multiple stressors responsible for non-attainment and targets must be adopted that are believed to result in future attainment.

Two parallel and related approaches have been used to identify stressors and potential targets for streams in the East Fork Little Miami River watershed. The Stressor Identification approach utilizes a weight of evidence process that considers the universe of potential stressors and looks at the relative probability of each one to contribute to the observed nonattainment. Alternatively, a biostatistical approach relies upon statistical evaluations of the relationships between available biological, physical, and chemical water quality data. The biostatistical approach and results are described further below.

D.2 Objectives

The objectives of the statistical analyses were to identify environmental factors that are directly and indirectly contributing to biological degradation; to build empirical models to establish linkages between environmental stressors and biological community; to develop biological indicators for environmental impairment; and to diagnose stressors that impact biological integrity.

D.3 Analysis Methods

An initial evaluation of the ecoregion-wide database indicated that there were very few matches (<60 samples) of macroinvertebrates and fish data and environmental characteristics at each exact site and date. The following procedures were therefore taken to increase the sample size and establish a more statistically-valid database:

- Expand the “window” of water quality samples that can be associated with biological samples to 3 months before the biological sample;
- Expand the definition of a “site” to be a contiguous stream reach with no intervening mapped tributaries or discharges. All sites within such a defined contiguous stream reach were then considered multiple observations of the same reach. This required evaluation of monitoring STATIONID assignments and modeling SUBBASINIDs to ensure no intervening tributaries;

Three statistical approaches were performed to implement the proposed objectives for the data analyses:

1) Correlation analyses identify the apparent linkage between biological conditions and environmental variables. They may or may not indicate the real relationship between biological condition (biological indices) and environmental characteristics.
2) Canonical Correspondence Analysis (CCA) is a direct gradient analysis, which is designed to detect the patterns of variation in the species data that can be ‘best’ explained by the observed environmental variables. The resulting ordination diagram expresses not only a pattern of variation in species composition but also the main relationships between the species and each of the environmental variables.

3) Weighted averaging regression is a method to estimate a taxon's optimal condition for growth and survival, and is used to infer the environmental condition based on all taxa present in the sample.

In addition to all the regular environmental variables (e.g., water chemistry, Qualitative Habitat Evaluation Indices (QHEI)) directly measured by Clermont County and Ohio EPA, a list of other variables were also made available for statistical modeling:

- Hydrology metrics (e.g., percentage over base flow, frequency of high flows, etc.) calculated from the watershed model for multiple regression analysis;
- Additional candidate predictor variables for multiple regression analysis; e.g., percent imperviousness, percent forest;
- Simulated 15%, 50%, and 85% TP, TN, and BOD statistics for each modeling subwatershed.

D.4 Correlation analysis

We first examined the direct correlations between biological indices and environmental characteristics. Macroinvertebrate ICI and fish IBI were calculated in the database. To increase the sample size, data collected from both the EFLMR watershed and the entire Interior Plateau ecoregion were included and resulted in the following:

- 195 matched macroinvertebrate and chemistry samples
- 283 matched macroinvertebrate and habitat scores
- 282 matched fish and chemistry samples
- 422 matched fish and habitat scores

In addition to the quantitative macroinvertebrate sampling from artificial substrates, OEPA collects a qualitative sample alongside every Hester-Dendy deployment. These qualitative macroinvertebrate samples were also used as our first bug response measure for habitat-related stressors.

Land use characteristics and hydrological modeling results from the EFLMR basin were also added to the list of environmental variables because of their potential influence on the condition on the aquatic community. For example, land use change brings with it an increase of impervious (non-absorbent/non-permeable) surfaces and studies have shown that stream health is directly related to imperviousness (Boward et al. 1999). As imperviousness increases, stream and ground water health decreases. According to the analysis of the EFLMR data, we found that modeling subwatershed percent imperviousness was strongly correlated with total nitrogen ($r=0.47$, $p<0.05$), NOx (nitrate+nitrite) ($r=0.51$, $p<0.05$), and total phosphorus concentrations ($r=-0.63$, $p<0.05$).

Several metrics describing instream flow conditions were also calculated using simulated output from the watershed model. These metrics are based on the Indicators of Hydrologic Alteration (IHA) tool (Richter, 1996) and include measures of flashiness, extreme wet and dry conditions, frequency and duration of flow pulses, and the rate and frequency of flow changes. The metrics were calculated for each of the modeling subwatersheds that had either macroinvertebrate or fish data and were based on output from the model for the period 1990 to 2000. By using the model, the predicted flows take into account the various mixes of soil types, land use types, and topography in each subwatershed

The Richards-Baker flashiness index was used in addition to the IHA metrics and is calculated by dividing the flow oscillations for a time interval (i.e., the sum of the absolute values of day-to-day

changes in mean daily flow) by total discharge during that time interval. This index in the watershed was negatively correlated with median TN (r=-0.50) and TP (r=-0.63) concentrations in the subwatershed in the EFLMR. Hydrological high pulse was defined as those periods within a year in which the daily mean water condition rises above the 75th percentile of all daily values for the pre-impact period. Other parameters included number of rises, falls, mean plus difference, mean minus difference, etc. of water level fluctuation in the modeled subbasins.

Because of the impact of different sources in the EFLMR watershed, the environmental conditions are highly heterogeneous, and many of the environmental parameters are not normally distributed. Therefore, Spearman rank-order correlation coefficients were used to examine the relation between biological indices and environmental variables. This measure is a nonparametric version of the Pearson correlation coefficient, based on the ranks of the data rather than the actual values.

Not surprisingly, many of the environmental variables correlated with each other. Conductivity as a measure of total ions, positively correlated with total hardness (r=0.847), and major ion concentrations (Ca 0.968, Cl 0.863, Mg 0.726, Na 0.874, Sulfate 0.670). Conductivity also correlated with several nutrient parameters (NOx 0.474, TP 0.361). Total hardness is composed of Ca (r=0.934) and Mg (r=0.898) and thus correlated very strongly with them. Among all the nutrient parameters, NOx and TP (r=0.657), Ammonia and TKN (r=0.630) showed strong correlations. Other parameters showing organic enrichment such as BOD, CBOD, COD correlated with ammonia and TKN (r>0.300).

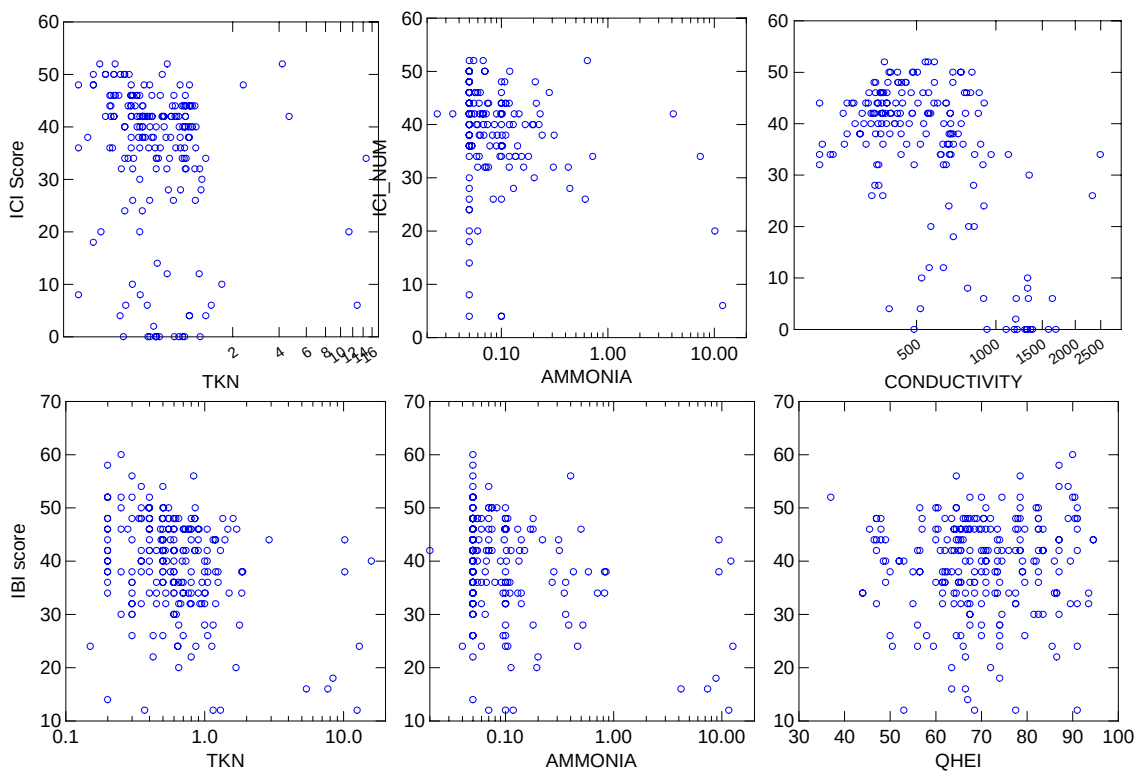

Figure D-1. Scatter plot of relationships between biological indices (ICI and IBI) and several important environmental variables (Ammonia, TKN, conductivity, and QHEI).

Environmental variables including watershed land use, general onsite measurement of environmental characteristics, ion and nutrient concentrations, and habitat related characteristics, as well as hydrological modeling parameters, were analyzed with macroinvertebrate ICI and fish IBI scores and are summarized in Table D-1. Notable results include the following (Figure D-1):

D.4.1 Ionic strength

- A number of ion-related variables were negatively correlated with macroinvertebrate ICI. Conductivity is generally an excellent predictor of biological condition of streams because many invertebrate taxa responded strongly to ion gradients. However, conductivity is dependent on the ions in the water, including cations (Ca, Mg) and anions (Cl, SO4, CO3). Conductivity, as a measure of total ion strength, was the strongest variable negatively associated with macroinvertebrate conditions in streams (r= -0.360). Another ion that weakly correlated with ICI was Ca. Total hardness, mainly composed of Ca and Mg, was also negatively correlated with ICI scores.

- Two indices were used to assess fish conditions in the streams, IBI and MIWB. Different from macroinvertebrates, fish were not significantly associated with total ionic strength and most of the single ion concentrations. On the other hand, fish were associated with high Mg concentrations (r=0.281 to IBI and 0.357 to MIWB), which contribute significantly to total hardness.

Table D-1. Correlation Matrix between biological indices and environmental variables. A * indicated highly significant correlation (p<0.05).

Spearman Correlation	No. of Case	ICI	No. of Case	IBI	MIWB
Land use					
% Impervious	102	0.089	113	0.026	0.150
%Forested	102	-0.209	113	0.037	-0.176
General					
pH	129	-0.112	173	0.133	0.200
Total Dissolved Residue	119	-0.129	166	-0.033	0.029
Total Suspended Solid	171	0.107	166	0.007	0.334*
Water Temperature	173	-0.163	239	0.004	0.175
Ion					
Conductivity	182	-0.36*	197	-0.067	0.076
Hardness Total	130	-0.184	233	0.089	0.182
Cadmium	134	-0.181	197	-0.025	0.099
Calcium	132	-0.242*	205	0.100	0.087
Chlorides	117	-0.177	177	-0.115	0.024
Copper	145	-0.134	210	-0.055	0.136
Iron	134	-0.232*	207	-0.099	0.227*
Lead	142	-0.259*	227	-0.117	-0.014
Magnesium	131	-0.184	131	0.281*	0.357*
Manganese	93	-0.164	131	-0.181	0.065
Zinc Total	137	-0.156	220	-0.213*	-0.123
Nutrients					
Ammonia	171	-0.268*	269	-0.176*	-0.101
NOX	193	0.069	255	0.065	0.268*
TKN	193	-0.272*	274	-0.178*	-0.064
Phosphorus Total	193	0.059	275	-0.122	0.039
BOD	112	-0.164	156	-0.29*	-0.275*
CBOD5	121	0.001	97	-0.101	-0.081
COD			155	0.180	0.124
Fecal Coliform	130	-0.153	117	-0.177	-0.245*
Habitat					
QHEI	117	0.107	422	0.391*	0.526*
SUBSTRATE	117	0.002	422	0.040	0.011
SILTCOVER	117	0.051	422	-0.087	-0.025
EMBEDDED	117	0.003	422	-0.151	-0.172
COVER	117	0.203*	422	0.416*	0.472*
RIPARIAN	117	-0.031	422	-0.056	0.025
POOL	117	0.091	422	0.389*	0.577*
RIFFLE	117	0.134	422	0.175*	0.346*
GRADIENT_S	117	-0.083	422	0.231*	0.279*
GRADIENT_V	117	-0.049	422	-0.119	-0.539*
Hydrological modeling					
HPCount	38	0.457*	54	-0.412*	-0.597*
HPDuration	38	-0.449*	54	0.388*	0.535*
Mean (+) Diff	38	0.063	54	0.206	0.572*

Spearman Correlation	No. of Case	ICI	No. of Case	IBI	MIWB
Mean (-) Diff	38	-0.039	54	-0.230	-0.593*
# Rises	38	-0.316*	54	0.397*	0.679*
# Falls	38	0.370*	54	-0.366*	-0.543*
Flashiness	38	0.345	54	-0.446*	-0.778*

D.4.2 Nutrient concentrations

Nutrients that were significantly correlated with ICI were ammonia (r=-0.268) and TKN (r=-0.272) (Figure 1). The negative correlation with ammonia is likely due to ammonia toxicity especially when ammonia concentration was over 1 mg/L. The negative correlation with TKN could be due to the fact it is a measure of organic enrichment as well as nitrogen enrichment. For example, BOD also showed a negative correlation with ICI.

Nutrient and organic enrichment were also negatively associated with fish IBI scores. Ammonia, TKN, and BOD again, were highly significantly associated with IBI and MIWB. Fecal coliform bacteria also negatively affected MIWB. COD and TP also significantly correlated with IBI though not with MIWB.

D.4.3 Habitat alteration

Changes in habitat were not associated with strong changes in ICI score. None of the QHEI parameters but cover (r=0.203) was significantly correlated with ICI score. Ohio sampling protocol for macroinvertebrates used artificial substrates in streams for quantitatively collecting macroinvertebrates. This method collected macroinvertebrate samples colonized on the artificial substrates during the past 6 weeks so the direct effect of substrate was eliminated from the habitat effect. This could be why the overall score of reach habitat had little effect on the macroinvertebrate communities on the substrates. However, cover measures the available habitat for fishes and invertebrates, and thus affect the number and composition of taxa in the streams. Cover scores in the stream reach had certain correlation with ICI scores.

Qualitative macroinvertebrate metrics indicated that EPT metrics in natural habitats responded strongly to habitat related parameters (Table D-2, Figure D-2). Total EPT taxa, total EPT individuals, and total taxa all positively correlated with QHEI scores indicating that habitat degradation would significantly decrease EPT taxa in natural habitats. Of the total habitat scores, cover, pool, gradient, and catchment area all significantly affected the EPT and total taxa metrics in the Ohio

Table D-2. Correlations of macroinvertebrate metrics based on qualitative sampling with habitat related environmental variables. * indicated a significant correlation.

Pearson Correlation	Total individual	Total taxa	Ephem. taxa	Trich. Taxa	Pleco. taxa	EPT Taxa
QHEI	0.458*	0.458*	0.469*	0.59*	0.222	0.607*
SUBSTRATE	-0.072	-0.072	0.02	0.171	0.051	0.11
EMBEDDED	0.484*	0.484*	0.225	0.255	-0.082	0.257
COVER	0.505*	0.505*	0.484*	0.512*	0.122	0.563*
CHANNEL	0.051	0.051	0.14	0.331	0.124	0.272
RIPARIAN	-0.389*	-0.389*	-0.189	-0.108	0.189	-0.147
POOL	0.743*	0.743*	0.598*	0.625*	0.159	0.693*
RIFFLE	0.211	0.211	0.255	0.363*	0.196	0.361*
GRADIENT_S	0.552*	0.552*	0.444*	0.425*	0.152	0.497*
CATCHMAREA	0.474*	0.474*	0.481*	0.234	0.057	0.404*

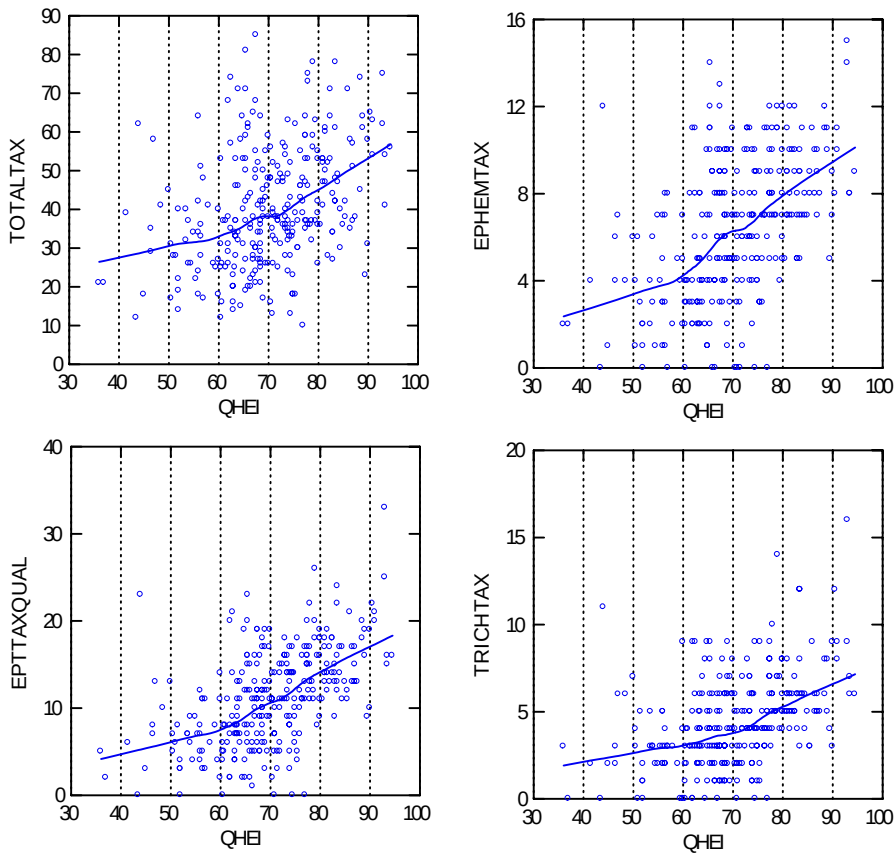

Figure D-2. Responses of macroinvertebrate metrics to habitat scores on natural habitat. A local weighted regression line was added to show the trend of change along the habitat gradient.

Fish IBI scores are highly significantly correlated with habitat scores (r≥0.391). The strongest parameters in the habitat scores were cover, and pool, which showed strongest correlations with IBI and MIWB.

D.4.4 Hydrological modeling

Surprisingly, macroinvertebrate ICI scores were positively correlated with flashiness (r=0.345). ICI scores were also negatively correlated with the number of rises and high pulse duration, but positively correlated with the number of falls and high pulse count. All of these indicated that healthy macroinvertebrate communities (bugs scored high in ICI) preferred low water levels. Flashiness, as a measure of flow frequency, had a negative impact on nutrient concentrations in the water column (r=-0.50 to median TN and -0.63 to median TP in the watershed). Because the ICI was calculated based on macroinvertebrates on artificial substrates, it is possible macroinvertebrates on artificial substrates do not respond to flashiness.

Fish, on the other hand, were negatively associated with flashiness (r=-0.446 with IBI, -0.778 with MIWB). It can be indicated by the strong positive correlation between high HP duration, number of rises, and the fish IBI scores. Apparently, fish prefer high water level and fewer changes in water level.

D.5 CCA ordination

Because the original data were from different sources, there were observed differences in data quality and resolution. For example, in some cases macroinvertebrate taxa were identified to species level while in other samples they were only identified to genus or even family level. To minimize the errors created by using taxa identified to different taxonomic level, we standardized macroinvertebrate data both to above genus level (include genus), and to above family (include family) level. We performed CCA on the relationship between these two sets of macroinvertebrate data and their related environmental variables. The results indicated that both the genus level and family level data produced very similar CCA output though family level data had less heterogeneinity and variation in the dataset as expected. Genus level data had much wider variations since the high-resolution data had stored much more information than the low taxonomical resolution (family level). Thus, we present here only results from genus level data, and used only genus level data for subsequent analysis.

The CCA results (Figure D-3) showed that the variance of macroinvertebrate data explained by the first two axes were 5 percent and 3.2 percent respectively. The third and fourth axes explained much less variance, as expected which indicated a successful CCA result. This indicates the ordination is "good" in the sense that we have successfully reduced the dimensionality of the data, the principal objective of ordination. If too many axes are significant (have large eigenvalue), that indicates the whole model is not much different from random. Global permutation tests, which judge the significance of the relationship between taxa and environment, were also used to evaluate the EFLMR data. The first canonical eigenvalue[2] is 0.26, and the F-ratio is 10.224. The resulting P-value is 0.0020, indicating that the first canonical axis is statistically significant at the one percent level. Thereafter, the test based on the sum of all canonical eighenvalues is report. The trace is 0.78, leading to an F-ratio[3] of 2.407. The resulting P-value is 0.0020, demonstrating that the relationship between the species and the environmental variables is highly significant.

[2] The eigenvalues measure the importance of each of the axes.
[3] The F-ratio is the ratio of two independent estimates of the variance of a normal distribution.

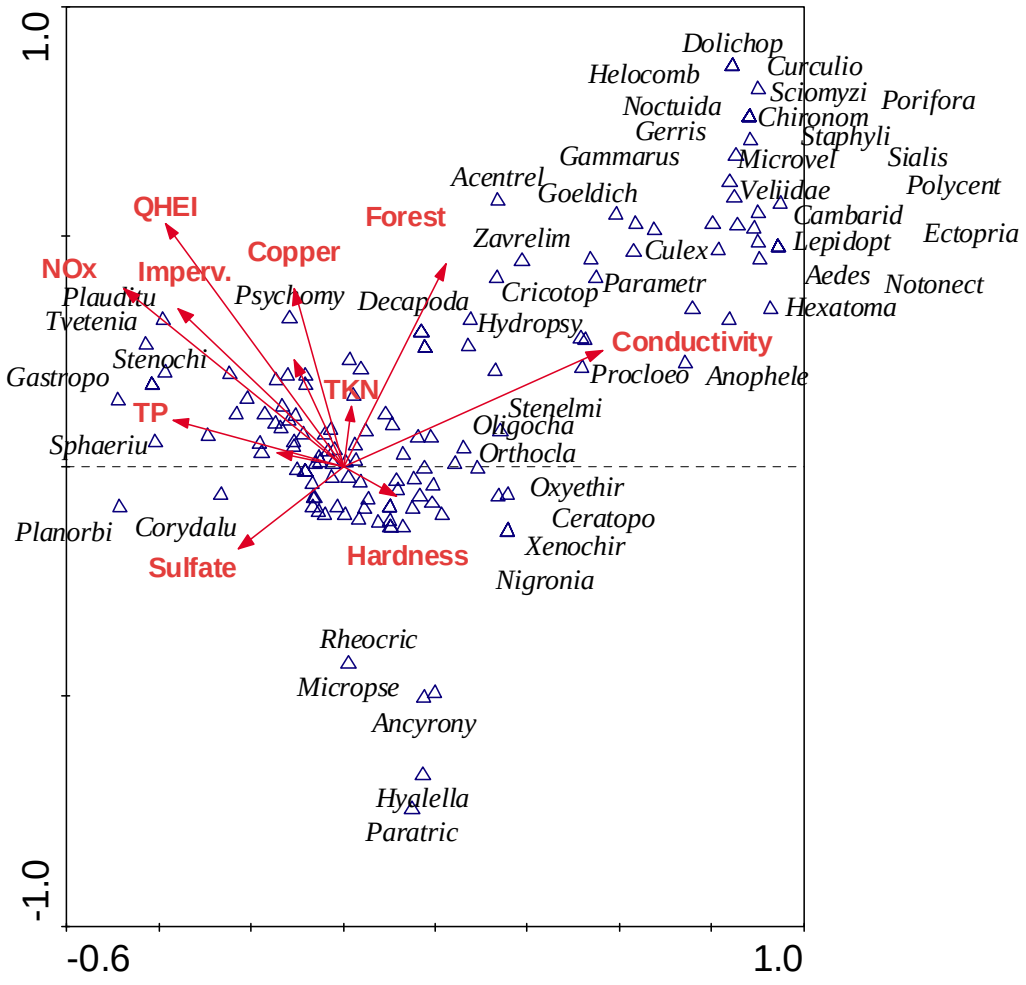

Figure D-3. Canonical Correspondence analysis of macroinvertebrates assemblages with environmental variables. The biplot shows the strength of environmental variables (arrows) and taxa distribution in the ordination space.

The ordination plot of CCA illustrated the relationship between environmental variables and macroinvertebrate genera. The arrows indicate the direction and strength of the environmental variables in the ordination spaces and each triangle represents the distribution of a macroinvertebrate genus in the environmental gradients. Only those taxa distributed in the end of environmental gradients were shown in the ordination. Apparently, a number of taxa are dispersed in the high conductivity gradient while some other taxa might indicate high nutrient (NOx) and good habitat scores (Figure 3).

Table D-3. Summary of a CCA based on invertebrate genus-up level data and environmental variables

Axes	1	2	3	4	Total inertia[2]
Eigenvalues[1] :	0.26	0.164	0.08	0.062	5.165
Species-environment correlations :	0.749	0.68	0.672	0.671	
Cumulative percentage variance					
of species data :	5	8.2	9.8	11	
of species-environment relation:	33.4	54.4	64.7	72.6	
Sum of all eigenvalues					5.165
Sum of all canonical eigenvalues					0.78

[1] The eigenvalues measure the importance of each of the axes;
[2]The total inertia is the total variance in the species data as measured by the chi-square of the simple-by-species table divided by the table's total;
[3]The species-environment correlation measures the strength of the relation between species and environment for a particular axis. It is the correlation between the sample scores for an axis derived from the species data and the sample scores that are linear combination of the environmental variables;
[4]The percentage of variance of the species data explained by the axes can be derived from the eigenvalues and the sum of all unconstrained eigenvalues.

Table D-4. Results of an automatic forward selection showing marginal and conditional effects of environmental variables to macroinvertebrate genus data

	Conditional Effects			Marginal Effects
Variable	LambdaA	P	F	Lambda1
Conductivity	0.13	0.002	4.8	0.13
NOx	0.15	0.002	6.19	0.11
QHEI	0.08	0.002	2.91	0.1
Hardness	0.06	0.002	2.72	0.05
TKN	0.05	0.014	2.05	0.05
Phosphorus	0.05	0.002	2.04	0.07
Fe	0.05	0.004	1.88	0.05
Ammonia	0.04	0.006	1.71	0.05
% Forested	0.04	0.05	1.59	0.06
% Imperviousness	0.05	0.002	1.85	0.07
Cu	0.03	0.086	1.37	0.07
Total Sulfate	0.03	0.12	1.31	0.05
Water Temperature	0.02	0.698	0.78	0.03

Table D-4 shows the importance of the environmental variables in the CCA ordination.

- Conditional effects shows the environmental variables in order of their inclusion in the model, together with the additional variance each variable explains at the time it was included. The Monte Carlo simulation estimates the significance of the variable (p-value) together with the test statistic (F-value).
- Marginal effects show the individual environmental variables in order of the variance they explain individually (i.e. when that particular variable is used as the only environmental variable.)

- Lambda is the inertia explained by each individual variable.
- Significance tests in forward selection are often too liberal. If none of a large number of variables has a real effect, the reported P-values of the best variable in the forward selection may be well below the conventional 5% level, just because of the selection.

The results indicated that the most important environmental variables that were associated to the type and abundance of species likely to be found at a particular site were conductivity, NOx, and habitat scores. Some other factors may also contribute and improve the model, such as hardness, TKN, and phosphorus. However, the effects of these variables are much weaker (from Lambda values) than the top three variables measured. TP is strongly correlated with NOx concentration.

Correlation analysis used calculated metrics, which are aggregations of taxa according to higher taxon level, or tolerance, or feeding mode. CCA used relative abundances of genera, which is a finer level of resolution than the metrics. We don't expect them to be the same because the bug genera may respond to habitat but when aggregated as metrics, they do not. Compared to direct correlation analyses between environmental variables and ICI scores, the CCA results provided more sensitive measurement of macroinvertebrate community responses to environmental gradients. The results identified variance and covariance in the multiple stressor environments and thus provided possible stressors for biological impairment. It is important to remember that a canonical ordination (as CCA) is nothing more than a multivariate correlation between 2 sets of variables: the environmental measures and the species composition.

Based on the CCA results, site scores and distributions of each site along the environmental gradients can also be plot in an environment-site biplot (Figure D-4). The graph allows one to rank the stream reaches along the environmental gradients and thus identify the possible impairment for each individual sites. The strong gradient of conductivity and a number of sites distributed in the high conductivity gradient indicated that many of those sites were impaired by high ionic strength. NOx gradient also showed good separation for many sampling sites. However, due to the unmatched environmental variables (very few sites had both habitat measurement and chemistry measurement), only conductivity and NOx gradients are reliable with sufficient data point. QHEI gradient shown in the graph was less reliable because only half of the QHEI samples matched with macroinvertebrate data. CCA here is only used for exploratory purpose. It has great potential for SI process.

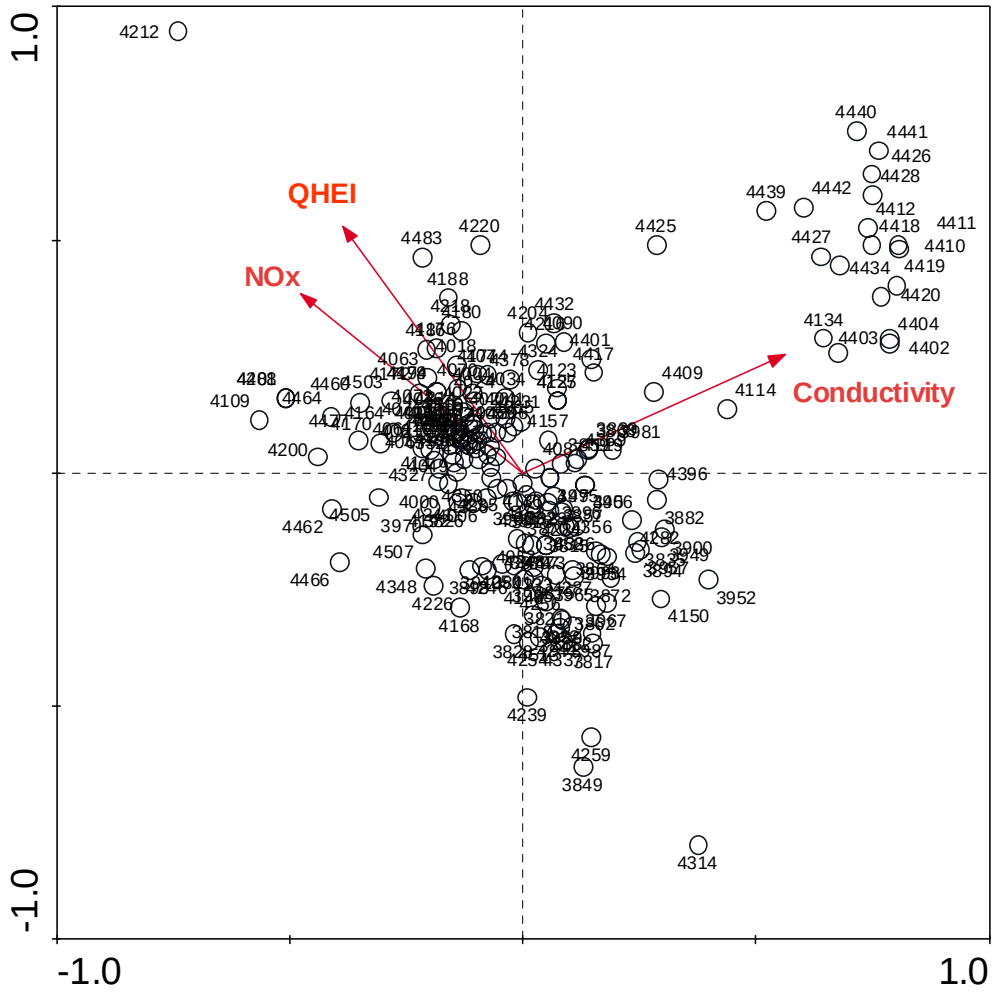

Figure D-4. Canonical Correspondence analysis of macroinvertebrates assemblages with environmental variables. The biplot shows the strength of environmental variables (arrows) and site distribution in the ordination space. Two environmental gradients (Conductivity and NOx) have been identified regulating macroinvertebrate composition, while habitat score is also significantly correlated with taxonomical composition.

D.5.1 Weighted averaging tolerance development

After the most important environmental variables that affect macroinvertebrate composition were identified through the correlation and CCA analyses, biological indicators to infer environmental conditions (stressor conditions) were developed.

This analysis estimates the most suitable values of an environmental variable of each species using the average of the values of the variable where taxa are present, weighted by the species' relative abundance (Birks et al., 1990). Consequently, the tolerance of a taxon refers to the environmental conditions where it is found at the highest relative abundance, and breadth is equivalent to the standard deviation from the tolerance. The calculated optima and tolerances were then scored to a 1 to 10 scale. After the tolerances of individual invertebrates were determined, WA calibration was used to recalibrate the environmental variables for each site based on the taxa score. Then the predictive power of WA inference models was

measured by calculating coefficients of determination (R^2) between invertebrate-inferred and observed values for environmental variables of interest and the root mean square error of prediction (RMSEP). The powerful re-sampling technique, bootstrapping, was used to examine the representativeness of samples in a random population. Cross-validation with bootstrapping is required to validate apparent R^2, and is most appropriate for assessing the predictive power of the inference models.

Table D-5. Performance of Weighted Averaging models based on genus up taxa and environmental data

	Conductivity	NOx	Habitat	TP	Hardness
RMSE	0.15	0.41	6.63	0.33	0.09
R^2	0.46	0.35	0.42	0.34	0.38
Boot_R^2	0.35	0.24	0.31	0.14	0.19
RMSEP	0.17	0.47	7.87	0.40	0.11

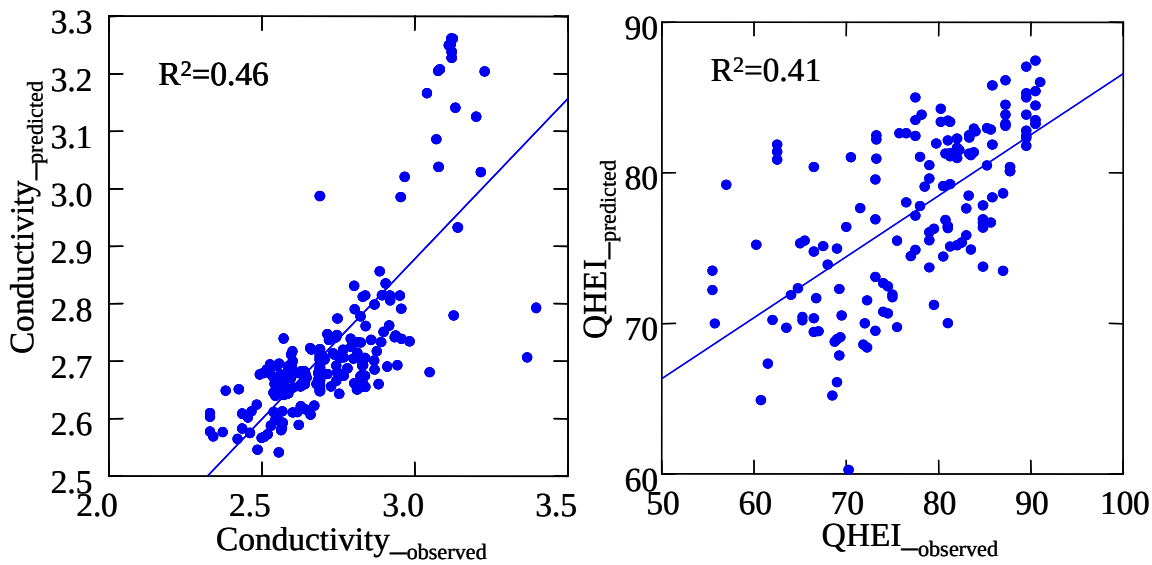

Figure D-5. Weighted averaging calibration graphs showing the observed conductivity and habitat scores (QHEI) at sampling stations and predicted conductivity and habitat scores based on macroinvertebrate assemblages.

Five WA models were developed and tested for candidate stressors (Conductivity, habitat, NOx, TP, and hardness) based on genus level macroinvertebrate abundance (Table 4). The performance of the WA models for each environmental variable were evaluated by R^2 and RMSE. The inference models for conductivity, NOx, hardness, and TP were developed with log-transformed environmental variables, but habitat scores were not log transformed. The best inference models were conductivity and habitat score, which had the highest coefficients (R^2=0.46 for conductivity, and 0.42 for habitat score) (Figure 5). The observed values and the predicted values based on macroinvertebrate taxa have a pretty good fit with each other. NOx model also performed well (R^2=0.35). The variance explained by the models decreased about 10 percent after cross-validation using bootstrapping. When the variance explained by the bootstrapping model was less than 20 percent, we consider the model was not successful. Therefore, only the tolerance models for conductivity, habitat score, and NOx were good models.

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APPENDIX E: LSPC MODELING

The following sections describe the steps required for setting up the East Fork Little Miami River LSPC models. Steps included defining modeling subwatersheds and reaches, followed by identification and processing of weather, land use, and soils data.

E.1 Watershed Delineation

LSPC was configured to simulate the East Fork Little Miami River watershed as a series of hydrologically connected subwatersheds. The spatial subdivision of the watersheds allowed for a more refined representation of a more realistic description of hydrologic factors. Subwatershed delineation was primarily based on Ohio 14 digit-huc and topography (30x30m Digital Elevation map), but also took into consideration spatial variation in sources, and hydrology boundaries. Output from LSPC is for the most downstream point of each subwatershed (sometimes referred to as the “pour point”). Subwatersheds were therefore delineated to obtain modeling output at key flow or USGS gage station. The East Fork Little Miami River LSPC model resulted in 249 delineated subwatersheds. Each of the subwatersheds is then represented as a single stream assumed to be a completely mixed, one-dimensional segment with a trapezoidal cross-section. The final delineated subwatersheds and streams for the East Fork Little Miami River models are shown in Figure E-1.

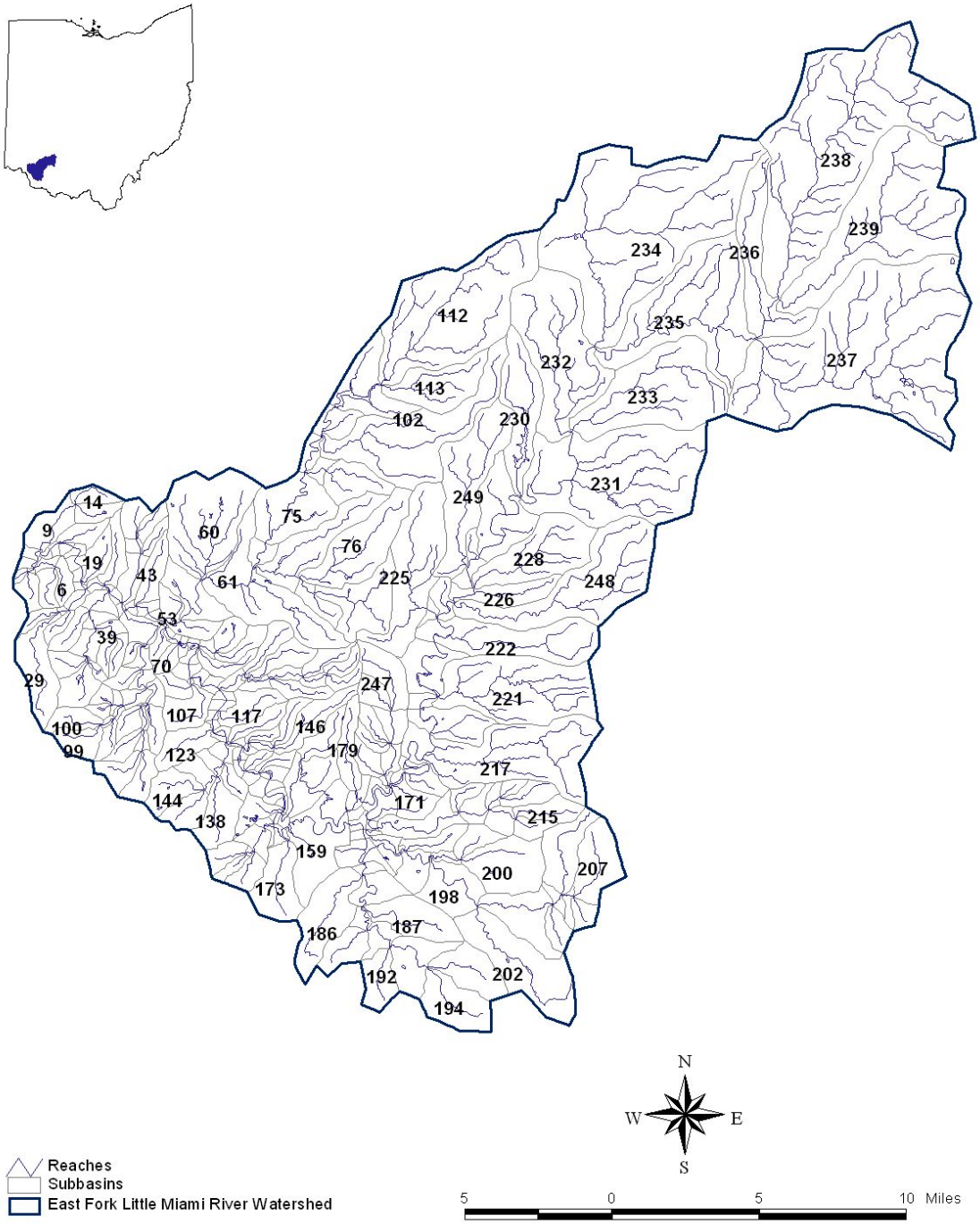


Figure E-1. East Fork Little Miami River Watershed

E.2 Waterbody Representation

Each delineated subwatershed in LSPC was represented with a single stream assumed to be a completely mixed, one-dimensional segment with a trapezoidal cross-section. Input parameters for the reaches include initial depth, length, depth, width, slope, Manning's roughness coefficient, and coefficients to describe the shape and of the stream channel. Physical characteristics of each stream were determined by Rosgen's method (Dave Rosgen, 1996). This method takes into account of watershed's size and location within U.S. continent to estimate the depth and the width of a stream. Parameters used for LSPC were IDEPTH (Reach Initial Water Depth), LENGTH (Reach Length), DEPTH (Reach Bankfull Depth), WIDTH (Reach Bankfull Width), SLOPE (Reach Slope), MANN (Manning's Roughness Coefficient for the Stream Channel),R1 (Reach ratio of Bottom Width to Bankfull Width), R2 (Reach Side Slope of Floodplain) and W1 (Reach Floodplain Width Factor) as shown Figure E-2.

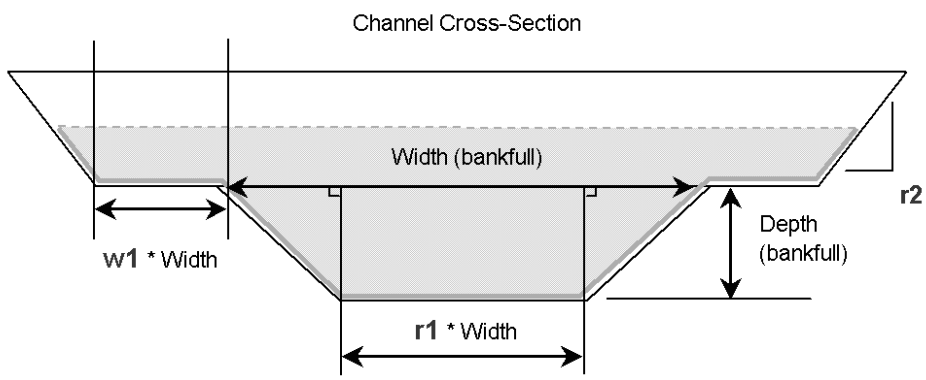


Figure E-2. Stream channel representation in the LSPC model.

E.3 Weather Data

The LSPC model is driven by precipitation and other climatologic data (e.g., temperature, cloud cover, wind speed). As a result, meteorological data are a critical component of the watershed modeling effort. Appropriate representation of precipitation, wind movement, solar radiation, potential evapotranspiration, cloud cover, temperature, and dew point are required to develop a valid model.

Daily climatologic data from the National Climatic Data Center (NCDC) during the period of 1992 to 2002 was accessed. The length of the selected period was determined based on the most recent available data and LSPC model requirements. The stations selected for this study were Chilo station (weather station ID number 331536), Hillsboro station (333758), Lebanon station (334459), and Wilmington station (339224)(Figure E-3). These four stations were selected for proximity and completeness of available data. Daily records obtained from the data were disaggregated to hourly data to meet LSPC model requirement. Assignments of each weather gage to subwatersheds were determined during hydrologic calibration process. Table E-1 describes the final assignment of each weather station to subwatersheds. At the time of the model setup, weather data were only available through 2003.

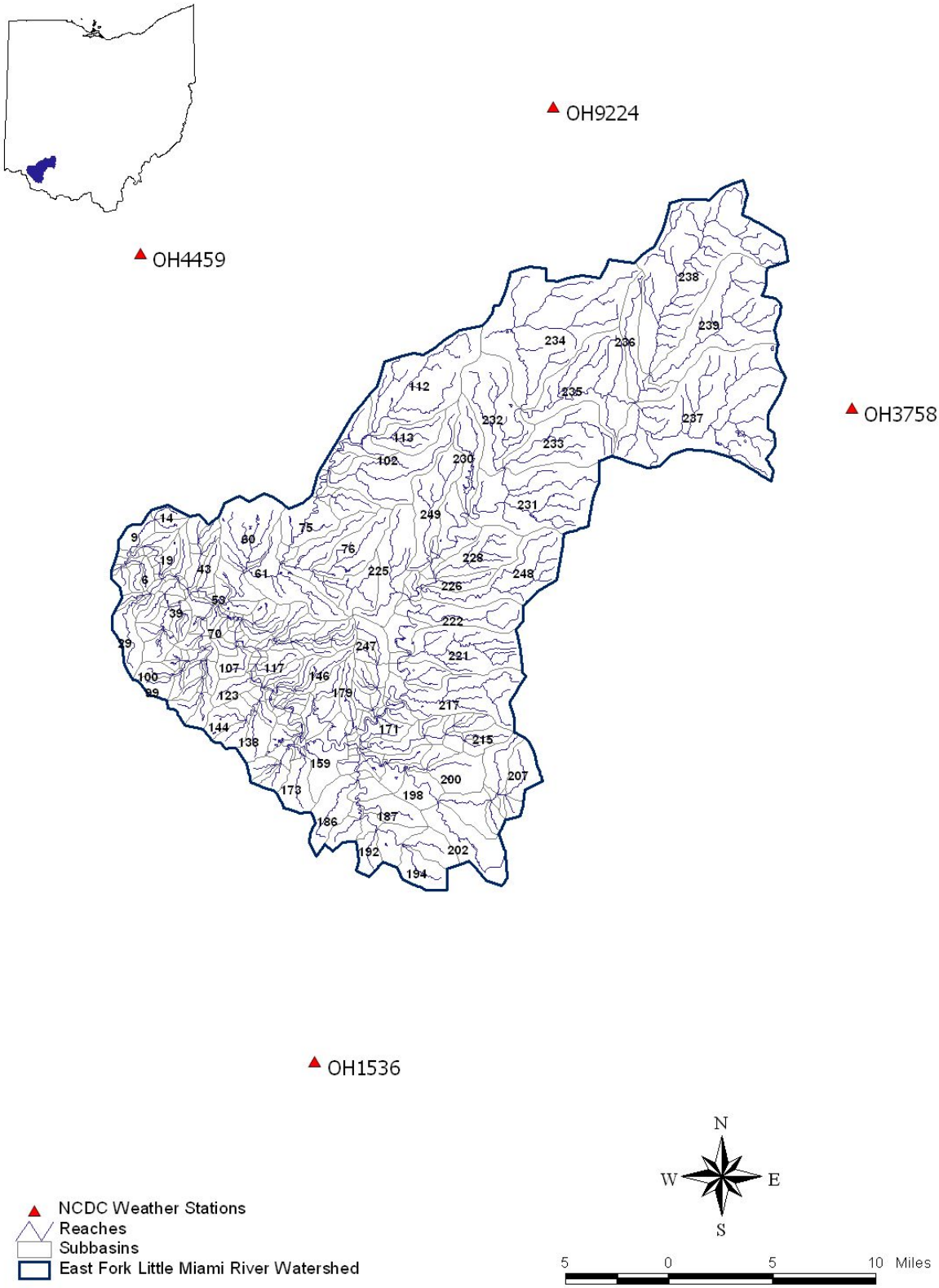


Figure E-3. The locations of NCDC weather stations

Table E-1. The assignment of weather stations to each subwatershed

Subbasin	Weather Station	Subbasin	Weather Station	Subbasin	Weather Station
1	OH4459	84	OH4459	167	OH1536
2	OH4459	85	OH4459	168	OH1536
3	OH4459	86	OH4459	169	OH1536
4	OH4459	87	OH4459	170	OH1536
5	OH4459	88	OH4459	171	OH1536
6	OH4459	89	OH4459	172	OH1536
7	OH4459	90	OH4459	173	OH1536
8	OH4459	91	OH4459	174	OH1536
9	OH4459	92	OH4459	175	OH1536
10	OH4459	93	OH4459	176	OH1536
11	OH4459	94	OH4459	177	OH3758
12	OH4459	95	OH4459	178	OH1536
13	OH4459	96	OH4459	179	OH1536
14	OH4459	97	OH4459	180	OH1536
15	OH4459	98	OH4459	181	OH1536
16	OH4459	99	OH4459	182	OH1536
17	OH4459	100	OH4459	183	OH1536
18	OH4459	101	OH4459	184	OH1536
19	OH4459	102	OH4459	185	OH1536
20	OH4459	103	OH4459	186	OH1536
21	OH4459	104	OH4459	187	OH1536
22	OH4459	105	OH4459	188	OH1536
23	OH4459	106	OH4459	189	OH1536
24	OH4459	107	OH4459	190	OH1536
25	OH4459	108	OH4459	191	OH1536
26	OH4459	109	OH4459	192	OH1536
27	OH4459	110	OH4459	193	OH1536
28	OH4459	111	OH4459	194	OH1536
29	OH4459	112	OH4459	195	OH1536
30	OH4459	113	OH4459	196	OH1536
31	OH4459	114	OH4459	197	OH1536
32	OH4459	115	OH4459	198	OH1536
33	OH4459	116	OH4459	199	OH1536
34	OH4459	117	OH4459	200	OH1536
35	OH4459	118	OH4459	201	OH1536
36	OH4459	119	OH4459	202	OH1536
37	OH4459	120	OH4459	203	OH1536
38	OH4459	121	OH4459	204	OH1536
39	OH4459	122	OH4459	205	OH1536
40	OH4459	123	OH4459	206	OH1536
41	OH4459	124	OH4459	207	OH1536
42	OH4459	125	OH4459	208	OH1536
43	OH4459	126	OH4459	209	OH1536
44	OH4459	127	OH4459	210	OH1536

Subbasin	Weather Station	Subbasin	Weather Station	Subbasin	Weather Station
45	OH4459	128	OH4459	211	OH1536
46	OH4459	129	OH4459	212	OH1536
47	OH4459	130	OH4459	213	OH1536
48	OH4459	131	OH4459	214	OH1536
49	OH4459	132	OH4459	215	OH1536
50	OH4459	133	OH4459	216	OH1536
51	OH4459	134	OH4459	217	OH3758
52	OH4459	135	OH4459	218	OH3758
53	OH4459	136	OH4459	219	OH3758
54	OH4459	137	OH4459	220	OH4459
55	OH4459	138	OH4459	221	OH3758
56	OH4459	139	OH4459	222	OH3758
57	OH4459	140	OH4459	223	OH4459
58	OH4459	141	OH4459	224	OH3758
59	OH4459	142	OH4459	225	OH4459
60	OH4459	143	OH4459	226	OH3758
61	OH4459	144	OH4459	227	OH4459
62	OH4459	145	OH4459	228	OH3758
63	OH4459	146	OH4459	229	OH4459
64	OH4459	147	OH4459	230	OH9224
65	OH4459	148	OH4459	231	OH3758
66	OH4459	149	OH4459	232	OH9224
67	OH4459	150	OH4459	233	OH3758
68	OH4459	151	OH4459	234	OH9224
69	OH4459	152	OH4459	235	OH3758
70	OH4459	153	OH4459	236	OH3758
71	OH4459	154	OH4459	237	OH3758
72	OH4459	155	OH4459	238	OH9224
73	OH4459	156	OH1536	239	OH3758
74	OH4459	157	OH1536	240	OH1536
75	OH4459	158	OH1536	241	OH1536
76	OH4459	159	OH1536	242	OH1536
77	OH4459	160	OH1536	243	OH1536
78	OH4459	161	OH1536	244	OH1536
79	OH4459	162	OH1536	245	OH1536
80	OH4459	163	OH1536	246	OH1536
81	OH4459	164	OH1536	247	OH1536
82	OH4459	165	OH1536	248	OH3758
83	OH4459	166	OH1536	249	OH4459

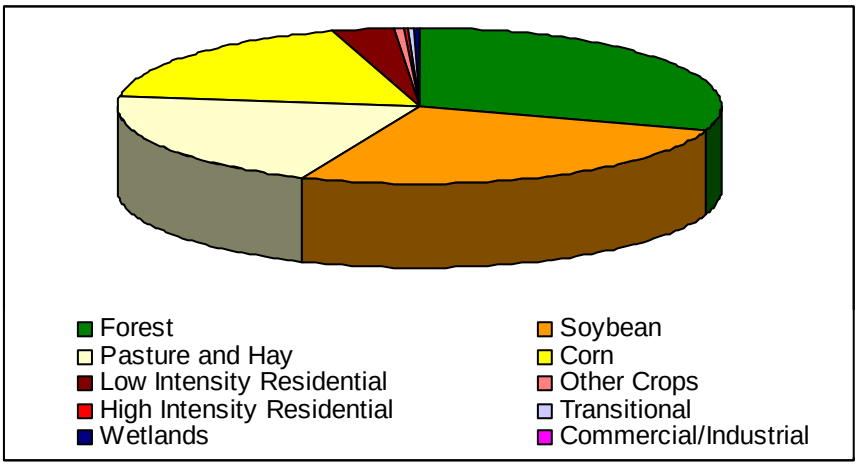
E.4 Land Cover Representation

LSPC requires a basis for distributing hydrologic parameters. This is necessary to appropriately represent hydrologic variability throughout each watershed, which is influenced by land surface and subsurface characteristics.

Land cover data were obtained from MRLC (1992/2001). At the time of modeling efforts 2001 data were only available for a portion of the watershed, 1992 MRLC data was used for areas where 2001 data was not available. Land uses identified in the coverage are shown in Table E-2 with a corresponding pie chart based on the land use percentages. Figure E-4 shows the land use distribution within the East Fork Little Miami River watershed.

Table E-2. Land uses distributions within East Fork Little Miami River Watershed

Land Use Description	Acres	Square Miles	Percentage
Forest	95,701	149.53	30.20%
Soybean	83,388	130.29	26.32%
Pasture and Hay	64,338	100.53	20.30%
Corn	58,726	91.76	18.53%
Low Intensity Residential	10,645	16.63	3.36%
Other Crops	1,199	1.87	0.38%
High Intensity Residential	1,350	2.11	0.43%
Transitional	738	1.15	0.23%
Wetlands	612	0.96	0.19%
Commercial/Industrial	167	0.26	0.05%



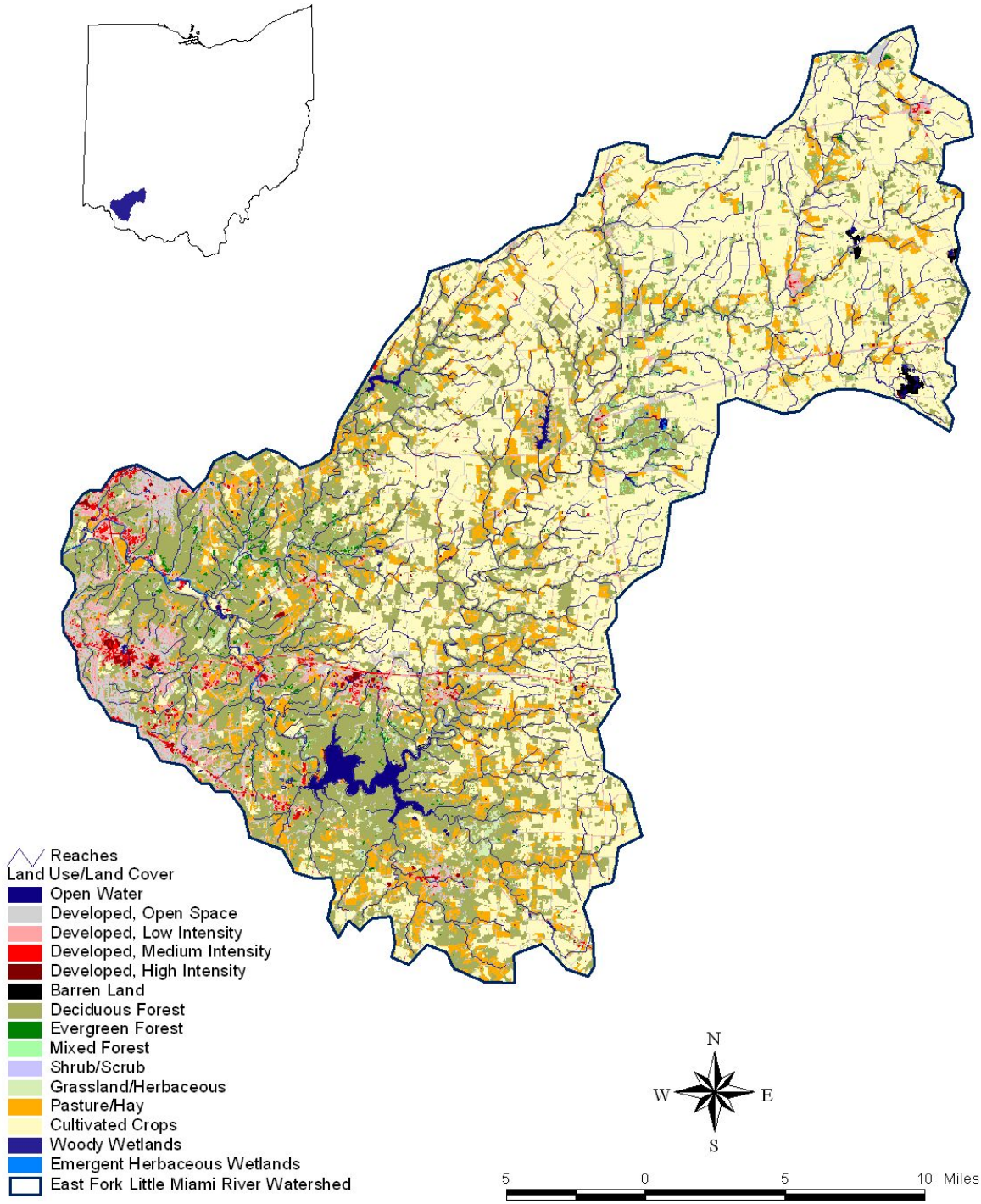


Figure E-4. East Fork Little Miami River Watershed Land uses

As part of the hydrology calibration process, it was important to evaluate the effects of impervious and pervious percentage of residential and commercial/industrial/transportation land uses. These percentages are not explicitly identified in the land use data. LSPC requires that land cover categories be divided into separate pervious and impervious land units for modeling. Separate model algorithms are then used to

simulate major hydrologic and pollutant loading processes for both land units – PERLND and IMPLND (respectively). For modeling purposes, it was assumed that 80 percent of low intensity residential, 60 percent of high intensity residential, and 20 percent of commercial/industrial/transportation were covered by pervious surfaces. All other land uses were assumed to be 100 percent pervious surfaces. The original land uses were grouped by similar characteristics to simplify the LSPC model and improve model run time. The LSPC land use groups, associated original land use classes and percentages of pervious/imperviousness are shown in Table E-3. The modeled land uses' area and their relative percentage to the entire watershed are shown in Table E-4 with a corresponding pie chart based on each landuses percentages.

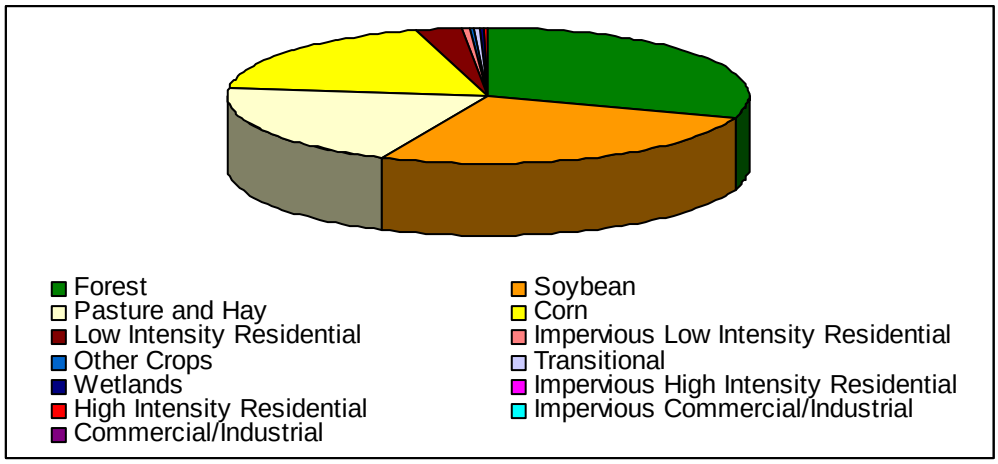
Table E-3. LSPC land use groups, associated original land use classes with percentages of pervious/imperviousness

modeled land use	*original land use description*	*percentage of perviousness*
Forest	Deciduous Forest	100
	Evergreen Forest	100
	Mixed Forest	100
Soybean	Row Crops	100
Pasture and Hay	Pasture/Hay	100
	Urban/Recreational Grasses	100
	Grassland/Herbaceous	100
	Shrub/Scrub	100
	Developed, Open Space	100
Corn	Row Crops/Cultivated Crops	100
Other Crops	Other Crops	100
Transitional	Barren land (Rock/Sand/Clay)	100
	Quarries/Strip Mines/Gravel	100
Wetlands	Emergent Herbaceous Wetlands	100
	Woody Wetlands	100
Low Intensity Residential	Low Intensity Residential	80
High Intensity Residential	High Intensity Residential	60
Commercial/Industrial/Transportation	Commercial/Industrial/Transportation	20
		percentage of imperviousness
Impervious Low Intensity Residential	Low Intensity Residential	20
Impervious High Intensity Residential	High Intensity Residential	40
Impervious Commercial/Industrial/Transportation	Commercial/Industrial/Transportation	80

Table E-4. The modeled land uses' area and their relative percentage

Land Use Description	Acres	Square Miles	Percentage
Forest	95,701	149.53	30.24%
Soybean	83,388	130.29	26.35%
Pasture and Hay	64,338	100.53	20.33%
Corn	58,726	91.76	18.56%
Low Intensity Residential	8,632	13.49	2.73%

Land Use Description	Acres	Square Miles	Percentage
Impervious Low Intensity Residential	2,013	3.15	0.64%
Other Crops	1,199	1.87	0.38%
Transitional	738	1.15	0.23%
Wetlands	612	0.96	0.19%
Impervious High Intensity Residential	590	0.92	0.19%
High Intensity Residential	341	0.53	0.11%
Impervious Commercial/Industrial	134	0.21	0.04%
Commercial/Industrial	33	0.05	0.01%



E.5 Watershed Grouping

The LSPC model allows for variation of input parameters by land use. Input parameters can also be varied by watershed groups. A watershed group is defined as a subset of modeling subwatersheds that have similar soils and geology. Watershed groups and their assigned subwatersheds are described in E.5

Table E-5. Watershed groups and their assigned subwatersheds

Modeling Group	Subbasin ID
1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 240, 241, 242, 243, 244, 245, 246, 247
2	224, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 248, 249
3	177, 217, 218, 219, 220, 221, 222, 223, 225

E.6 Hydrologic Calibration

Hydrologic calibration was performed after the initial model setup. Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. For LSPC, calibration is an iterative procedure of parameter evaluation and refinement as a result of comparing simulated and observed values at a specified location in the watershed. Calibration is required for parameters that cannot be deterministically and uniquely evaluated from topographic, climatic, physical characteristics of the watershed and compounds of interest. Calibration generally covers more than a few years to capture a variety of climactic conditions. In the East Fork Little Miami River watershed, USGS gage 3247500 (East Fork Little Miami River at Perintown, OH) was used in the process of calibration (Figure E-5).

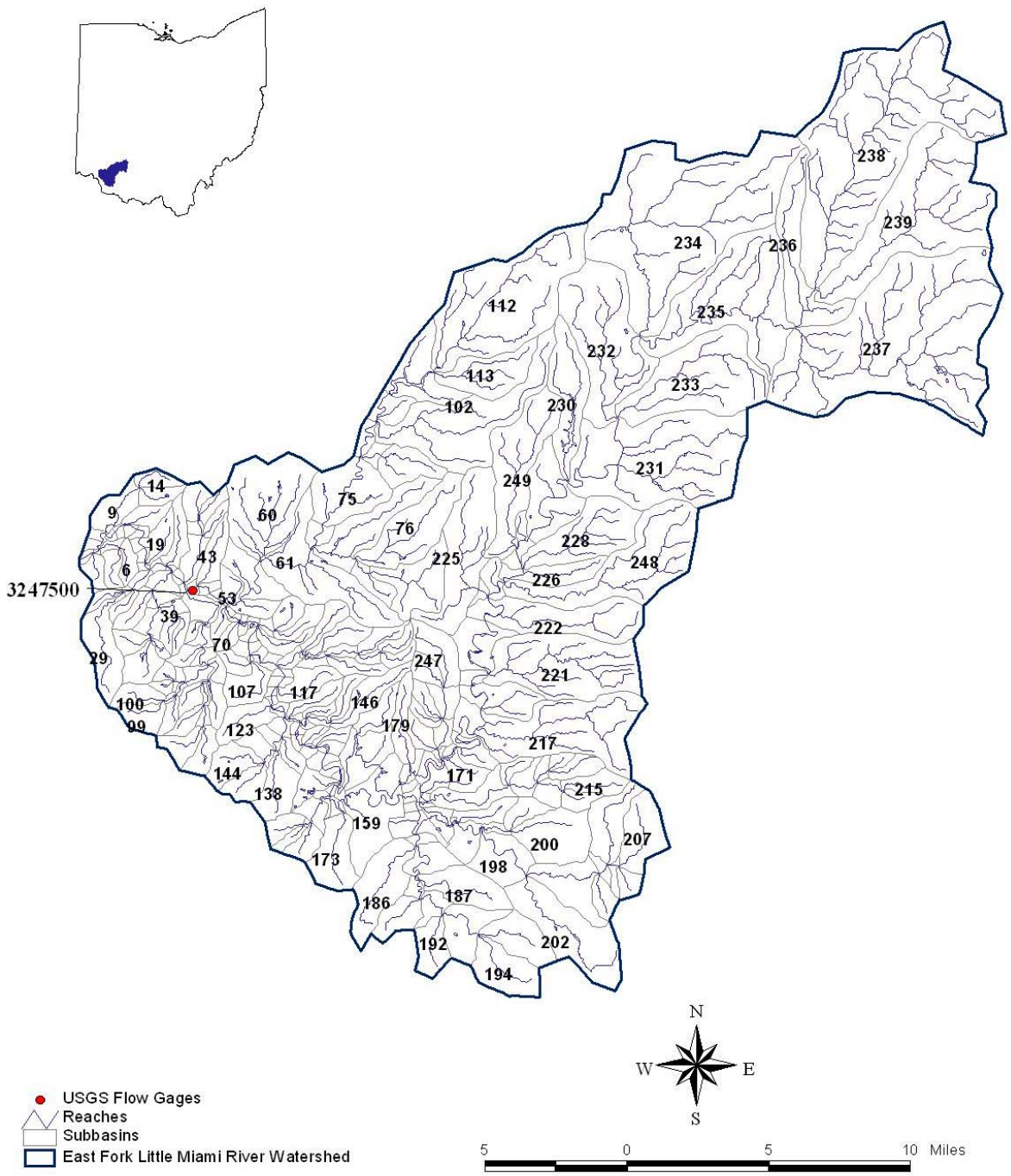


Figure E-5. The location of USGS gage 3247500.

The hydrologic calibration process involved a comparison of observed data to modeled in-stream flow and an adjustment of key parameters. Modeling parameters were varied within generally accepted bounds and in accordance with observed temporal trends and soil and land cover characteristics. An attempt was made to remain within the guidelines for parameter values set out in BASINS Technical Note 6 (USEPA, 2000). Calibration time period was selected from 1992 to 2002 during the period that USGS continuous daily flow data is available.

Model parameters were adjusted after model iterations to improve model performance. The parameters that were adjusted include those that account for the partitioning of surface versus subsurface flow, infiltration rate, surface and subsurface storage, evapotranspiration, and surface runoff and snow.

The hydrology calibration results are shown below. Figure E-6 shows a monthly simulation comparison between modeled and observed flow. The regression line in Figure E-7 shows how well the model predicts monthly flows against the observed flows. Table E-6 shows statistically shows the model results with observed data.

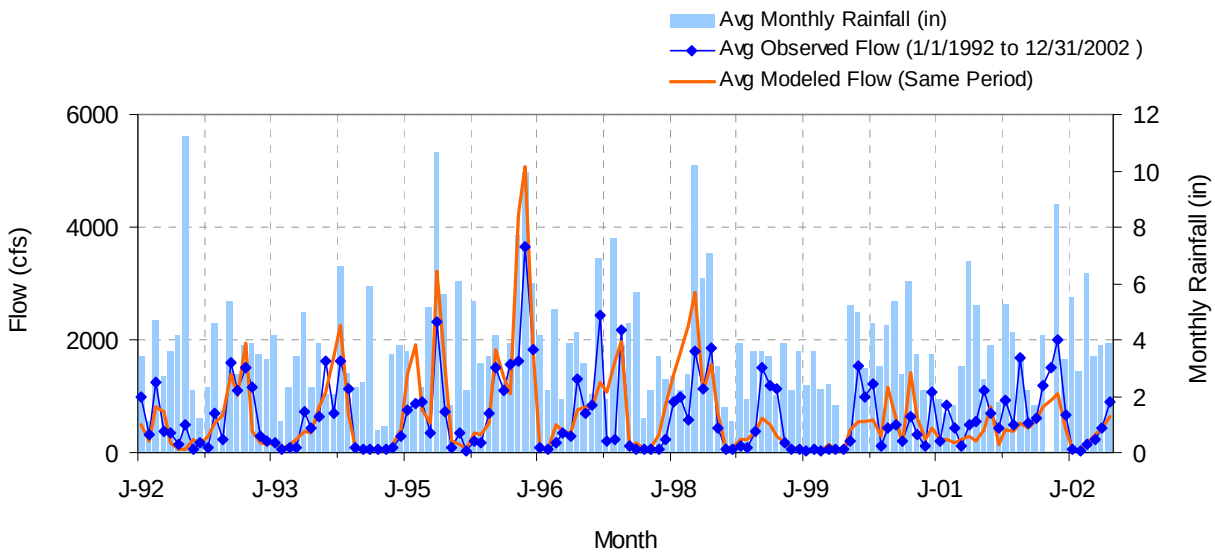


Figure E-6. Monthly modeled and observed flow

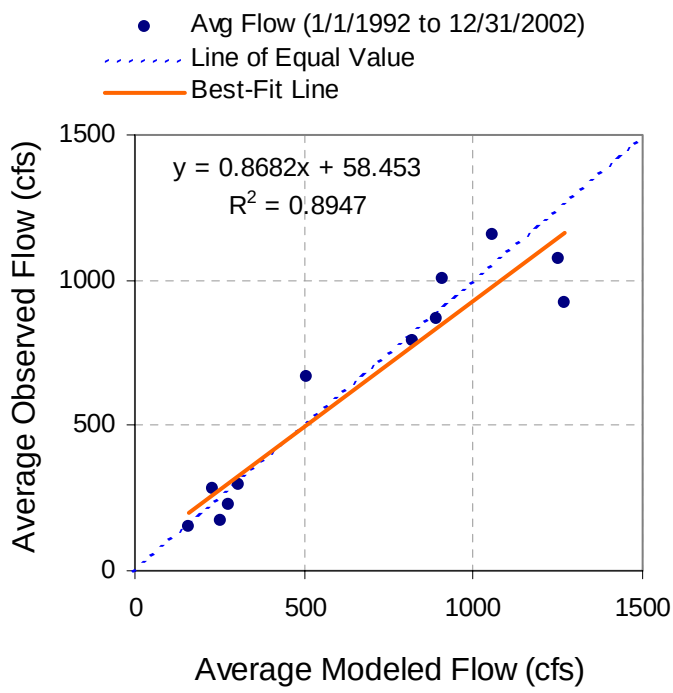


Figure E-7. Modeled Monthly flow simulation results against observed flow

Table E-6. Statistical comparison between the simulated and the observed flow

LSPC Simulated Flow		Observed Flow Gage	
REACH OUTFLOW FROM SUBBASIN 27 11-Year Analysis Period: 1/1/1992 - 12/31/2002 Flow volumes are normalized, with total observed as 100		USGS 03247500 East Fork Little Miami River at Perintown OH Clermont County, Ohio Hydrologic Unit Code 05090202 Latitude 39°08'13", Longitude 84°14'17" NAD27 Drainage area 476.00 square miles	
Total Simulated In-stream Flow:	**104.54**	Total Observed In-stream Flow:	**100.00**
Total of simulated highest 10% flows:	**50.42**	Total of Observed highest 10% flows:	**52.97**
Total of Simulated lowest 50% flows:	**7.42**	Total of Observed Lowest 50% flows:	**5.30**
Simulated Summer Flow Volume (months 7-9):	**8.56**	Observed Summer Flow Volume (7-9):	**8.08**
Simulated Fall Flow Volume (months 10-12):	**14.60**	Observed Fall Flow Volume (10-12):	**15.80**
Simulated Winter Flow Volume (months 1-3):	**37.32**	Observed Winter Flow Volume (1-3):	**39.45**
Simulated Spring Flow Volume (months 4-6):	**44.06**	Observed Spring Flow Volume (4-6):	**36.67**
Total Simulated Storm Volume:	**20.20**	Total Observed Storm Volume:	**18.56**
Simulated Summer Storm Volume (7-9):	**1.37**	Observed Summer Storm Volume (7-9):	**1.89**
Errors (Simulated-Observed)	*Error Statistics*	*Recommended Criteria*	
Error in total volume:	4.54	10	
Error in 50% lowest flows:	**40.06**	**10**	
Error in 10% highest flows:	-4.81	15	
Seasonal volume error - Summer:	5.91	30	
Seasonal volume error - Fall:	-7.62	30	
Seasonal volume error - Winter:	-5.39	30	
Seasonal volume error - Spring:	20.16	30	
Error in storm volumes:	8.87	20	
Error in summer storm volumes:	-27.30	50	

E.7 Water Quality Calibration

Water Quality calibration was performed after the hydrologic calibration. Water quality calibration was performed for all listed tributaries within the East Fork Little Miami River Watershed that had sufficient data to calibrate to.

The water quality calibration process involved a comparison of observed data to modeled in-stream data and an adjustment of key parameters. Modeling parameters were varied within generally accepted bounds and in accordance with observed temporal trends and soil and land cover characteristics. Calibration time period was selected from 1992 to 2002 during the period that USGS continuous daily flow data is available.

The water quality calibration results for Shayler Run are shown below. Figure E-8 shows a daily simulation comparison between modeled and observed TSS. Figure E-9 shows a daily simulation comparison between modeled and observed NO2NO3. Figure E-10 shows a daily simulation comparison between modeled and observed Total Phosphorus.

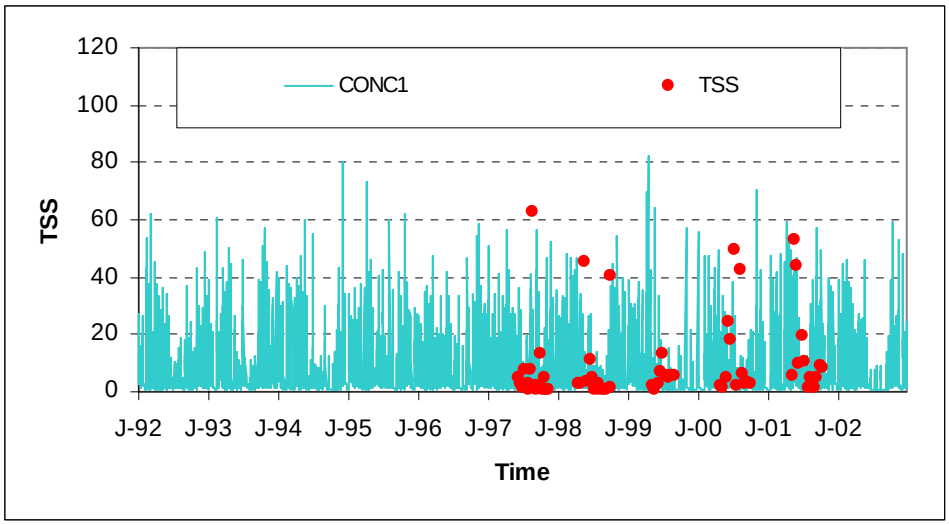


Figure E-8. Modeled and observed TSS.

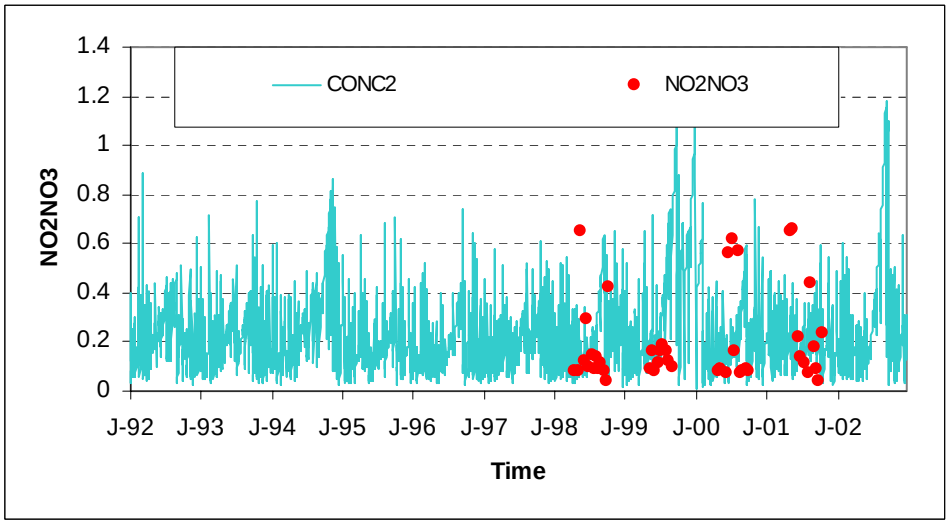


Figure E-9. Modeled and observed NO2NO3.

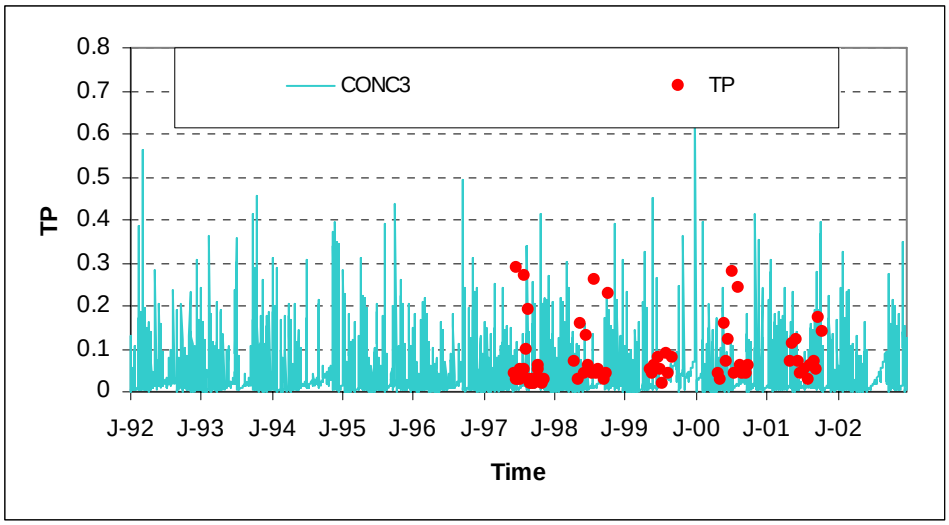


Figure E-10. Modeled and observed TP.

References

Dave Rosgen, 1996. *Applied River Morphology*.

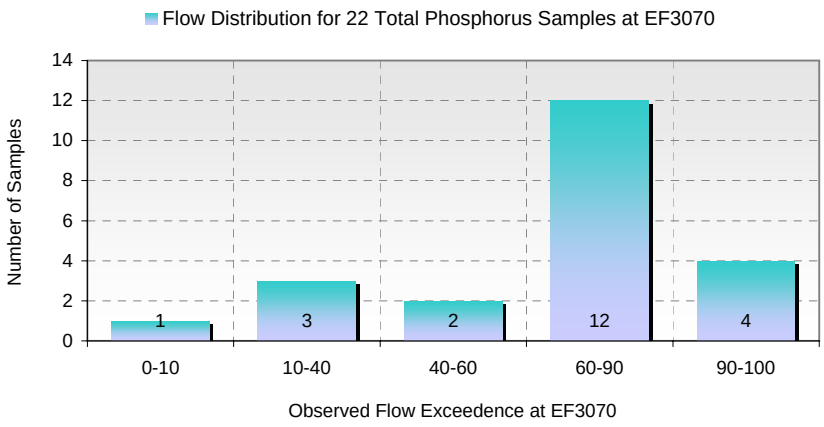
EPA BASINS Technical Note 6; Estimating Hydrology and Hydraulic Parameters for HSPF. 2000, office of water, Unites States Environmental Protection Agency

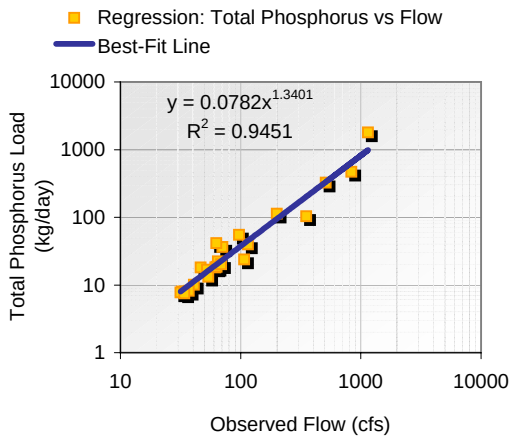
David B. Baker, R. Peter Richards, Timothy T. Loftus, and Jack W. Kramer, 2004. *A NEW FLASHINESS INDEX: CHARACTERISTICS AND APPLICATIONS TO MIDWESTERN RIVERS AND STREAMS.* JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION. April, 2004

APPENDIX F: LOAD DURATION CURVES

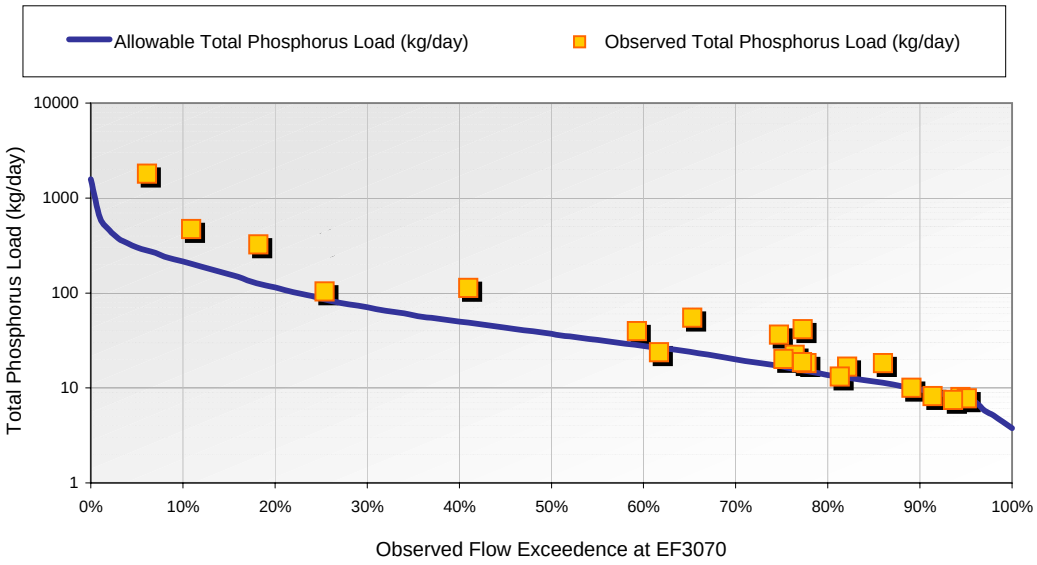
[27: Total Phosphorus at EF3070 (mg/L)] -vs- [26: Flow at EF3070 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

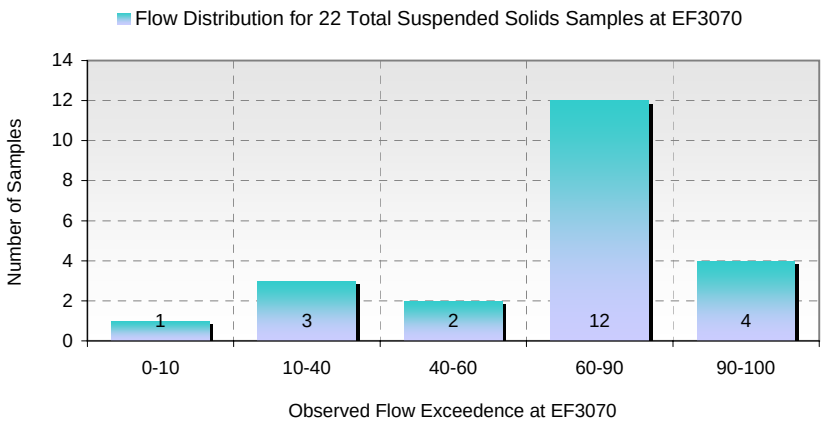


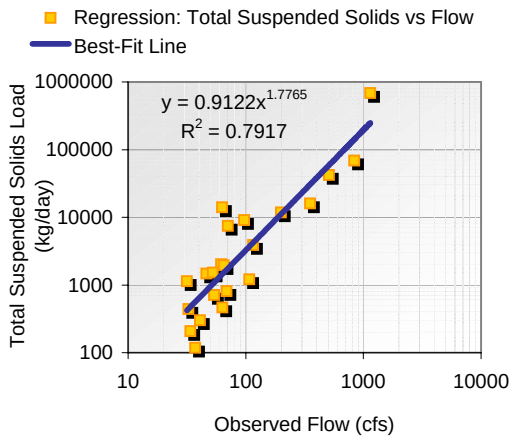
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	22-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	1,239.38	303	1,798	83.1%
10-40	3	356.82	87	325	73.1%
40-60	2	151.60	37	76	51.2%
60-90	12	69.04	17	19	12.9%
90-100	4	31.67	8	8	1.6%

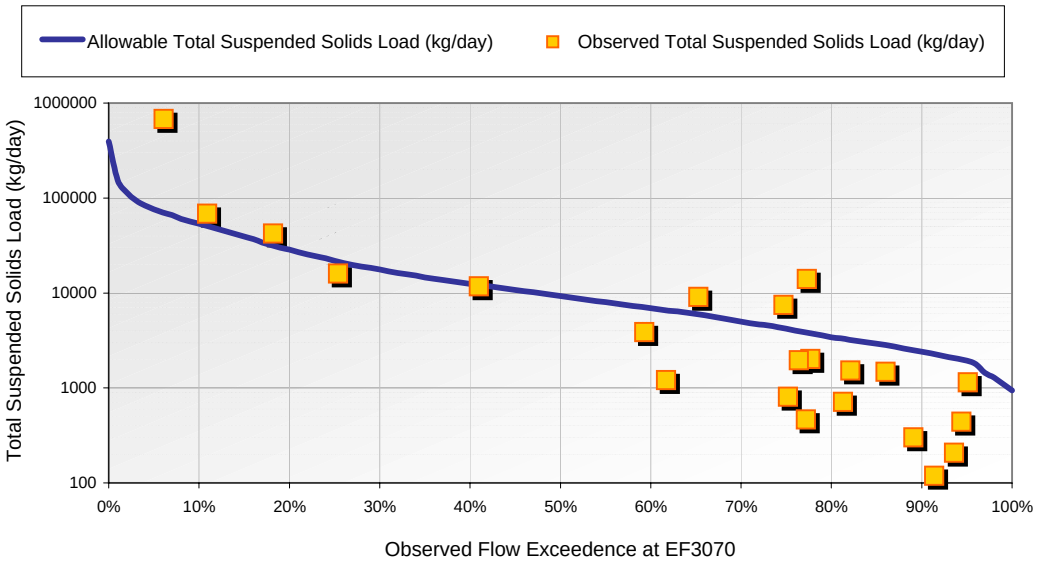
[27: Total Suspended Solids at EF3070 (mg/L)] -vs- [26: Flow at EF3070 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

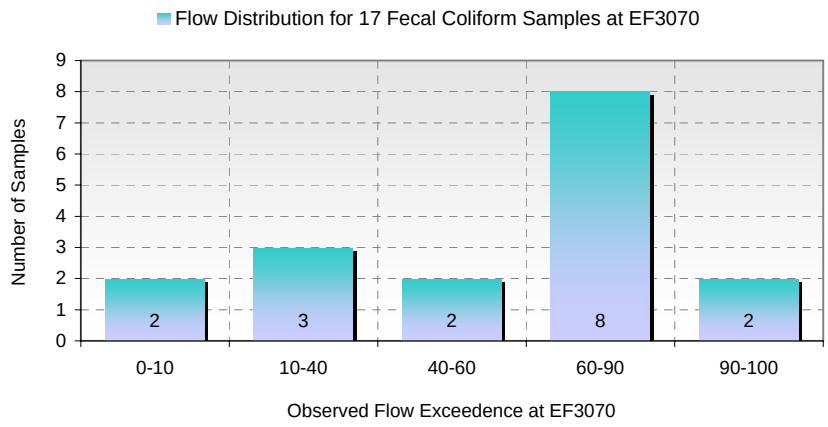


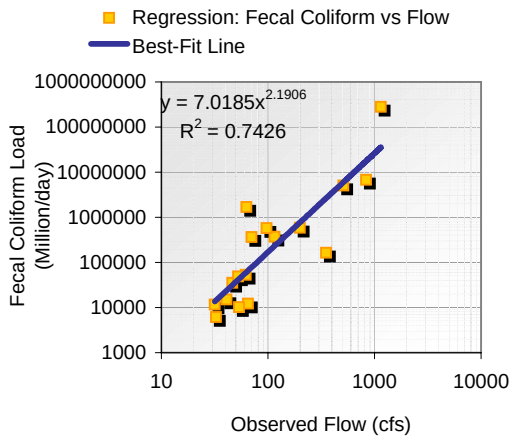
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	22-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	1,239.38	75,806	680,050	88.9%
10-40	3	356.82	21,825	42,128	48.2%
40-60	2	151.60	9,272	7,809	0.0%
60-90	12	69.04	4,223	1,498	0.0%
90-100	4	31.67	1,937	324	0.0%

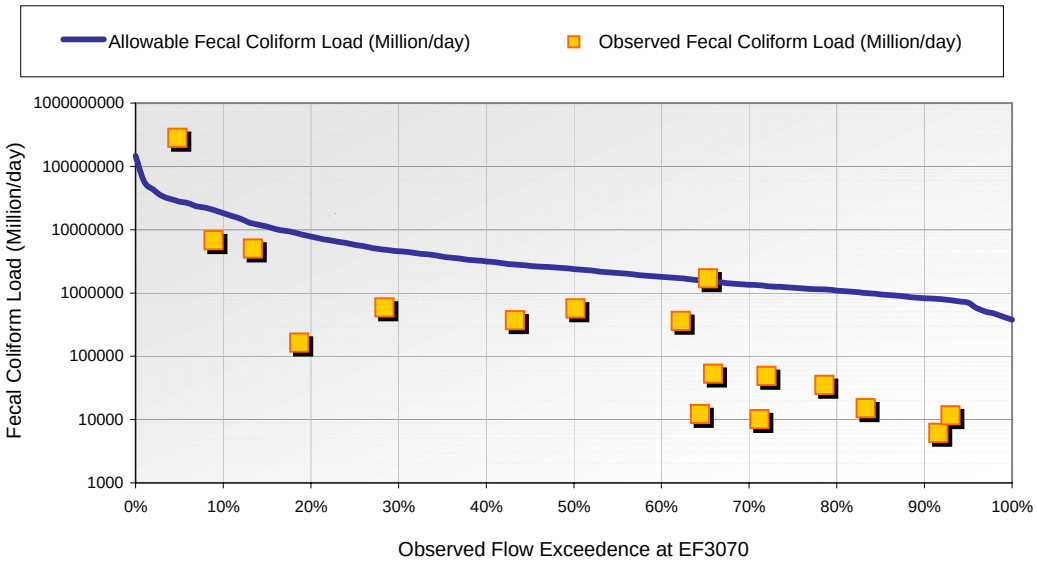
[22: Fecal Coliform at EF3070 (MPN/100mL)] -vs- [26: Flow at EF3070 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

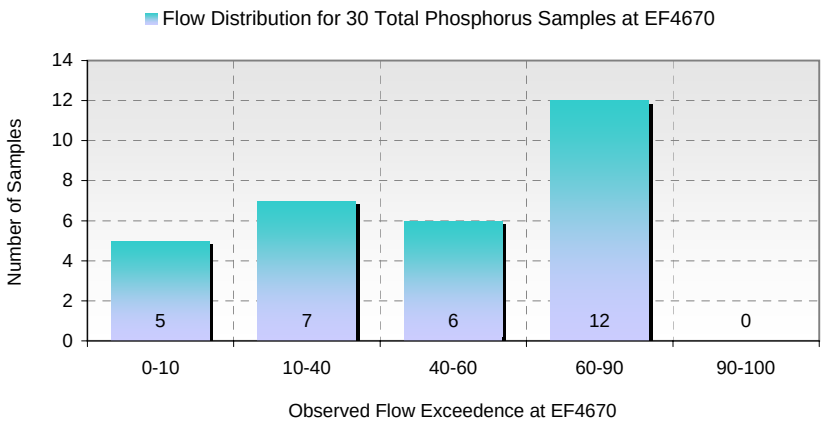


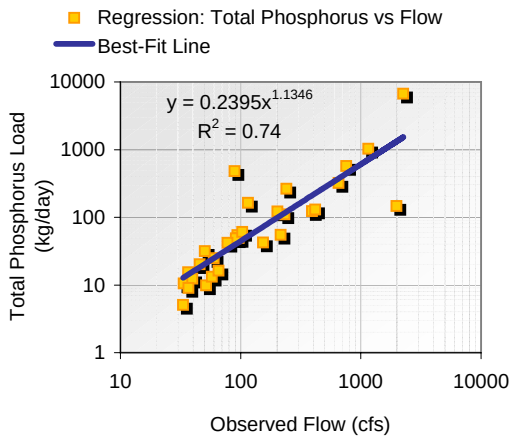
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	17-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	1,132.97	27,718,987	143,881,493	80.7%
10-40	3	236.48	5,785,551	587,027	0.0%
40-60	2	97.55	2,386,540	469,766	0.0%
60-90	8	49.62	1,213,933	42,054	0.0%
90-100	2	28.55	698,399	8,894	0.0%

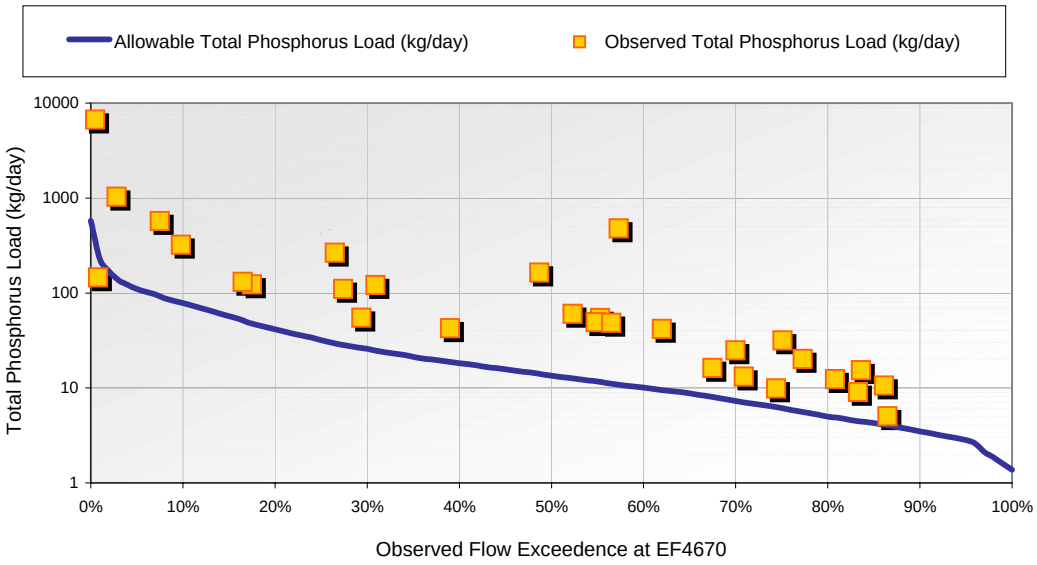
[31: Total Phosphorus at EF4670 (mg/L)] -vs- [32: Flow at EF4670 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

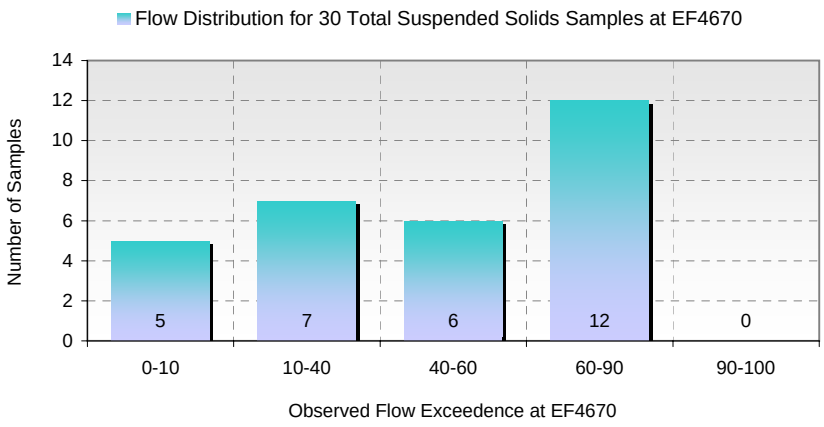


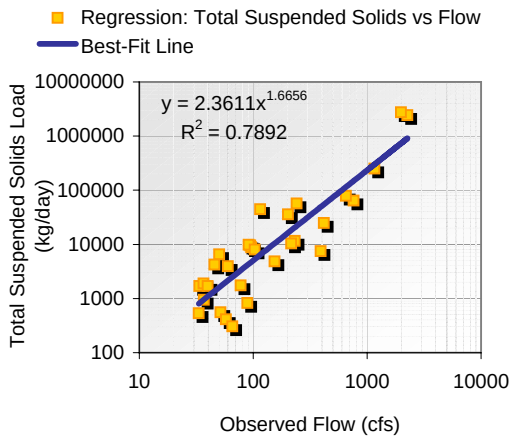
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	30-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	902.70	110	572	80.7%
10-40	7	259.89	32	121	73.8%
40-60	6	110.42	14	57	76.4%
60-90	12	50.29	6	14	56.9%
90-100	0	23.07	3	No Data	No Data

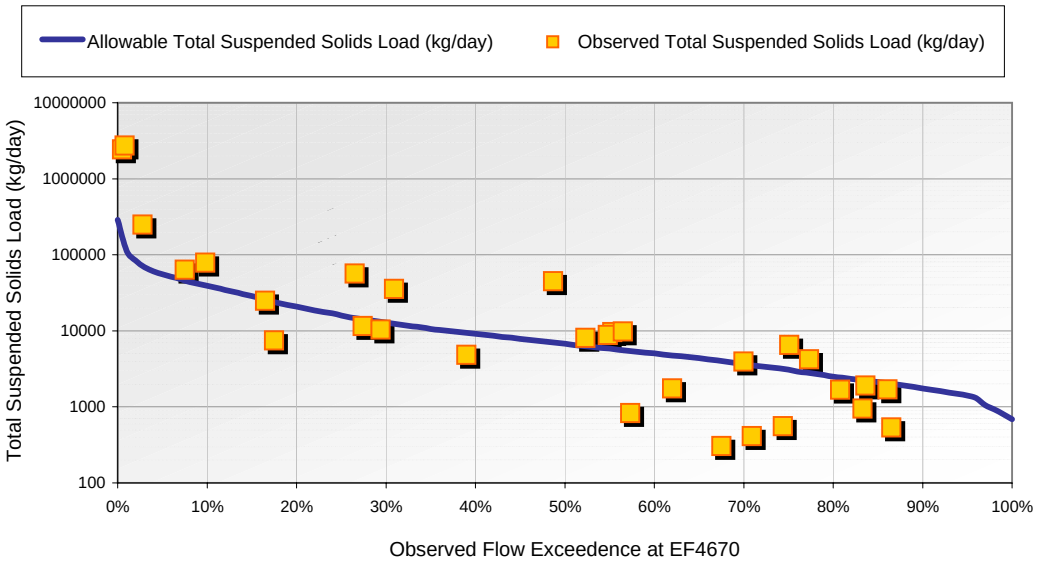
[31: Total Suspended Solids at EF4670 (mg/L)] -vs- [32: Flow at EF4670 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

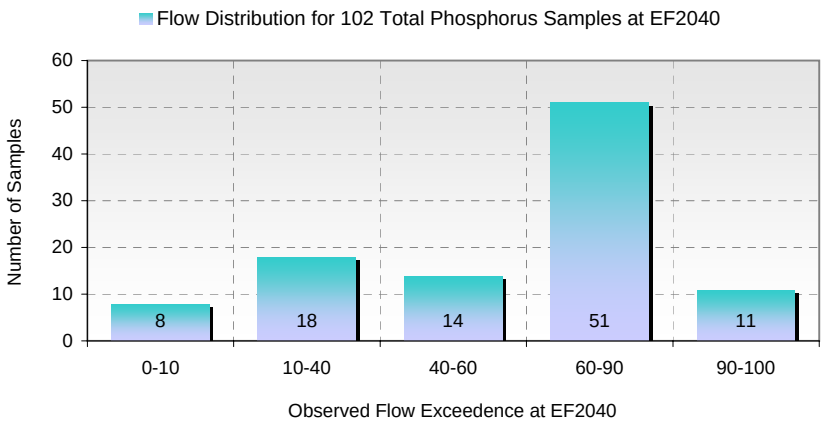


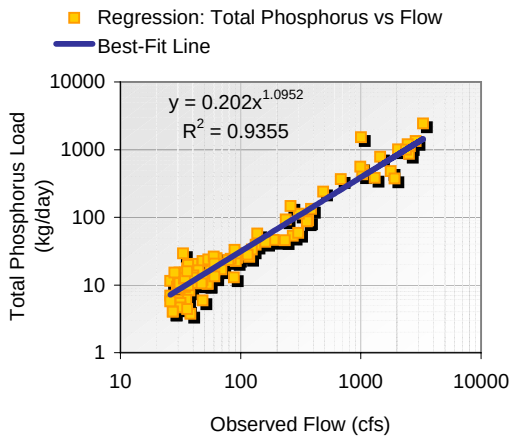
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	30-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	902.70	55,213	249,643	77.9%
10-40	7	259.89	15,896	11,590	0.0%
40-60	6	110.42	6,754	9,193	26.5%
60-90	12	50.29	3,076	1,687	0.0%
90-100	0	23.07	1,411	No Data	No Data

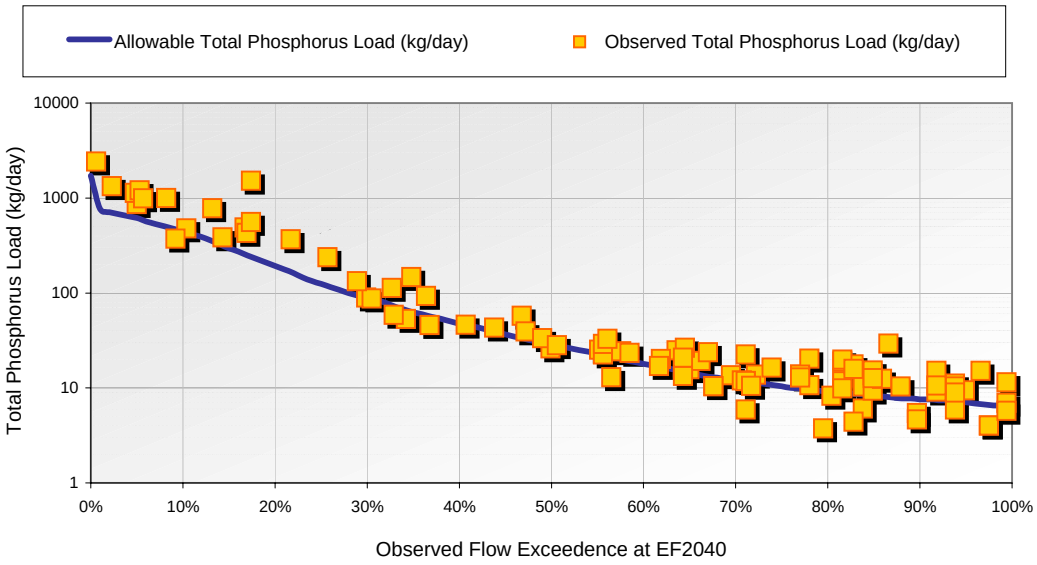
[28: Total Phosphorus at EF2040 (mg/L)] -vs- [25: Flow at EF2040 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

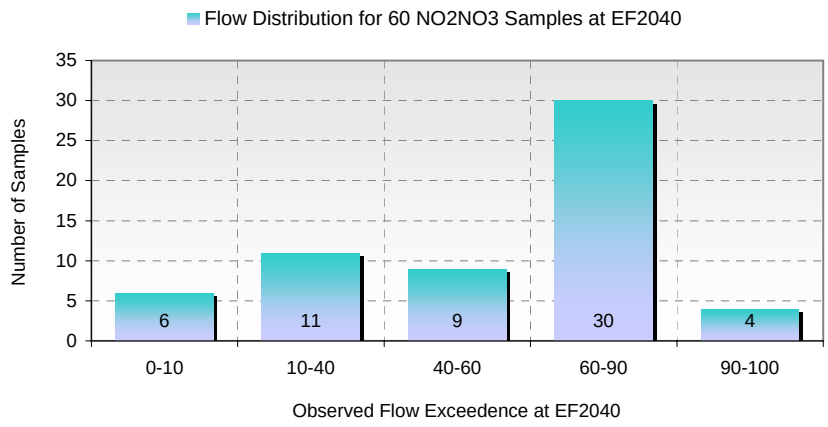


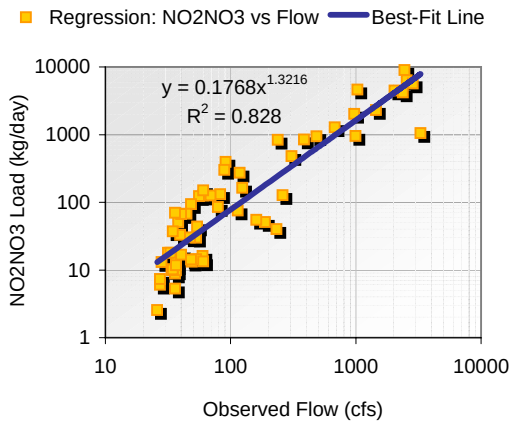
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	102-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	2,514.85	615	1,064	42.2%
10-40	18	511.62	125	193	35.0%
40-60	14	117.46	29	29	0.0%
60-90	51	42.51	10	13	19.7%
90-100	11	28.82	7	9	20.6%

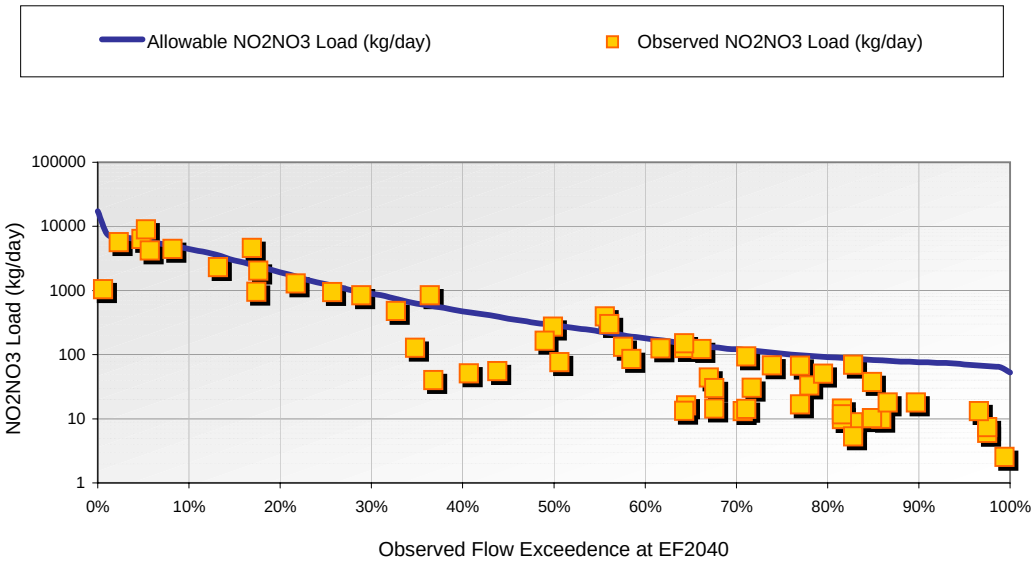
[20: Nitrite Plus Nitrate as Nitrogen at EF2040 (mg/L)] -vs- [25: Flow at EF2040 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

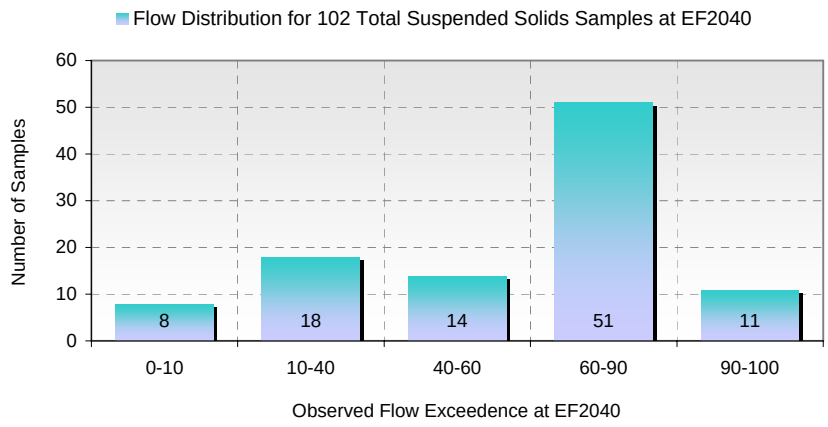


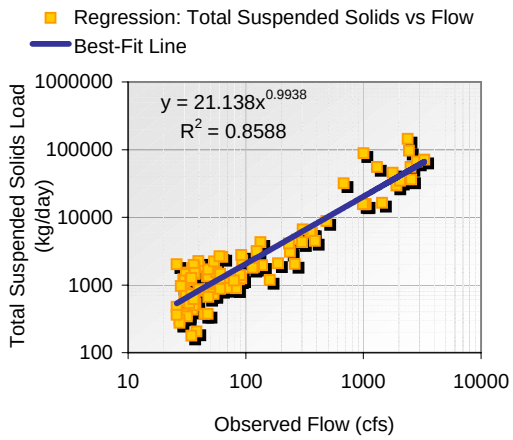
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	60-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	2,514.85	6,153	5,063	0.0%
10-40	11	511.62	1,252	941	0.0%
40-60	9	117.46	287	132	0.0%
60-90	30	42.51	104	18	0.0%
90-100	4	28.82	71	7	0.0%

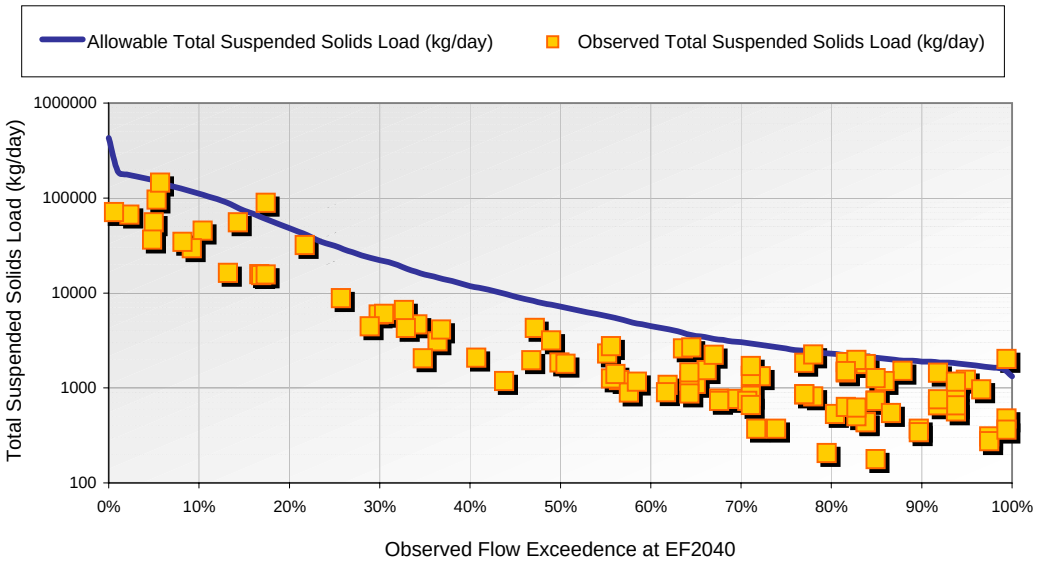
[28: Total Suspended Solids at EF2040 (mg/L)] -vs- [25: Flow at EF2040 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

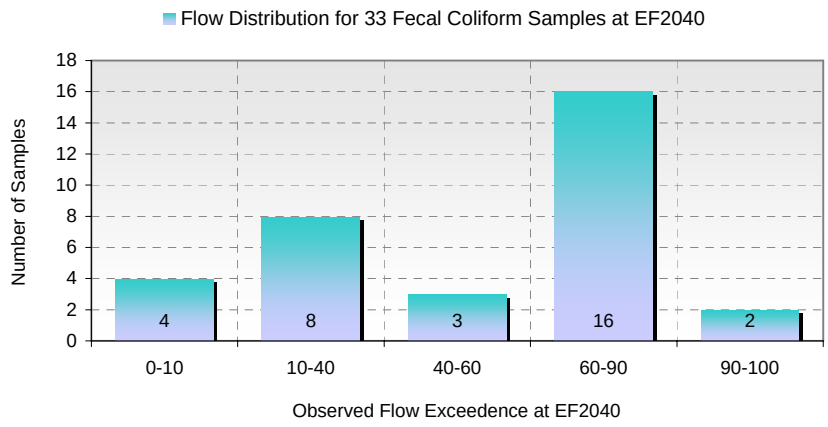


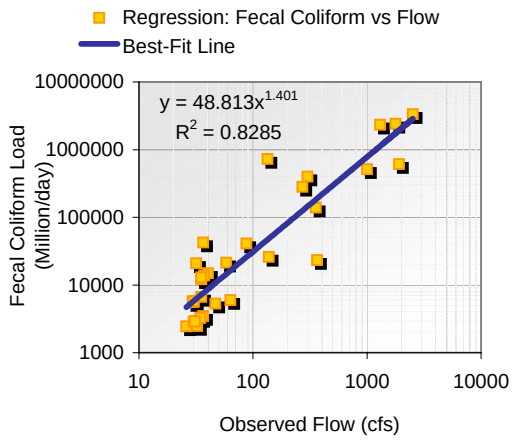
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	102-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	2,514.85	153,819	61,012	0.0%
10-40	18	511.62	31,293	7,706	0.0%
40-60	14	117.46	7,184	1,822	0.0%
60-90	51	42.51	2,600	859	0.0%
90-100	11	28.82	1,763	652	0.0%

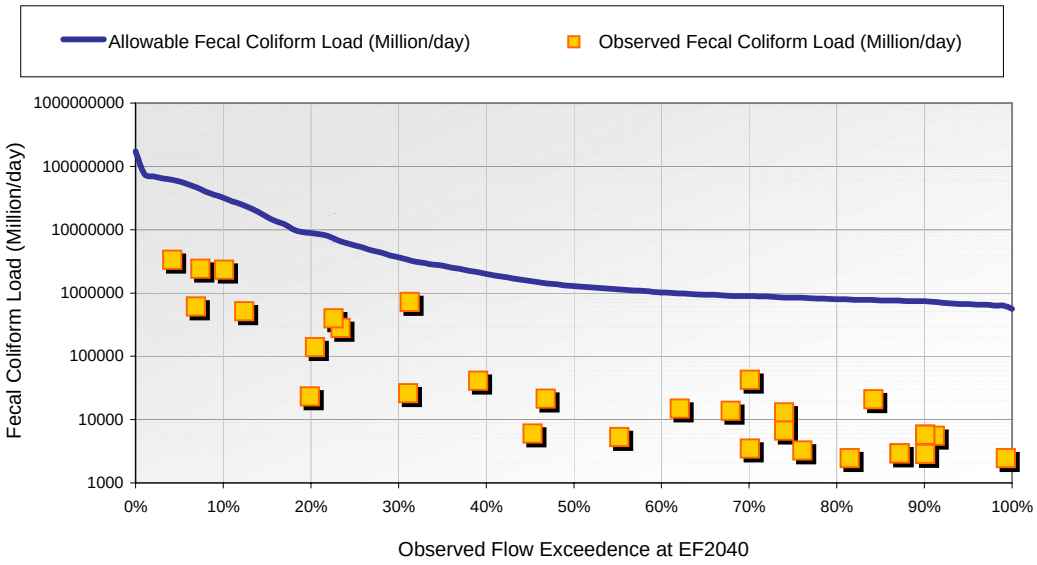
[23: Fecal Coliform at EF2040 (MPN/100mL)] -vs- [25: Flow at EF2040 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

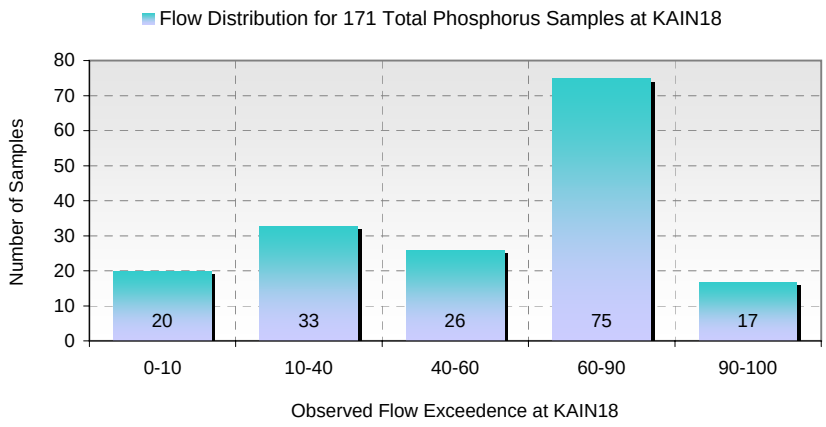


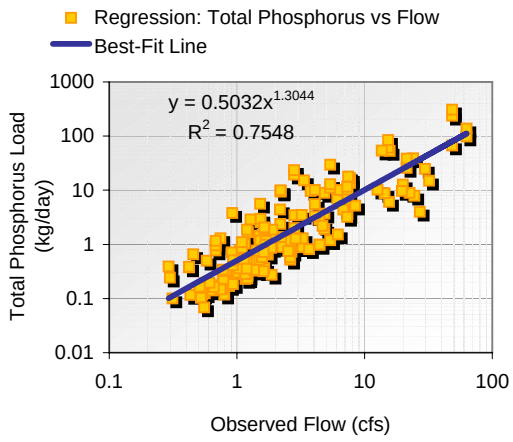
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	33-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	2,360.65	57,755,007	2,362,208	0.0%
10-40	8	230.59	5,641,515	209,618	0.0%
40-60	3	52.60	1,286,971	5,973	0.0%
60-90	16	34.59	846,227	5,701	0.0%
90-100	2	27.38	669,930	4,005	0.0%

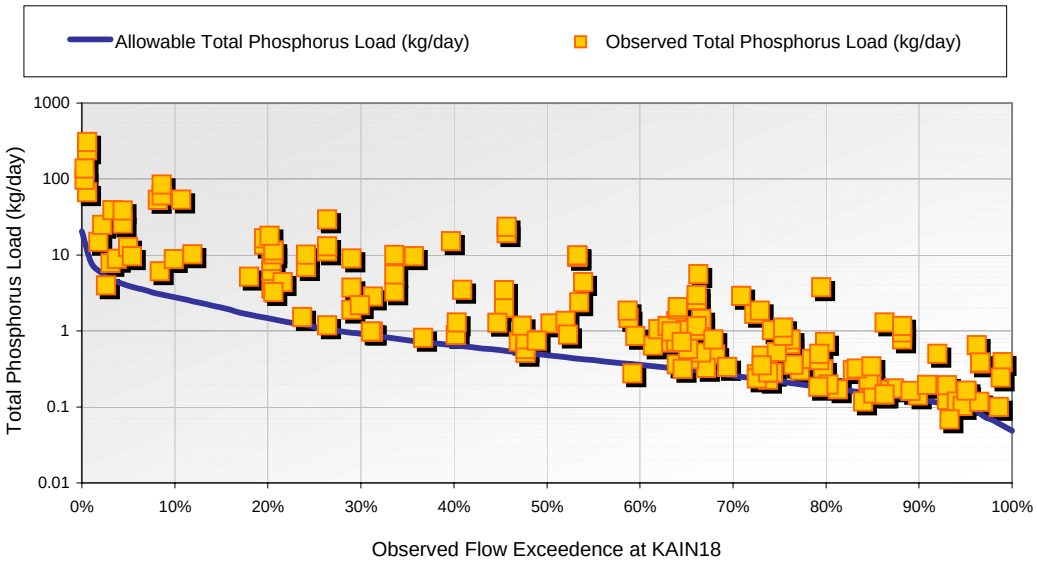
[6: Total Phosphorus at KAIN18 (mg/L)] -vs- [8: Flow at KAIN18 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

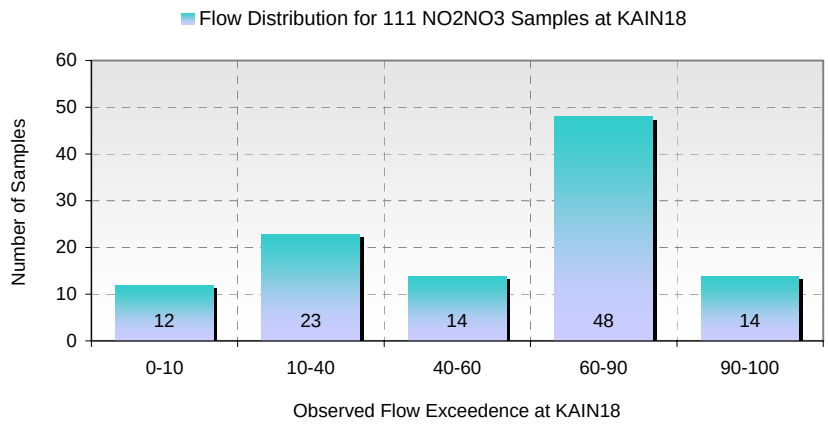


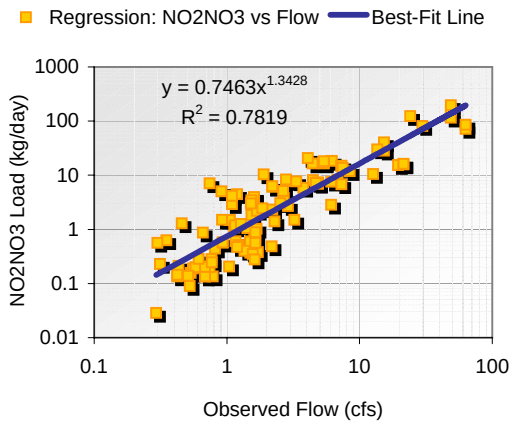
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	171-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	20	20.01	4	32	87.8%
10-40	33	5.76	1	7	83.7%
40-60	26	2.45	0	1	63.7%
60-90	75	1.11	0	1	57.7%
90-100	17	0.51	0	0	38.5%

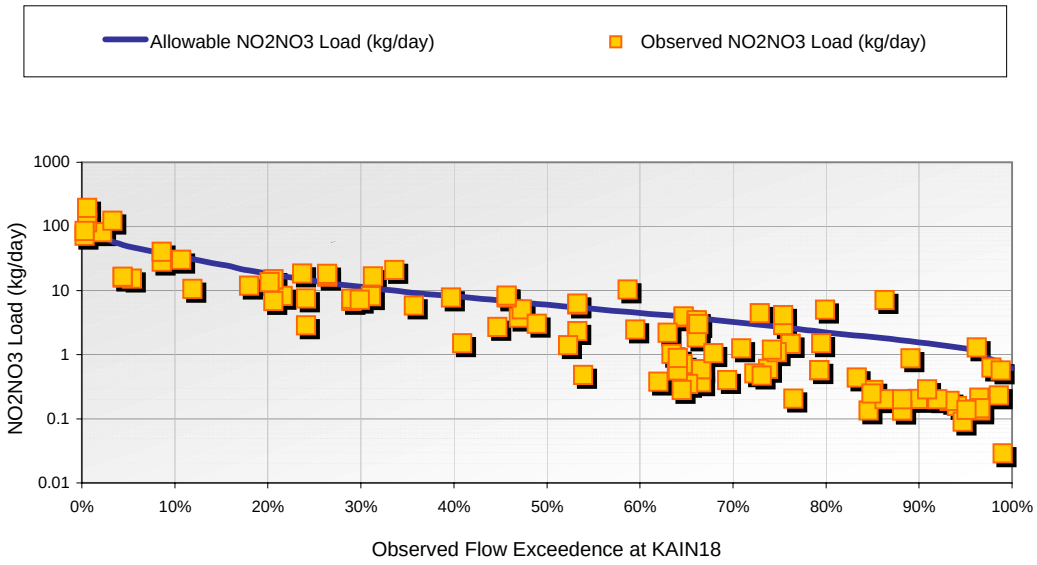
[5: Nitrite Plus Nitrate as Nitrogen at KAIN18 (mg/L)] -vs- [8: Flow at KAIN18 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

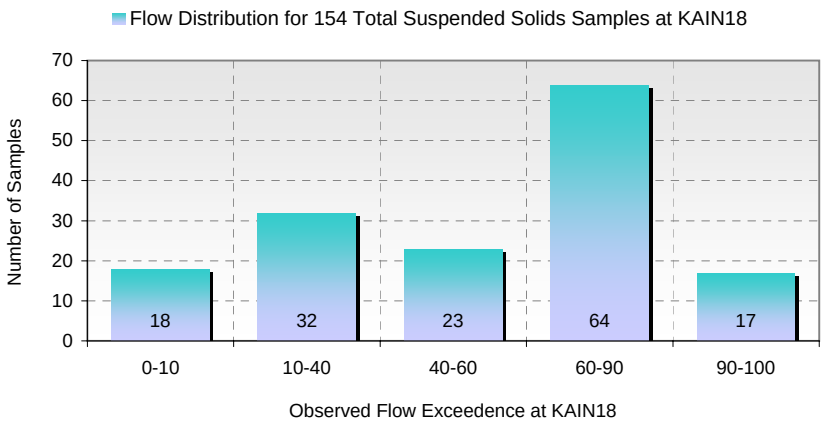


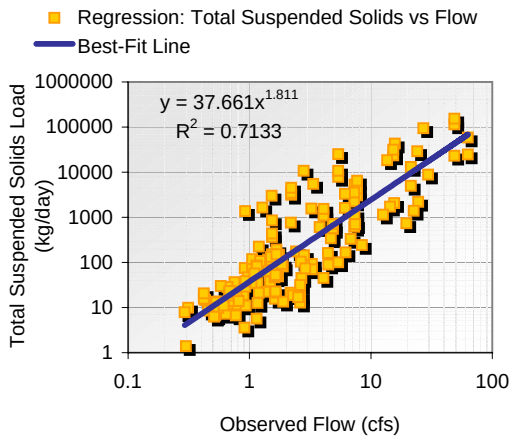
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	111-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	12	20.01	49	76	35.5%
10-40	23	5.76	14	11	0.0%
40-60	14	2.45	6	3	0.0%
60-90	48	1.11	3	1	0.0%
90-100	14	0.51	1	0	0.0%

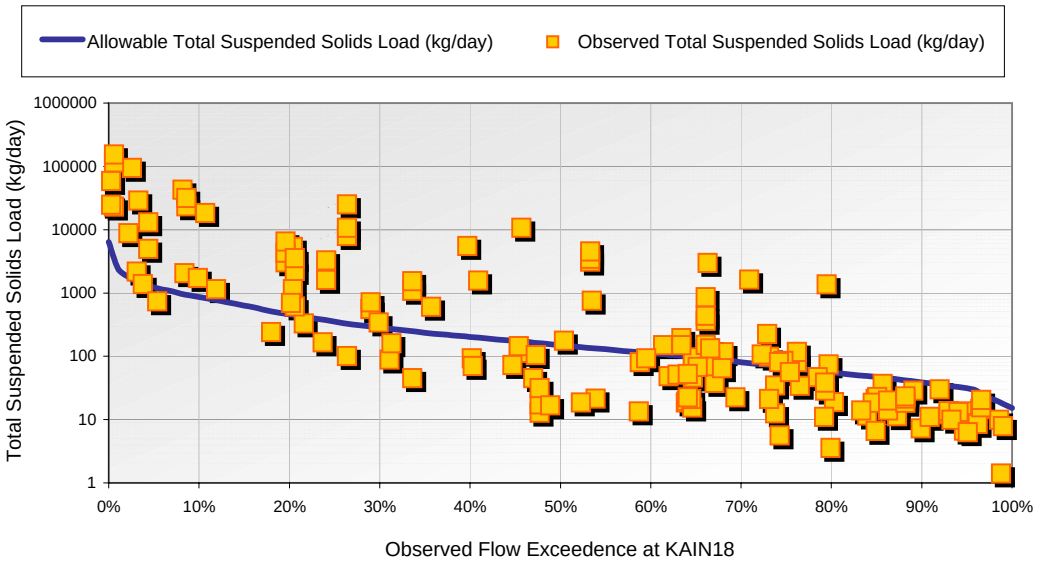
[6: Total Suspended Solids at KAIN18 (mg/L)] -vs- [8: Flow at KAIN18 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

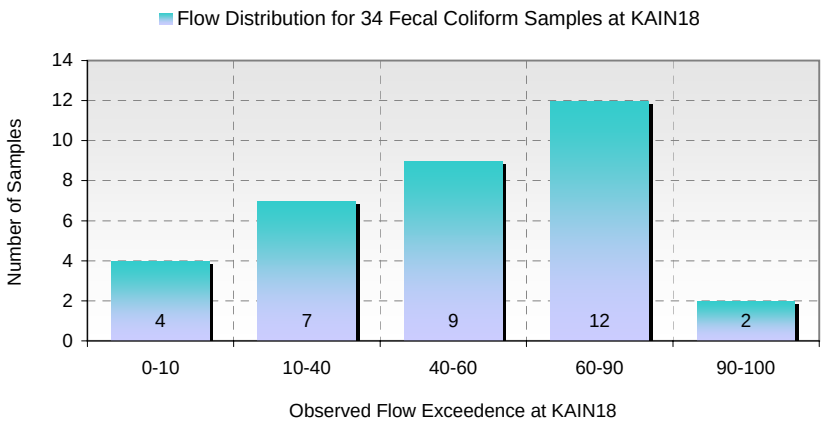


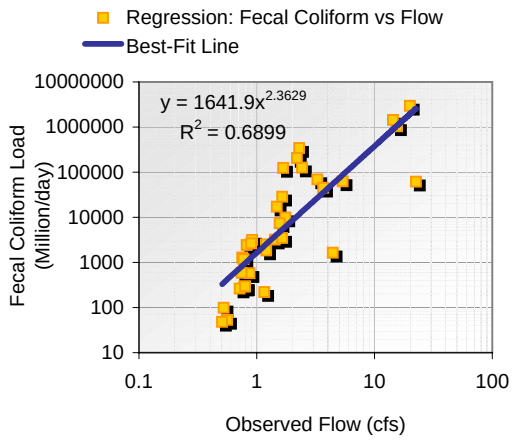
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	154-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	18	20.01	1,224	23,138	94.7%
10-40	32	5.76	352	1,144	69.2%
40-60	23	2.45	150	92	0.0%
60-90	64	1.11	68	42	0.0%
90-100	17	0.51	31	11	0.0%

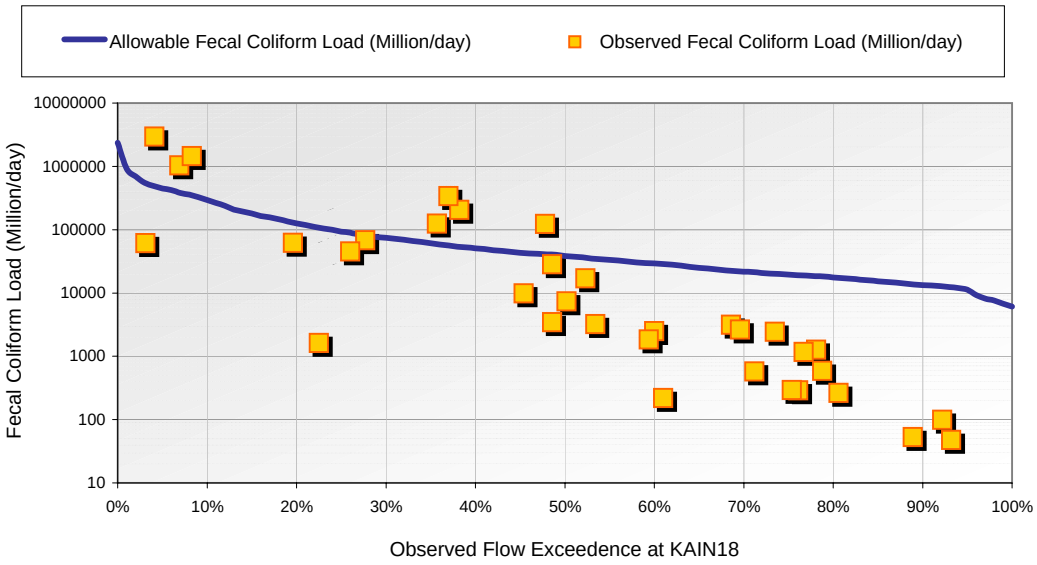
[6: Fecal Coliform at KAIN18 (MPN/100mL)] -vs- [8: Flow at KAIN18 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

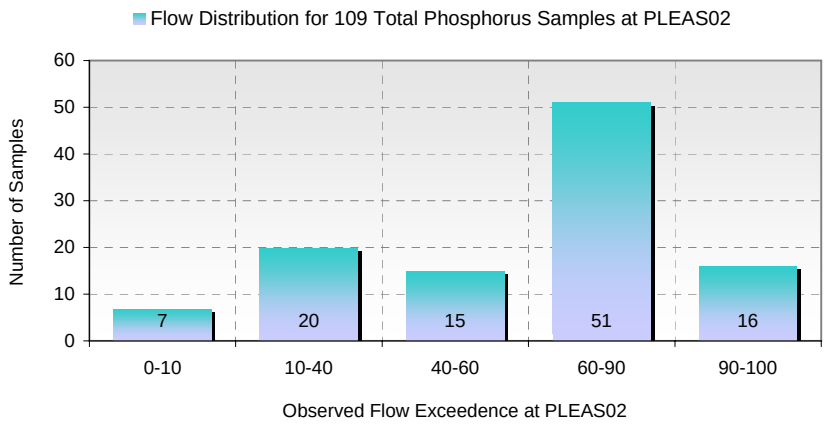


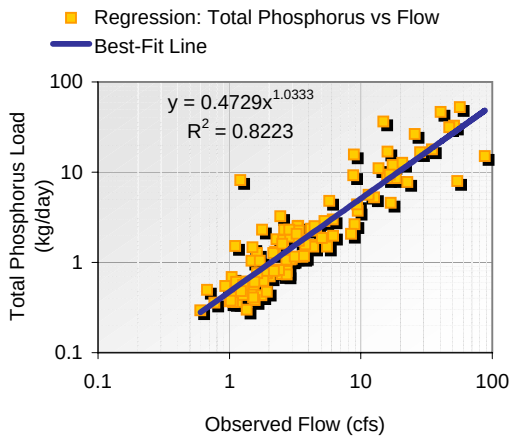
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	34-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	18.29	447,432	1,235,776	63.8%
10-40	7	3.82	93,389	68,182	0.0%
40-60	9	1.57	38,523	7,304	0.0%
60-90	12	0.80	19,595	579	0.0%
90-100	2	0.46	11,273	73	0.0%

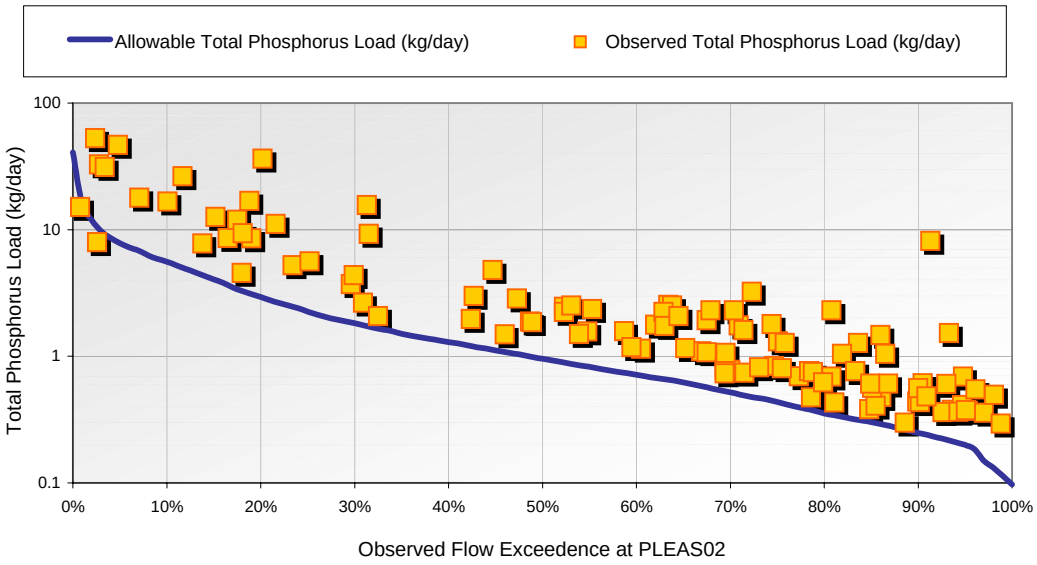
[9: Total Phosphorus at PLEAS02 (mg/L)] -vs- [11: Flow at PLEAS02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

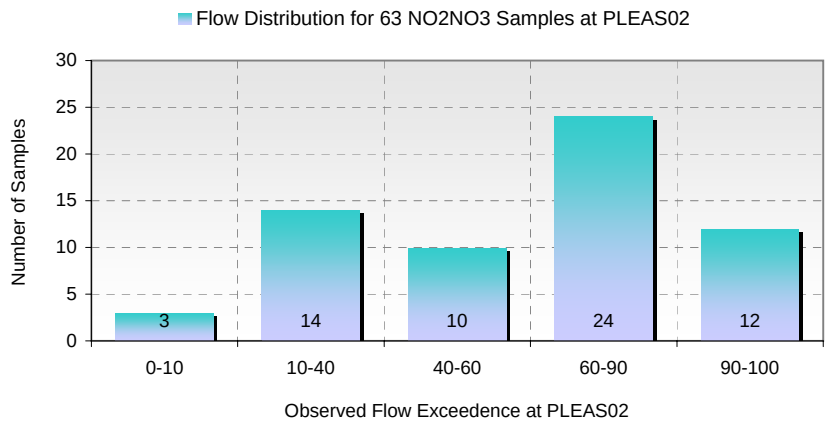


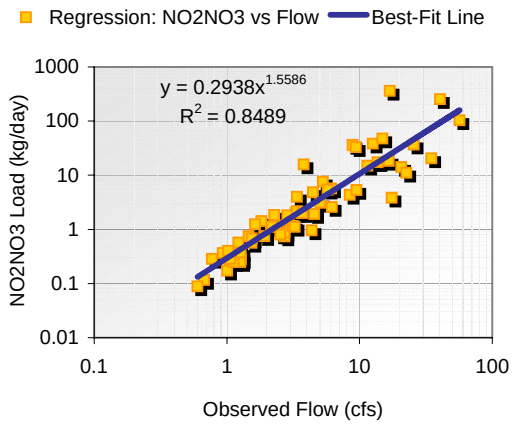
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	109-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	7	40.01	8	31	74.9%
10-40	20	11.52	2	9	74.7%
40-60	15	4.89	1	2	51.2%
60-90	51	2.23	0	1	47.8%
90-100	16	1.02	0	0	55.1%

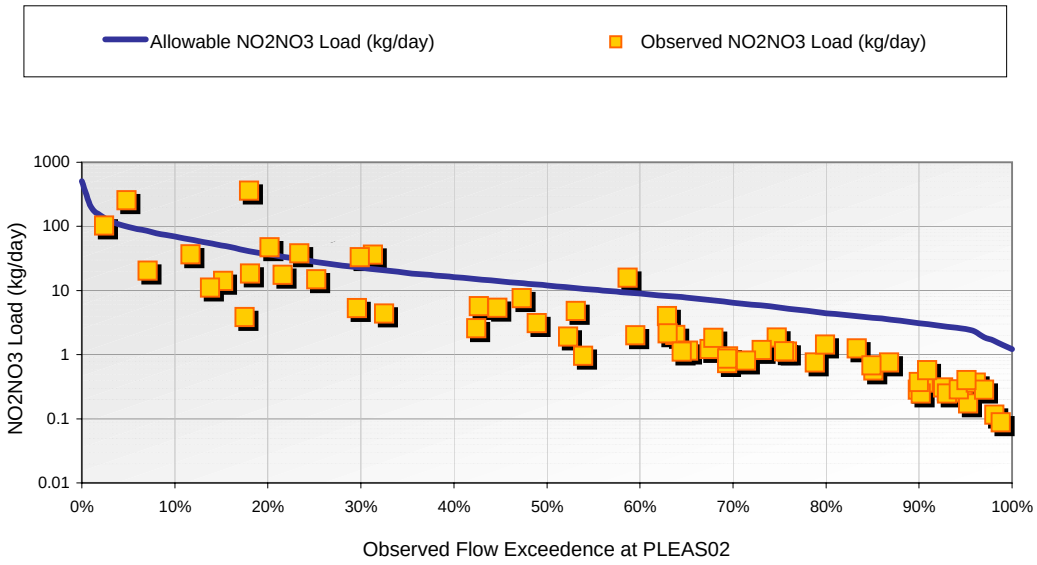
[7: Nitrite Plus Nitrate as Nitrogen at PLEAS02 (mg/L)] -vs- [11: Flow at PLEAS02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

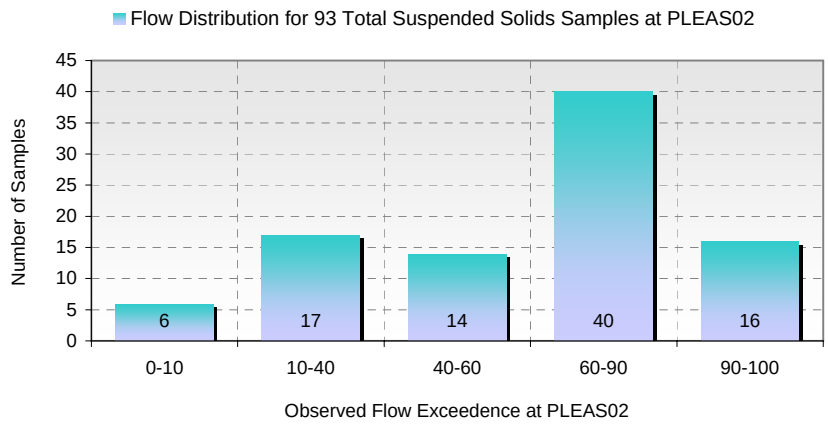


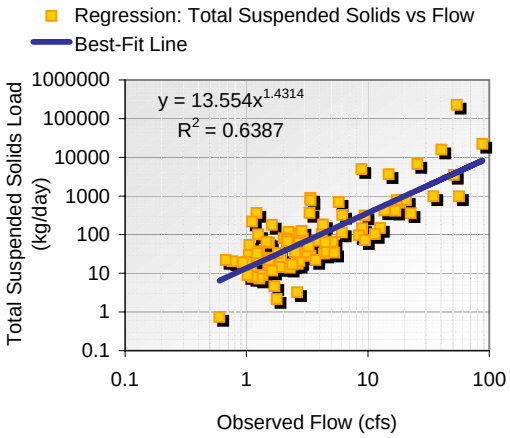
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	63-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	3	40.01	98	103	4.5%
10-40	14	11.52	28	18	0.0%
40-60	10	4.89	12	4	0.0%
60-90	24	2.23	5	1	0.0%
90-100	12	1.02	3	0	0.0%

[9: Total Suspended Solids at PLEAS02 (mg/L)] -vs- [11: Flow at PLEAS02 (cfs)]

1. Data Assessment and Trend Confirmation





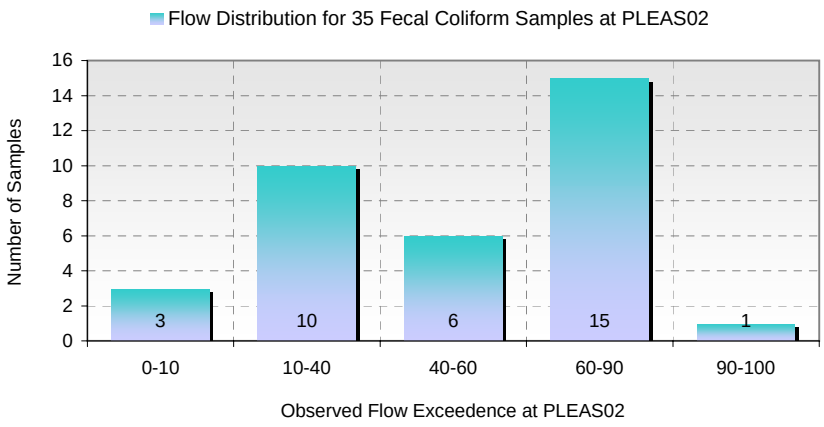
2. Load Exceedence Analysis

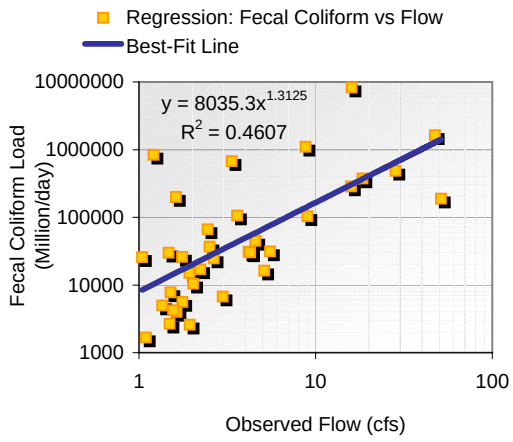
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	93-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	40.01	2,447	9,636	74.6%
10-40	17	11.52	705	422	0.0%
40-60	14	4.89	299	64	0.0%
60-90	40	2.23	136	31	0.0%
90-100	16	1.02	63	21	0.0%

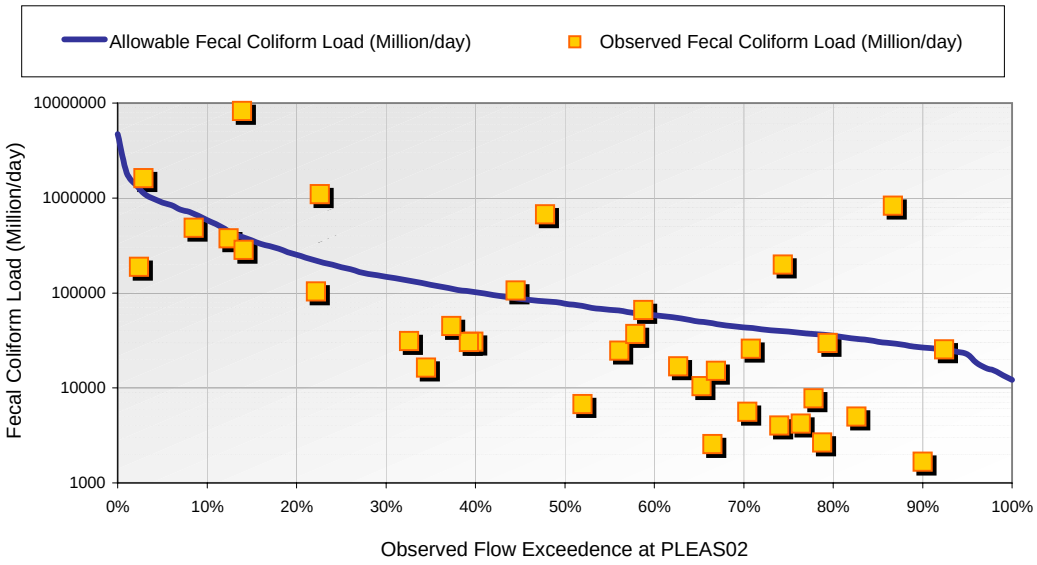
[8: Fecal Coliform at PLEAS02 (MPN/100mL)] -vs- [11: Flow at PLEAS02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

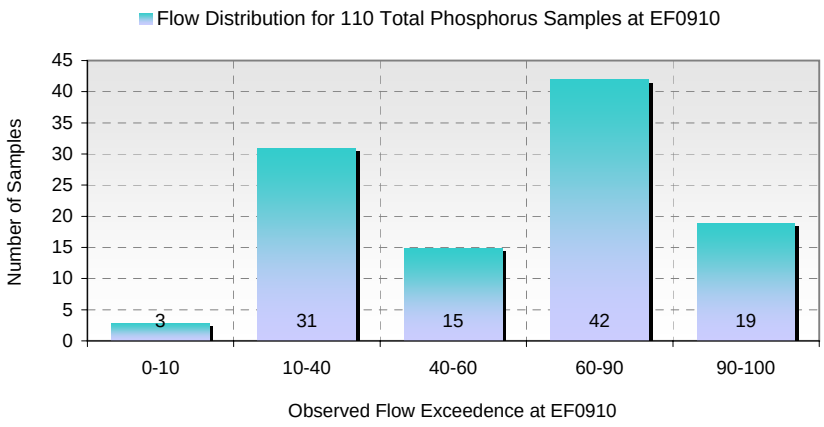


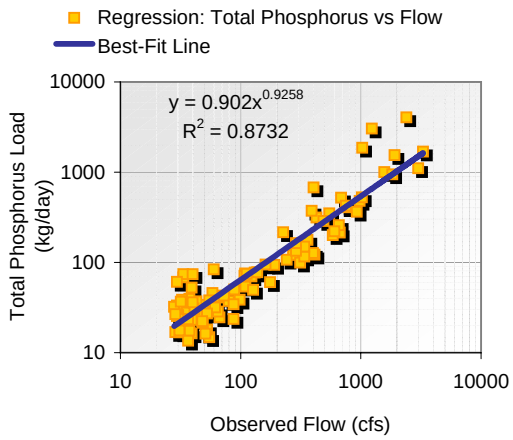
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	35-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	3	36.58	894,865	485,622	0.0%
10-40	10	7.63	186,778	74,111	0.0%
40-60	6	3.15	77,046	51,389	0.0%
60-90	15	1.60	39,190	7,775	0.0%
90-100	1	0.92	22,547	25,515	11.6%

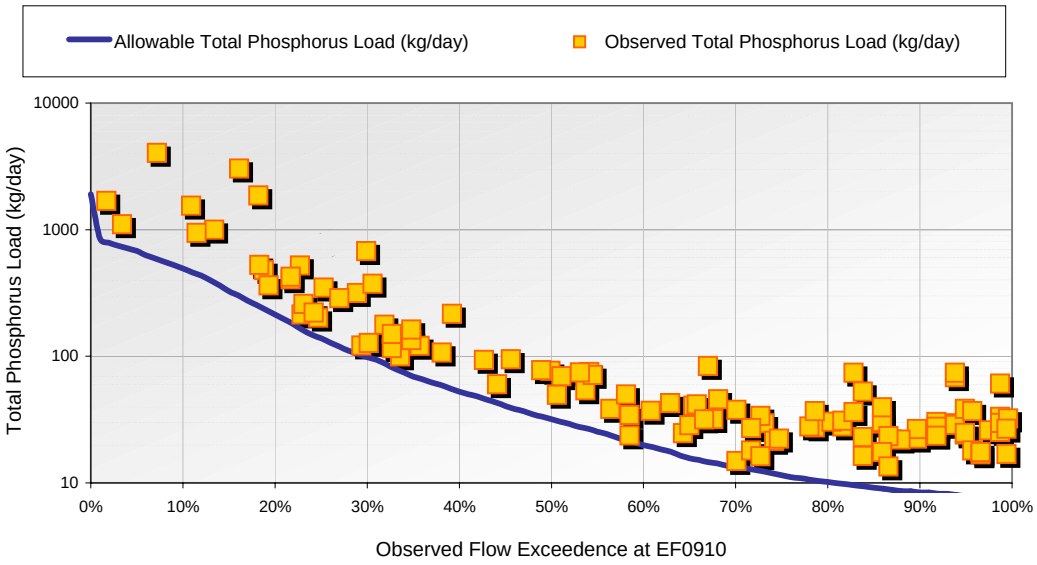
[26: Total Phosphorus at EF0910 (mg/L)] -vs- [23: Flow at EF0910 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

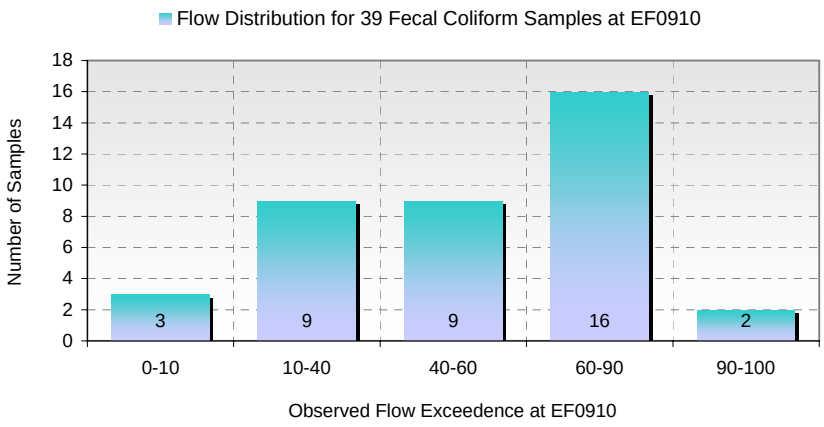


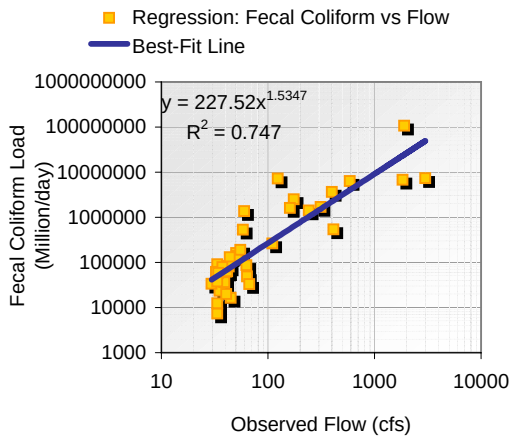
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	110-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	3	2,786.13	682	1,690	59.7%
10-40	31	566.81	139	288	51.8%
40-60	15	130.13	32	70	54.3%
60-90	42	47.10	12	29	60.2%
90-100	19	31.93	8	29	72.8%

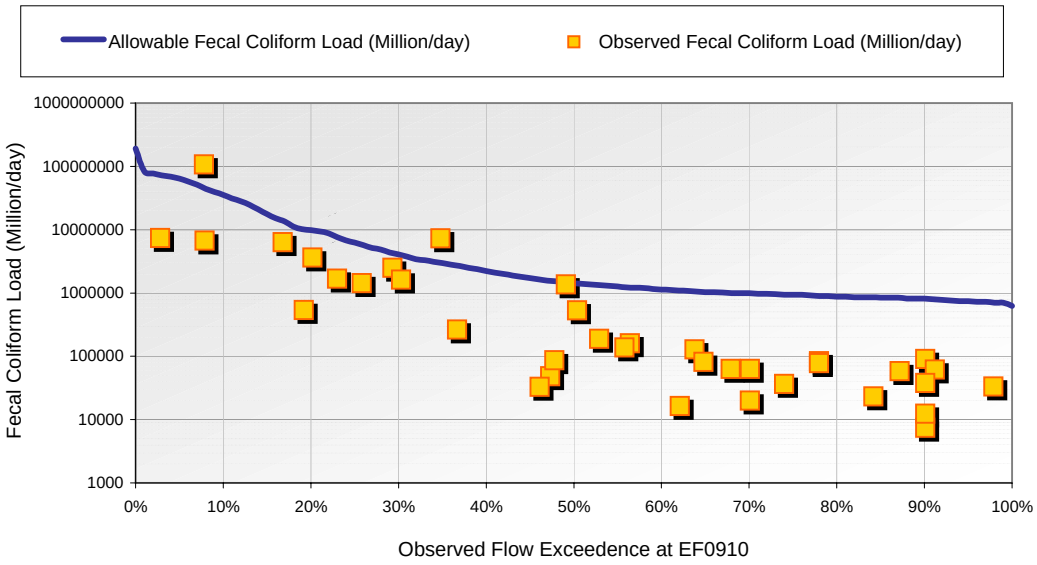
[21: Fecal Coliform at EF0910 (MPN/100mL)] -vs- [23: Flow at EF0910 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

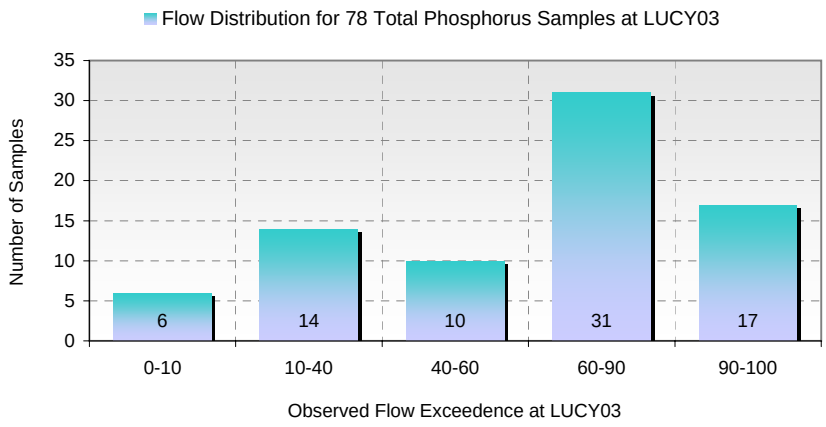


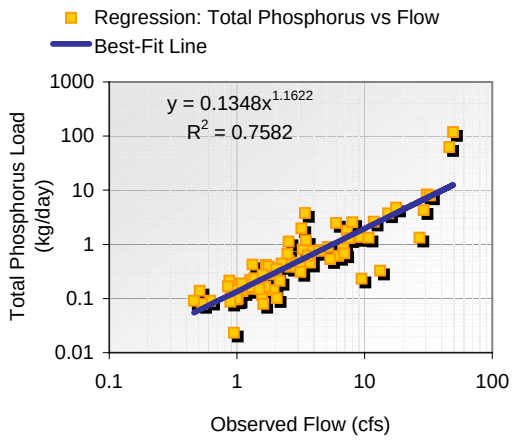
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	39-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	3	2,615.29	63,985,139	7,363,370	0.0%
10-40	9	255.46	6,250,075	1,684,395	0.0%
40-60	9	58.28	1,425,798	148,732	0.0%
60-90	16	38.32	937,511	57,950	0.0%
90-100	2	30.34	742,196	47,452	0.0%

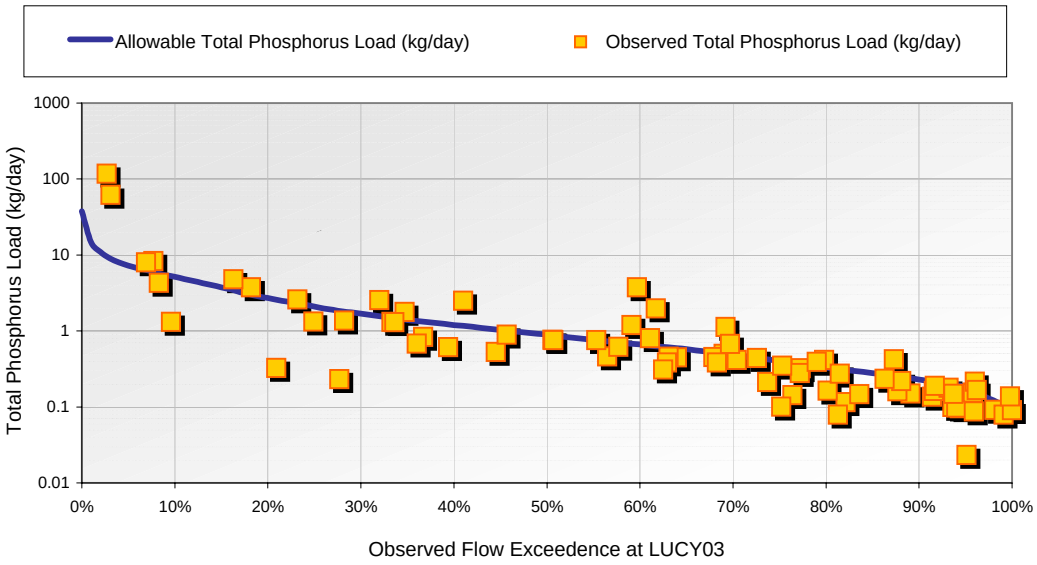
[8: Total Phosphorus at LUCY03 (mg/L)] -vs- [10: Flow at LUCY03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

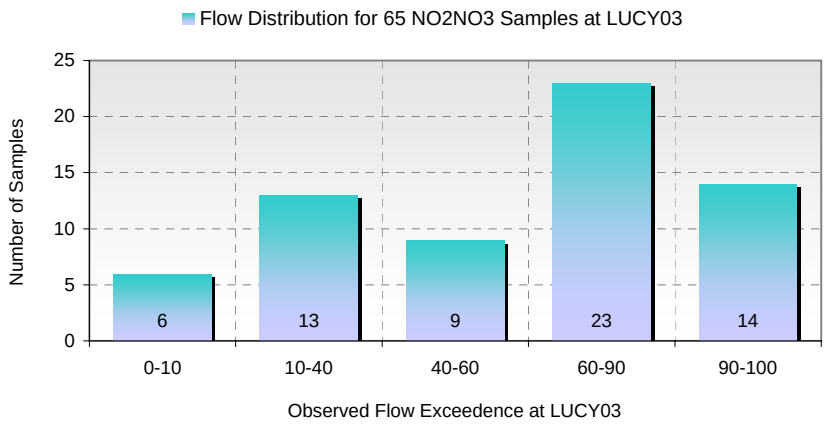


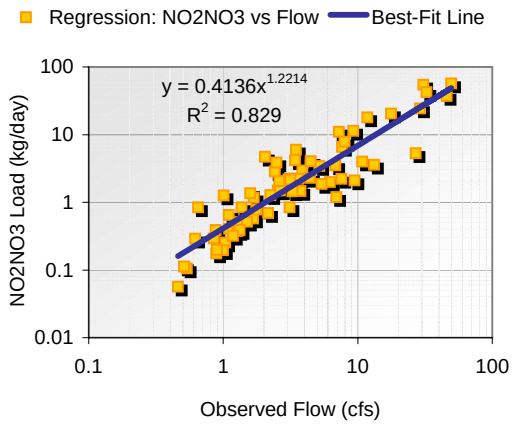
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	78-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	37.08	7	8	10.8%
10-40	14	10.68	2	1	0.0%
40-60	10	4.54	1	1	0.0%
60-90	31	2.07	0	0	0.0%
90-100	17	0.95	0	0	0.0%

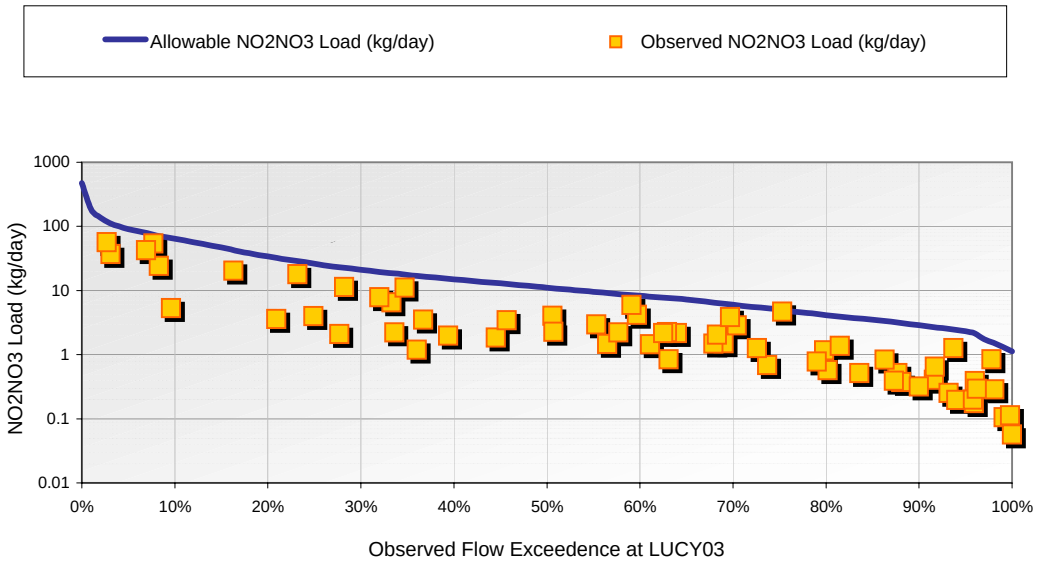
[6: Nitrite Plus Nitrate as Nitrogen at LUCY03 (mg/L)] -vs- [10: Flow at LUCY03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

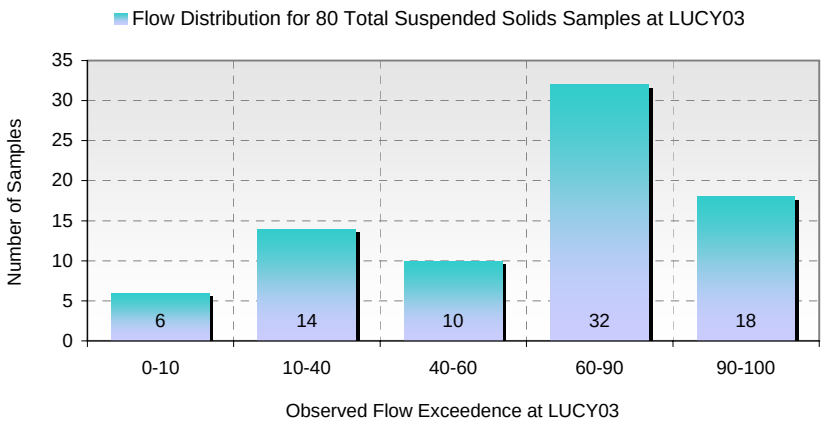


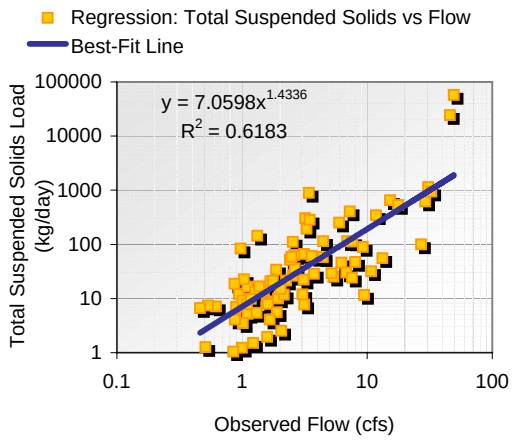
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	65-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	37.08	91	40	0.0%
10-40	13	10.68	26	4	0.0%
40-60	9	4.54	11	3	0.0%
60-90	23	2.07	5	1	0.0%
90-100	14	0.95	2	0	0.0%

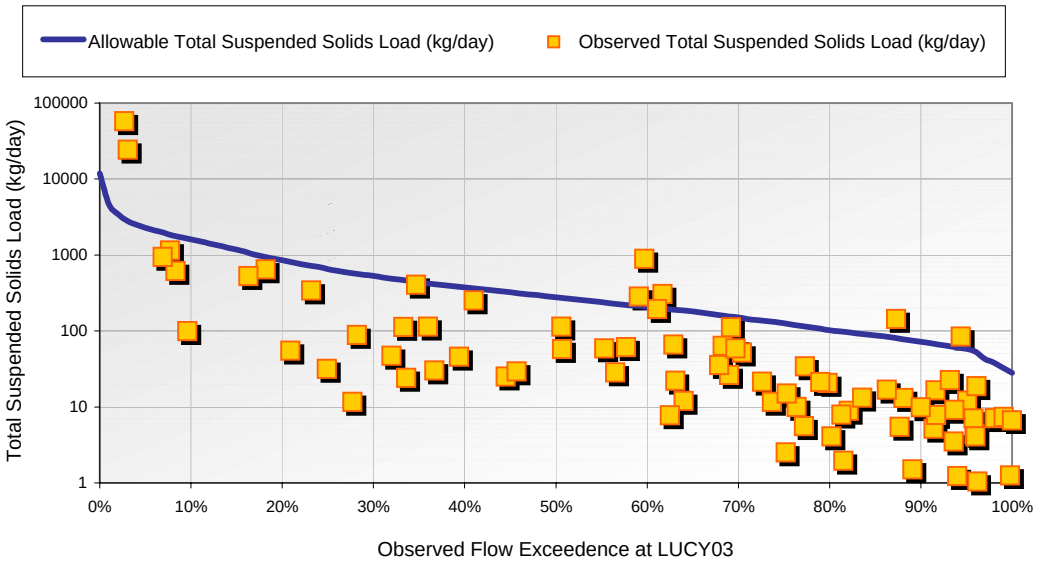
[8: Total Suspended Solids at LUCY03 (mg/L)] -vs- [10: Flow at LUCY03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

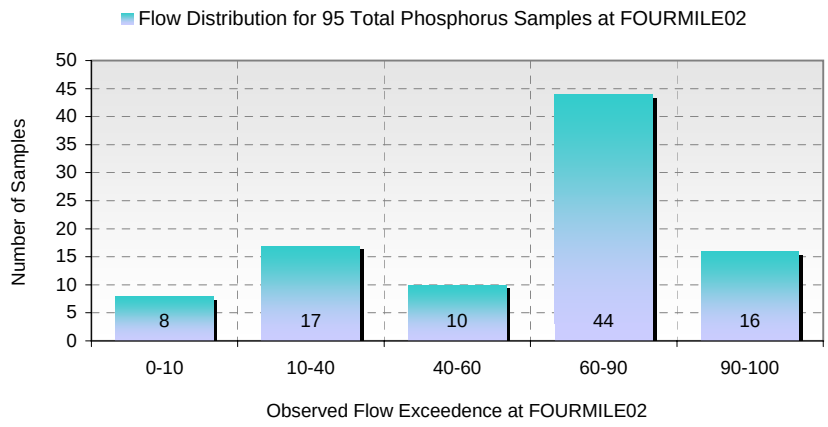


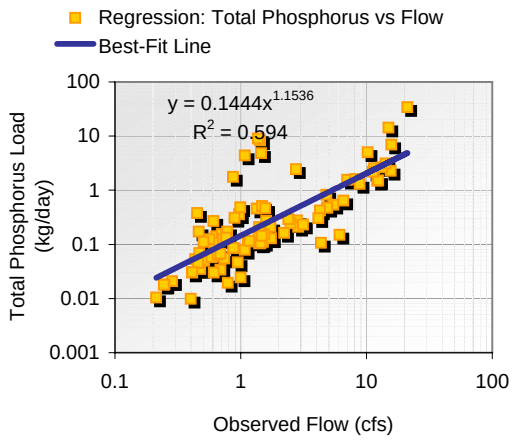
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	80-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	37.08	2,268	1,040	0.0%
10-40	14	10.68	653	72	0.0%
40-60	10	4.54	277	60	0.0%
60-90	32	2.07	126	16	0.0%
90-100	18	0.95	58	7	0.0%

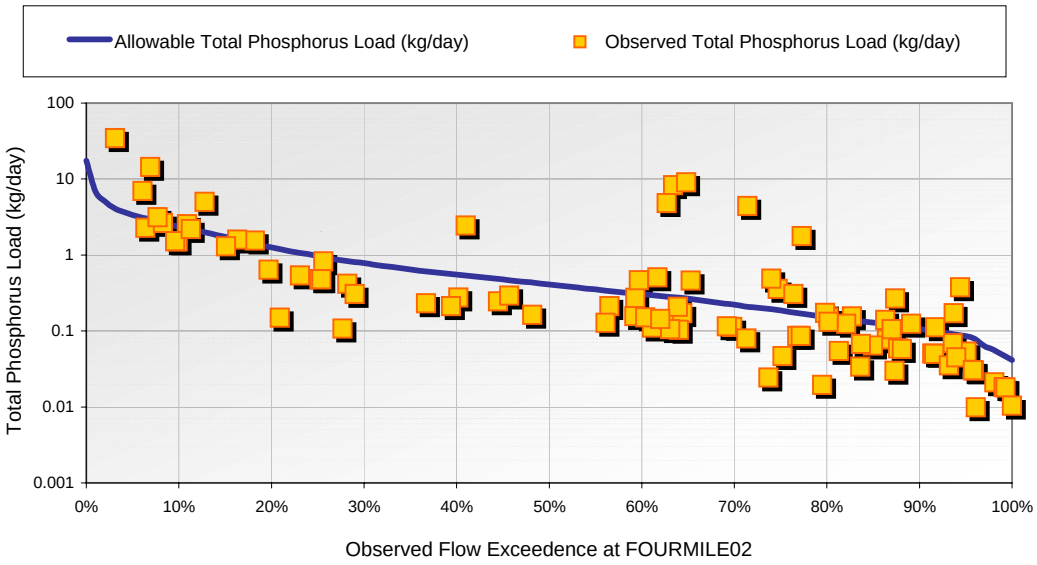
[3: Total Phosphorus at FOURMILE02 (mg/L)] -vs- [5: Flow at FOURMILE02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

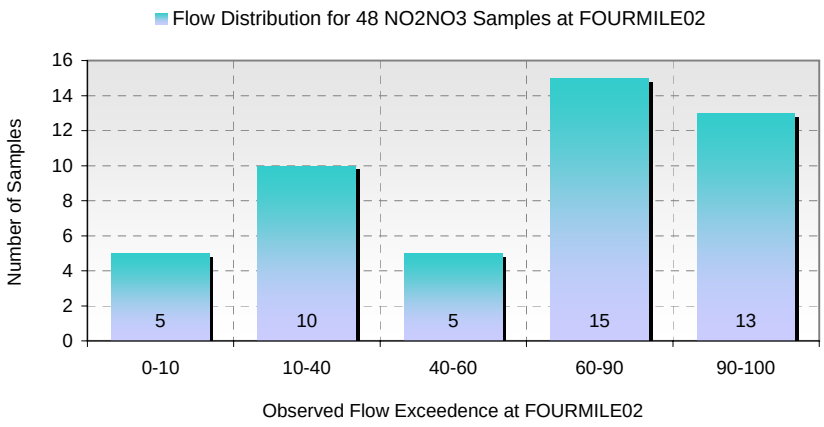


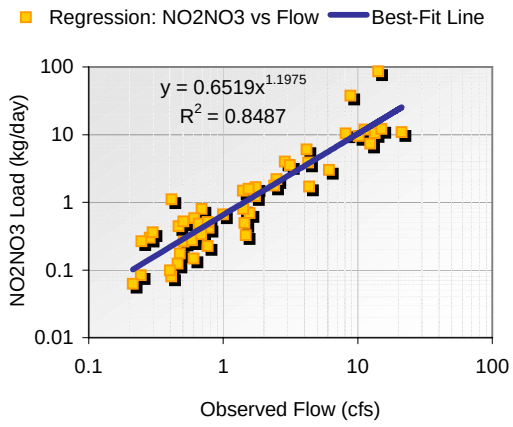
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	95-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	17.08	3	3	0.0%
10-40	17	4.92	1	1	0.0%
40-60	10	2.09	0	0	0.0%
60-90	44	0.95	0	0	0.0%
90-100	16	0.44	0	0	0.0%

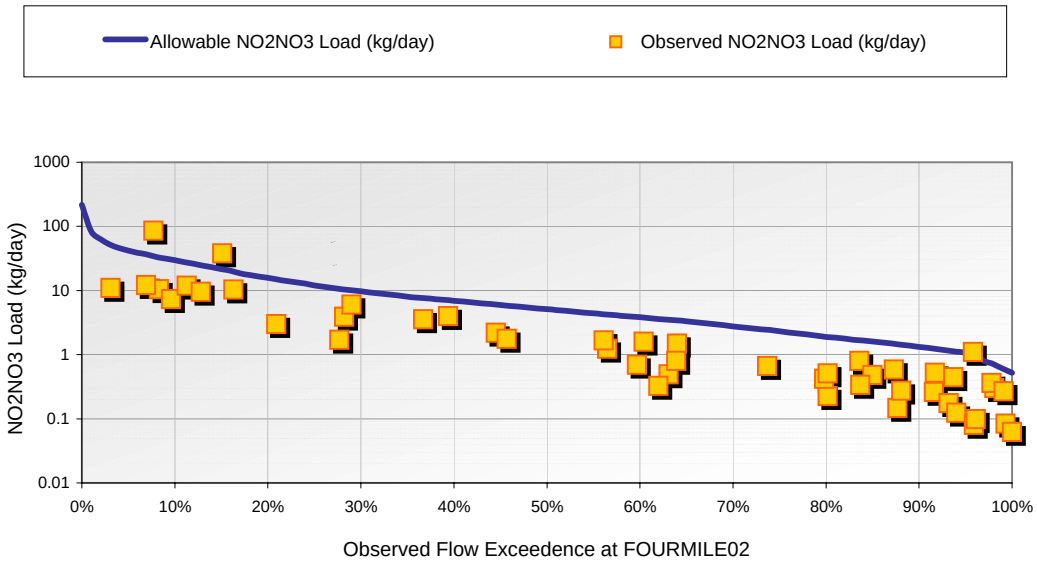
[2: Nitrite Plus Nitrate as Nitrogen at FOURMILE02 (mg/L)] -vs- [5: Flow at FOURMILE02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

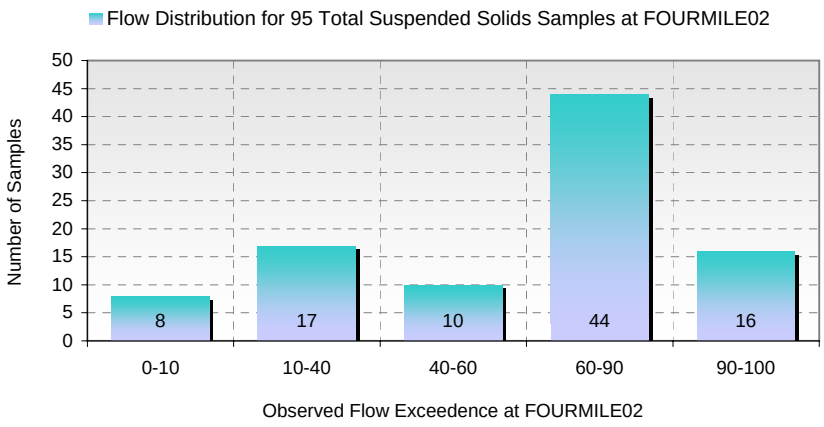


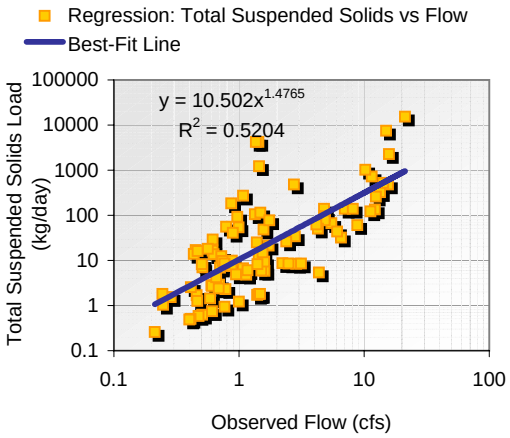
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	48-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	17.08	42	11	0.0%
10-40	10	4.92	12	5	0.0%
40-60	5	2.09	5	2	0.0%
60-90	15	0.95	2	0	0.0%
90-100	13	0.44	1	0	0.0%

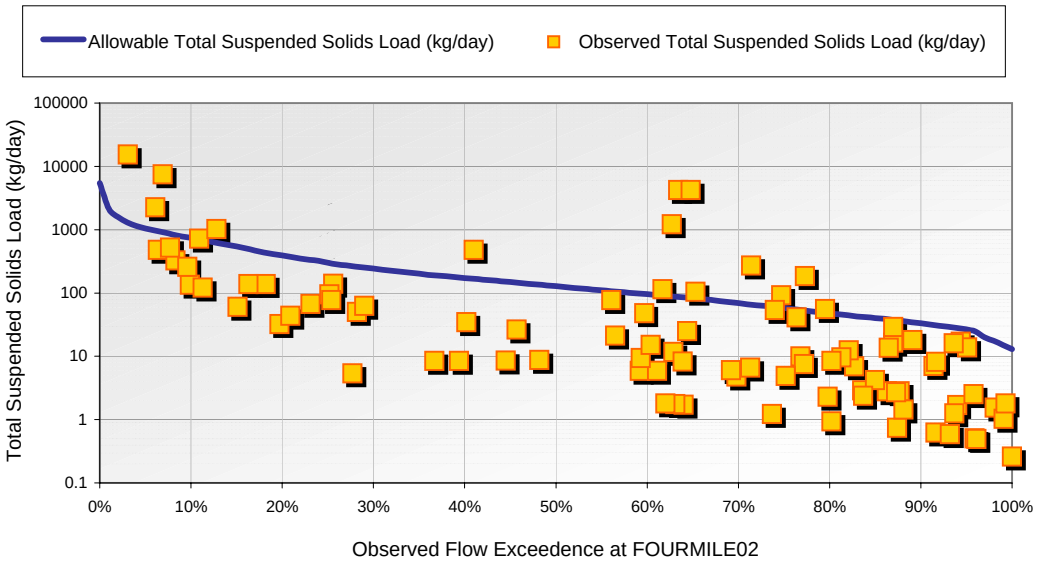
[3: Total Suspended Solids at FOURMILE02 (mg/L)] -vs- [5: Flow at FOURMILE02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

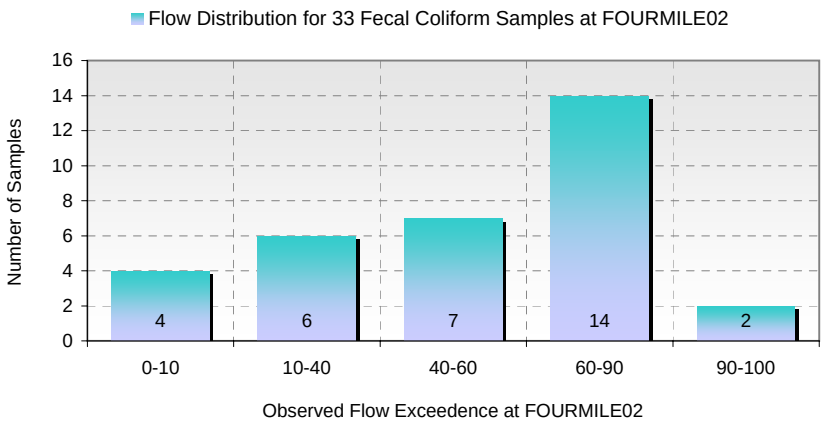


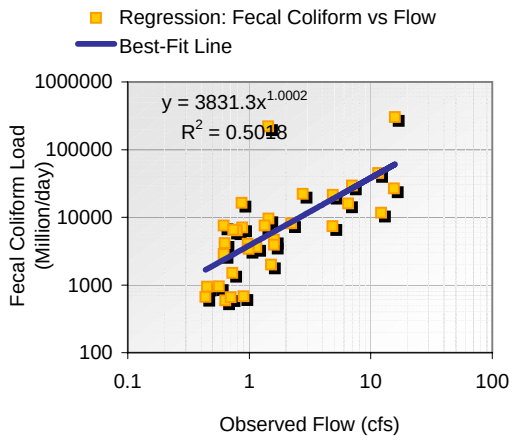
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	95-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	17.08	1,045	499	0.0%
10-40	17	4.92	301	67	0.0%
40-60	10	2.09	128	24	0.0%
60-90	44	0.95	58	8	0.0%
90-100	16	0.44	27	2	0.0%

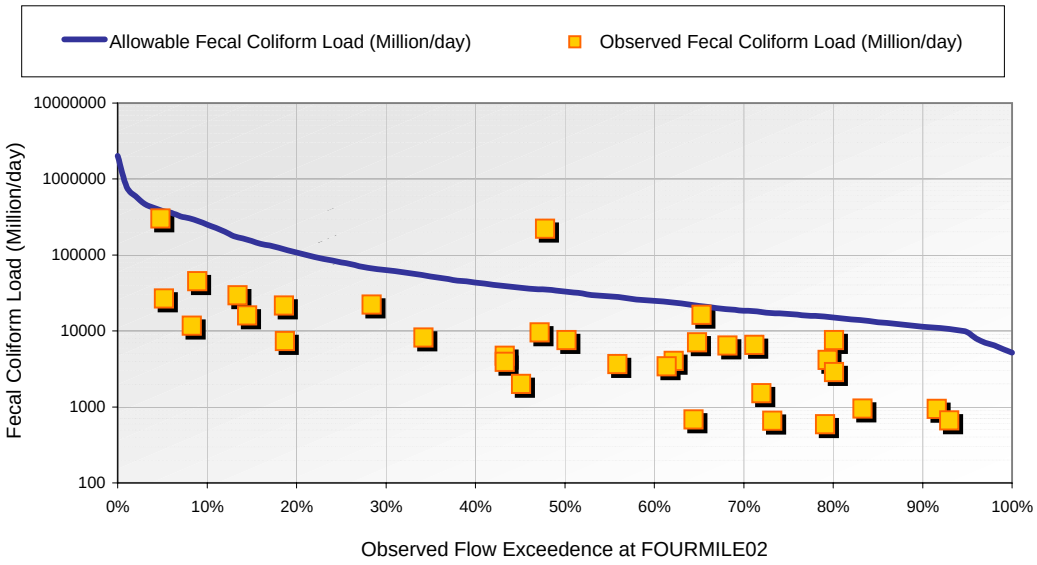
[3: Fecal Coliform at FOURMILE02 (MPN/100mL)] -vs- [5: Flow at FOURMILE02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

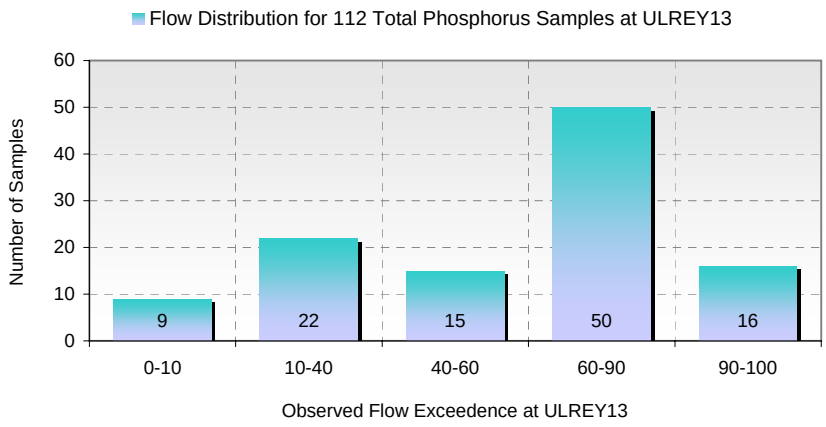


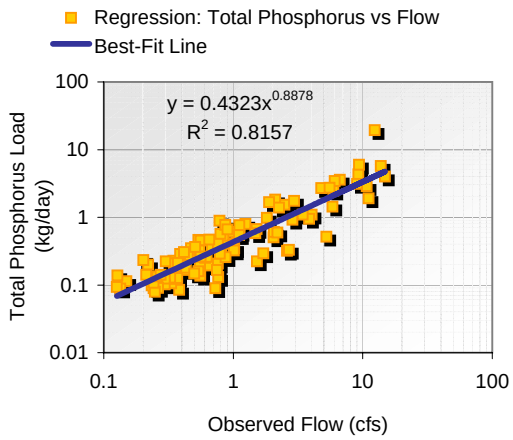
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	33-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	15.61	381,955	35,879	0.0%
10-40	6	3.26	79,722	18,770	0.0%
40-60	7	1.34	32,885	4,689	0.0%
60-90	14	0.68	16,727	3,720	0.0%
90-100	2	0.39	9,624	800	0.0%

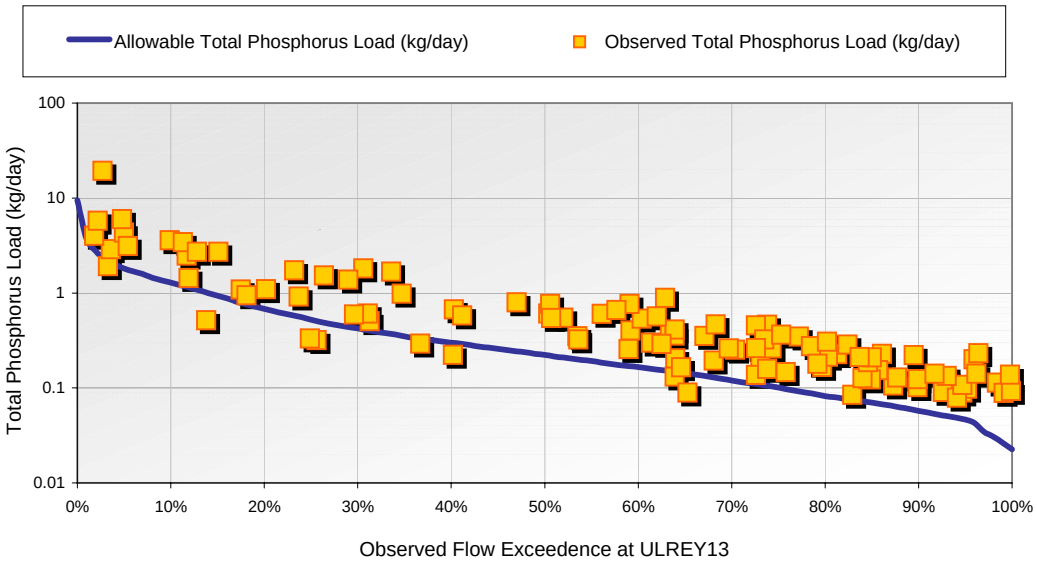
[17: Total Phosphorus at ULREY13 (mg/L)] -vs- [19: Flow at ULREY13 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

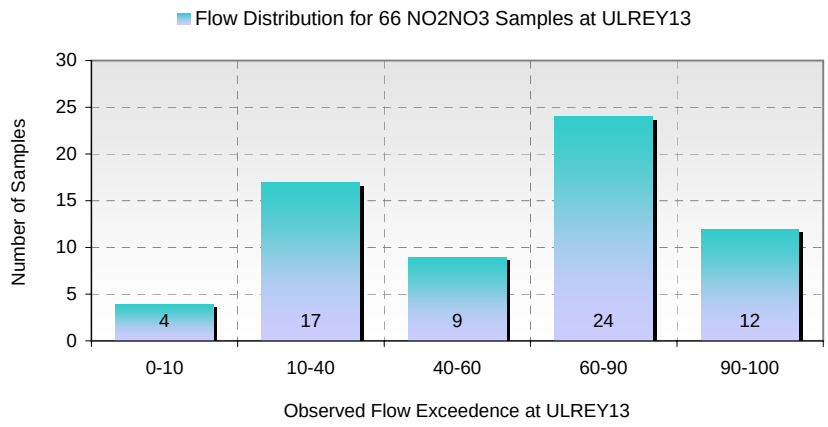


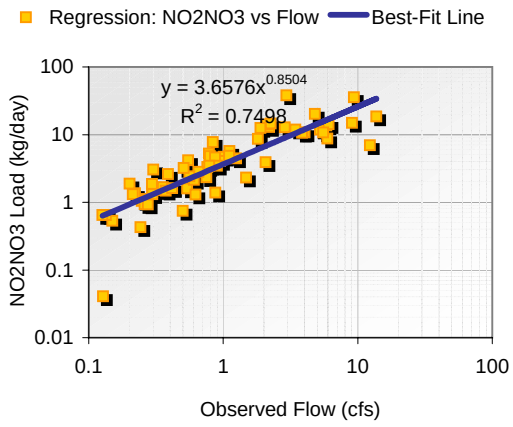
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	112-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	9	9.27	2	4	54.6%
10-40	22	2.67	1	1	52.1%
40-60	15	1.13	0	1	61.7%
60-90	50	0.52	0	0	54.9%
90-100	16	0.24	0	0	58.0%

[13: Nitrite Plus Nitrate as Nitrogen at ULREY13 (mg/L)] -vs- [19: Flow at ULREY13 (cfs)]

1. Data Assessment and Trend Confirmation





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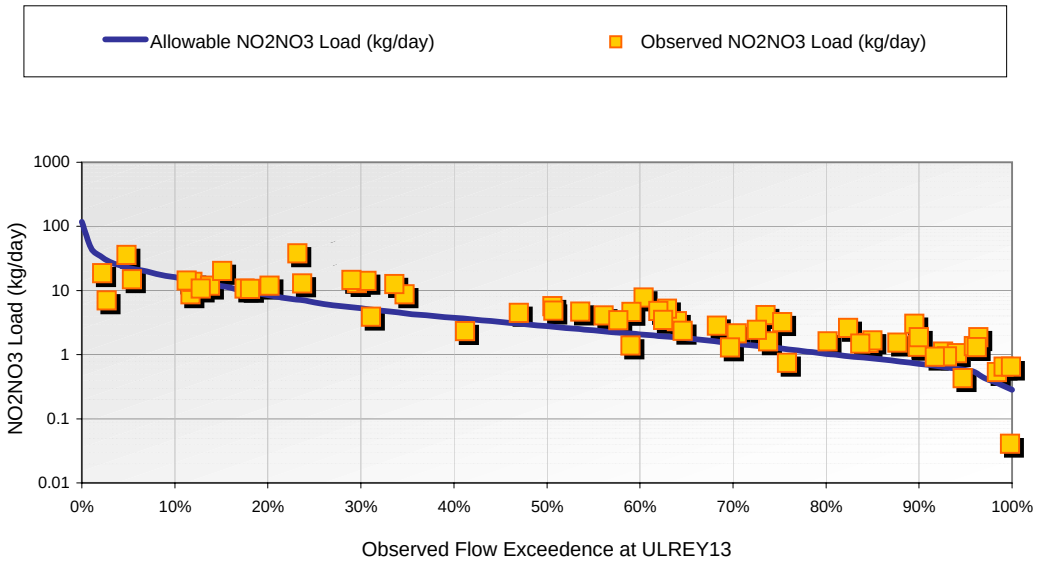
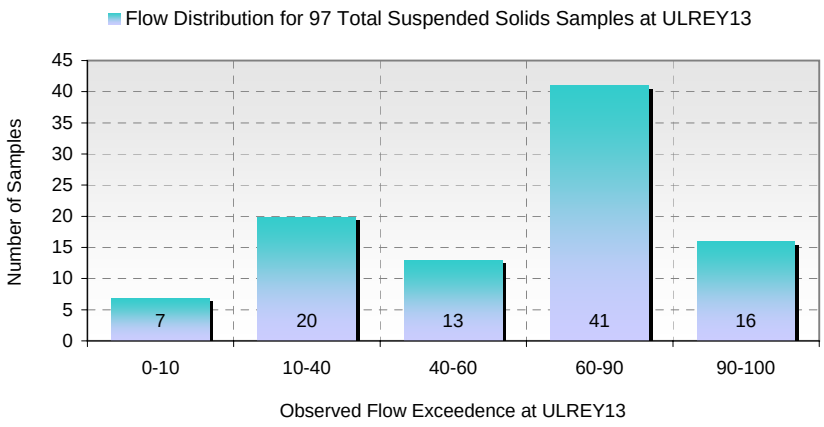


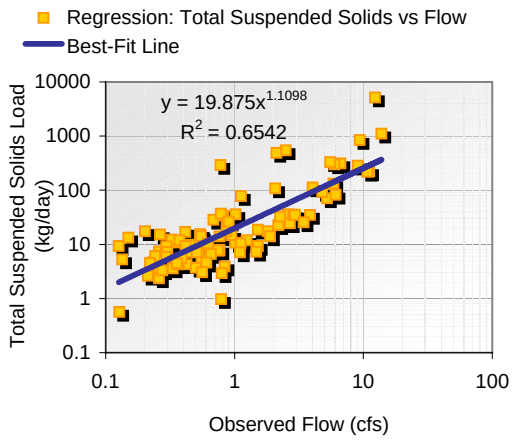
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	66-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	4	9.27	23	17	0.0%
10-40	17	2.67	7	13	48.0%
40-60	9	1.13	3	4	37.7%
60-90	24	0.52	1	2	43.9%
90-100	12	0.24	1	1	37.8%

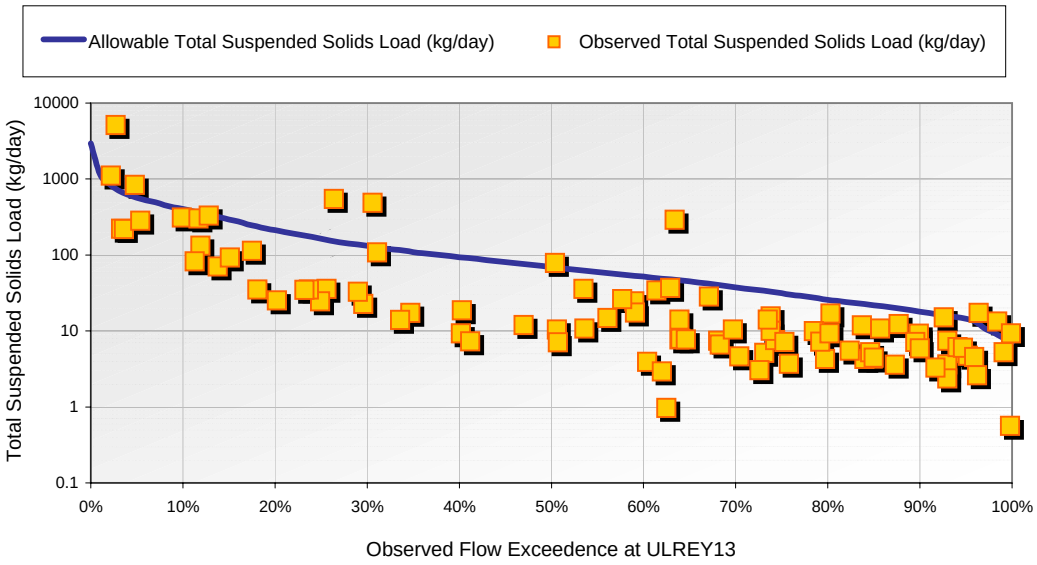
[17: Total Suspended Solids at ULREY13 (mg/L)] -vs- [19: Flow at ULREY13 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

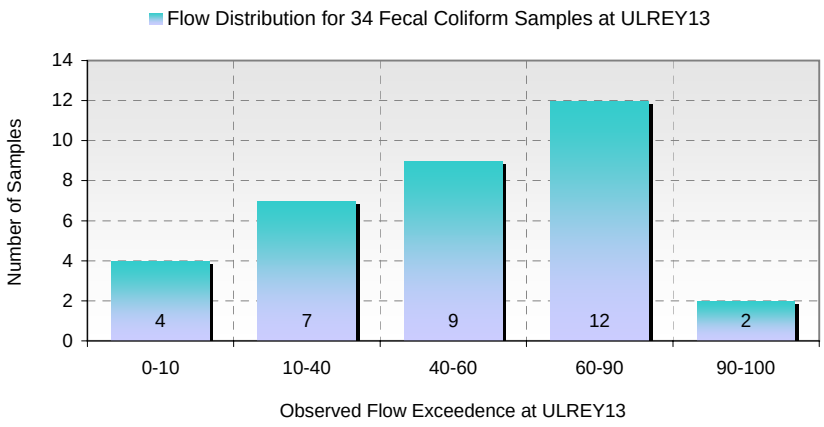


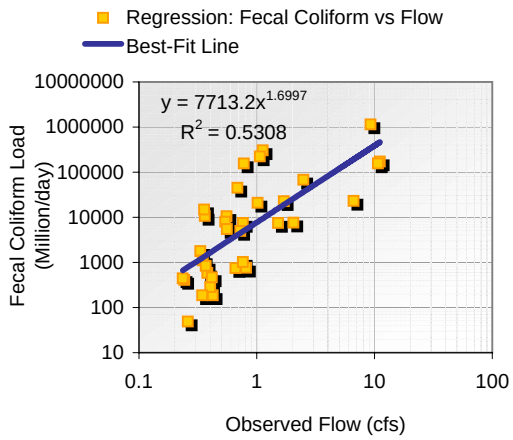
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	97-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	7	9.27	567	310	0.0%
10-40	20	2.67	163	53	0.0%
40-60	13	1.13	69	15	0.0%
60-90	41	0.52	32	8	0.0%
90-100	16	0.24	14	5	0.0%

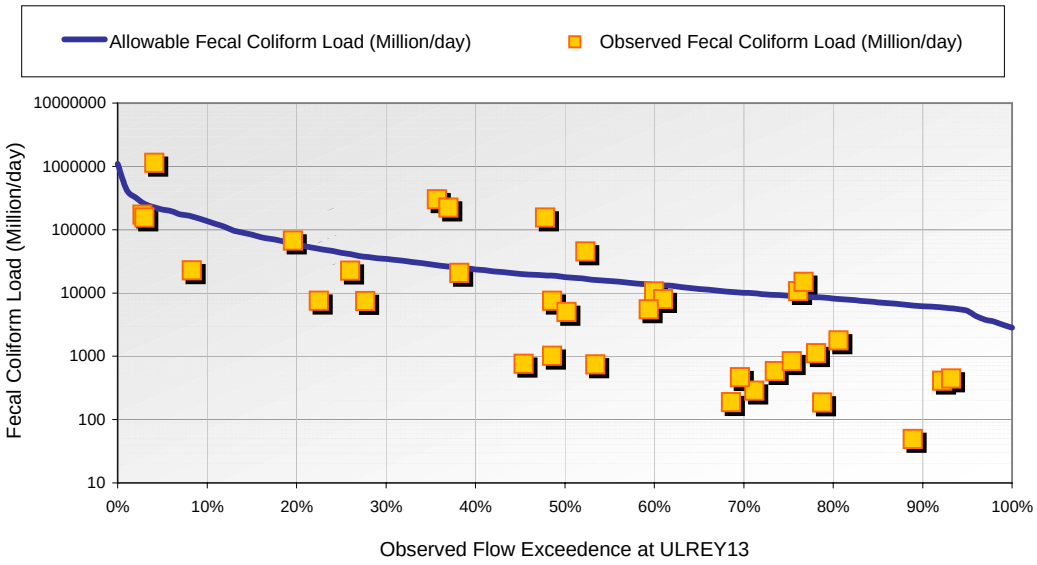
[15: Fecal Coliform at ULREY13 (MPN/100mL)] -vs- [19: Flow at ULREY13 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

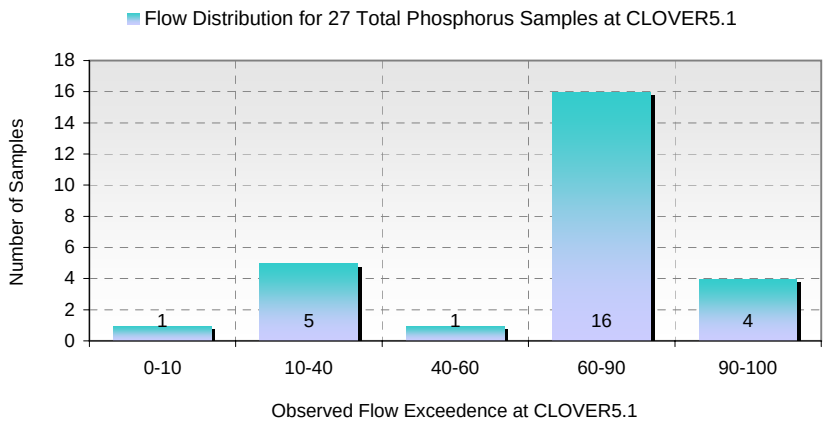


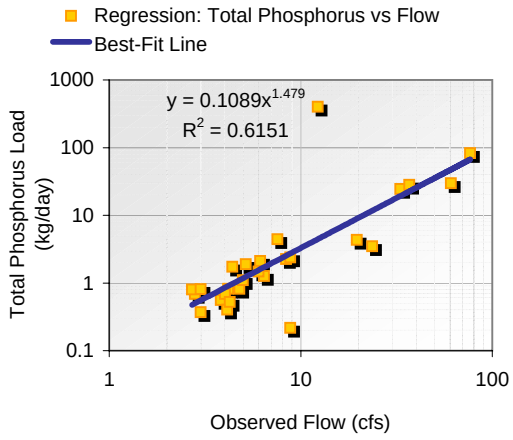
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	34-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	8.47	207,347	163,447	0.0%
10-40	7	1.77	43,278	22,535	0.0%
40-60	9	0.73	17,852	5,472	0.0%
60-90	12	0.37	9,081	706	0.0%
90-100	2	0.21	5,224	427	0.0%

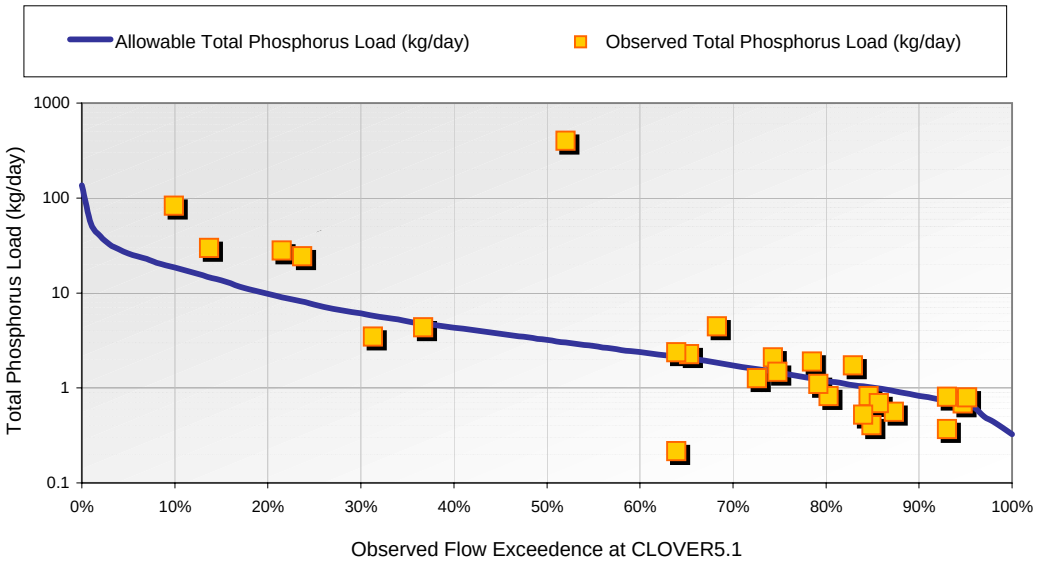
[30: Total Phosphorus at CLOVER5.1 (mg/L)] -vs- [31: Flow at CLOVER5.1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

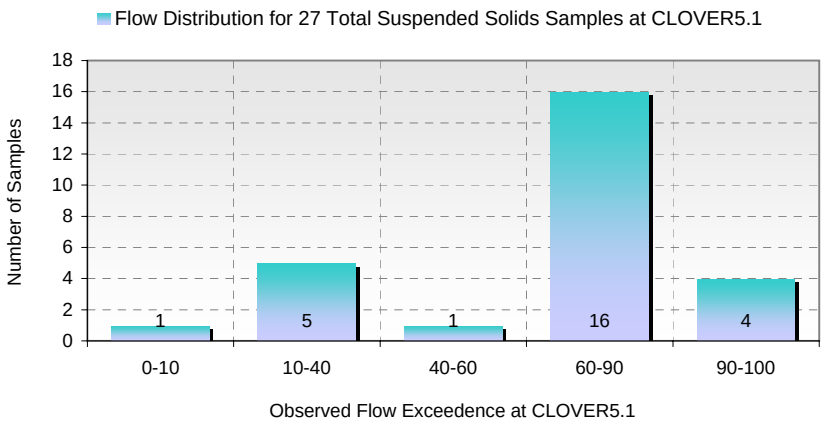


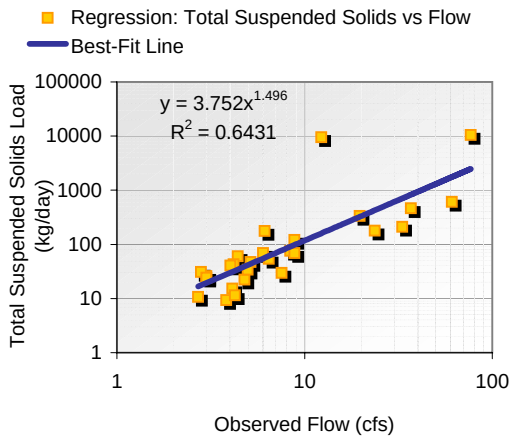
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	27-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	106.86	26	83	68.4%
10-40	5	30.77	8	24	69.0%
40-60	1	13.07	3	400	99.2%
60-90	16	5.95	1	1	0.0%
90-100	4	2.73	1	1	9.9%

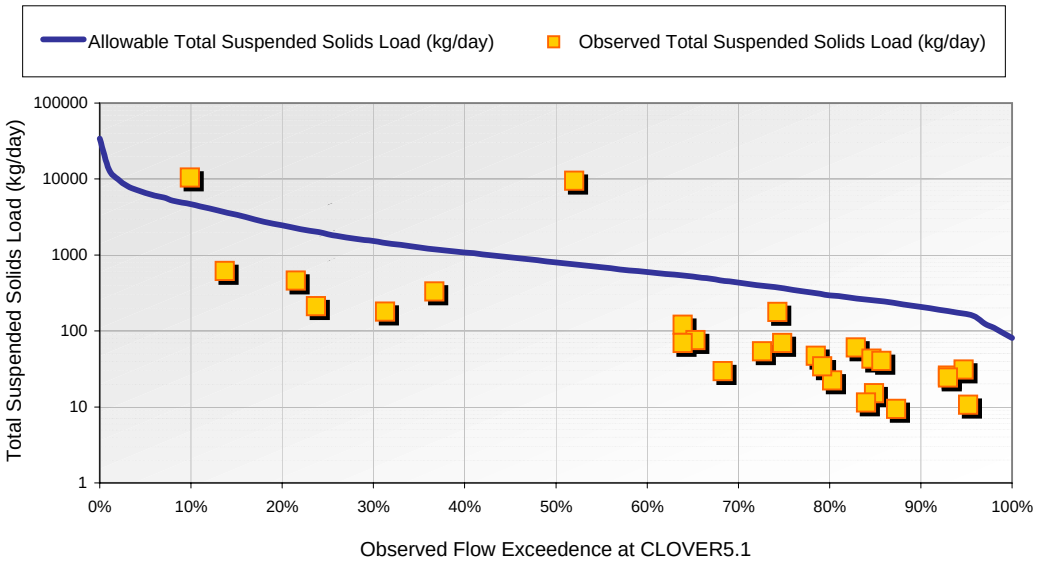
[30: Total Suspended Solids at CLOVER5.1 (mg/L)] -vs- [31: Flow at CLOVER5.1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

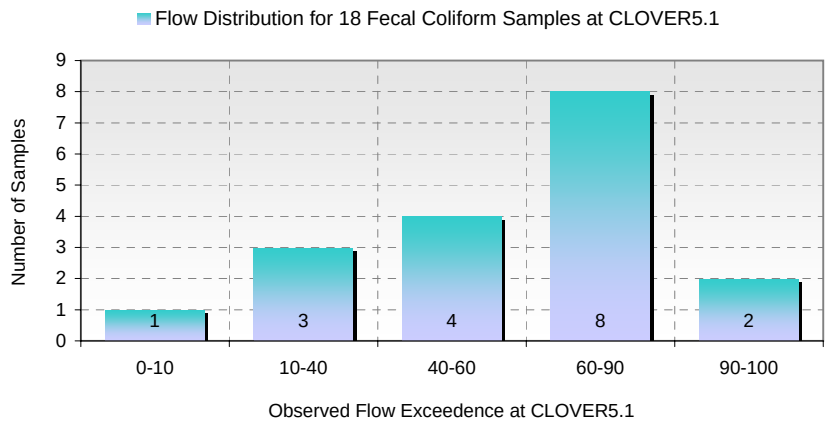


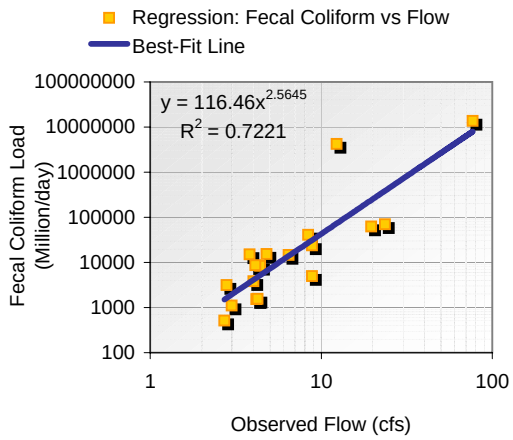
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	27-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	106.86	6,536	10,431	37.3%
10-40	5	30.77	1,882	332	0.0%
40-60	1	13.07	799	9,454	91.5%
60-90	16	5.95	364	45	0.0%
90-100	4	2.73	167	25	0.0%

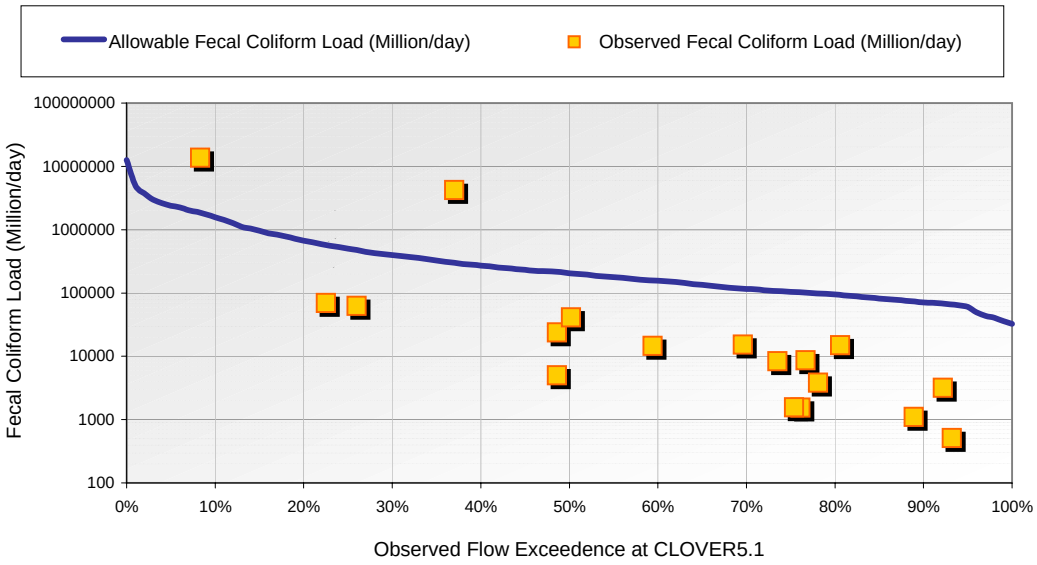
[24: Fecal Coliform at CLOVER5.1 (MPN/100mL)] -vs- [30: Flow at CLOVER5.1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

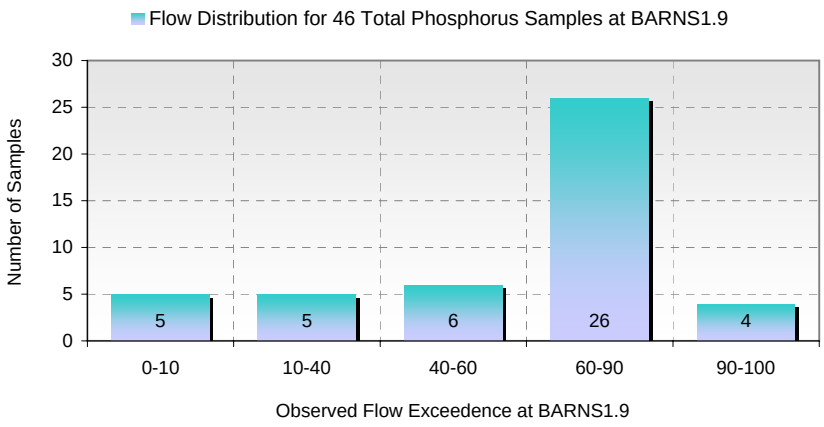


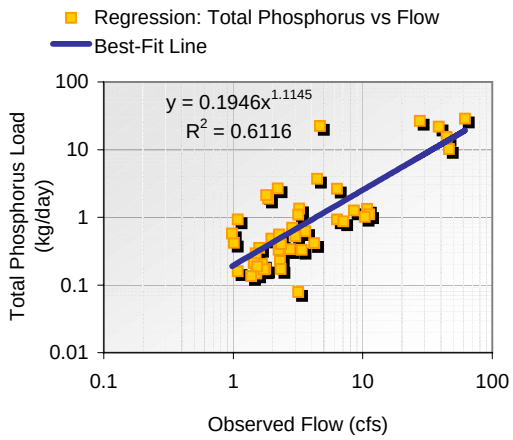
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	18-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	1	97.69	2,389,944	13,720,579	82.6%
10-40	3	20.39	498,833	69,480	0.0%
40-60	4	8.41	205,769	19,133	0.0%
60-90	8	4.28	104,666	6,069	0.0%
90-100	2	2.46	60,216	1,833	0.0%

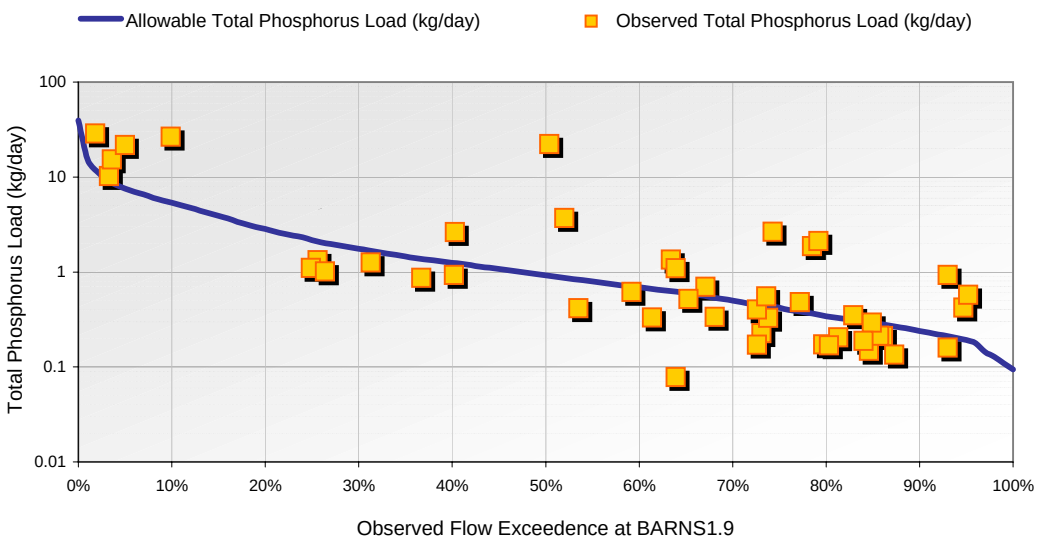
[1: Total Phosphorus at BARNS1.9 (mg/L)] -vs- [3: Flow at BARNS1.9 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

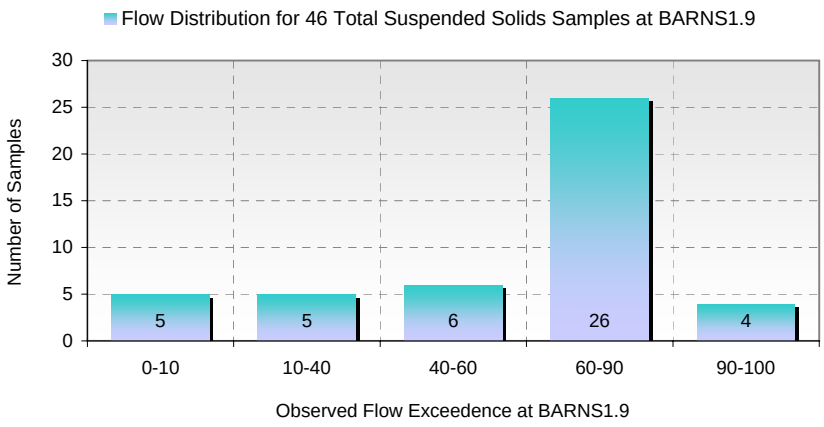


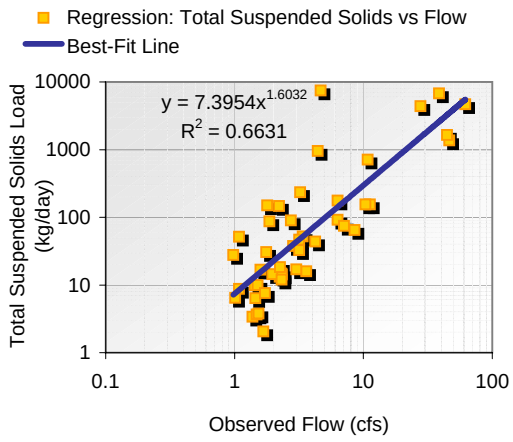
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	46-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	38.55	8	22	65.3%
10-40	5	11.10	2	1	0.0%
40-60	6	4.72	1	2	48.1%
60-90	26	2.15	0	0	0.0%
90-100	4	0.99	0	0	61.3%

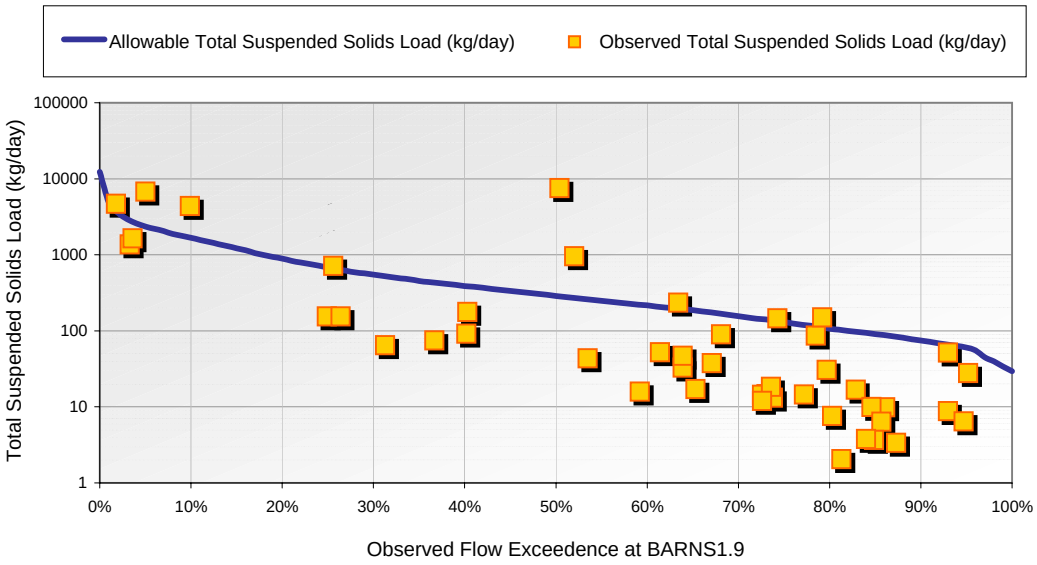
[1: Total Suspended Solids at BARNS1.9 (mg/L)] -vs- [3: Flow at BARNS1.9 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

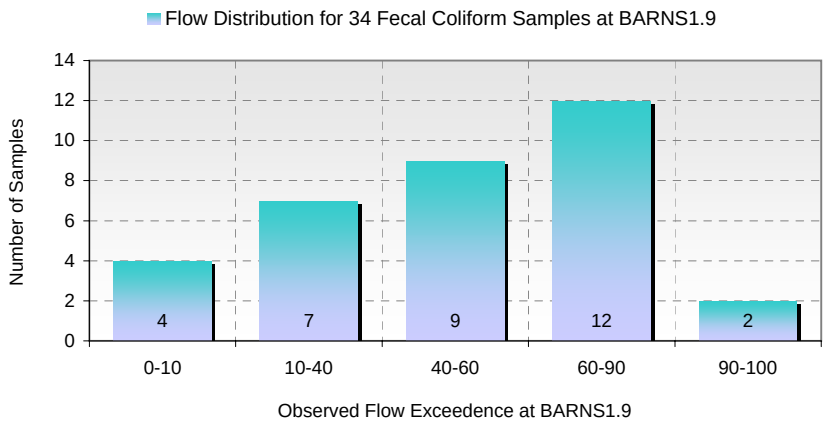


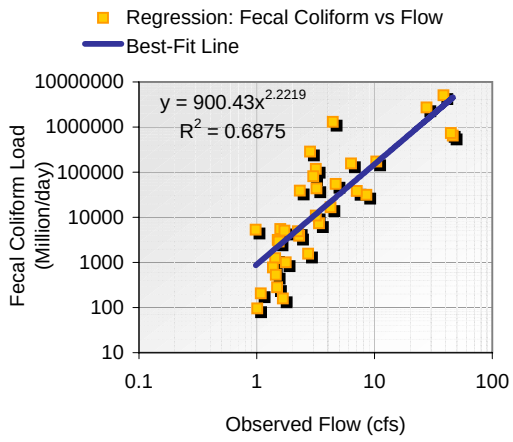
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	46-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	38.55	2,358	4,387	46.3%
10-40	5	11.10	679	154	0.0%
40-60	6	4.72	288	134	0.0%
60-90	26	2.15	131	16	0.0%
90-100	4	0.99	60	18	0.0%

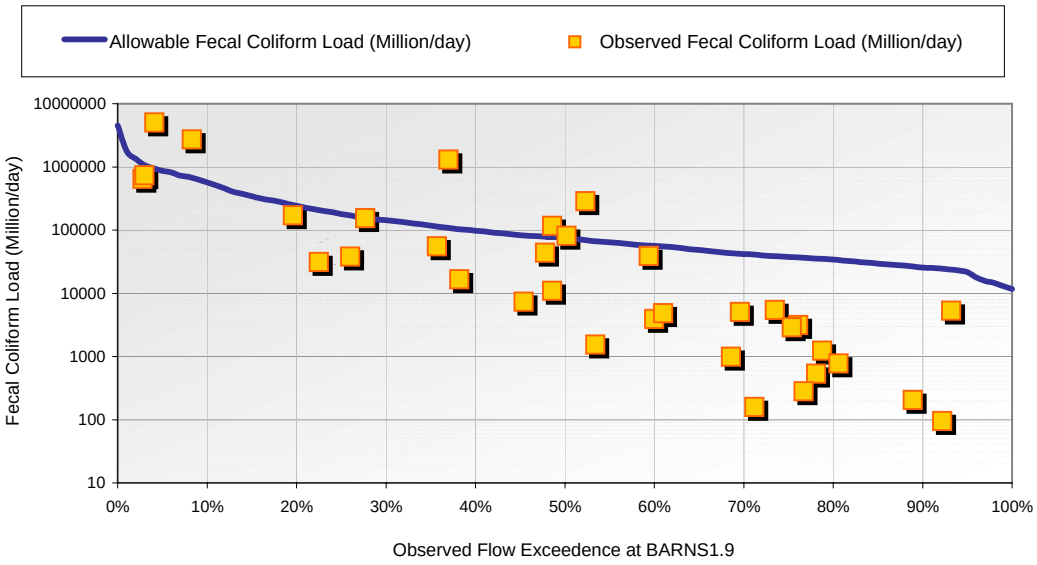
[1: Fecal Coliform at BARNS1.9 (MPN/100mL)] -vs- [3: Flow at BARNS1.9 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

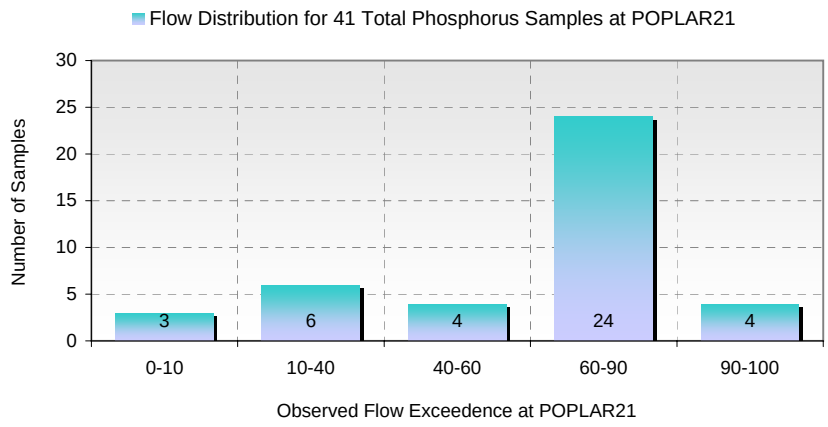


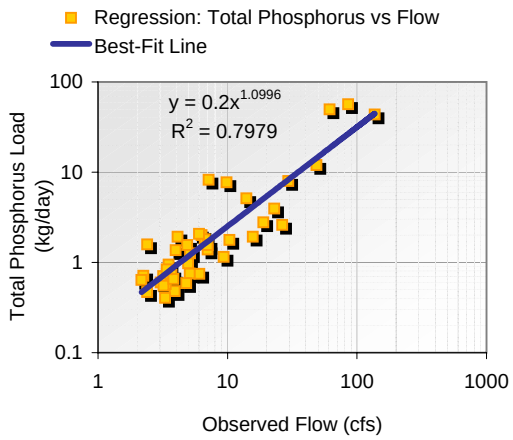
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	34-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	35.24	862,126	1,722,003	49.9%
10-40	7	7.35	179,944	54,909	0.0%
40-60	9	3.03	74,227	38,675	0.0%
60-90	12	1.54	37,756	1,113	0.0%
90-100	2	0.89	21,722	2,681	0.0%

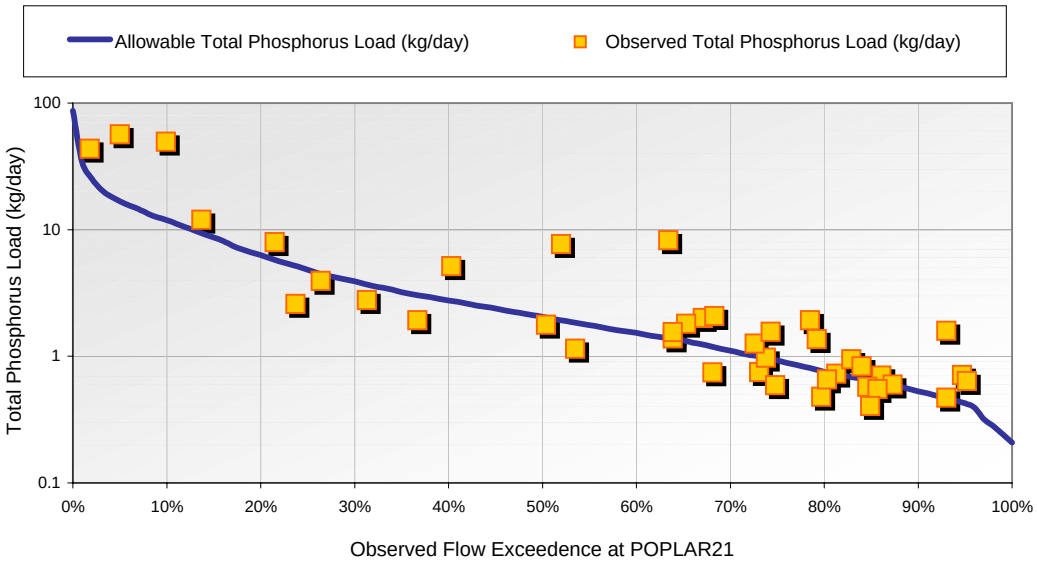
[10: Total Phosphorus at POPLAR21 (mg/L)] -vs- [12: Flow at POPLAR21 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

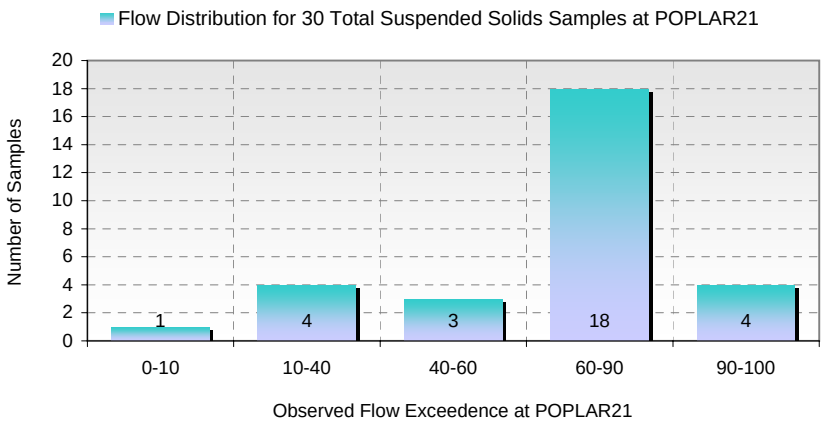


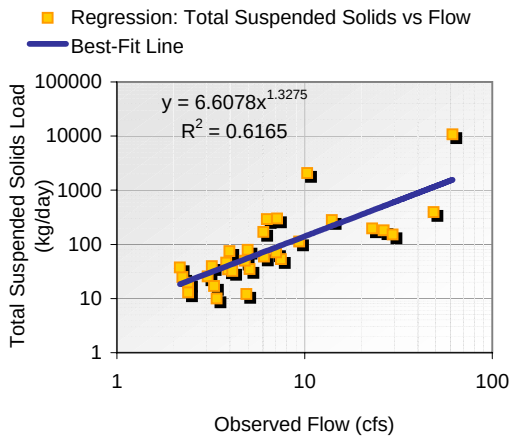
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	41-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	3	85.39	17	50	66.3%
10-40	6	24.58	5	3	0.0%
40-60	4	10.44	2	3	40.8%
60-90	24	4.76	1	1	0.0%
90-100	4	2.18	0	1	36.7%

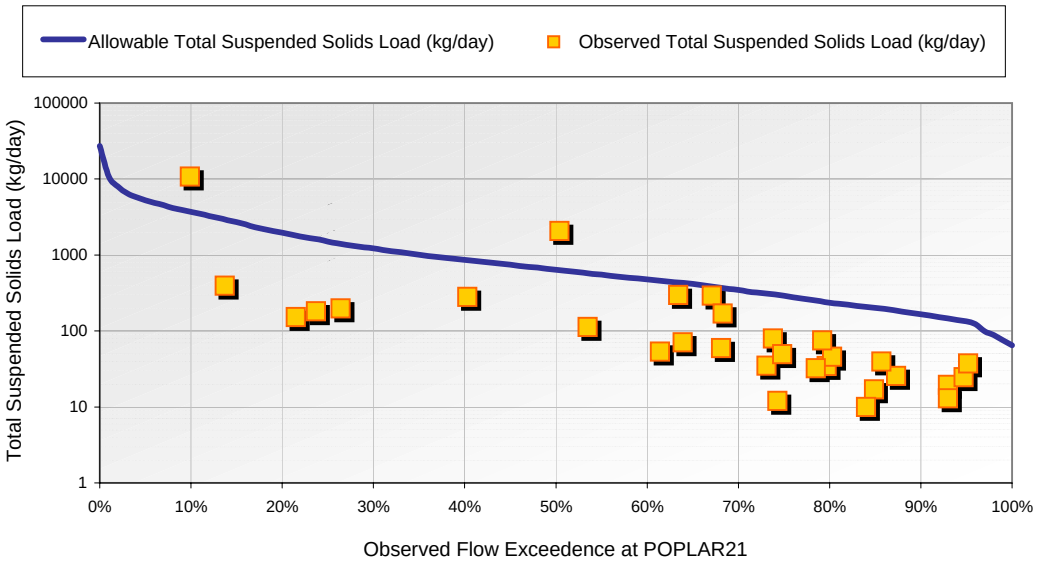
[10: Total Suspended Solids at POPLAR21 (mg/L)] -vs- [12: Flow at POPLAR21 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

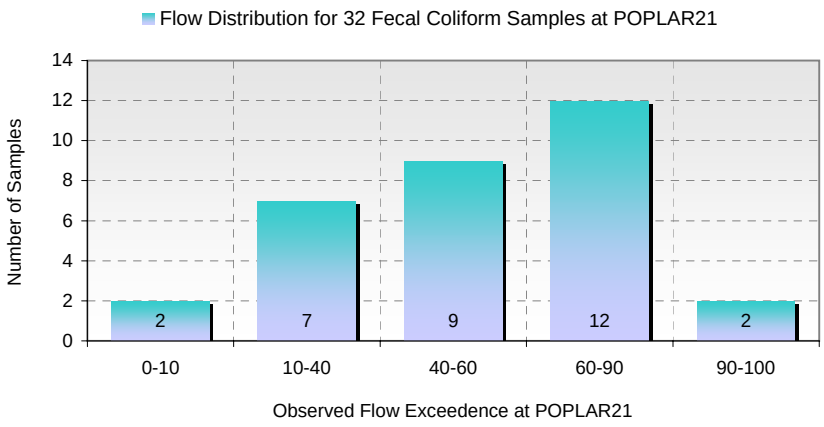


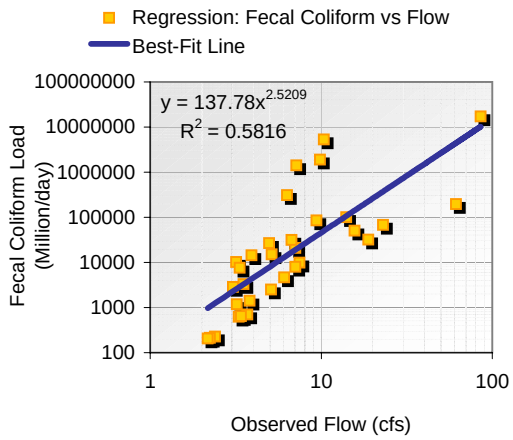
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	30-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	85.39	5,223	10,754	51.4%
10-40	4	24.58	1,504	189	0.0%
40-60	3	10.44	639	281	0.0%
60-90	18	4.76	291	48	0.0%
90-100	4	2.18	133	22	0.0%

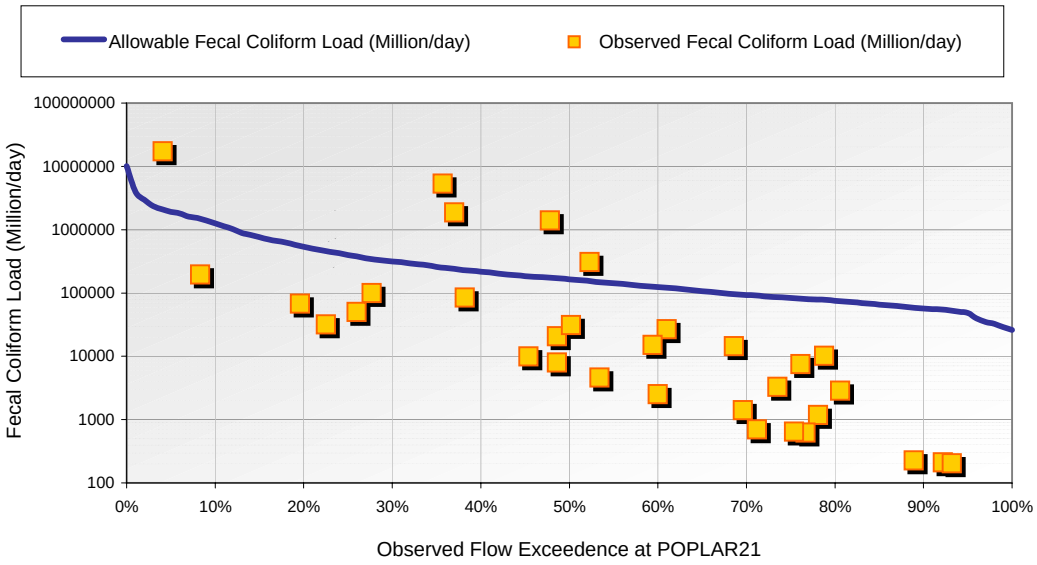
[9: Fecal Coliform at POPLAR21 (MPN/100mL)] -vs- [12: Flow at POPLAR21 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

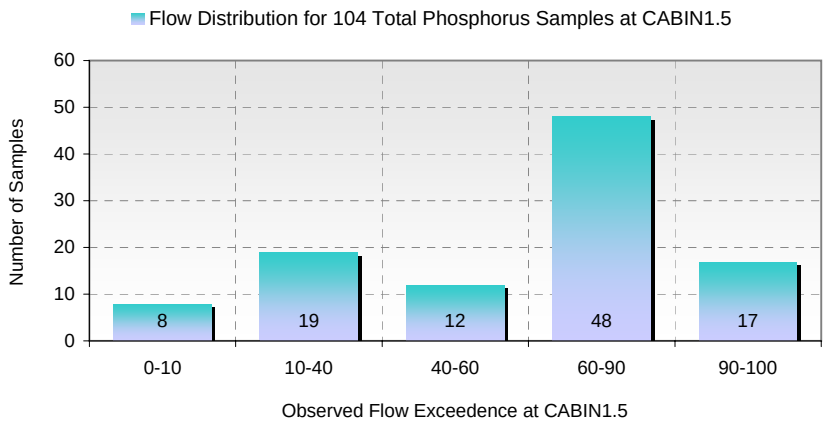


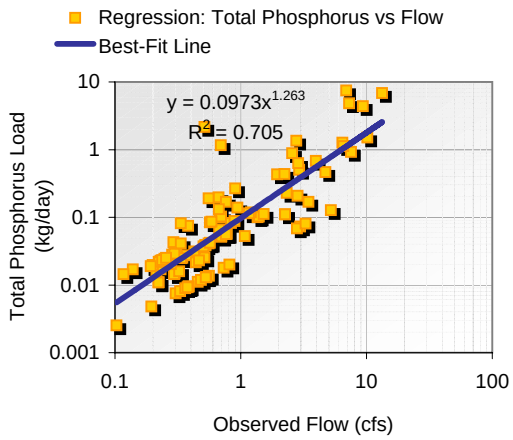
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	32-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	78.06	1,909,773	8,698,649	78.0%
10-40	7	16.29	398,611	84,936	0.0%
40-60	9	6.72	164,427	15,119	0.0%
60-90	12	3.42	83,637	2,122	0.0%
90-100	2	1.97	48,118	208	0.0%

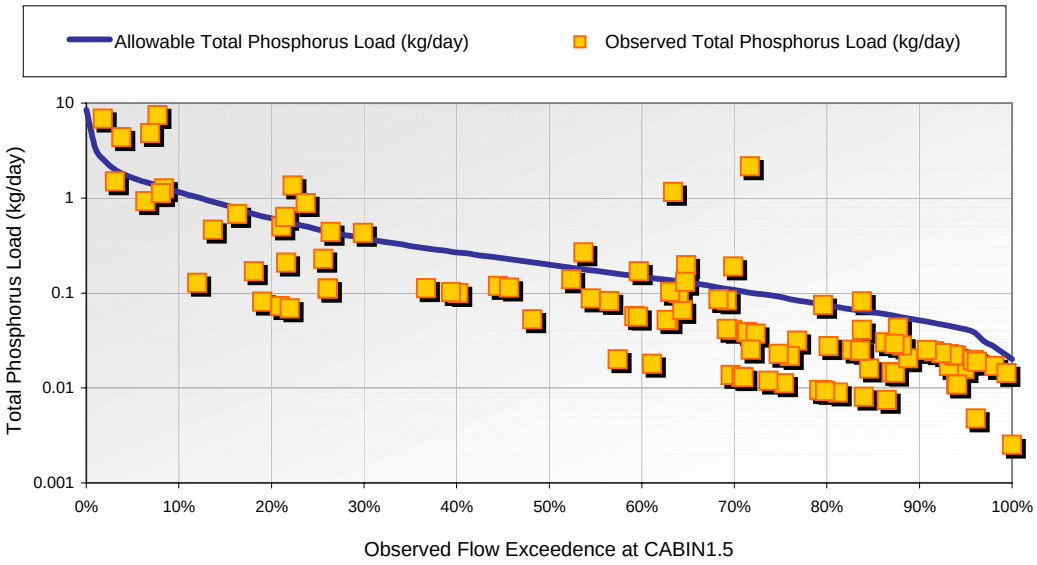
[2: Total Phosphorus at CABIN1.5 (mg/L)] -vs- [4: Flow at CABIN1.5 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

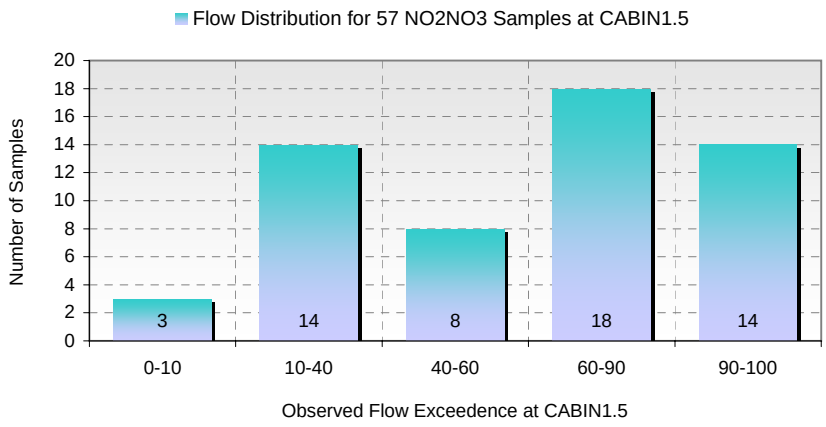


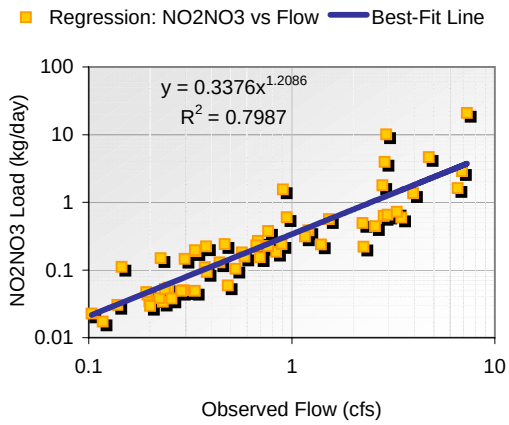
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	104-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	8.30	2	3	44.5%
10-40	19	2.39	0	0	0.0%
40-60	12	1.01	0	0	0.0%
60-90	48	0.46	0	0	0.0%
90-100	17	0.21	0	0	0.0%

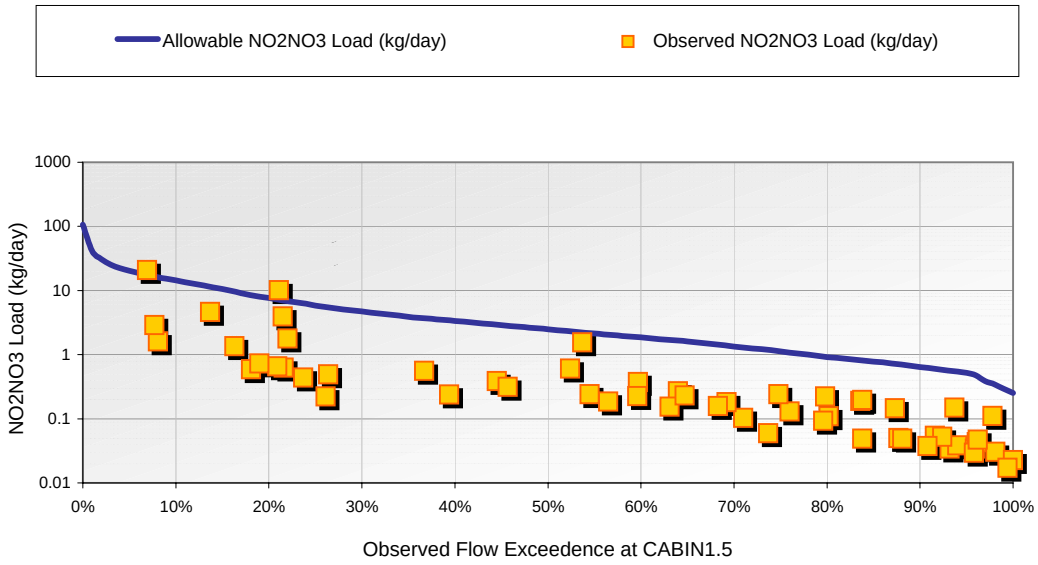
[1: Nitrite Plus Nitrate as Nitrogen at CABIN1.5 (mg/L)] -vs- [4: Flow at CABIN1.5 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

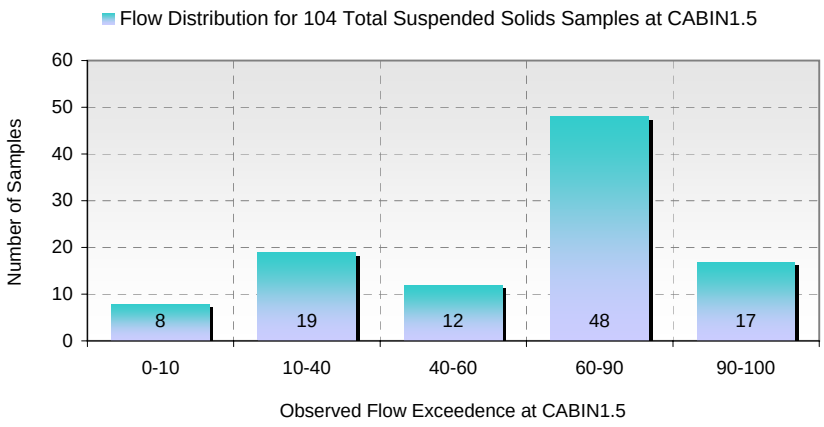


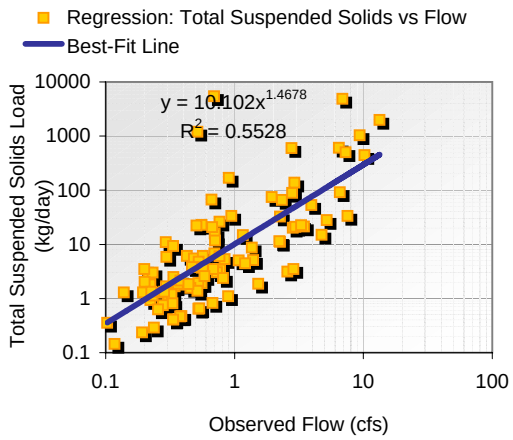
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	57-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	3	8.30	20	3	0.0%
10-40	14	2.39	6	1	0.0%
40-60	8	1.01	2	0	0.0%
60-90	18	0.46	1	0	0.0%
90-100	14	0.21	1	0	0.0%

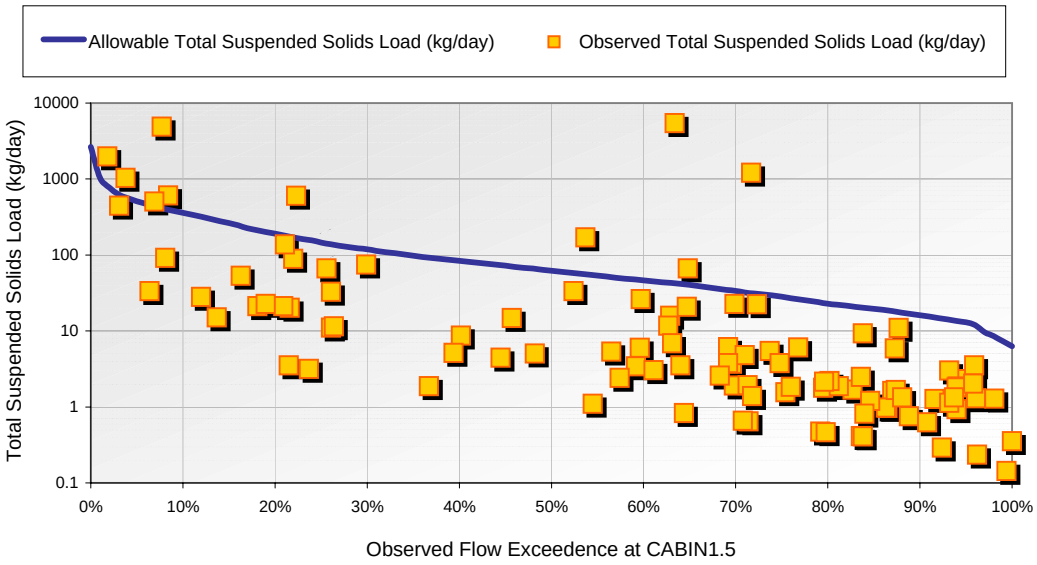
[2: Total Suspended Solids at CABIN1.5 (mg/L)] -vs- [4: Flow at CABIN1.5 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

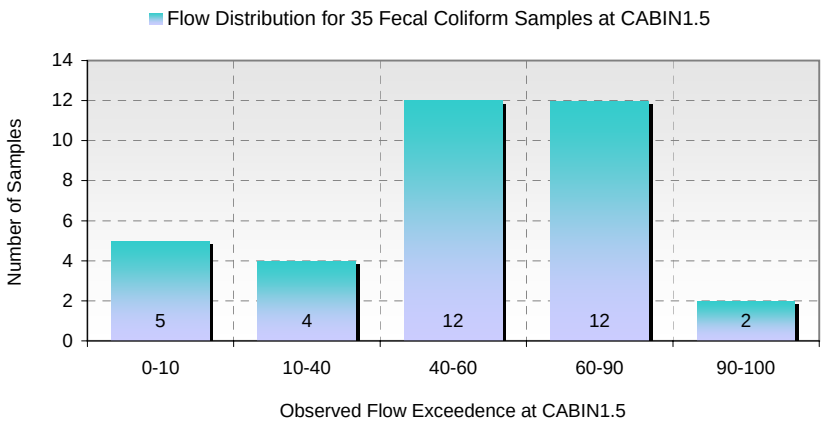


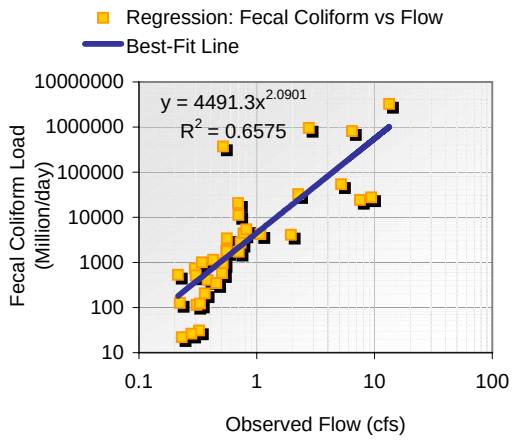
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	104-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	8.30	507	553	8.3%
10-40	19	2.39	146	21	0.0%
40-60	12	1.01	62	6	0.0%
60-90	48	0.46	28	2	0.0%
90-100	17	0.21	13	1	0.0%

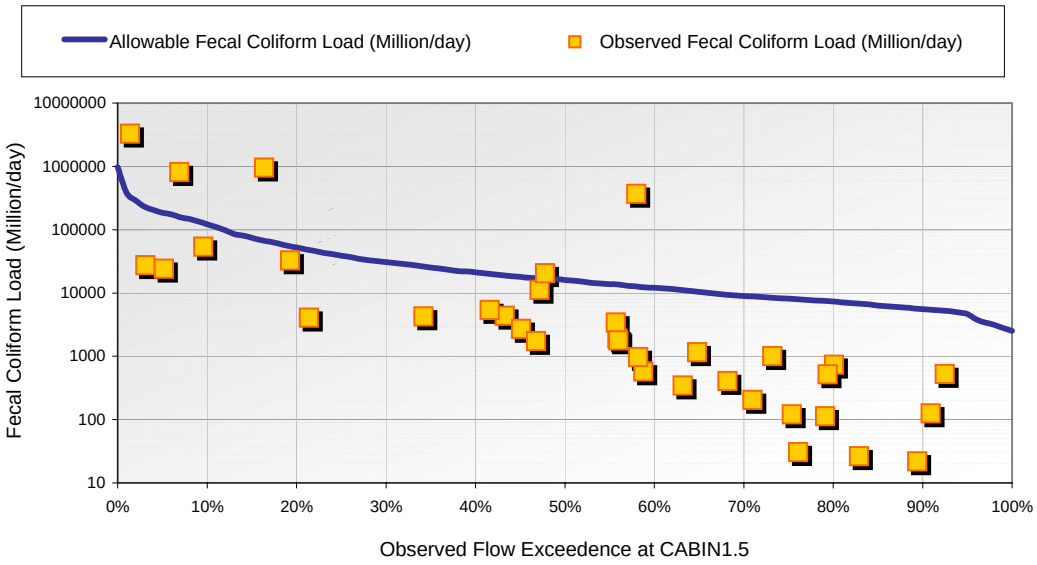
[2: Fecal Coliform at CABIN1.5 (MPN/100mL)] -vs- [4: Flow at CABIN1.5 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

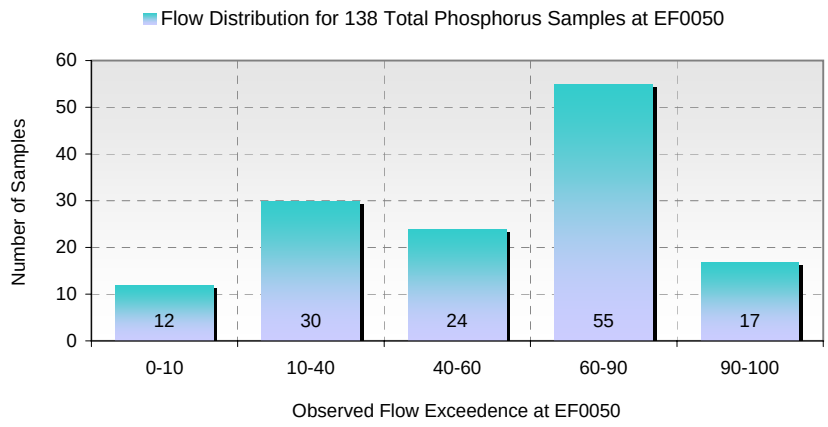


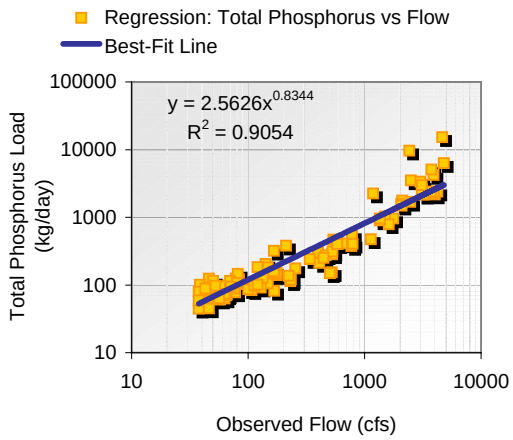
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	35-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	5	7.58	185,521	53,582	0.0%
10-40	4	1.58	38,722	18,432	0.0%
40-60	12	0.65	15,973	3,057	0.0%
60-90	12	0.33	8,125	275	0.0%
90-100	2	0.19	4,674	326	0.0%

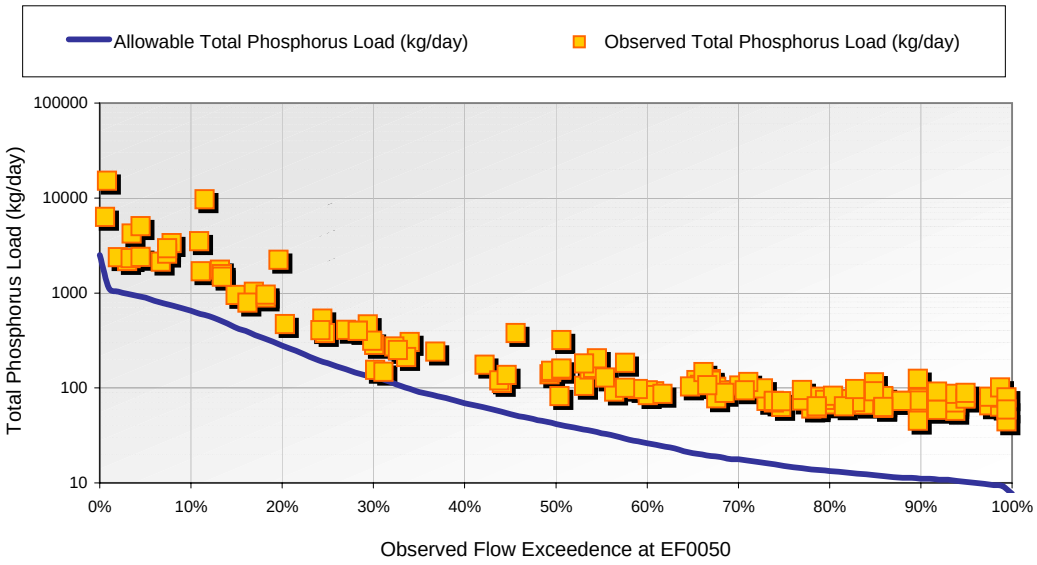
[24: Total Phosphorus at EF0050 (mg/L)] -vs- [21: Flow at EF0050 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

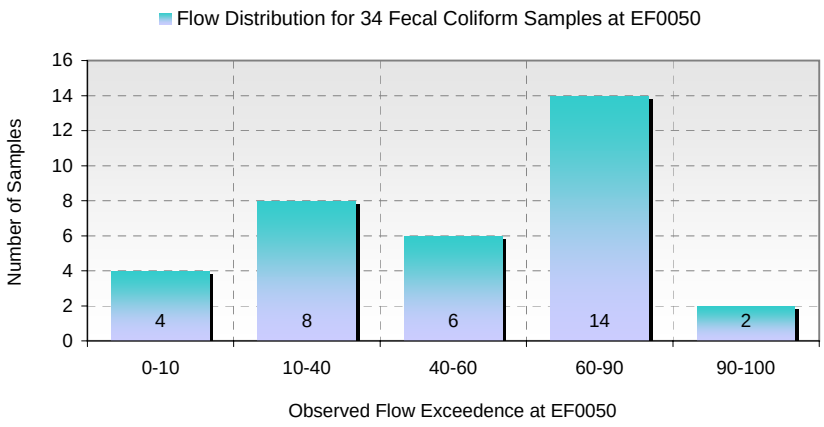


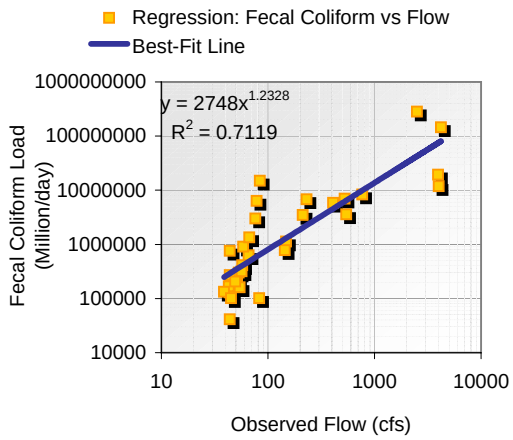
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	138-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	12	3,658.63	895	2,771	67.7%
10-40	30	744.31	182	465	60.8%
40-60	24	170.88	42	143	70.7%
60-90	55	61.85	15	78	80.6%
90-100	17	41.93	10	70	85.3%

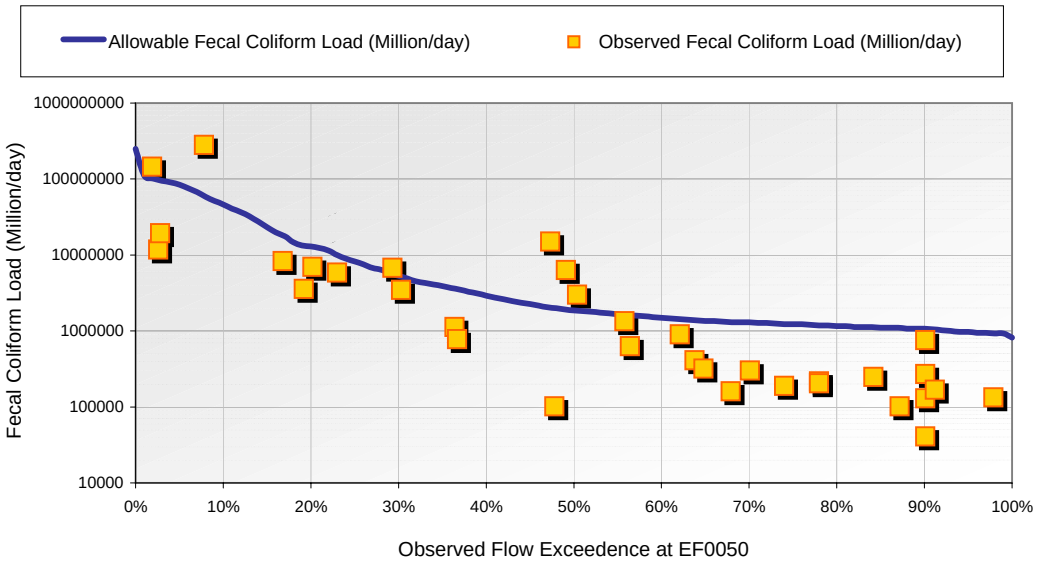
[19: Fecal Coliform at EF0050 (MPN/100mL)] -vs- [21: Flow at EF0050 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

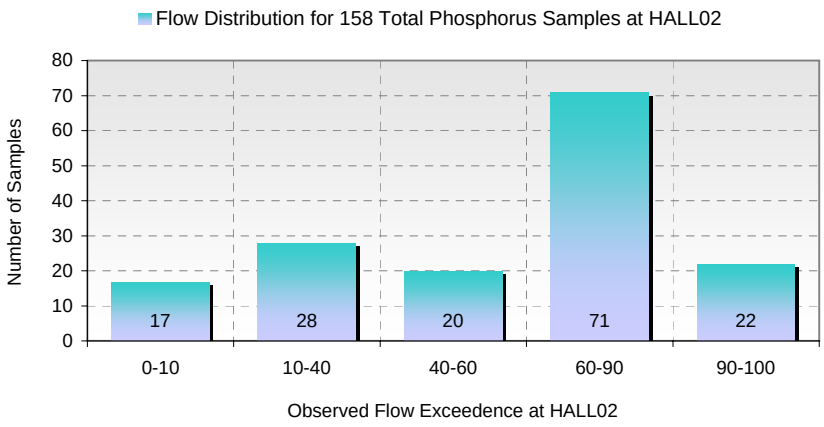


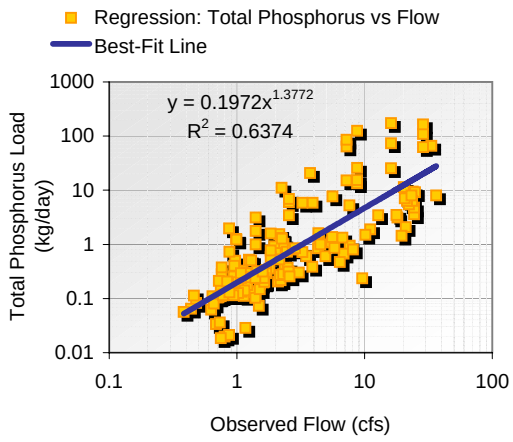
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	34-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	3,434.29	84,022,590	82,022,062	0.0%
10-40	8	335.46	8,207,336	4,709,215	0.0%
40-60	6	76.53	1,872,298	2,170,840	13.8%
60-90	14	50.32	1,231,100	232,627	0.0%
90-100	2	39.84	974,621	150,553	0.0%

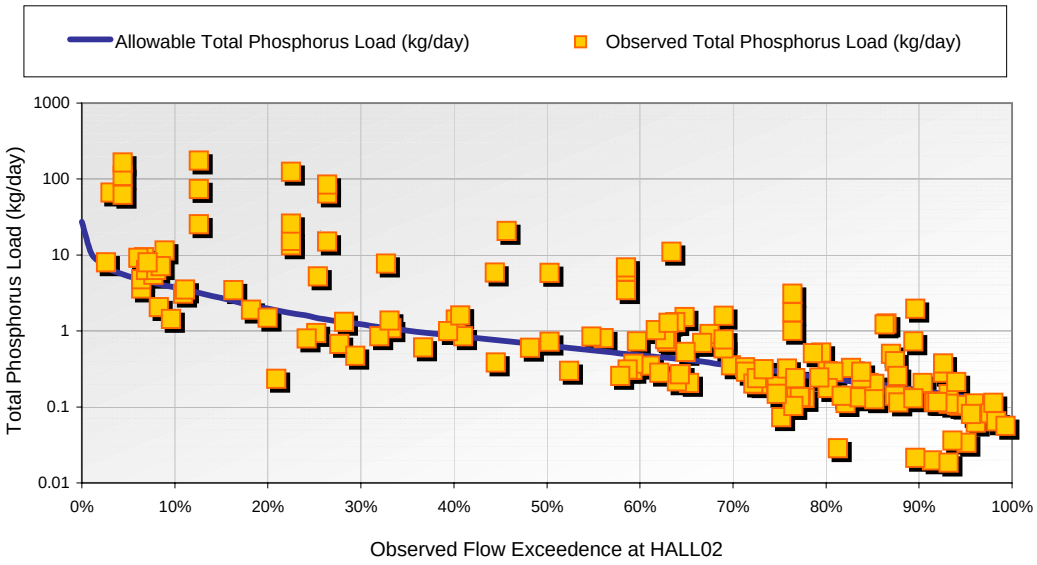
[4: Total Phosphorus at HALL02 (mg/L)] -vs- [6: Flow at HALL02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

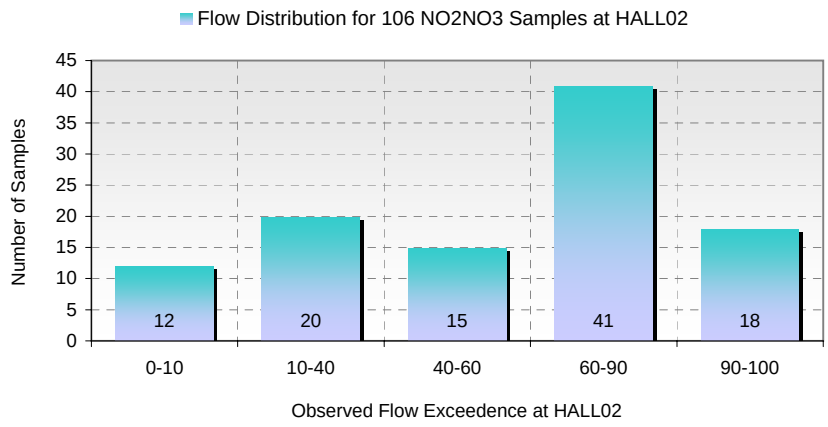


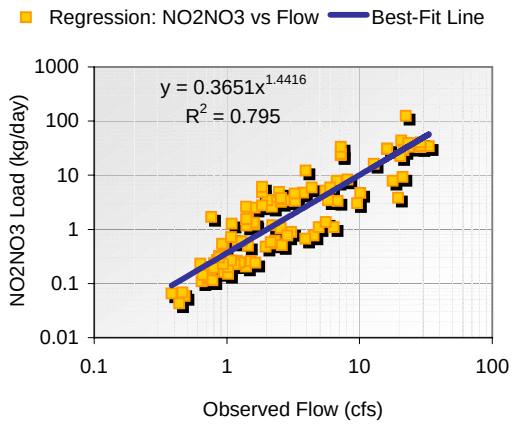
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	158-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	17	26.84	5	8	34.2%
10-40	28	7.73	2	3	53.8%
40-60	20	3.28	1	1	22.0%
60-90	71	1.50	0	0	0.0%
90-100	22	0.69	0	0	0.0%

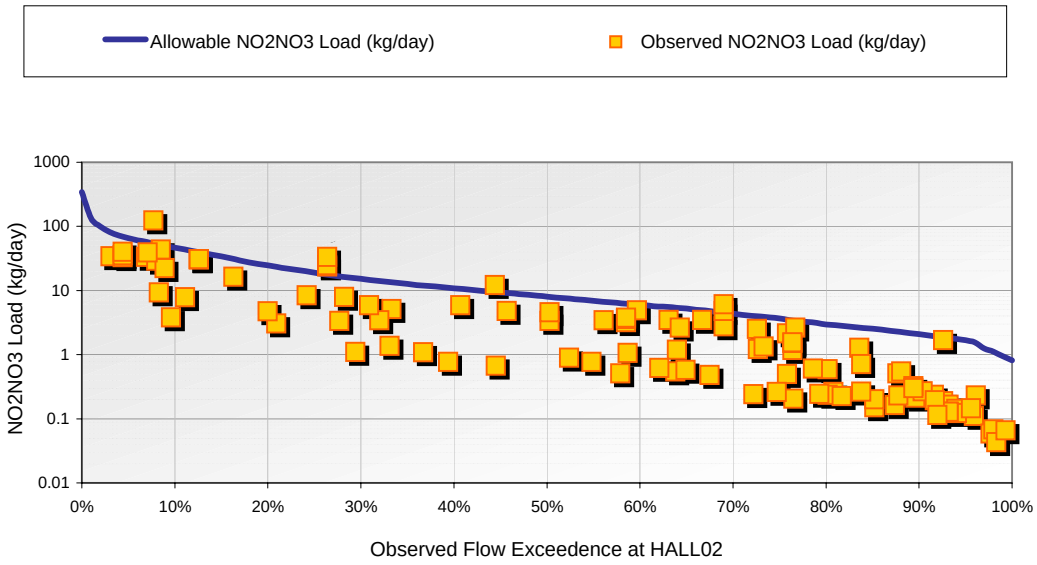
[3: Nitrite Plus Nitrate as Nitrogen at HALL02 (mg/L)] -vs- [6: Flow at HALL02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

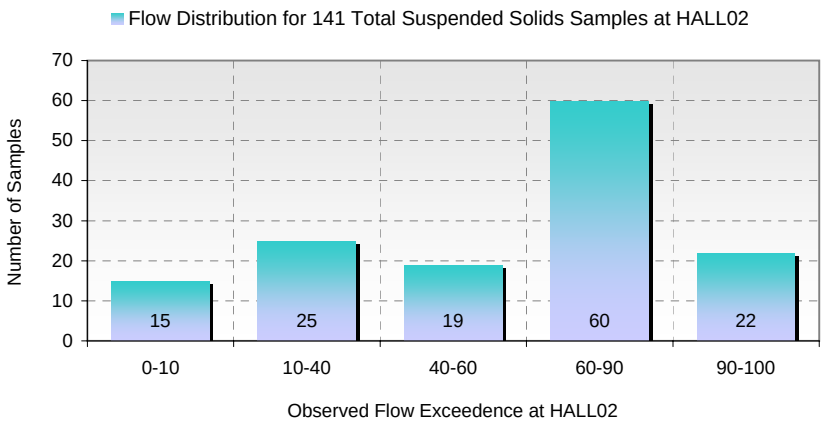


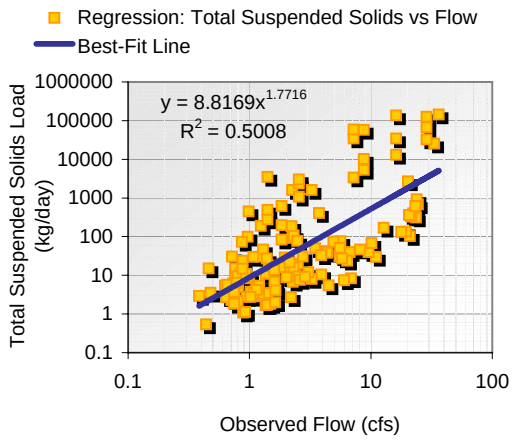
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	106-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	12	26.84	66	34	0.0%
10-40	20	7.73	19	7	0.0%
40-60	15	3.28	8	3	0.0%
60-90	41	1.50	4	1	0.0%
90-100	18	0.69	2	0	0.0%

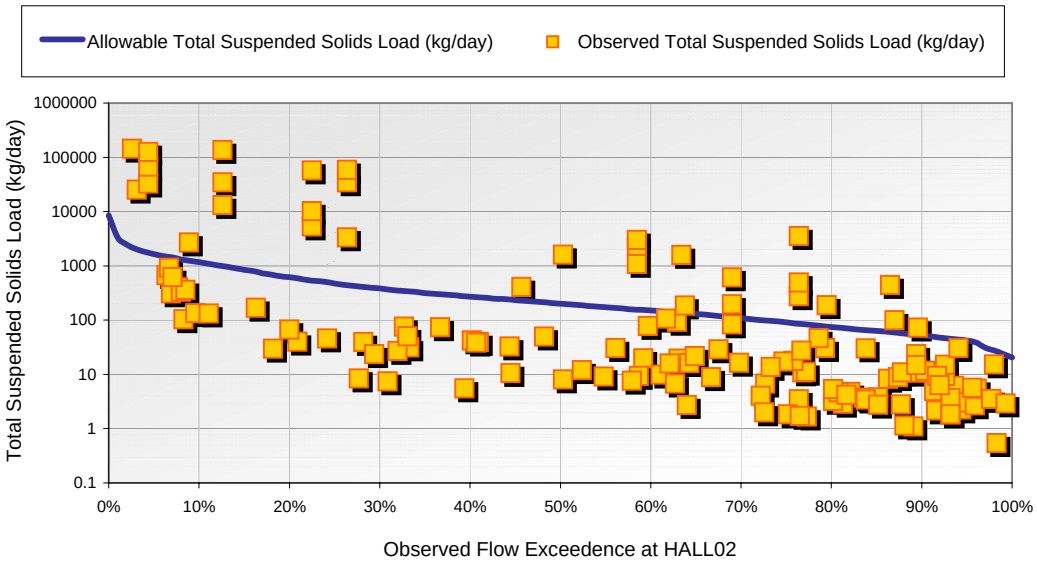
[4: Total Suspended Solids at HALL02 (mg/L)] -vs- [6: Flow at HALL02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

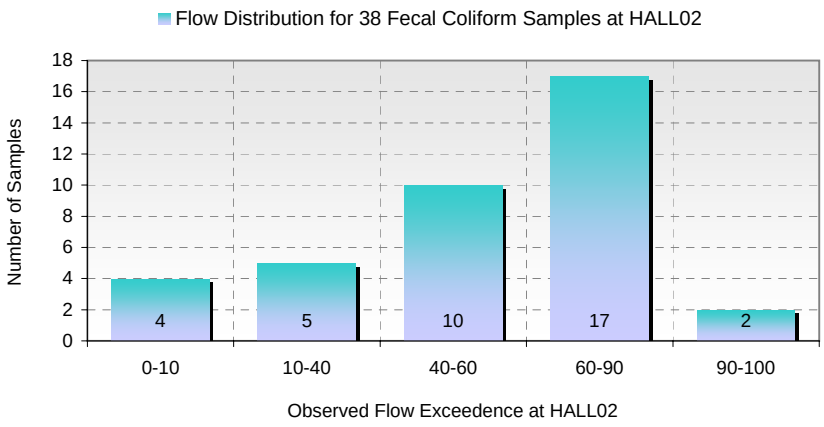


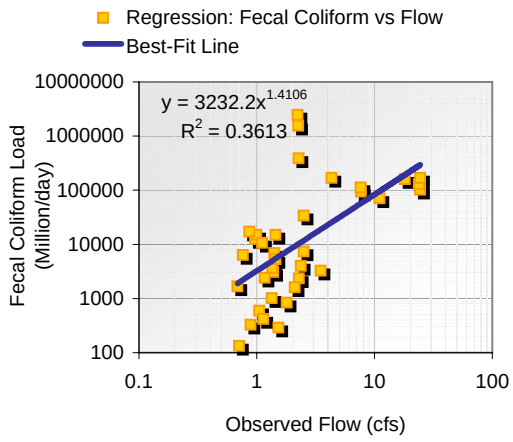
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	141-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	15	26.84	1,641	676	0.0%
10-40	25	7.73	473	74	0.0%
40-60	19	3.28	201	38	0.0%
60-90	60	1.50	91	11	0.0%
90-100	22	0.69	42	4	0.0%

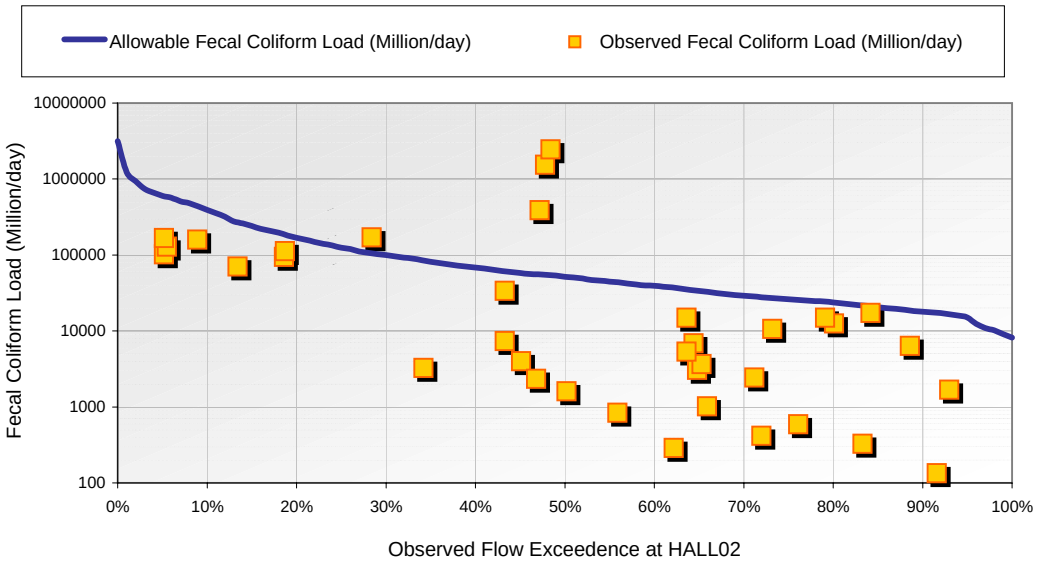
[4: Fecal Coliform at HALL02 (MPN/100mL)] -vs- [6: Flow at HALL02 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

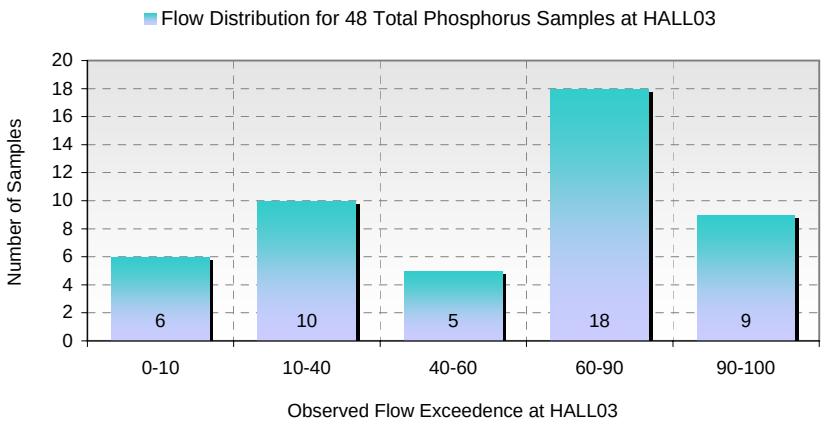


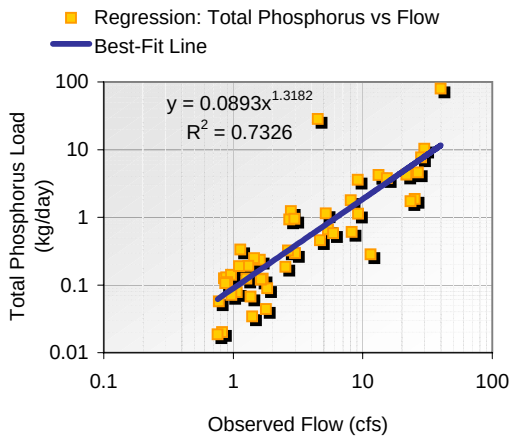
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	38-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	4	24.53	600,214	144,081	0.0%
10-40	5	5.12	125,278	93,958	0.0%
40-60	10	2.11	51,677	7,369	0.0%
60-90	17	1.07	26,286	4,493	0.0%
90-100	2	0.62	15,123	906	0.0%

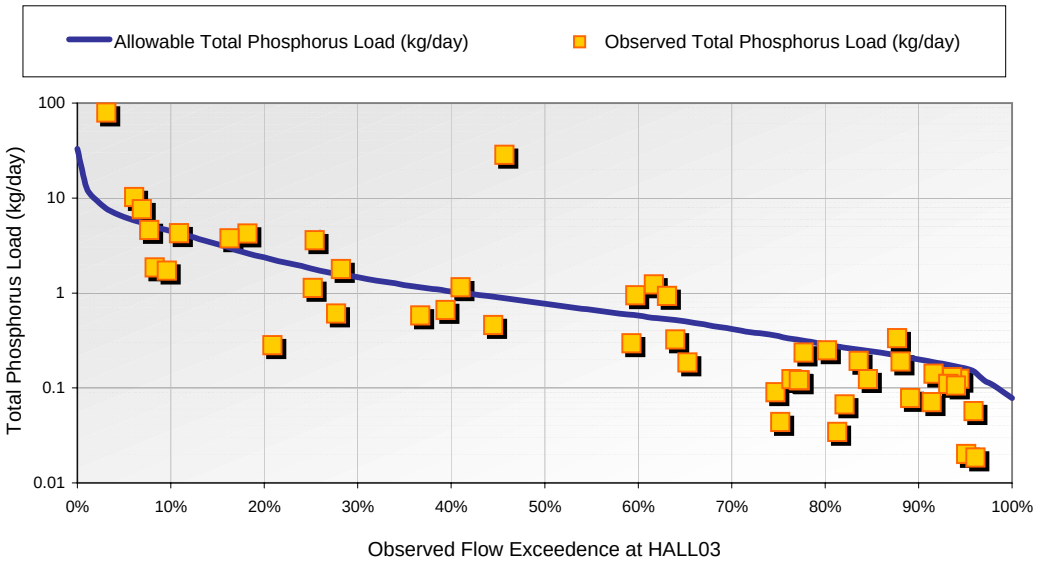
[5: Total Phosphorus at HALL03 (mg/L)] -vs- [7: Flow at HALL03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

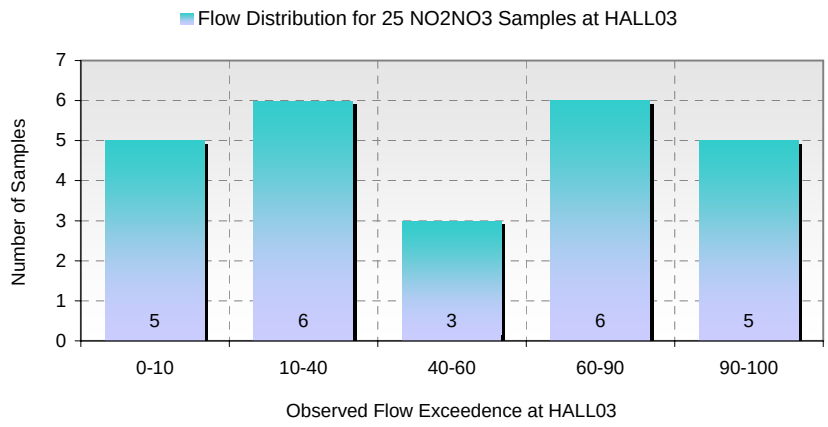


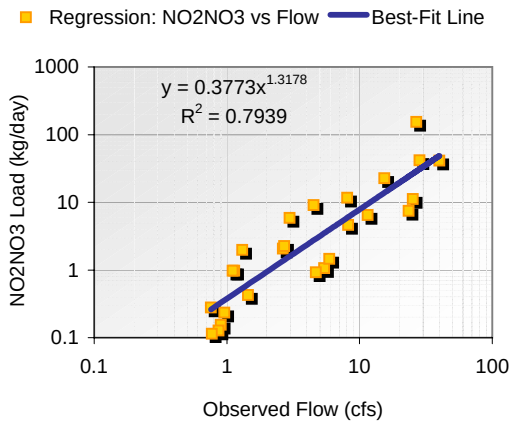
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	48-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	32.20	6	6	0.0%
10-40	10	9.27	2	1	0.0%
40-60	5	3.94	1	1	18.3%
60-90	18	1.79	0	0	0.0%
90-100	9	0.82	0	0	0.0%

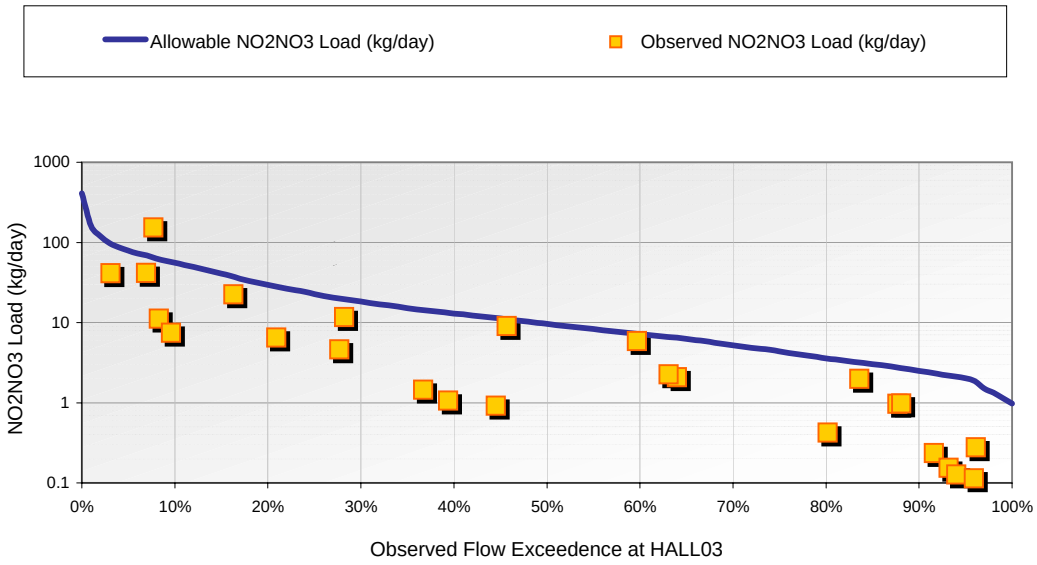
[4: Nitrite Plus Nitrate as Nitrogen at HALL03 (mg/L)] -vs- [7: Flow at HALL03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

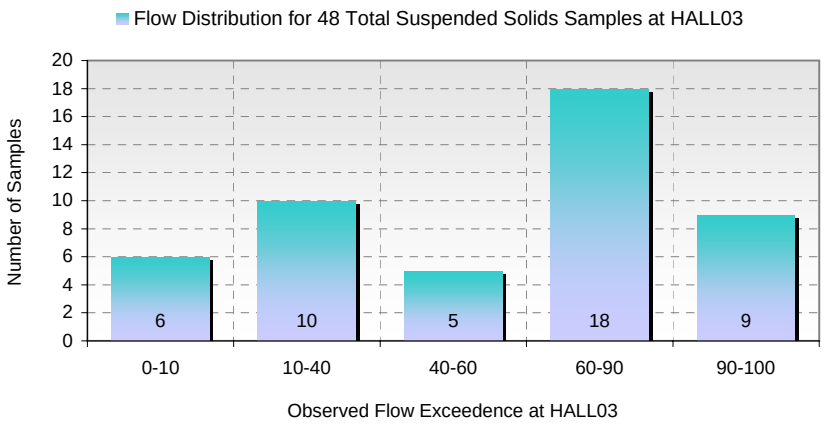


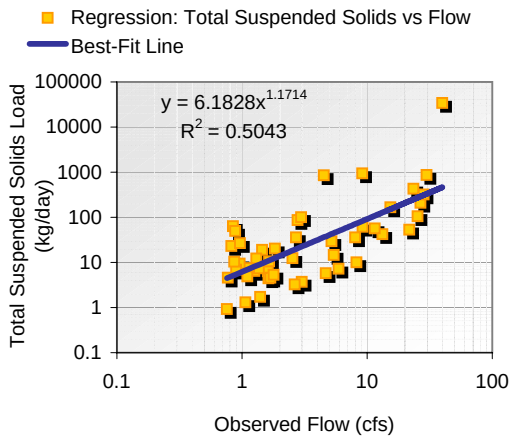
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	25-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	32.20	79	41	0.0%
10-40	6	9.27	23	6	0.0%
40-60	3	3.94	10	6	0.0%
60-90	6	1.79	4	1	0.0%
90-100	5	0.82	2	0	0.0%

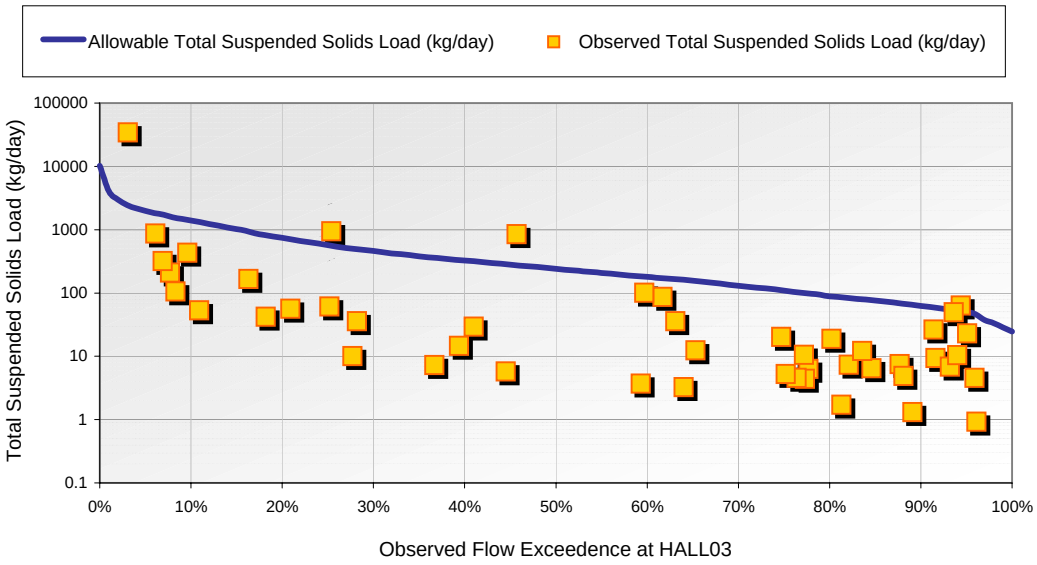
[5: Total Suspended Solids at HALL03 (mg/L)] -vs- [7: Flow at HALL03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

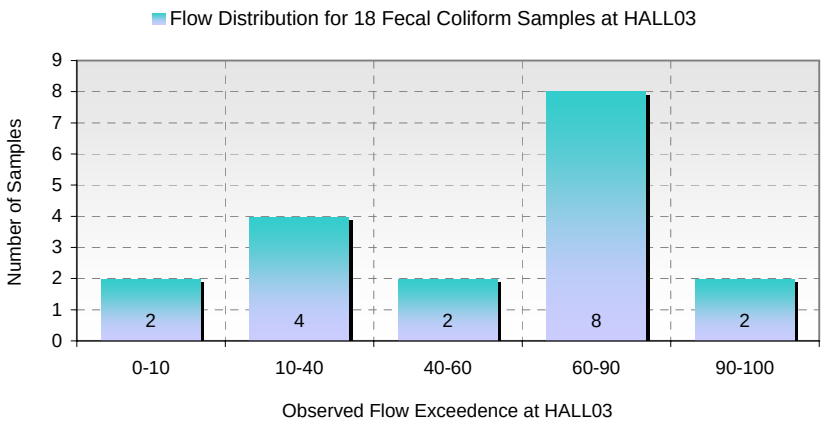


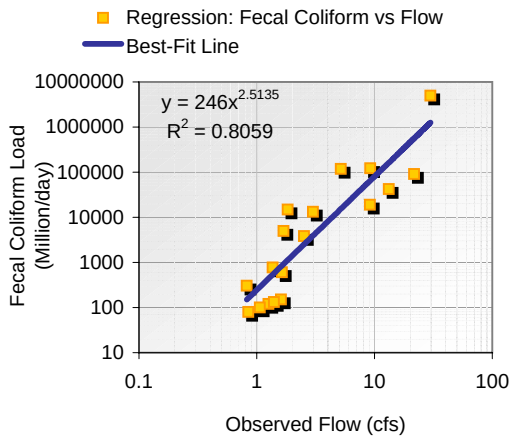
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	48-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	32.20	1,970	374	0.0%
10-40	10	9.27	567	48	0.0%
40-60	5	3.94	241	29	0.0%
60-90	18	1.79	110	7	0.0%
90-100	9	0.82	50	10	0.0%

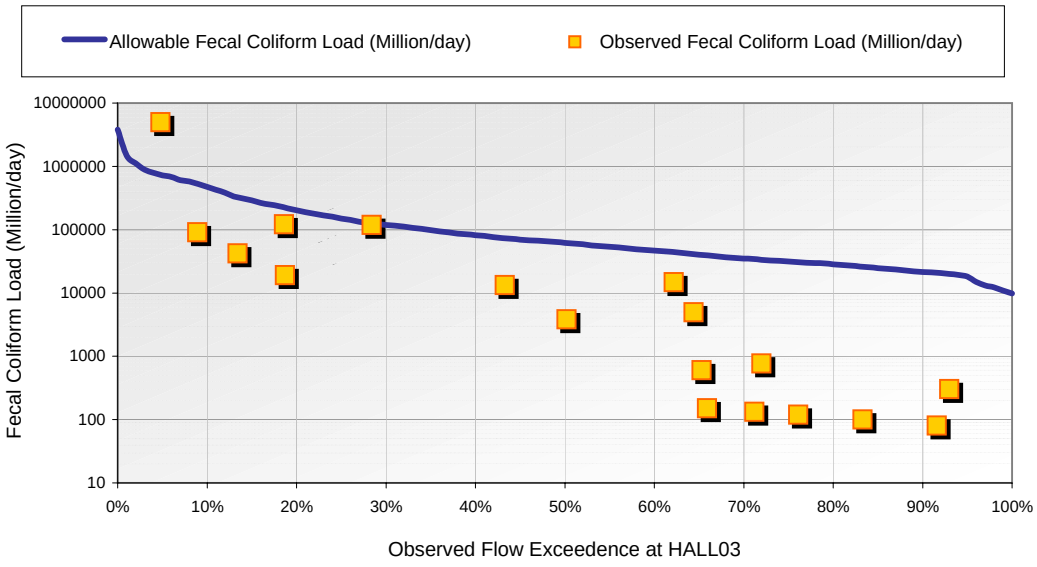
[5: Fecal Coliform at HALL03 (MPN/100mL)] -vs- [7: Flow at HALL03 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

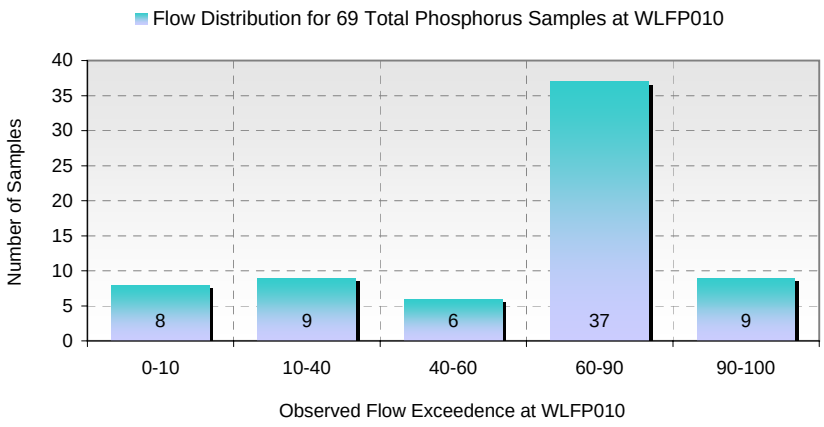


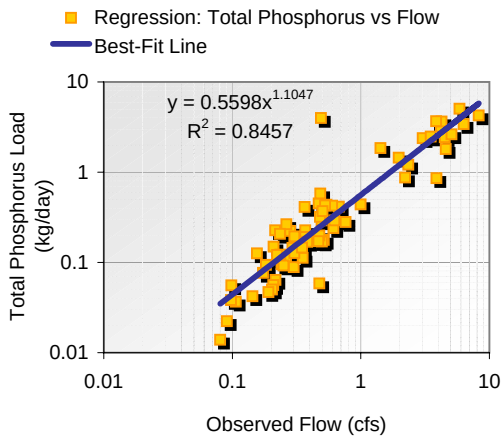
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	18-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	29.44	720,257	2,527,826	71.5%
10-40	4	6.14	150,333	80,221	0.0%
40-60	2	2.53	62,012	8,538	0.0%
60-90	8	1.29	31,543	376	0.0%
90-100	2	0.74	18,147	191	0.0%

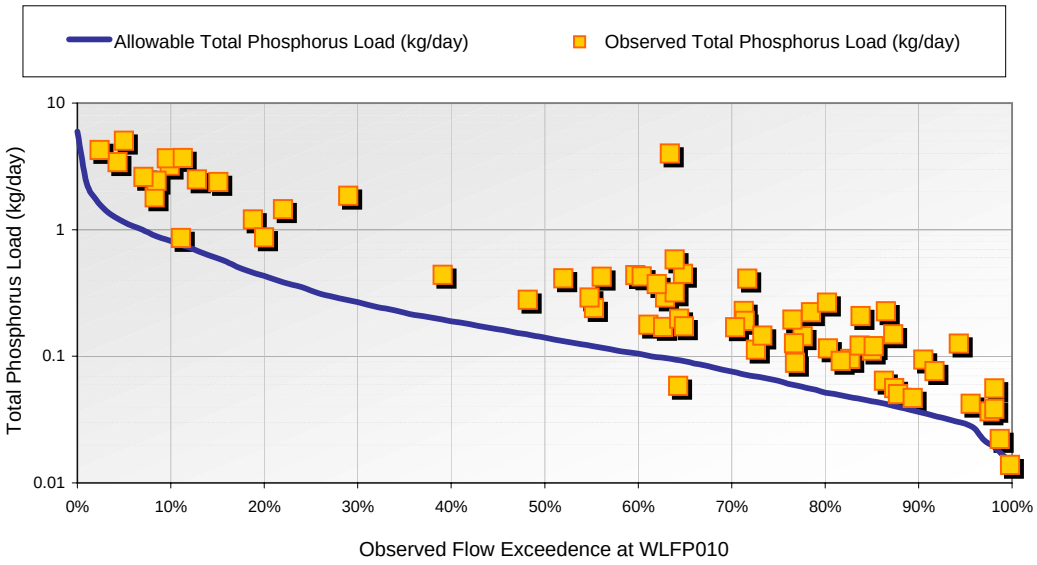
[18: Total Phosphorus at WLFP010 (mg/L)] -vs- [20: Flow at WLFP010 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

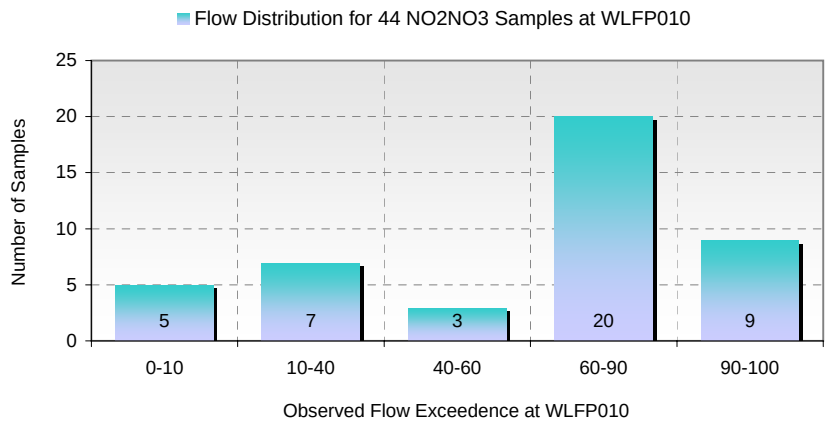


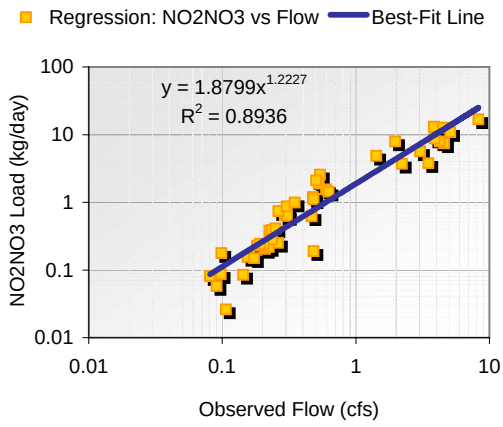
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	69-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	5.86	1	3	65.3%
10-40	9	1.69	0	1	77.2%
40-60	6	0.72	0	0	60.1%
60-90	37	0.33	0	0	62.6%
90-100	9	0.15	0	0	30.6%

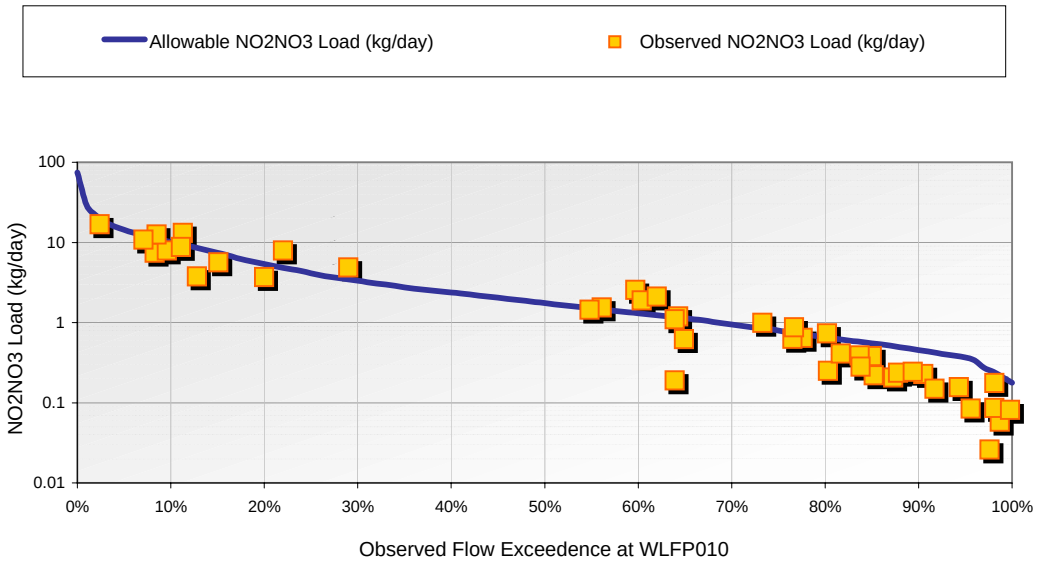
[14: Nitrite Plus Nitrate as Nitrogen at WLFP010 (mg/L)] -vs- [20: Flow at WLFP010 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

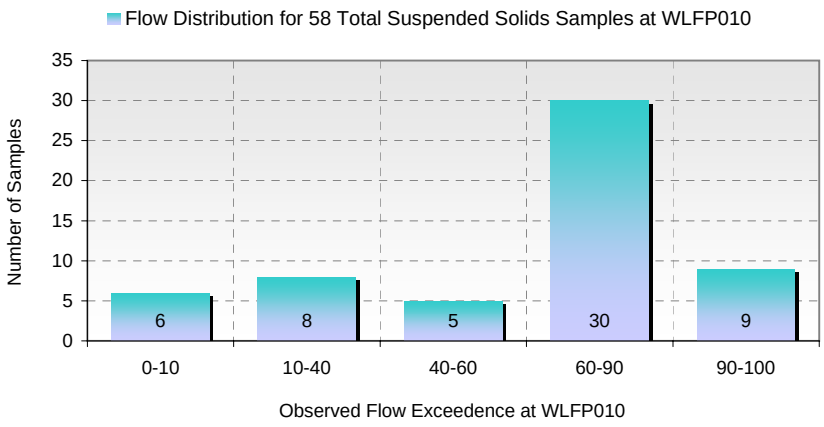


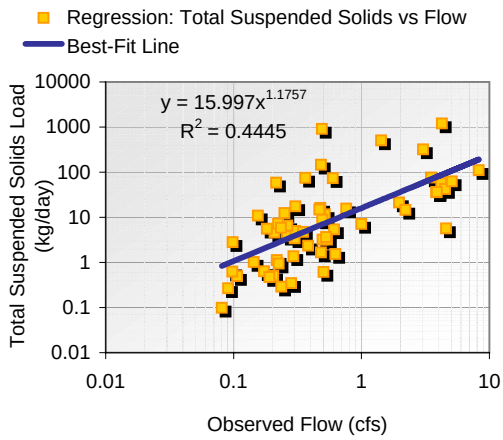
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	44-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	5.86	14	11	0.0%
10-40	7	1.69	4	6	26.9%
40-60	3	0.72	2	2	0.0%
60-90	20	0.33	1	1	0.0%
90-100	9	0.15	0	0	0.0%

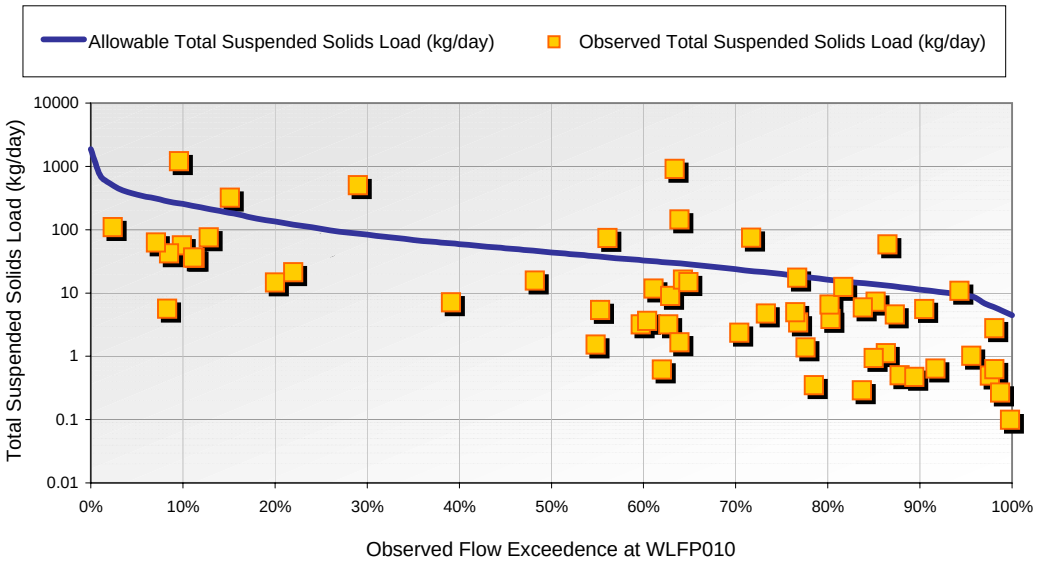
[18: Total Suspended Solids at WLFP010 (mg/L)] -vs- [20: Flow at WLFP010 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

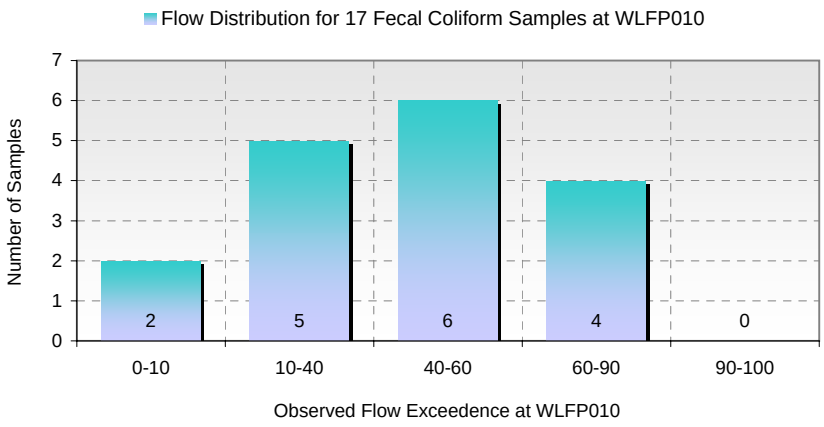


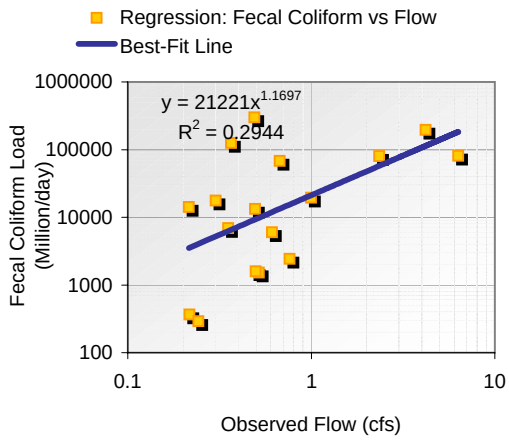
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	58-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	5.86	358	59	0.0%
10-40	8	1.69	103	36	0.0%
40-60	5	0.72	44	5	0.0%
60-90	30	0.33	20	5	0.0%
90-100	9	0.15	9	1	0.0%

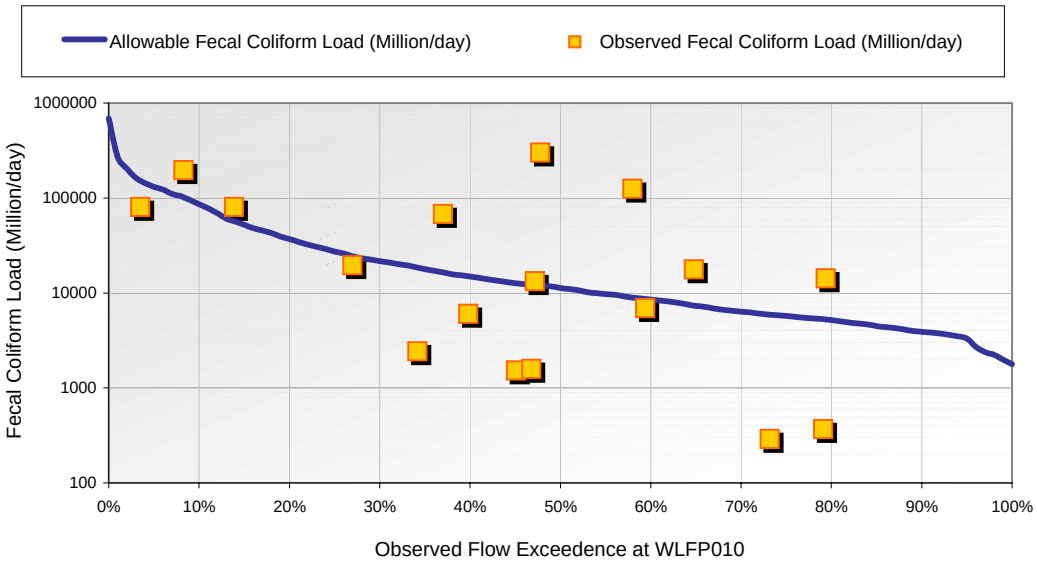
[16: Fecal Coliform at WLFP010 (MPN/100mL)] -vs- [20: Flow at WLFP010 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

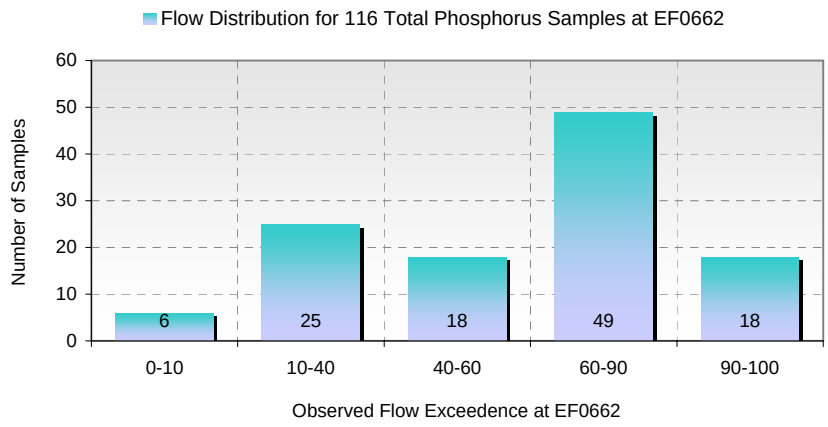


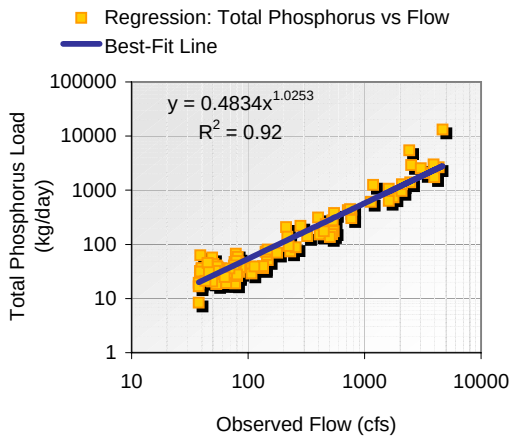
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	17-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	5.35	130,956	138,067	5.2%
10-40	5	1.12	27,333	19,504	0.0%
40-60	6	0.46	11,275	10,113	0.0%
60-90	4	0.23	5,735	7,300	21.4%
90-100	0	0.13	3,300	No Data	No Data

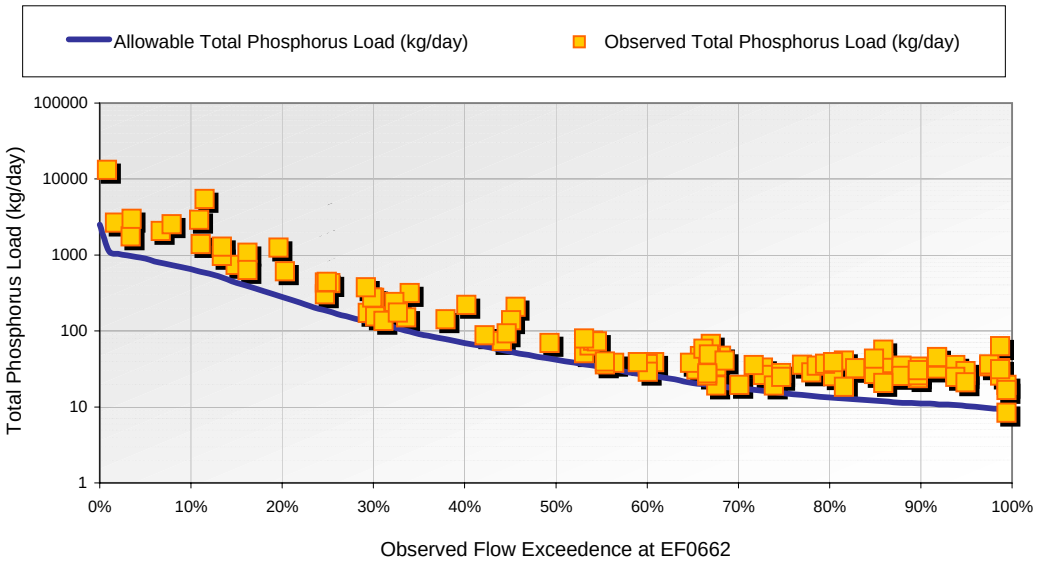
[25: Total Phosphorus at EF0662 (mg/L)] -vs- [22: Flow at EF0662 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

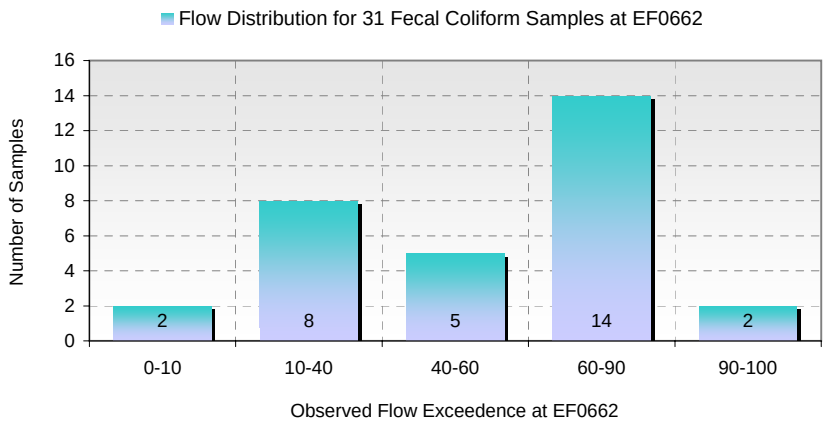


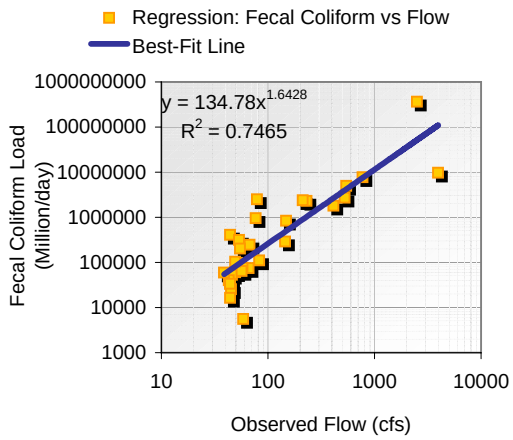
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	116-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	3,665.97	897	2,586	65.3%
10-40	25	745.80	182	424	56.9%
40-60	18	171.22	42	71	41.1%
60-90	49	61.97	15	33	53.9%
90-100	18	42.02	10	30	65.6%

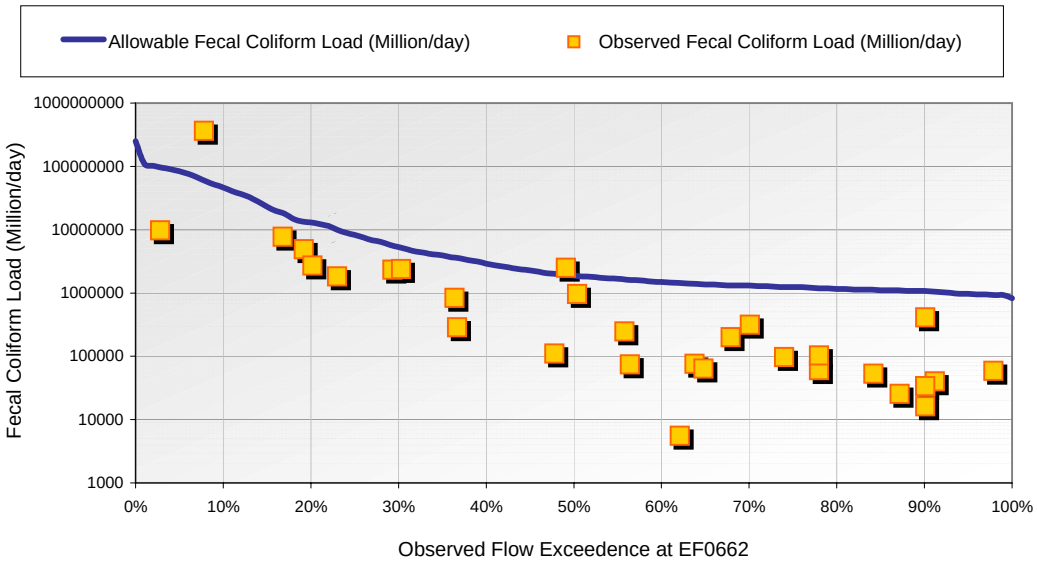
[20: Fecal Coliform at EF0662 (MPN/100mL)] -vs- [22: Flow at EF0662 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

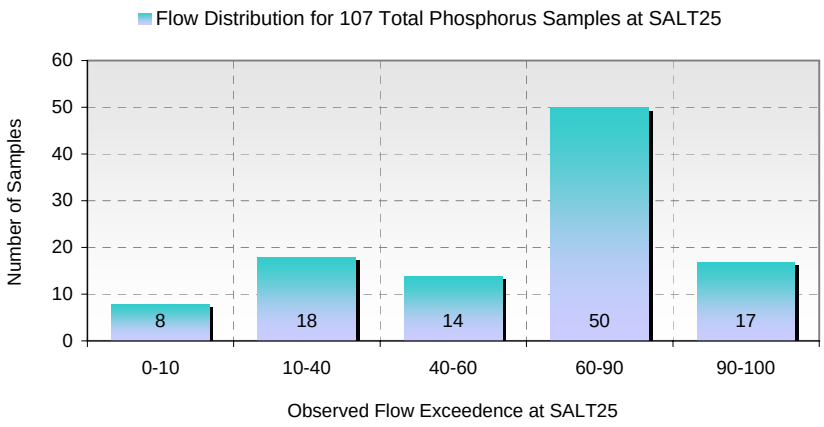


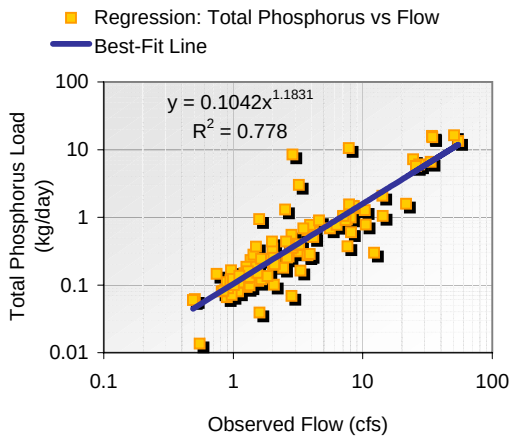
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	31-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	3,441.18	84,190,972	186,037,399	54.7%
10-40	8	336.13	8,223,783	2,353,030	0.0%
40-60	5	76.68	1,876,051	246,714	0.0%
60-90	14	50.42	1,233,568	62,115	0.0%
90-100	2	39.92	976,574	49,497	0.0%

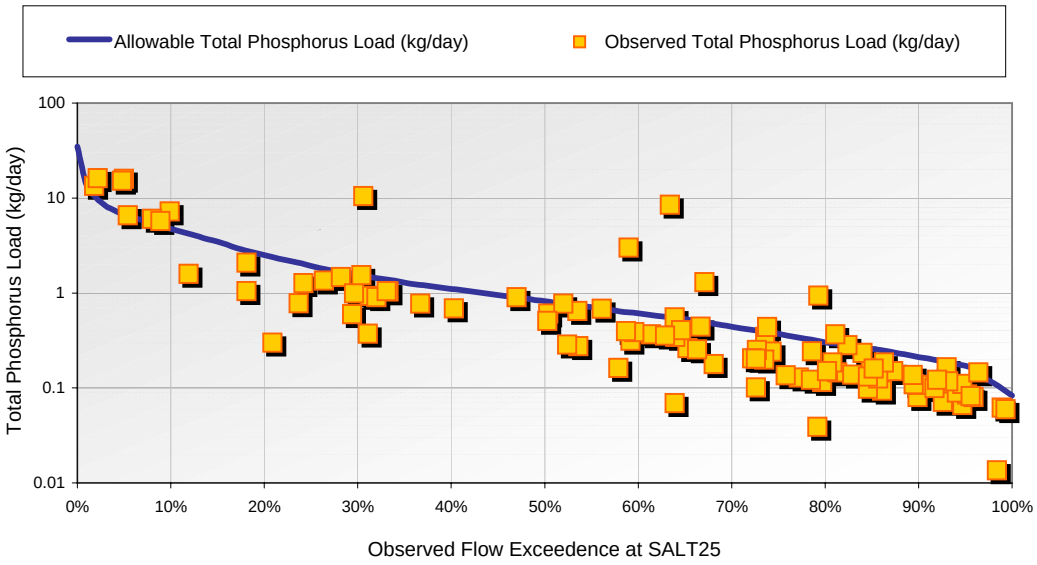
[12: Total Phosphorus at SALT25 (mg/L)] -vs- [14: Flow at SALT25 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

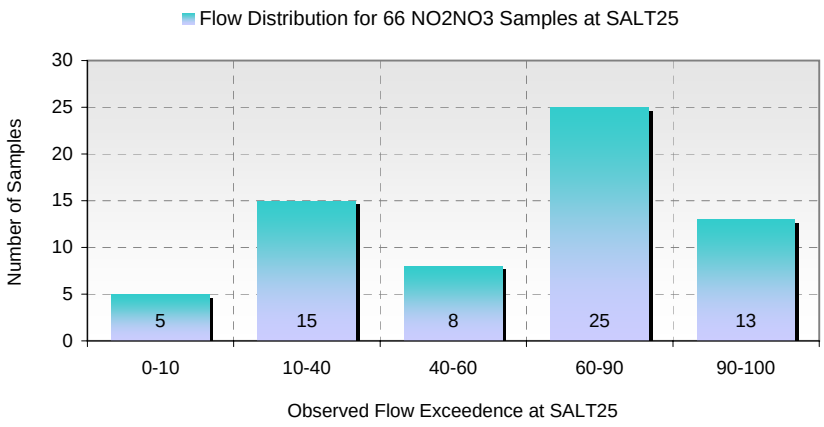


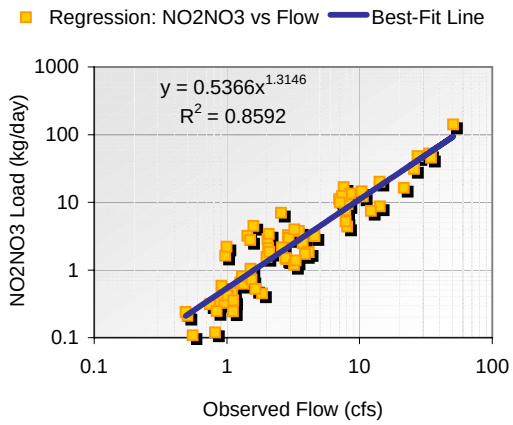
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	107-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	8	34.16	7	10	35.1%
10-40	18	9.83	2	1	0.0%
40-60	14	4.18	1	1	0.0%
60-90	50	1.90	0	0	0.0%
90-100	17	0.87	0	0	0.0%

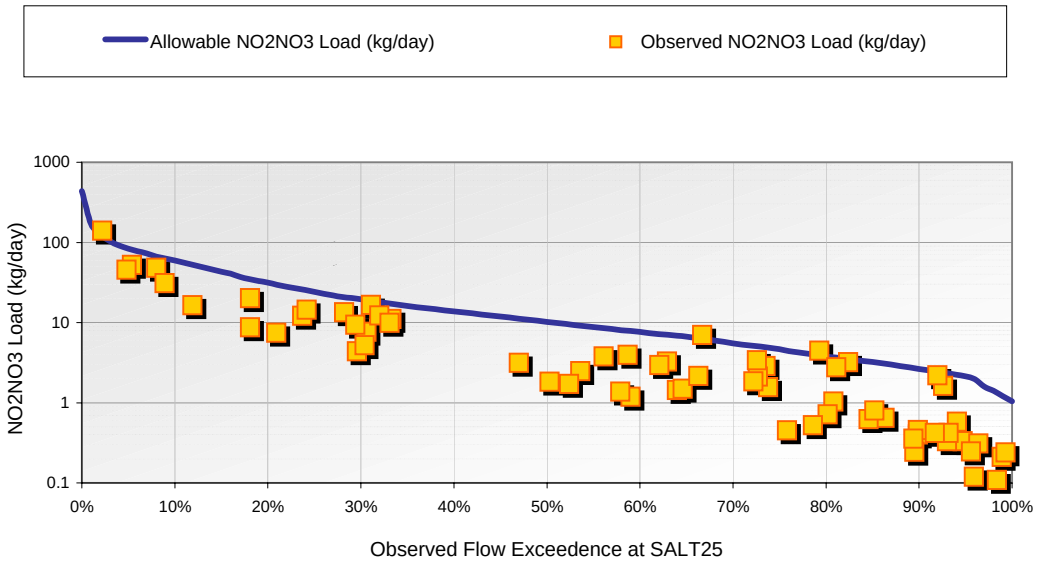
[9: Nitrite Plus Nitrate as Nitrogen at SALT25 (mg/L)] -vs- [14: Flow at SALT25 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

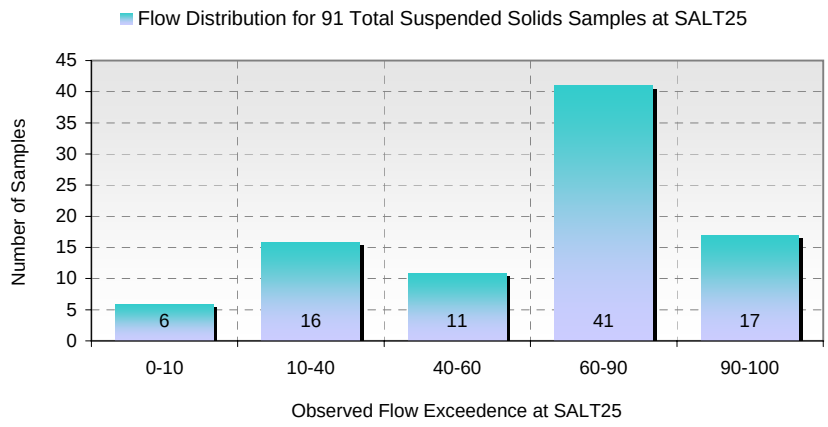


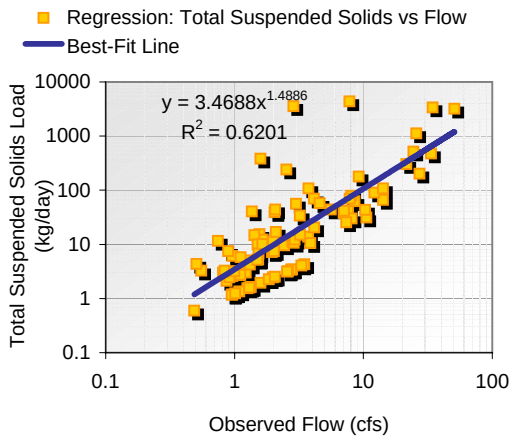
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	66-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	34.16	84	48	0.0%
10-40	15	9.83	24	11	0.0%
40-60	8	4.18	10	2	0.0%
60-90	25	1.90	5	1	0.0%
90-100	13	0.87	2	0	0.0%

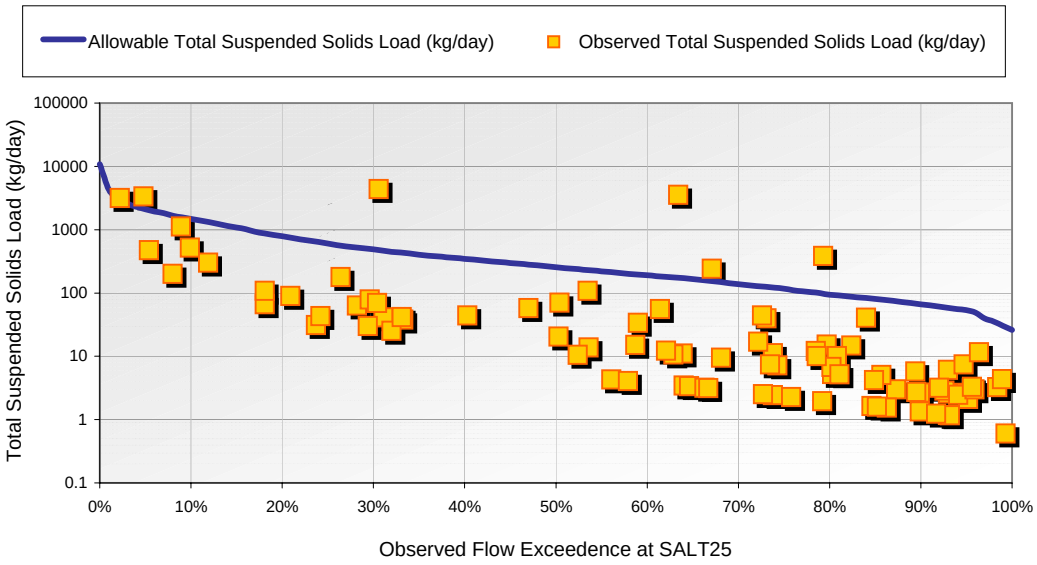
[12: Total Suspended Solids at SALT25 (mg/L)] -vs- [14: Flow at SALT25 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

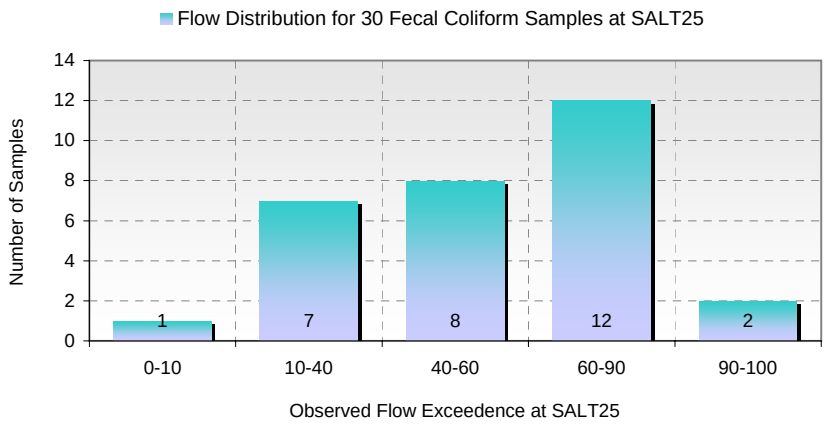


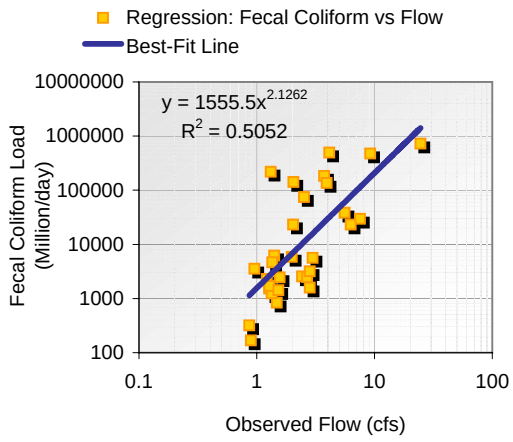
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	91-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	6	34.16	2,089	821	0.0%
10-40	16	9.83	601	65	0.0%
40-60	11	4.18	256	20	0.0%
60-90	41	1.90	116	7	0.0%
90-100	17	0.87	53	3	0.0%

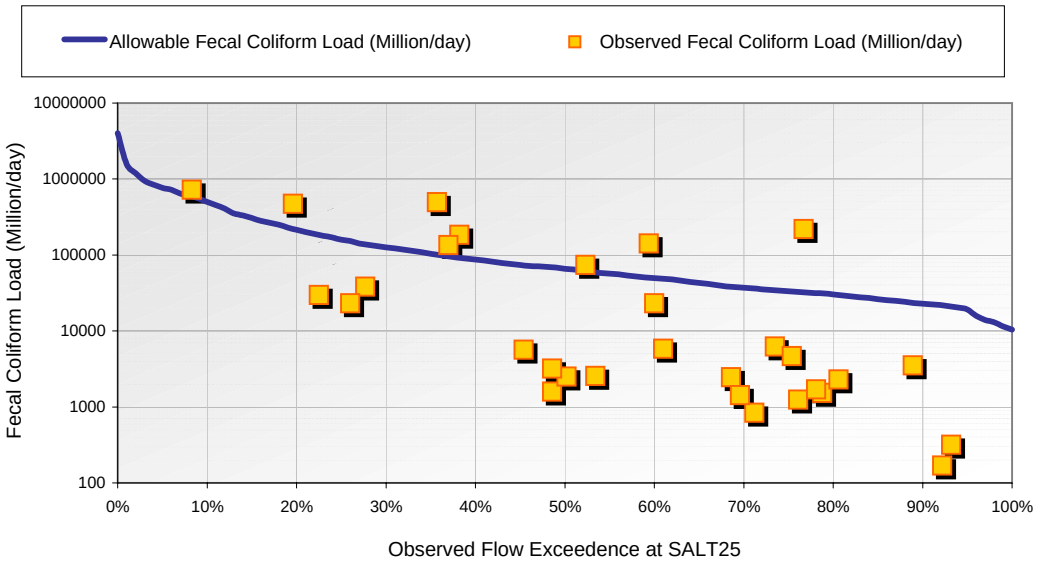
[10: Fecal Coliform at SALT25 (MPN/100mL)] -vs- [14: Flow at SALT25 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

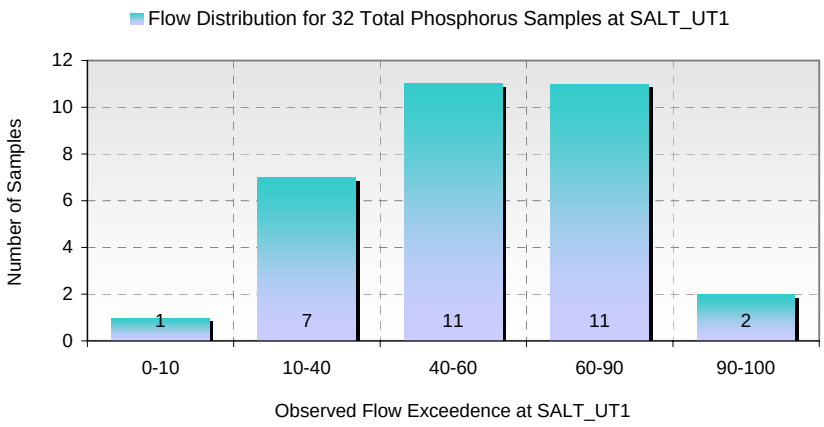


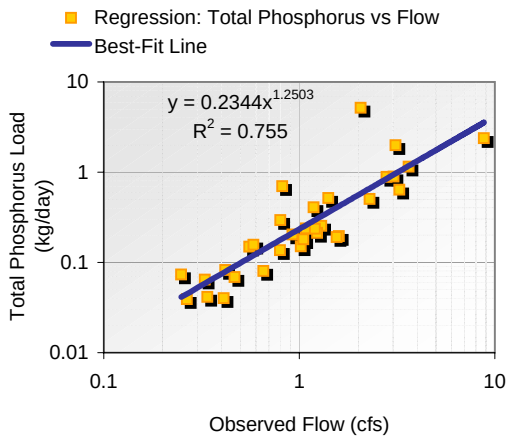
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	30-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	1	31.22	763,909	720,916	0.0%
10-40	7	6.52	159,444	134,730	0.0%
40-60	8	2.69	65,771	4,411	0.0%
60-90	12	1.37	33,455	2,376	0.0%
90-100	2	0.79	19,247	243	0.0%

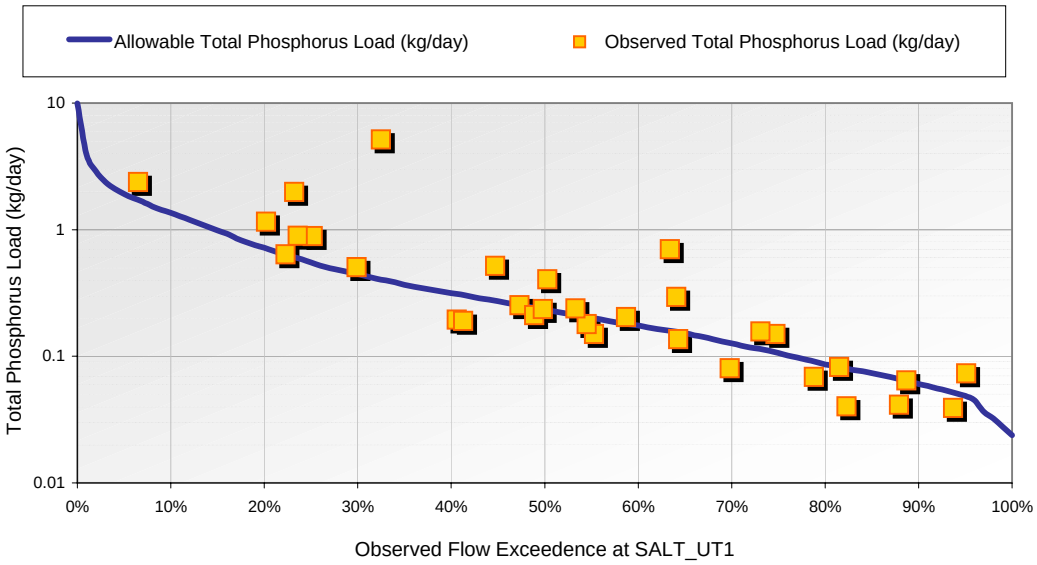
[11: Total Phosphorus at SALT_UT1 (mg/L)] -vs- [13: Flow at SALT_UT1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

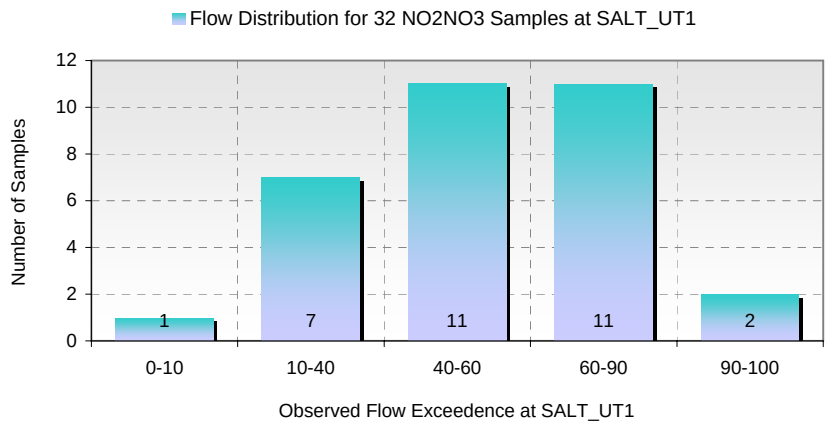


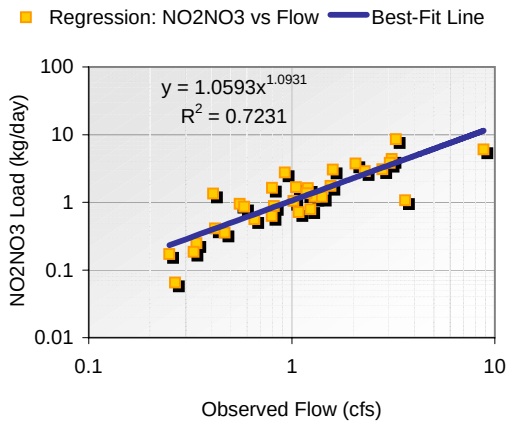
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	32-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	9.76	2	2	19.5%
10-40	7	2.81	1	1	38.4%
40-60	11	1.19	0	0	0.0%
60-90	11	0.54	0	0	0.0%
90-100	2	0.25	0	0	13.0%

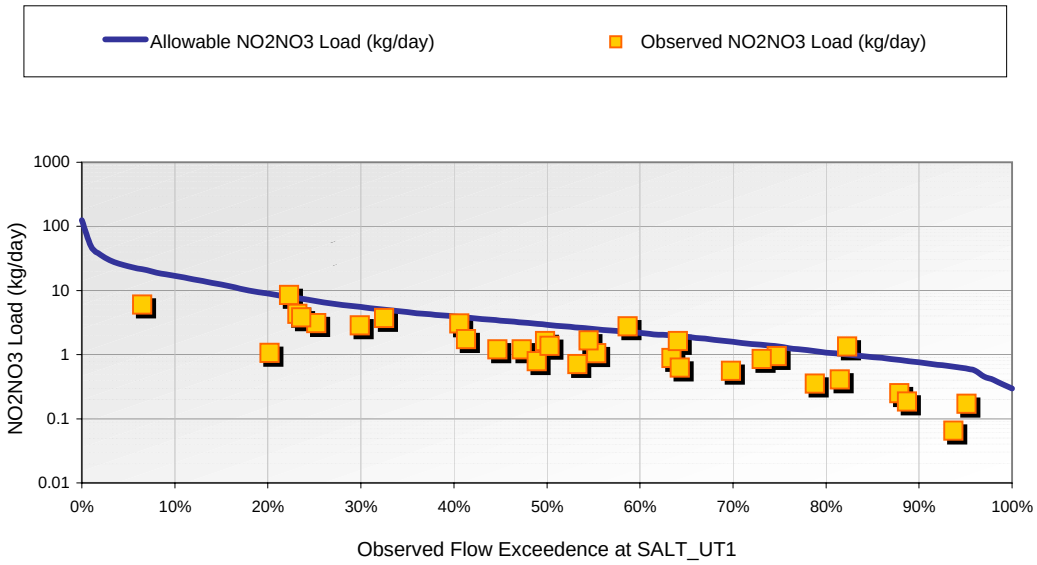
[8: Nitrite Plus Nitrate as Nitrogen at SALT_UT1 (mg/L)] -vs- [13: Flow at SALT_UT1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

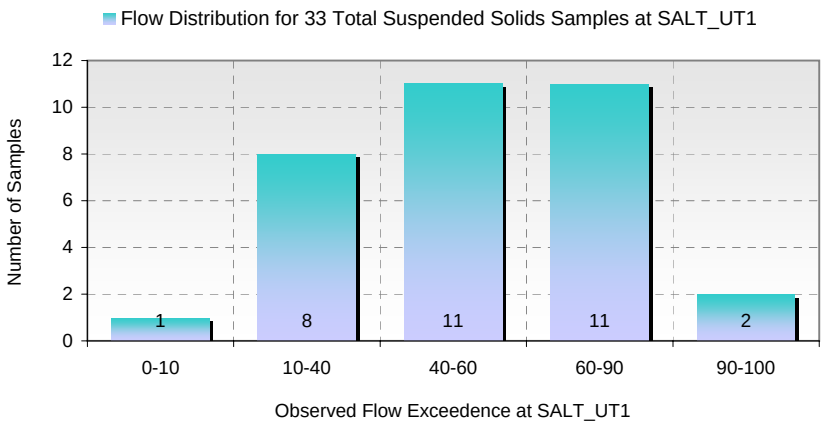


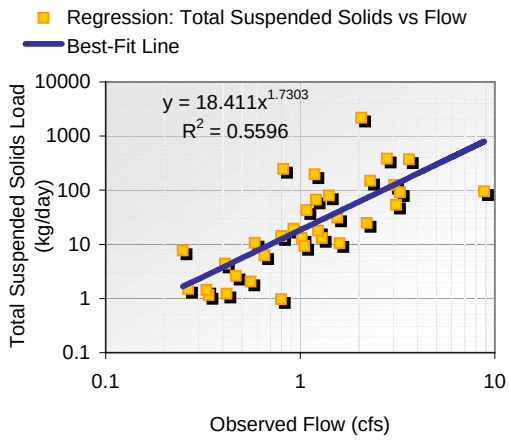
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	32-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	9.76	24	6	0.0%
10-40	7	2.81	7	4	0.0%
40-60	11	1.19	3	1	0.0%
60-90	11	0.54	1	1	0.0%
90-100	2	0.25	1	0	0.0%

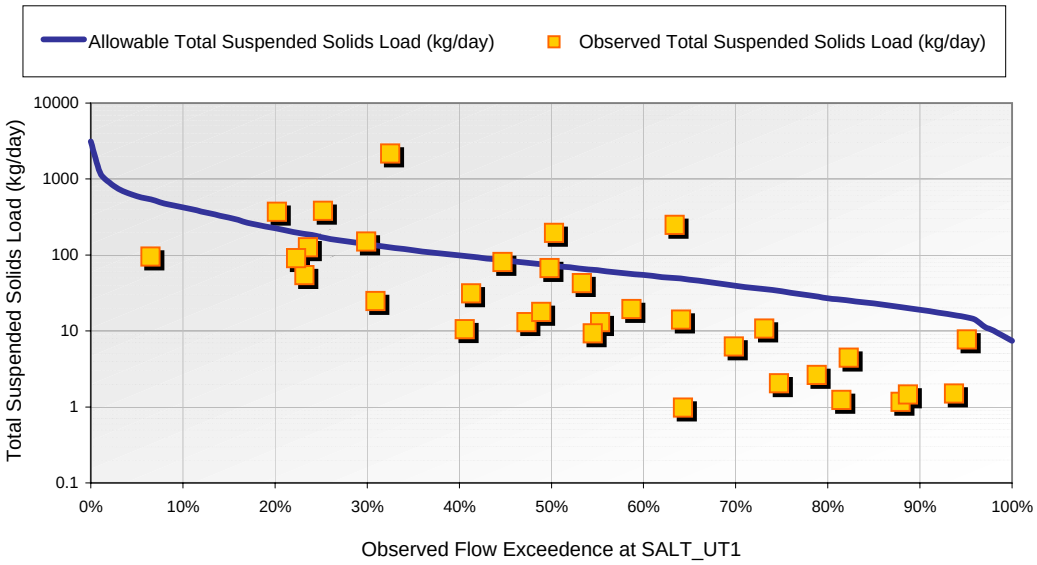
[11: Total Suspended Solids at SALT_UT1 (mg/L)] -vs- [13: Flow at SALT_UT1 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

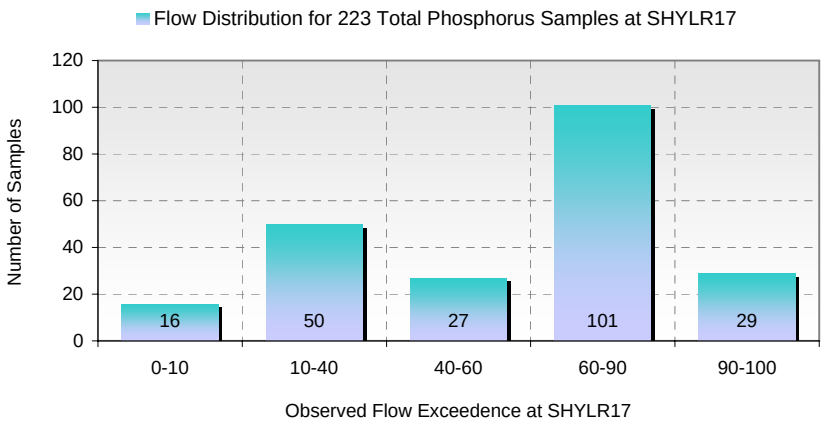


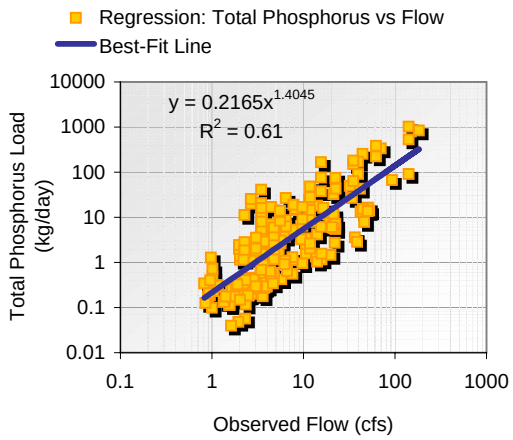
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	33-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	9.76	597	95	0.0%
10-40	8	2.81	172	138	0.0%
40-60	11	1.19	73	19	0.0%
60-90	11	0.54	33	3	0.0%
90-100	2	0.25	15	5	0.0%

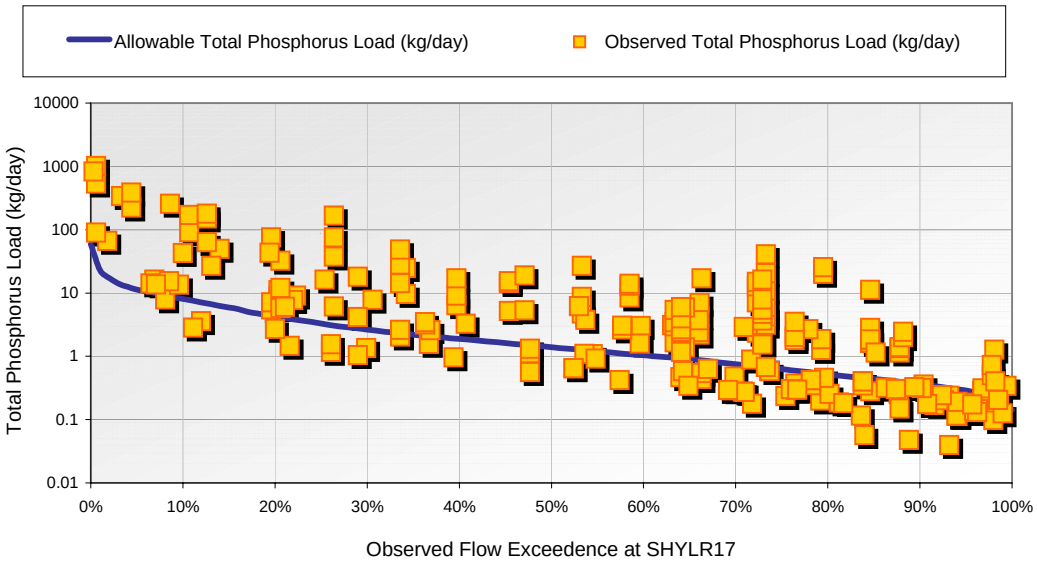
[13: Total Phosphorus at SHYLR17 (mg/L)] -vs- [15: Flow at SHYLR17 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

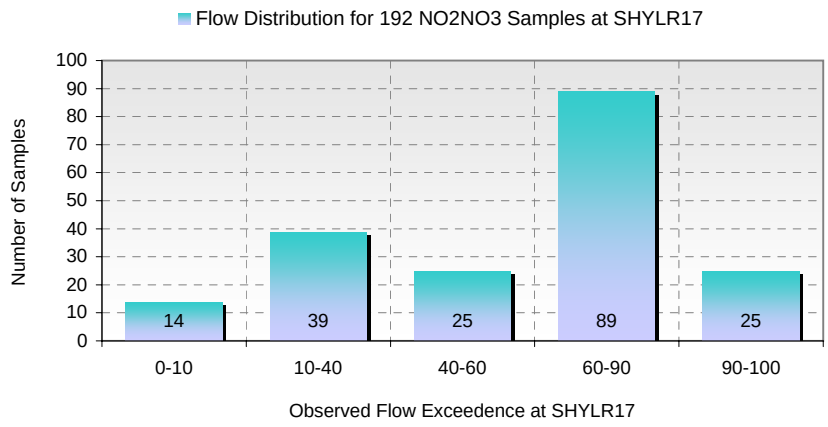


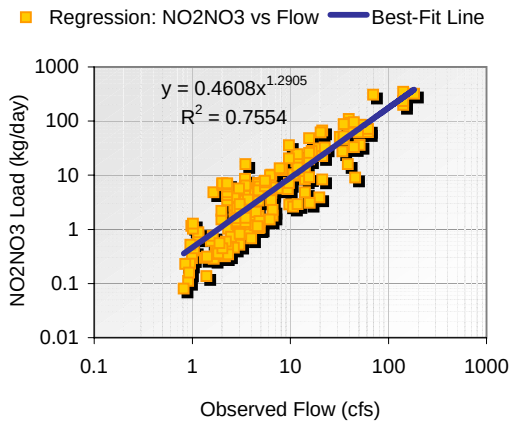
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	223-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	16	58.07	11	78	85.5%
10-40	50	16.72	3	9	63.4%
40-60	27	7.10	1	3	57.0%
60-90	101	3.23	1	2	60.8%
90-100	29	1.48	0	0	0.0%

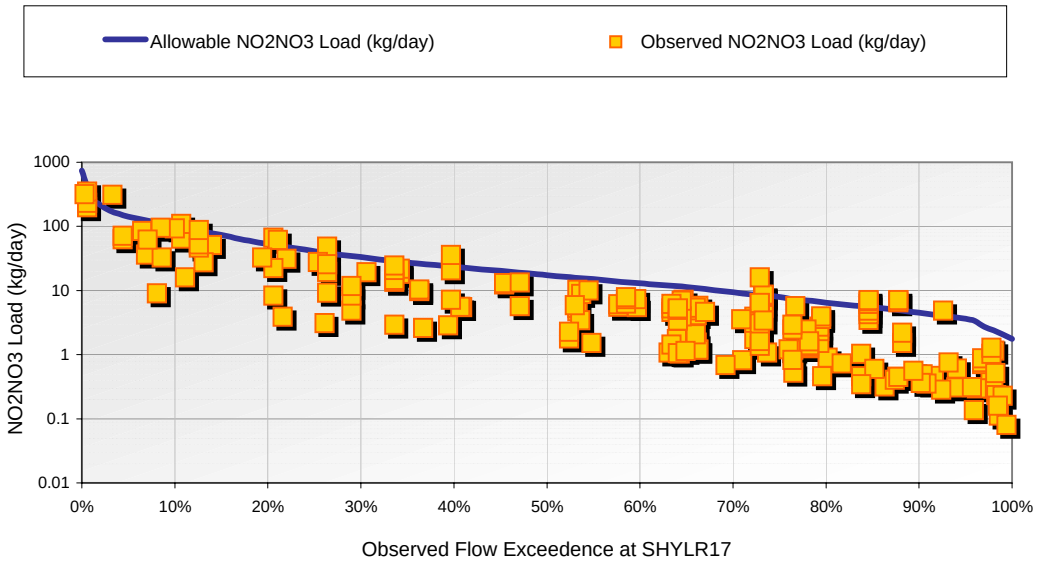
[10: Nitrite Plus Nitrate as Nitrogen at SHYLR17 (mg/L)] -vs- [15: Flow at SHYLR17 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

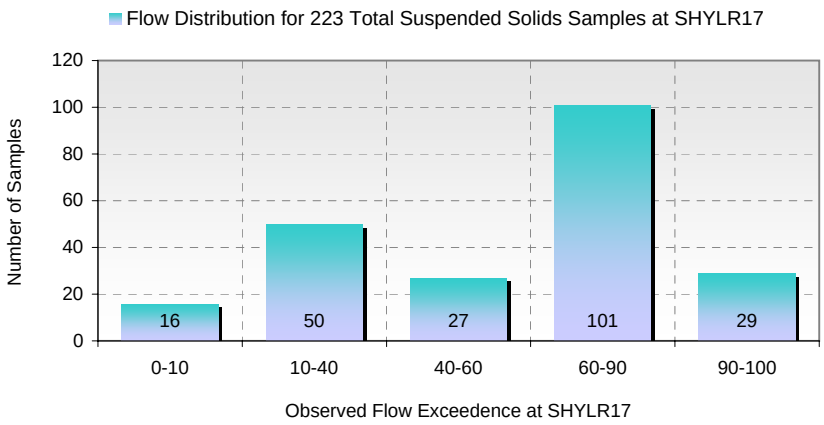


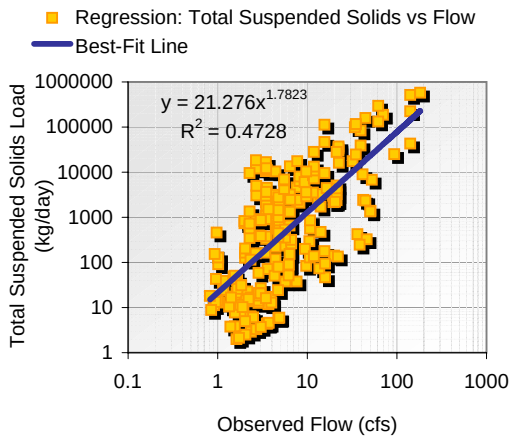
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	192-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	14	58.07	142	89	0.0%
10-40	39	16.72	41	20	0.0%
40-60	25	7.10	17	6	0.0%
60-90	89	3.23	8	2	0.0%
90-100	25	1.48	4	0	0.0%

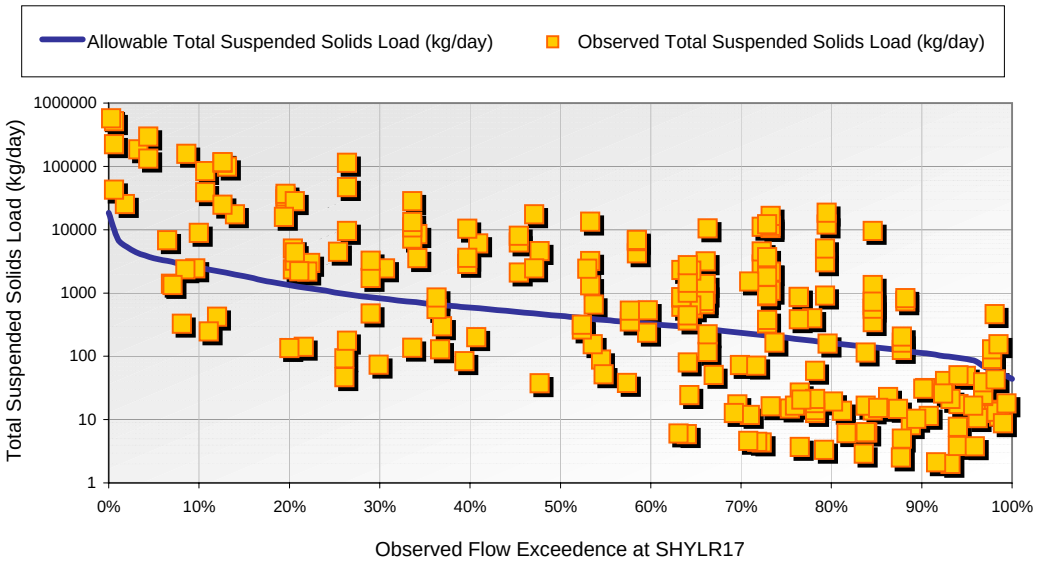
[13: Total Suspended Solids at SHYLR17 (mg/L)] -vs- [15: Flow at SHYLR17 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

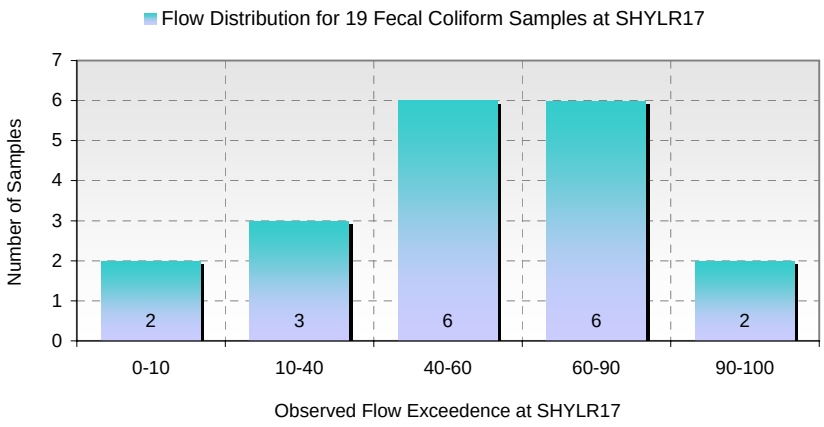


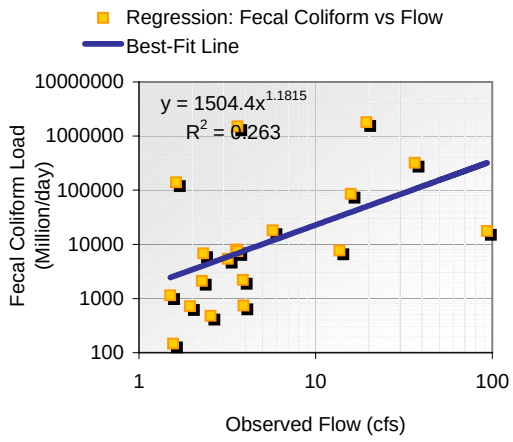
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	223-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	16	58.07	3,552	33,849	89.5%
10-40	50	16.72	1,023	3,566	71.3%
40-60	27	7.10	434	1,309	66.8%
60-90	101	3.23	198	345	42.7%
90-100	29	1.48	91	18	0.0%

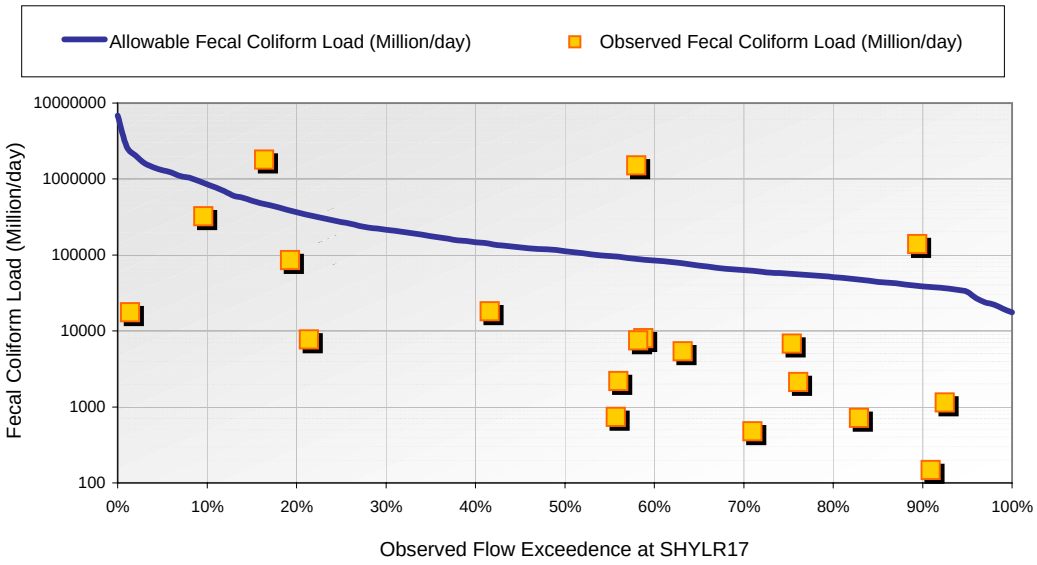
[11: Fecal Coliform at SHYLR17 (MPN/100mL)] -vs- [15: Flow at SHYLR17 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

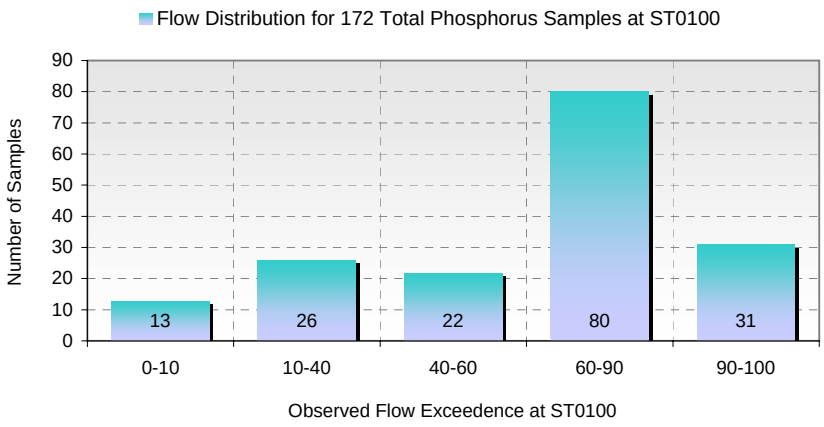


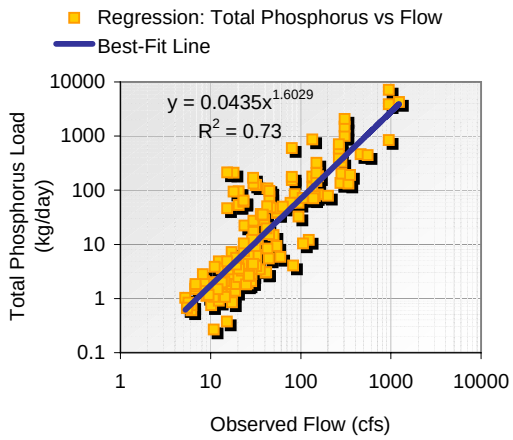
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	19-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	53.08	1,298,645	169,541	0.0%
10-40	3	11.08	271,055	85,189	0.0%
40-60	6	4.57	111,810	7,751	0.0%
60-90	6	2.32	56,873	3,746	0.0%
90-100	2	1.34	32,720	644	0.0%

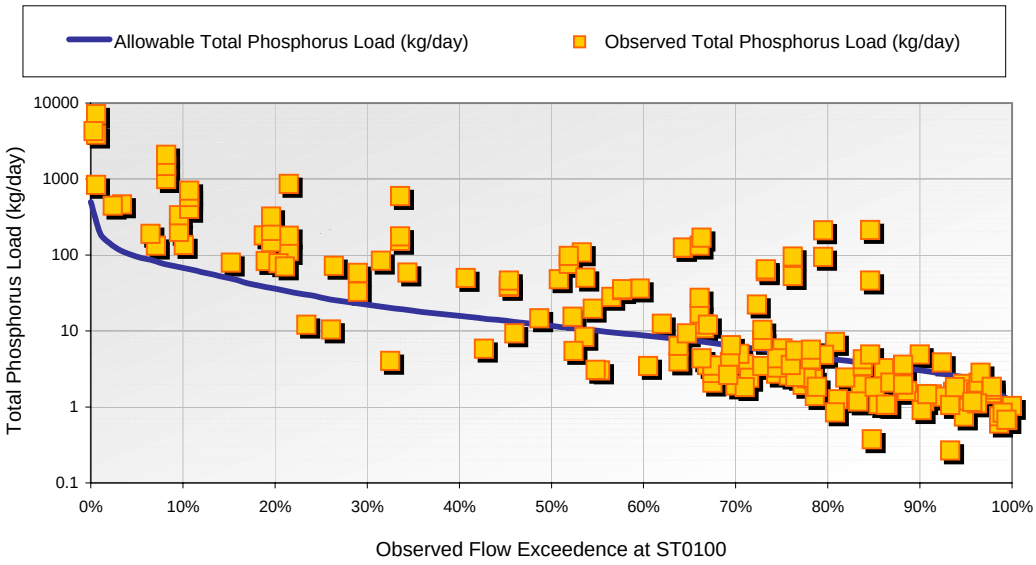
[14: Total Phosphorus at ST0100 (mg/L)] -vs- [16: Flow at ST0100 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

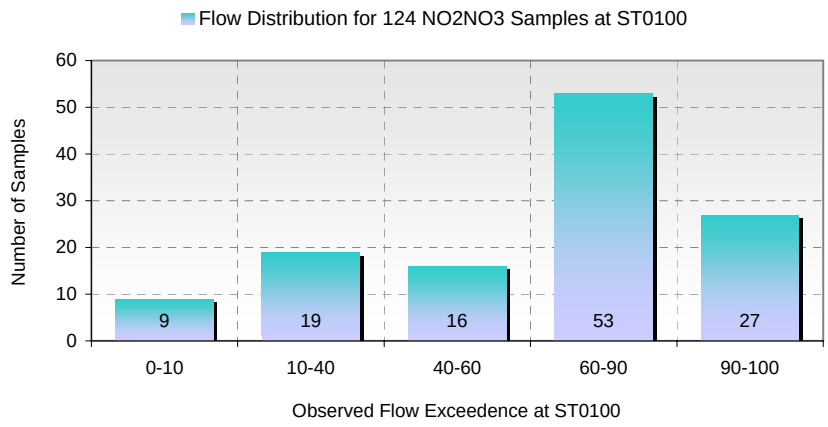


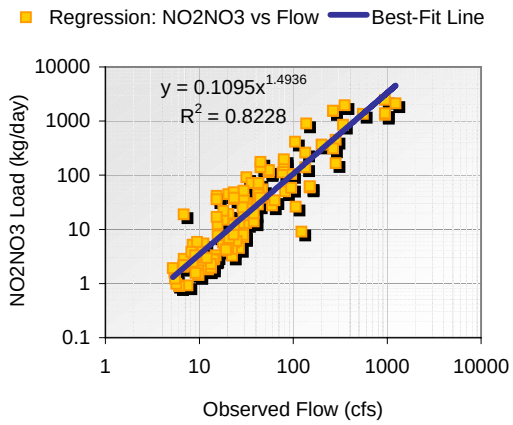
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	172-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	13	390.36	96	838	88.6%
10-40	26	112.39	27	124	77.8%
40-60	22	47.75	12	35	66.5%
60-90	80	21.75	5	4	0.0%
90-100	31	9.98	2	1	0.0%

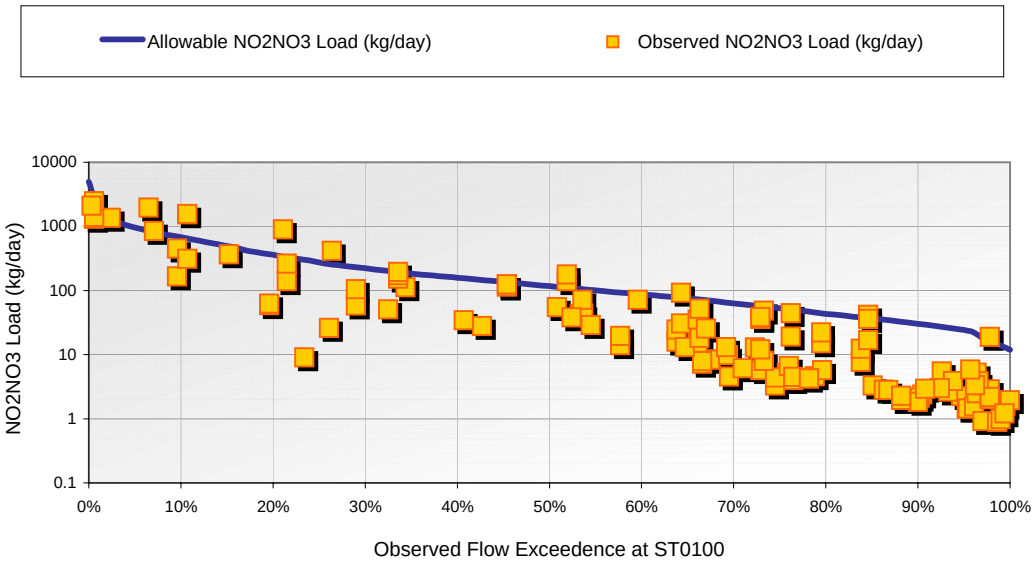
[11: Nitrite Plus Nitrate as Nitrogen at ST0100 (mg/L)] -vs- [16: Flow at ST0100 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

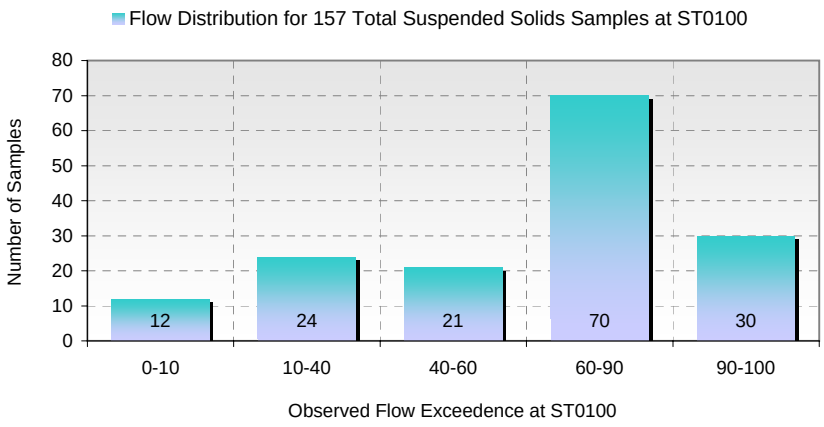


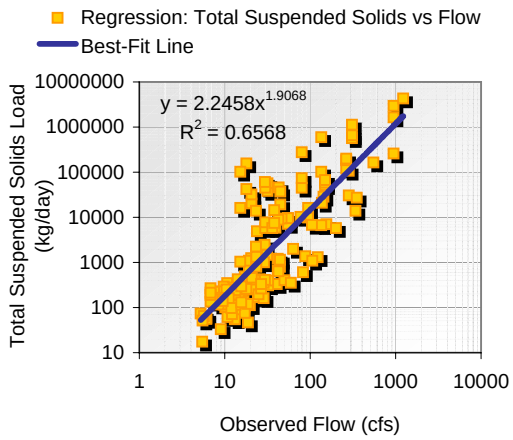
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	124-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	9	390.36	955	1,352	29.4%
10-40	19	112.39	275	152	0.0%
40-60	16	47.75	117	49	0.0%
60-90	53	21.75	53	8	0.0%
90-100	27	9.98	24	2	0.0%

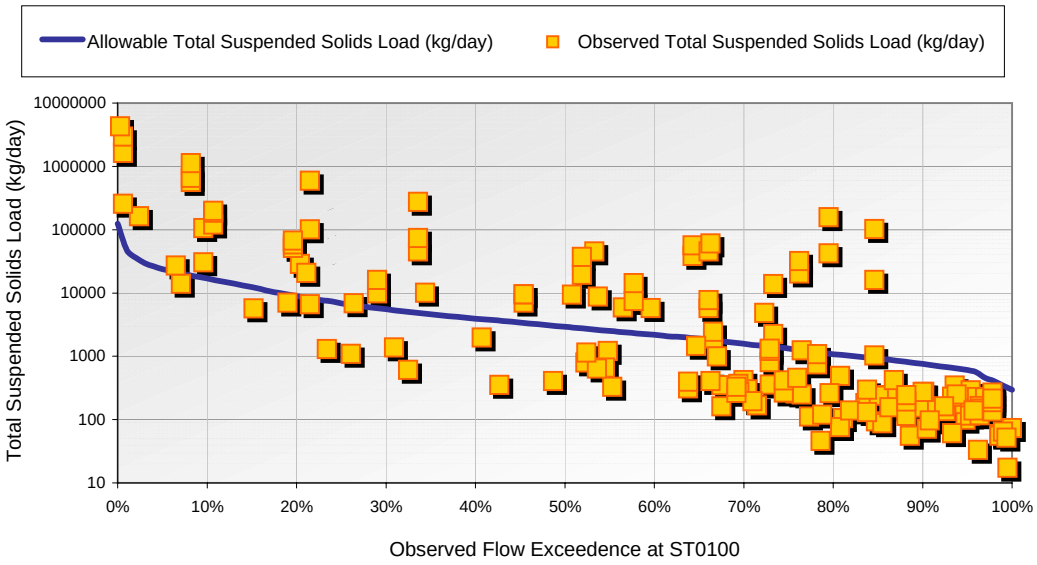
[14: Total Suspended Solids at ST0100 (mg/L)] -vs- [16: Flow at ST0100 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

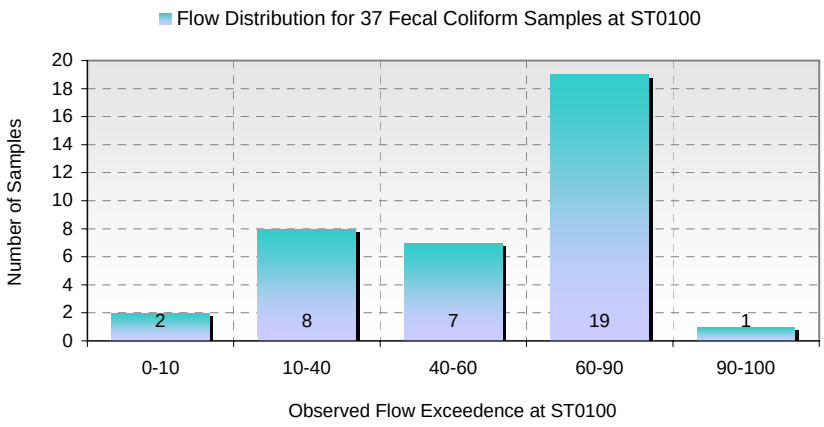


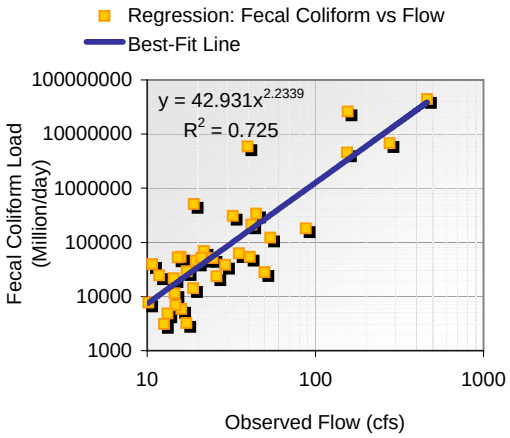
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	157-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	12	390.36	23,876	411,057	94.2%
10-40	24	112.39	6,874	24,659	72.1%
40-60	21	47.75	2,920	5,857	50.1%
60-90	70	21.75	1,330	358	0.0%
90-100	30	9.98	610	138	0.0%

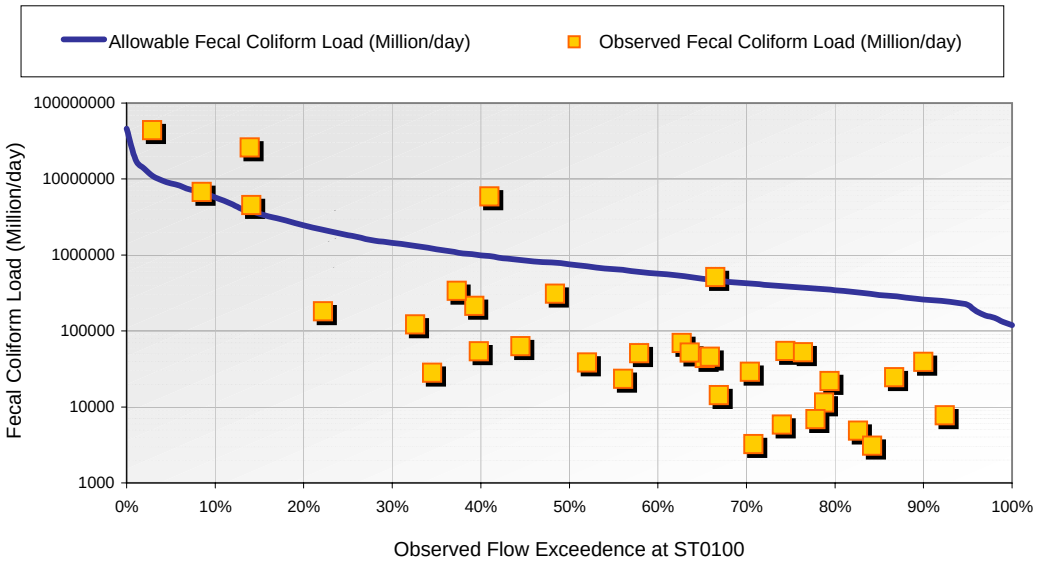
[12: Fecal Coliform at ST0100 (MPN/100mL)] -vs- [16: Flow at ST0100 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

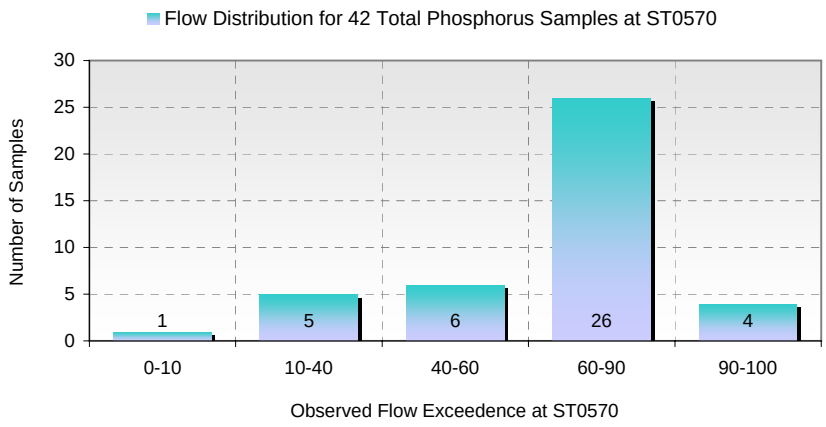


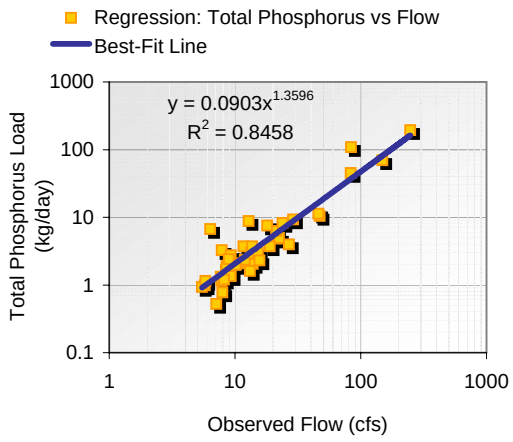
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	37-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	356.84	8,730,390	25,402,084	65.6%
10-40	8	74.48	1,822,221	197,312	0.0%
40-60	7	30.72	751,666	56,930	0.0%
60-90	19	15.63	382,341	26,846	0.0%
90-100	1	8.99	219,968	7,717	0.0%

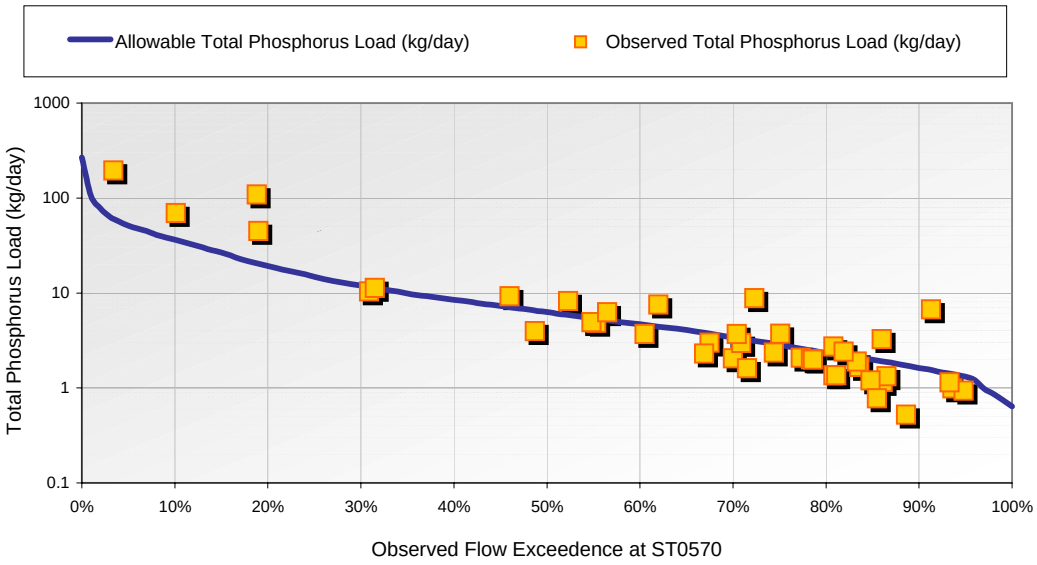
[15: Total Phosphorus at ST0570 (mg/L)] -vs- [17: Flow at ST0570 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

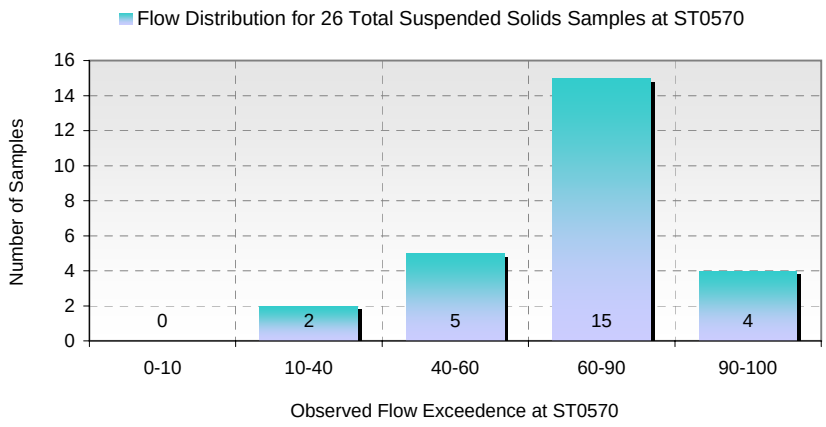


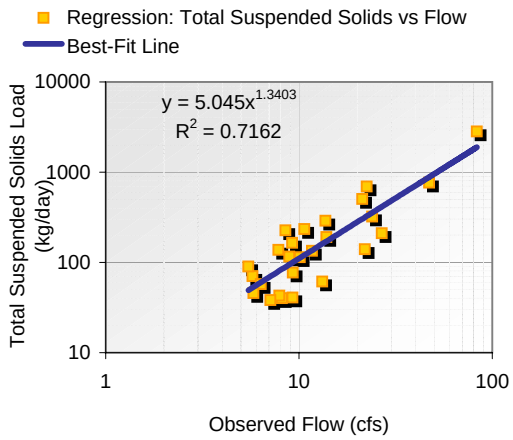
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	42-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	209.82	51	194	73.6%
10-40	5	60.41	15	45	67.0%
40-60	6	25.66	6	6	0.0%
60-90	26	11.69	3	2	0.0%
90-100	4	5.36	1	1	0.0%

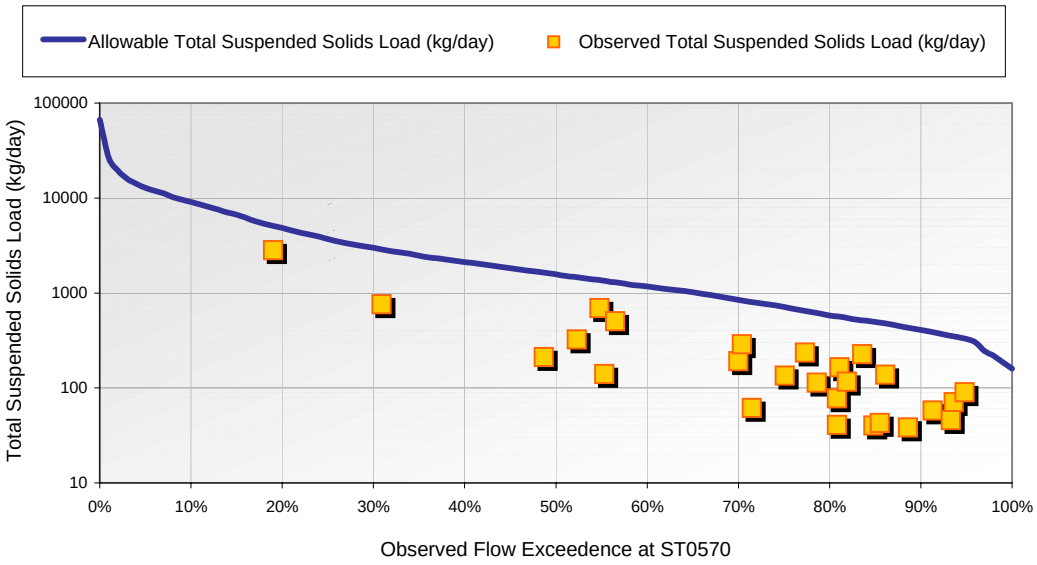
[15: Total Suspended Solids at ST0570 (mg/L)] -vs- [17: Flow at ST0570 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

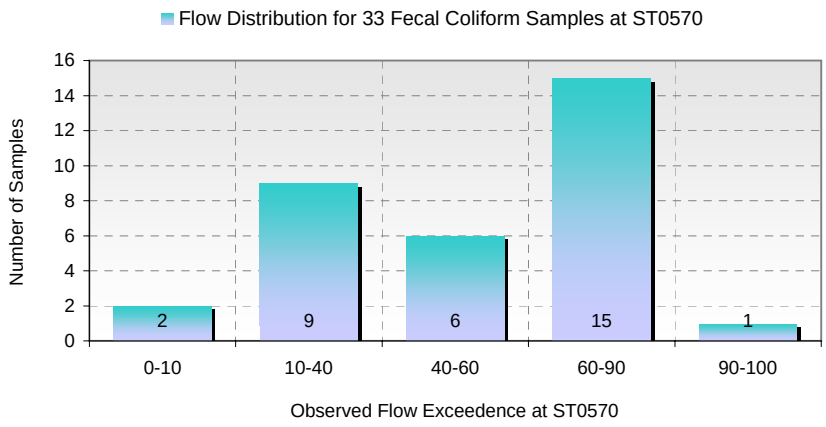


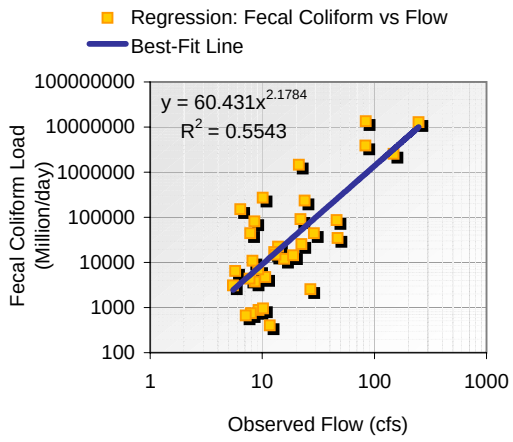
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	26-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	0	209.82	12,833	No Data	No Data
10-40	2	60.41	3,695	1,787	0.0%
40-60	5	25.66	1,570	323	0.0%
60-90	15	11.69	715	116	0.0%
90-100	4	5.36	328	64	0.0%

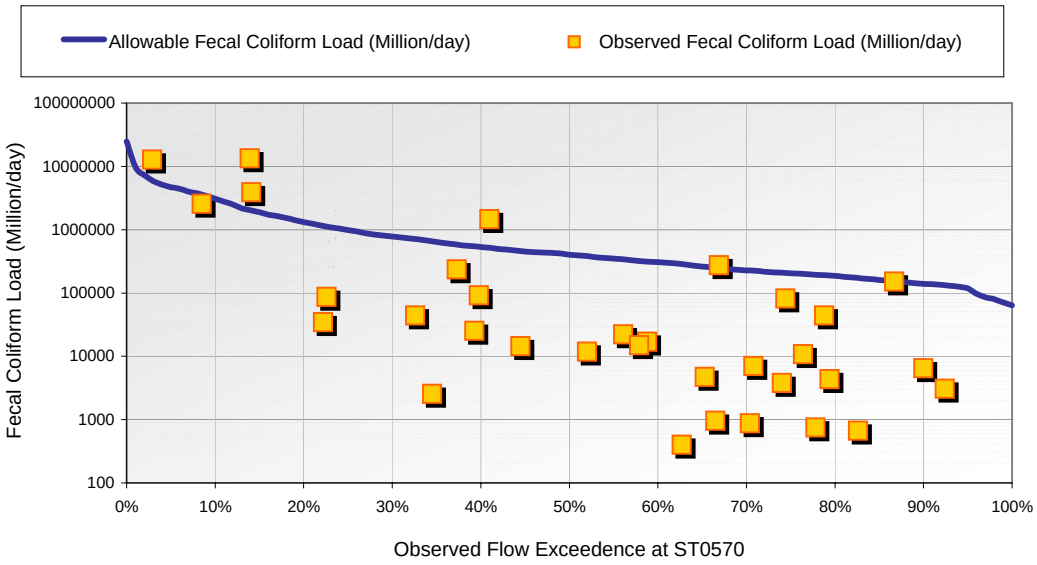
[13: Fecal Coliform at ST0570 (MPN/100mL)] -vs- [17: Flow at ST0570 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

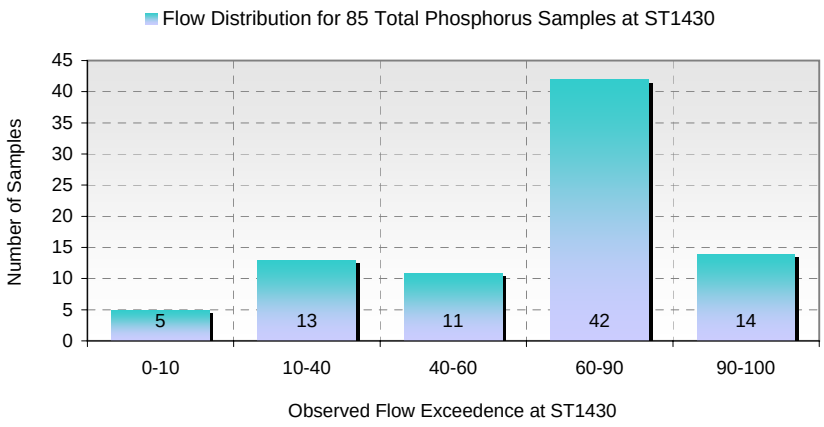


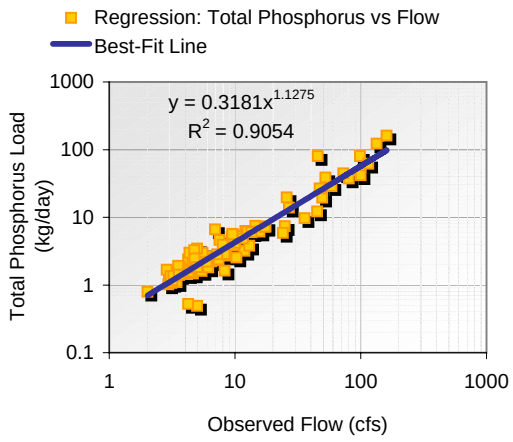
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	33-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	191.80	4,692,584	7,645,782	38.6%
10-40	9	40.03	979,444	86,864	0.0%
40-60	6	16.51	404,021	15,898	0.0%
60-90	15	8.40	205,508	4,691	0.0%
90-100	1	4.83	118,233	3,077	0.0%

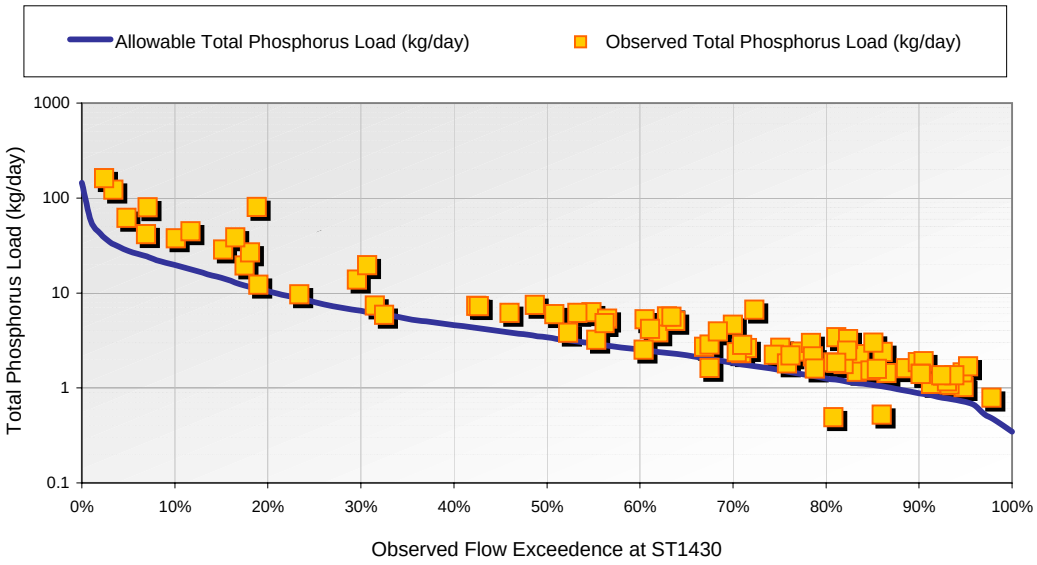
[16: Total Phosphorus at ST1430 (mg/L)] -vs- [18: Flow at ST1430 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

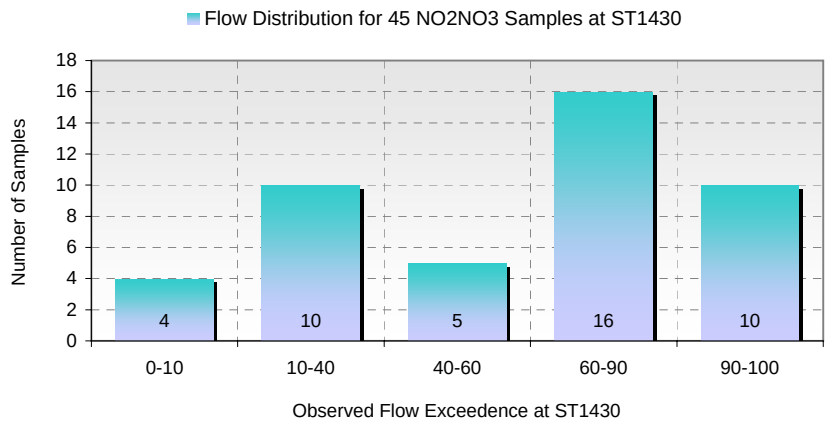


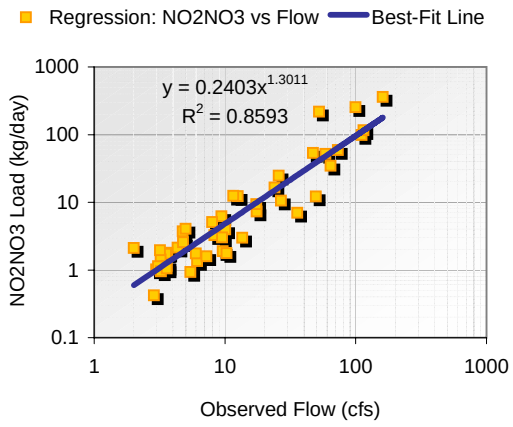
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	85-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	5	113.69	28	80	65.1%
10-40	13	32.73	8	20	59.0%
40-60	11	13.91	3	6	44.7%
60-90	42	6.33	2	2	35.3%
90-100	14	2.91	1	1	47.3%

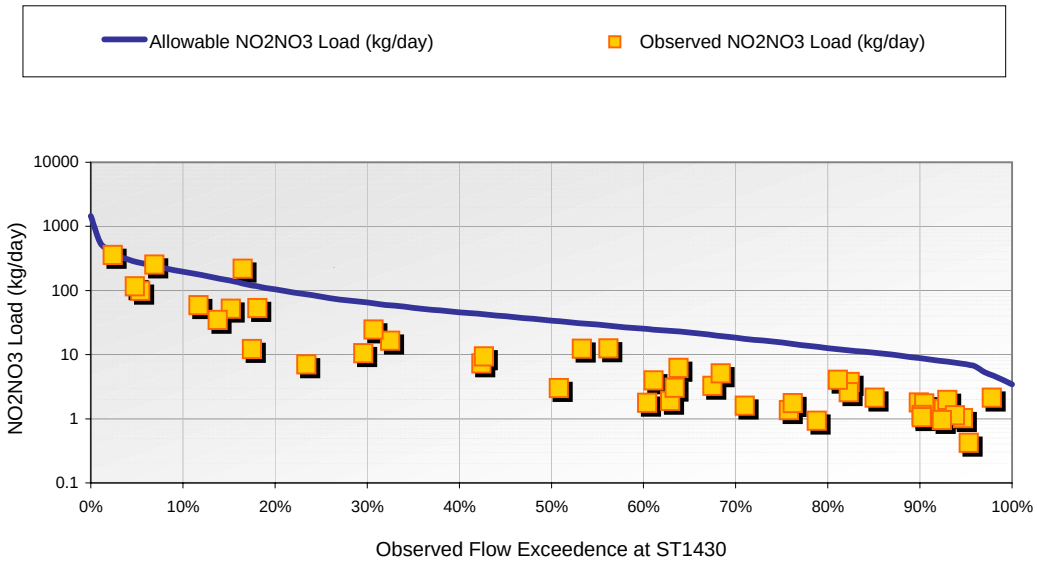
[12: Nitrite Plus Nitrate as Nitrogen at ST1430 (mg/L)] -vs- [18: Flow at ST1430 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

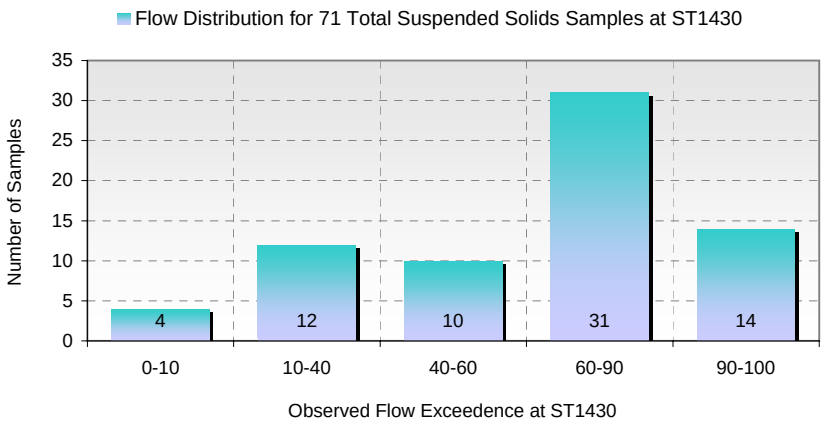


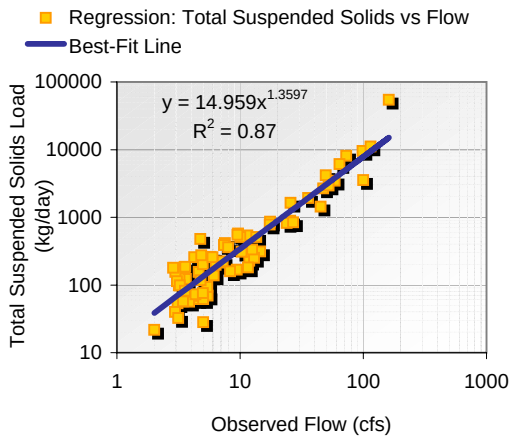
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	45-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	4	113.69	278	185	0.0%
10-40	10	32.73	80	30	0.0%
40-60	5	13.91	34	9	0.0%
60-90	16	6.33	15	2	0.0%
90-100	10	2.91	7	1	0.0%

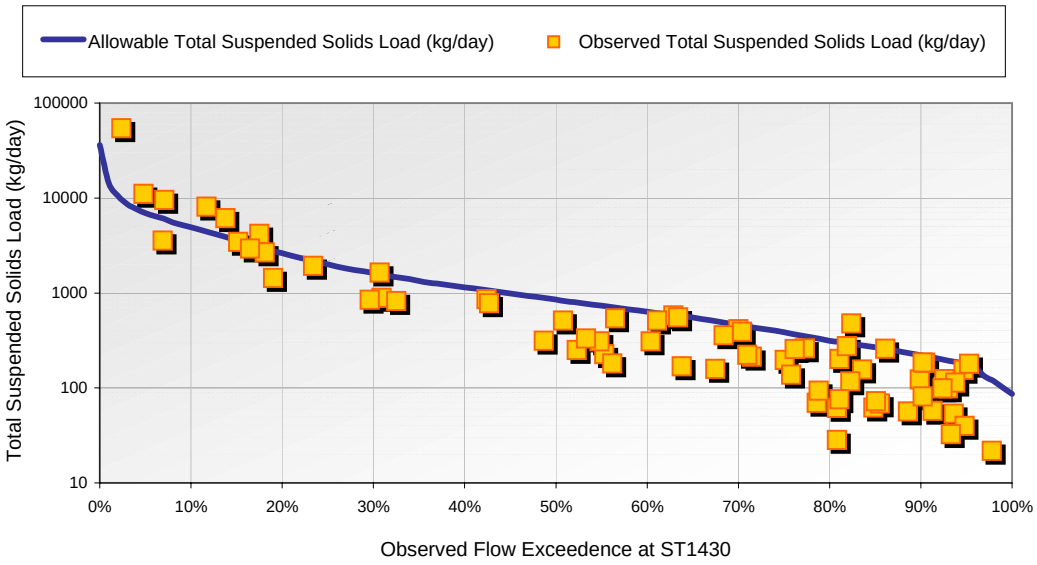
[16: Total Suspended Solids at ST1430 (mg/L)] -vs- [18: Flow at ST1430 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

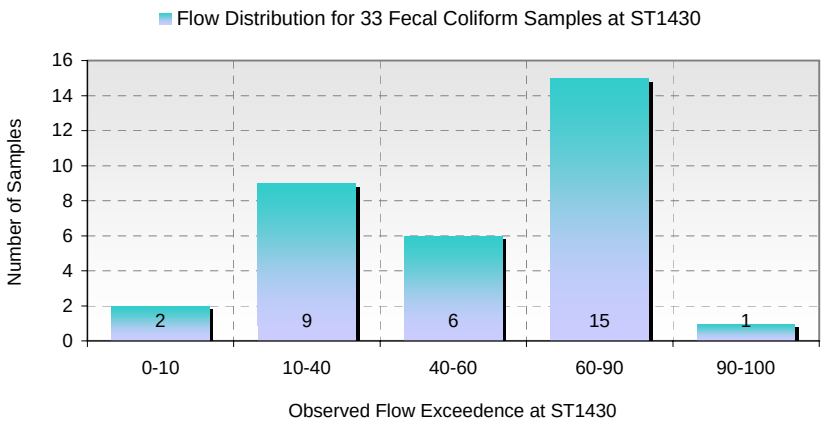


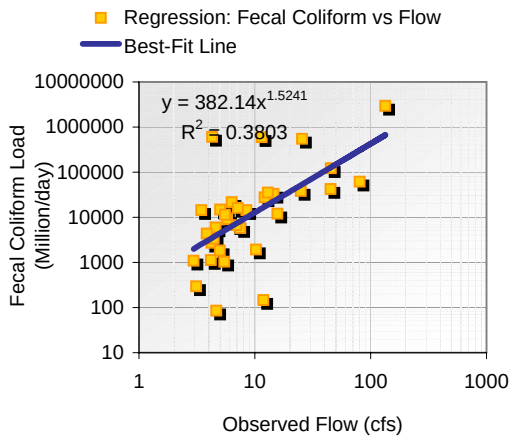
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	71-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	4	113.69	6,954	10,278	32.3%
10-40	12	32.73	2,002	2,294	12.7%
40-60	10	13.91	851	323	0.0%
60-90	31	6.33	387	197	0.0%
90-100	14	2.91	178	99	0.0%

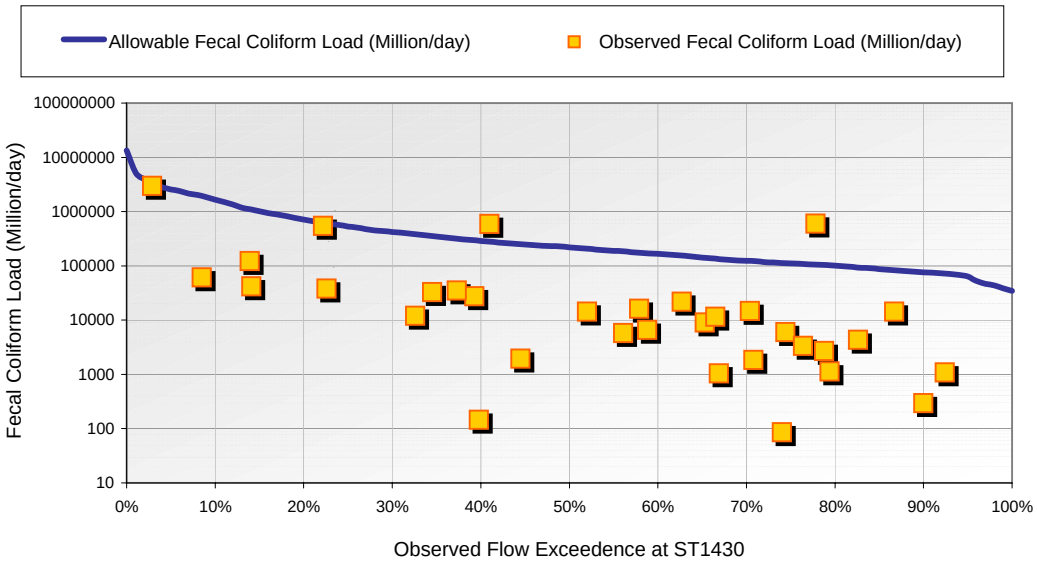
[14: Fecal Coliform at ST1430 (MPN/100mL)] -vs- [18: Flow at ST1430 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

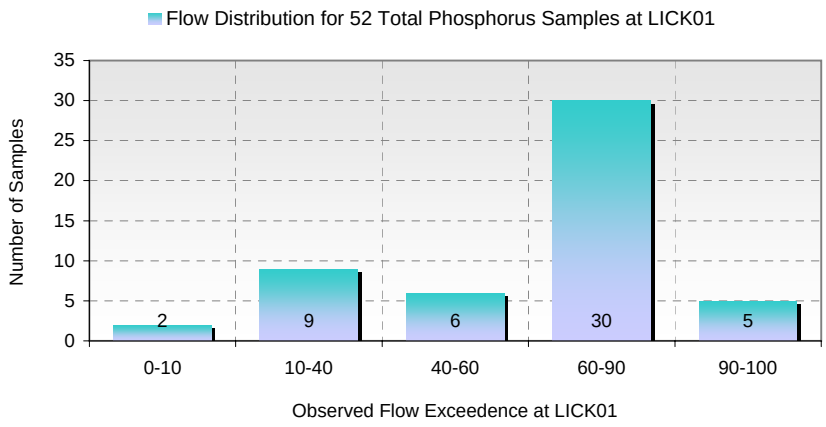


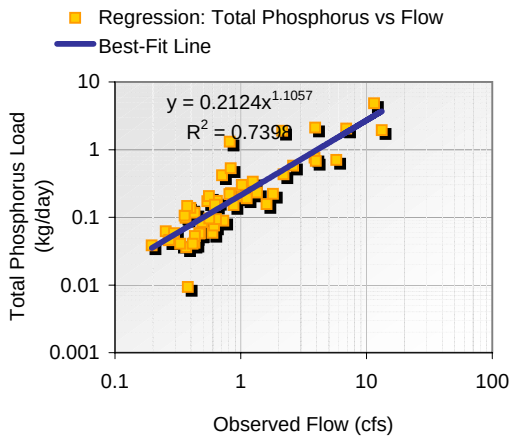
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	33-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	103.93	2,542,726	1,510,415	0.0%
10-40	9	21.69	530,722	34,976	0.0%
40-60	6	8.95	218,923	10,478	0.0%
60-90	15	4.55	111,357	4,338	0.0%
90-100	1	2.62	64,066	1,088	0.0%

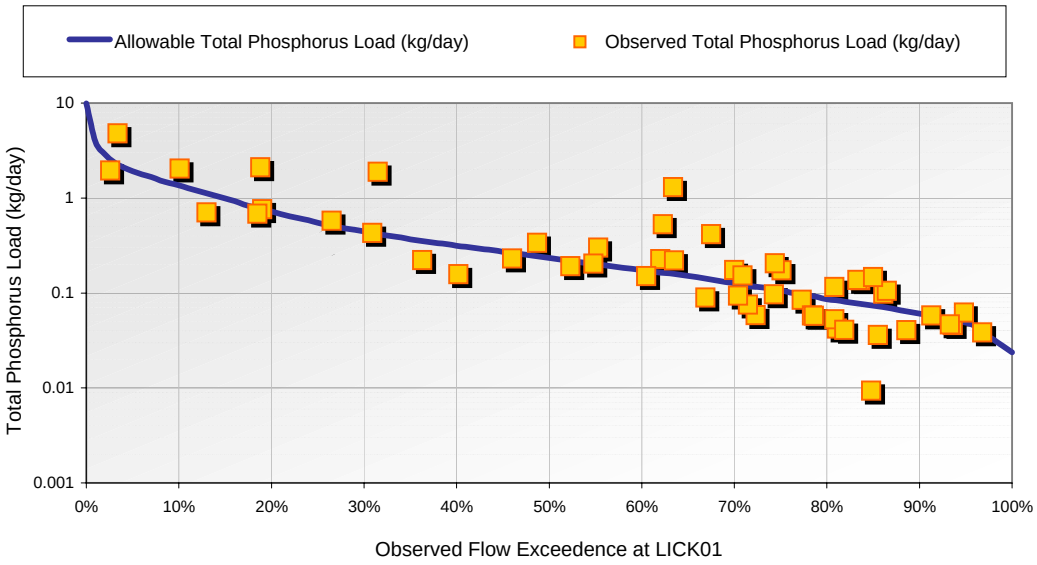
[7: Total Phosphorus at LICK01 (mg/L)] -vs- [9: Flow at LICK01 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

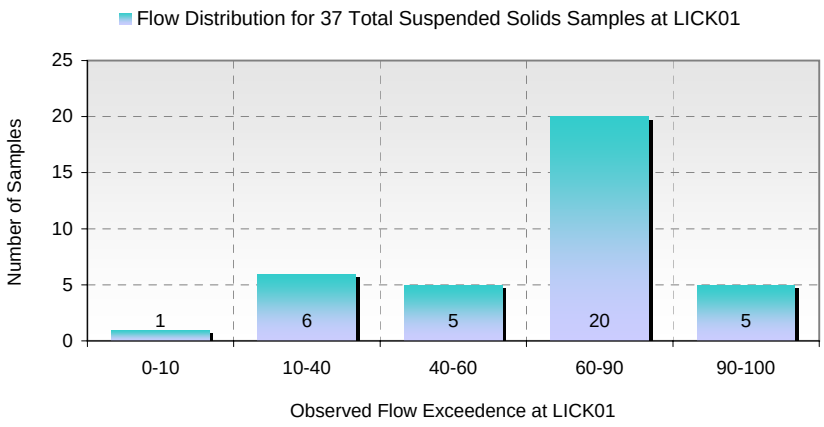


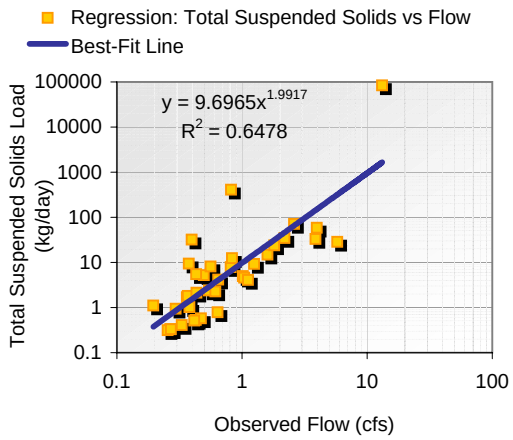
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	52-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	2	9.76	2	3	43.3%
10-40	9	2.81	1	1	22.1%
40-60	6	1.19	0	0	0.0%
60-90	30	0.54	0	0	0.0%
90-100	5	0.25	0	0	0.0%

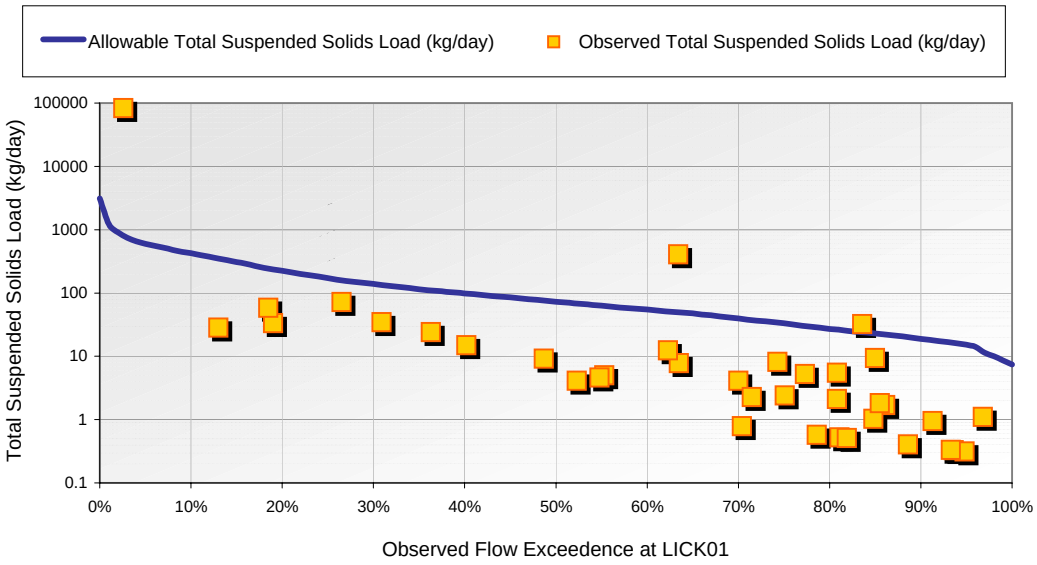
[7: Total Suspended Solids at LICK01 (mg/L)] -vs- [9: Flow at LICK01 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

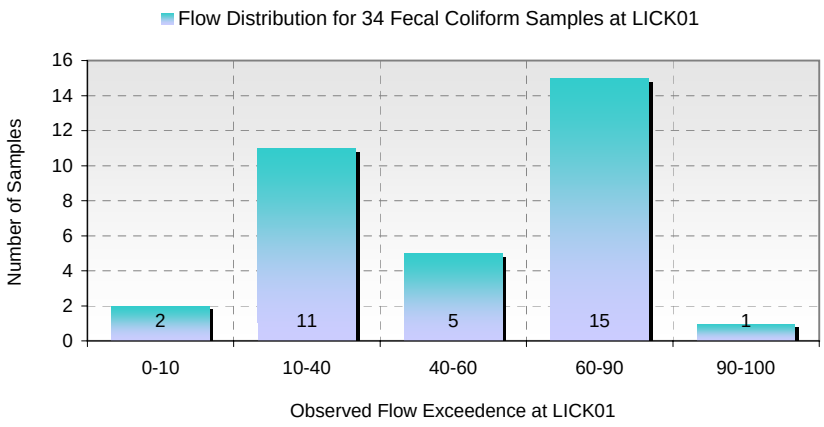


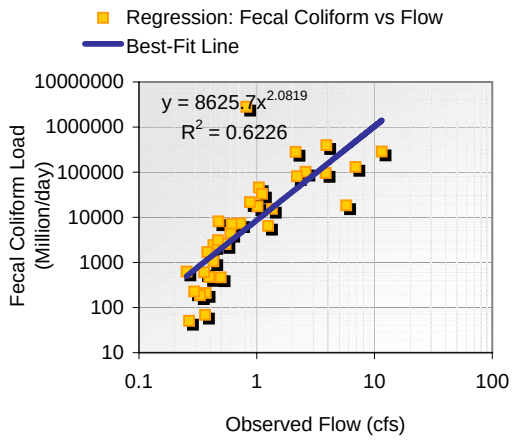
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	37-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	9.76	597	83,104	99.3%
10-40	6	2.81	172	34	0.0%
40-60	5	1.19	73	5	0.0%
60-90	20	0.54	33	2	0.0%
90-100	5	0.25	15	0	0.0%

[7: Fecal Coliform at LICK01 (MPN/100mL)] -vs- [9: Flow at LICK01 (cfs)]

1. Data Assessment and Trend Confirmation





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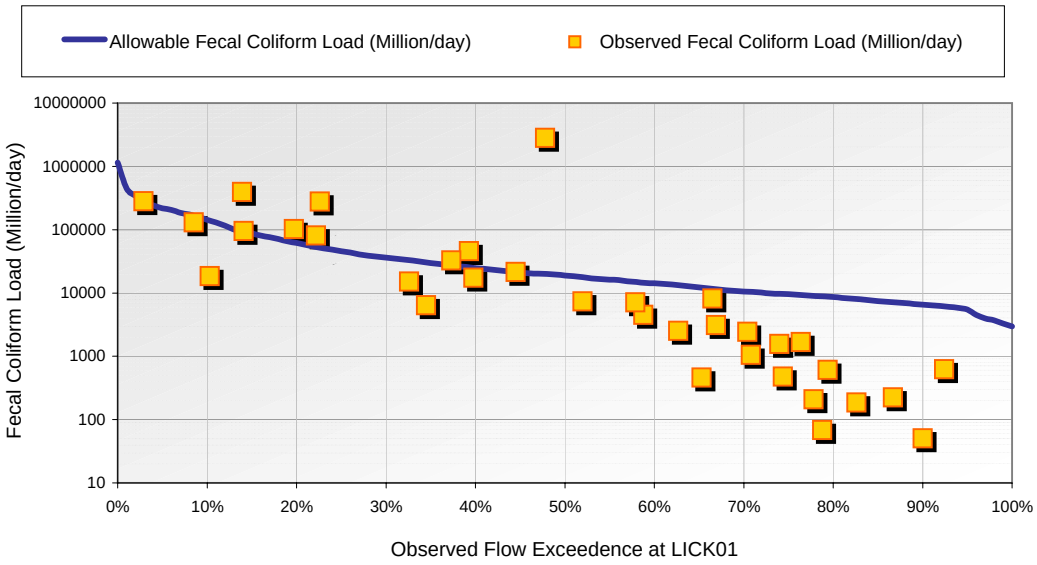
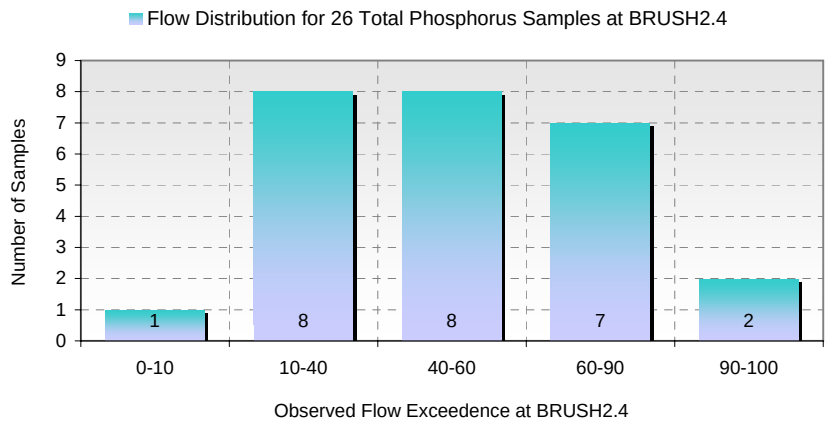


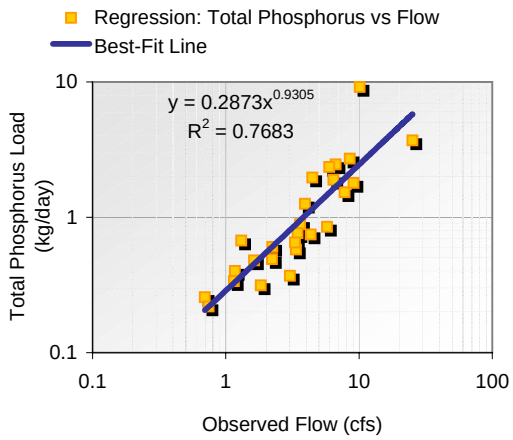
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	34-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (Million/day)	Observed Load (Million/day)	Estimated Reduction (%)
0-10	2	8.92	218,260	206,285	0.0%
10-40	11	1.86	45,556	45,905	0.8%
40-60	5	0.77	18,792	7,304	0.0%
60-90	15	0.39	9,559	606	0.0%
90-100	1	0.22	5,499	622	0.0%

[29: Total Phosphorus at BRUSH2.4 (mg/L)] -vs- [30: Flow at BRUSH2.4 (cfs)]

1. Data Assessment and Trend Confirmation





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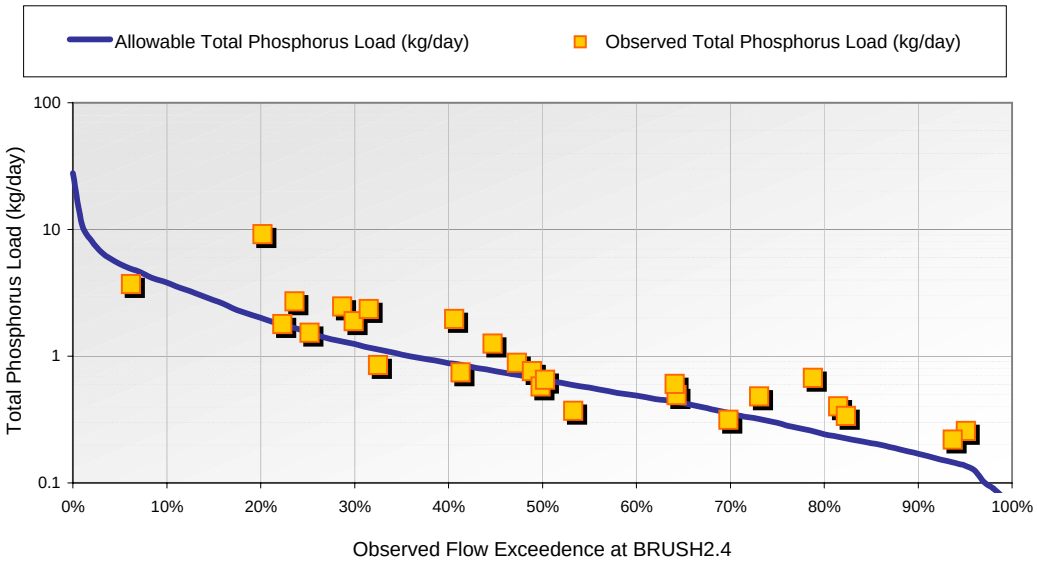
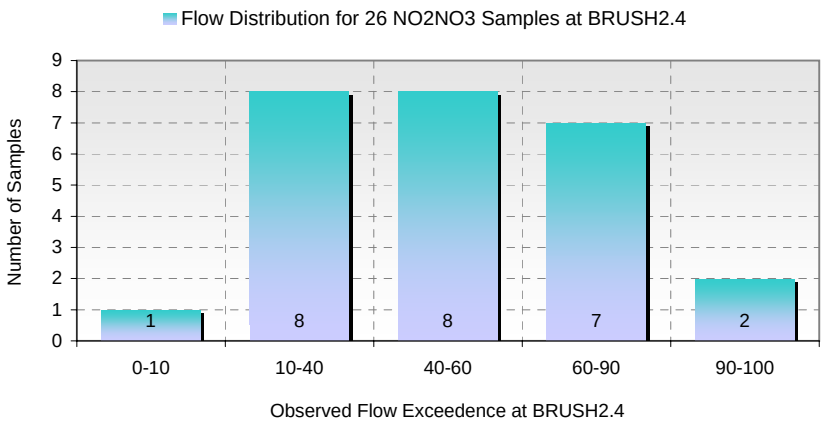


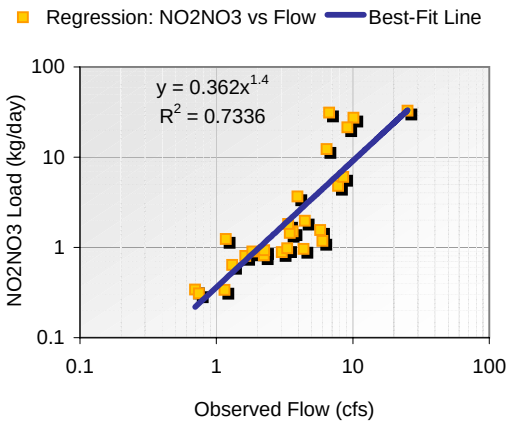
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	26-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	27.33	5	4	0.0%
10-40	8	7.87	2	2	27.3%
40-60	8	3.34	1	1	13.2%
60-90	7	1.52	0	0	37.9%
90-100	2	0.70	0	0	42.4%

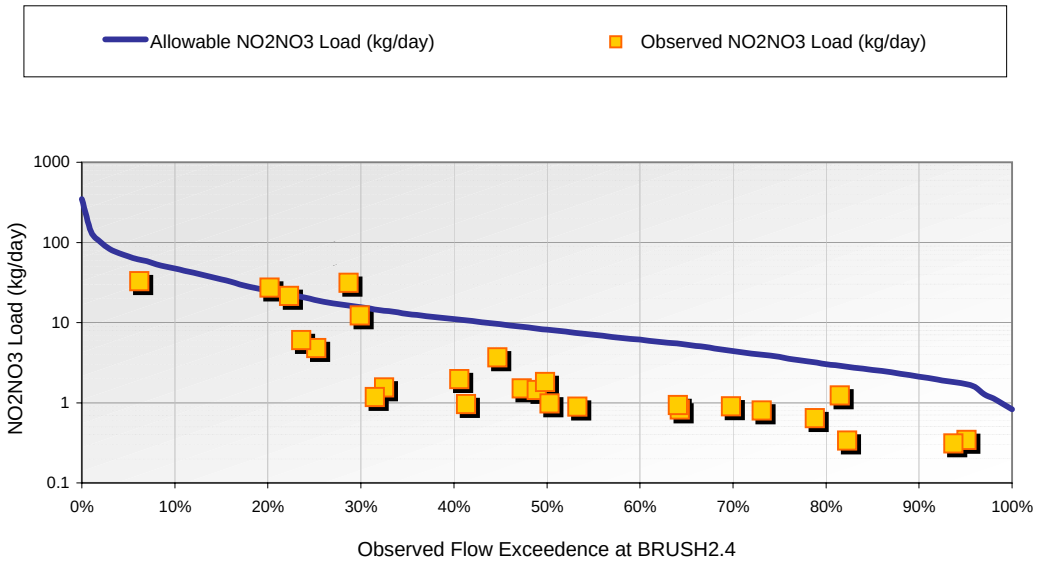
[21: NO2NO3 at BRUSH2.4 (mg/L)] -vs- [30: Flow at BRUSH2.4 (cfs)]

1. Data Assessment and Trend Confirmation





2. Load Exceedence Analysis

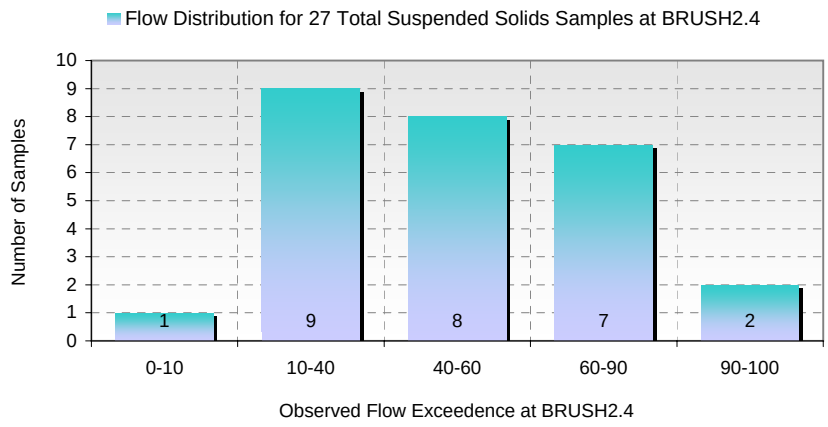


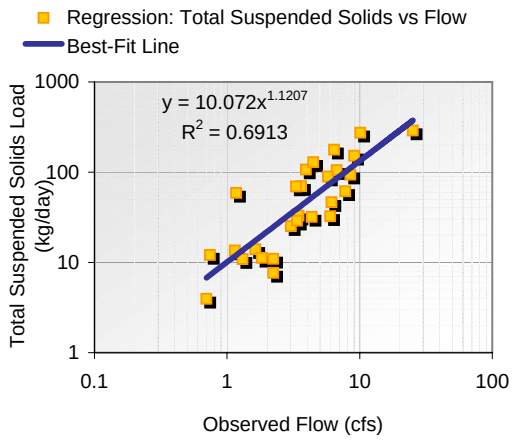
3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	26-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	27.33	67	33	0.0%
10-40	8	7.87	19	9	0.0%
40-60	8	3.34	8	1	0.0%
60-90	7	1.52	4	1	0.0%
90-100	2	0.70	2	0	0.0%

[29: Total Suspended Solids at BRUSH2.4 (mg/L)] -vs- [30: Flow at BRUSH2.4 (cfs)]

1. Data Assessment and Trend Confirmation





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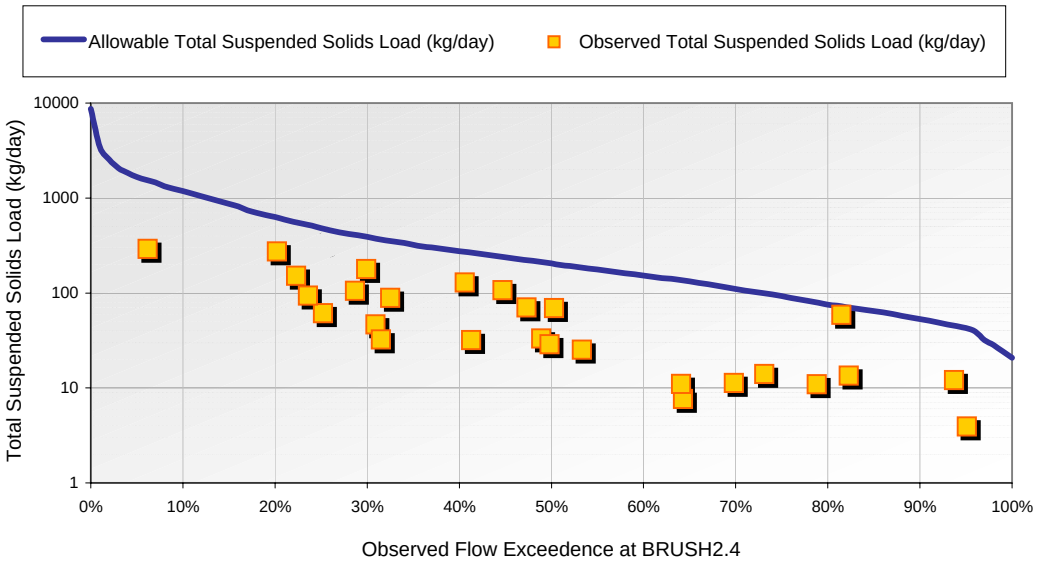

3. Estimated TMDL Loads by Flow Exceedence Range

Flow Exceedence Ranges	27-Sample Distribution	Median Observed Flow (cfs)	Allowable Load (kg/day)	Observed Load (kg/day)	Estimated Reduction (%)
0-10	1	27.33	1,671	290	0.0%
10-40	9	7.87	481	94	0.0%
40-60	8	3.34	204	51	0.0%
60-90	7	1.52	93	11	0.0%
90-100	2	0.70	43	8	0.0%

APPENDIX G: BATHTUB MODELING FOR HARSHA LAKE, OHIO

A BATHTUB model has been set up for Harsha Lake to assess the impacts of reducing total phosphorus and nitrate/nitrite loads to the lake relative to existing conditions. This memo summarizes the assumptions used to estimate the loading to the lake under both scenarios as well as the BATHTUB modeling setup and results.

G.1 Estimating Existing Loads to the Lake

The BATHTUB model requires an estimate of total nitrogen and total phosphorus loading as well as the percent inorganic fraction for both nutrients. Simulated loads to Harsha Lake include watershed loading (point and nonpoint sources) as well as atmospheric deposition.

G.1.1 Watershed Loading

Regression Equations

During development of the preliminary total phosphorus and nitrate/nitrite TMDLs for the East Fork Little Miami River watershed, Tetra Tech developed load duration curves to estimate nutrient loading from various tributaries in the watershed to Harsha Lake. These regression equations are based on water quality samples collected from 1999 to 2004 by Clermont County at seven water quality stations in the watershed (Figure G-1). To develop loading estimates, only the most downstream station on each monitored tributary was used, with the exception of the East Fork mainstem which had significantly less data at the downstream station. Table G-1 summarizes the equations for each station and nutrient species that was monitored.

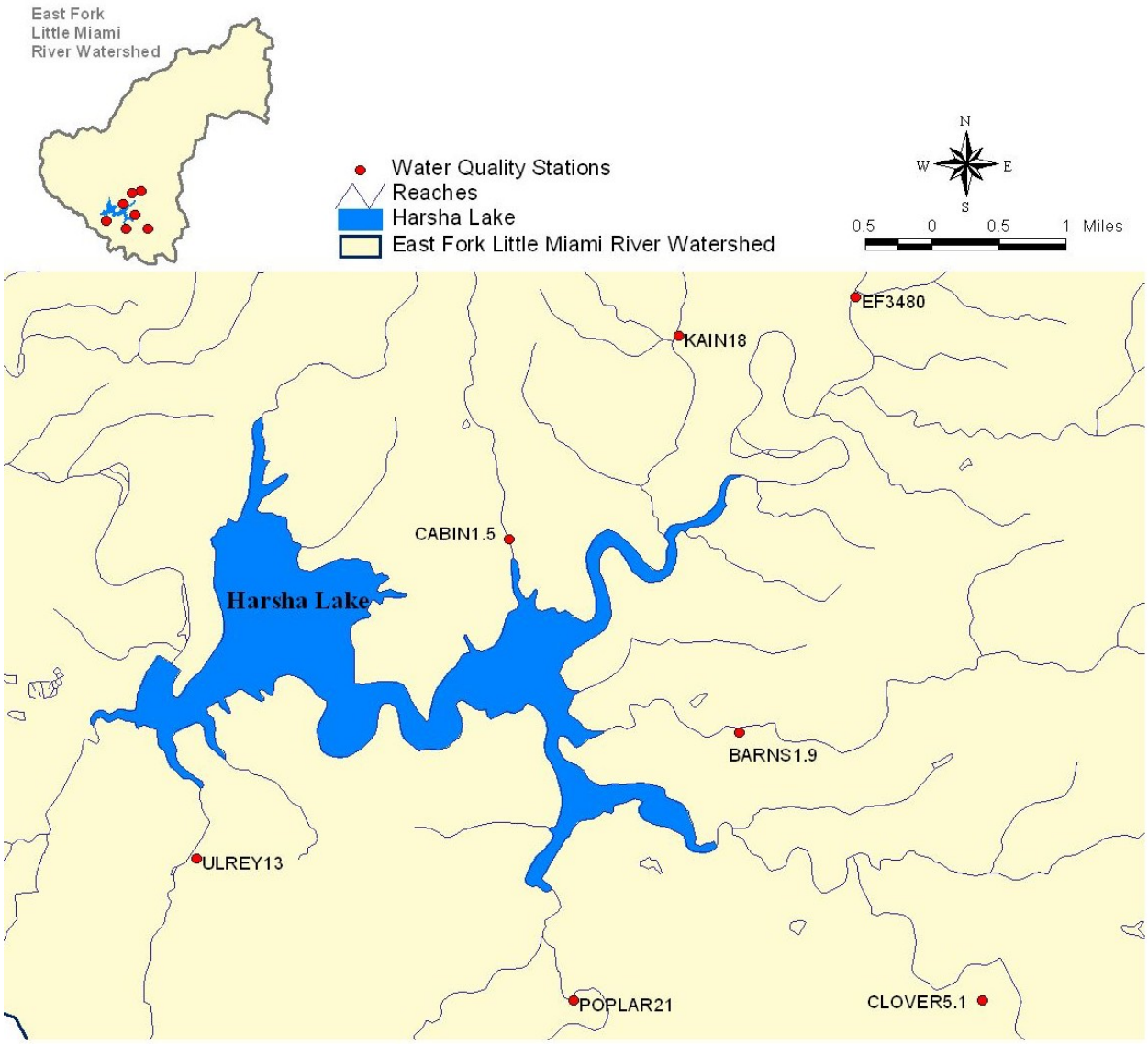

Figure G-1. Downstream Monitoring Stations for the Harsha Lake Tributaries

Table G-1. Regression on Flow (Q cfs) for Estimating Nutrient Loads at Downstream Water Quality Stations on Tributaries to Harsha Lake

Station	Phosphate (kg/d)	Total Phosphorus (kg/d)	Nitrate plus Nitrite (kg/d)	Ammonia (kg/d)	TKN (kg/d)
EF3480	ND	$0.3202Q^{1.1631}$	$0.6738Q^{1.1840}$	$0.1127Q^{1.0547}$	$1.7223Q^{1.1019}$
KAIN18	ND	$0.5032Q^{1.3044}$	$0.7463Q^{1.3428}$	$0.1659Q^{1.1397}$	$2.6793Q^{1.1896}$
CABIN1.5	$0.0839Q^{1.0005}$	$0.0973Q^{1.2630}$	$0.3376Q^{1.2086}$	$0.1290Q^{1.0421}$	$1.2506Q^{1.1851}$
ULREY13	ND	$0.4323Q^{0.8878}$	$3.6576Q^{0.8504}$	$0.1272Q^{1.0283}$	$1.5474Q^{1.0192}$
POPLAR21	ND	$0.2000Q^{1.0996}$	ND	$0.1058Q^{1.1138}$	$1.8130Q^{1.0680}$
CLOVER5.1	ND	$0.1089Q^{1.479}$	ND	$0.1056Q^{1.1201}$	$1.5759Q^{1.1303}$
BARNS1.9	$0.0951Q^{1.1463}$	$0.1946Q^{1.1145}$	$0.2145Q^{1.5923}$	$0.1140Q^{1.1054}$	$1.9804Q^{0.6795}$

ND: No water quality samples were available to develop a regression equation for this parameter.

The regression equations require an estimate of daily average flow at each station. Flows measured at USGS Gage 03245500 on the Little Miami River at Milford, Ohio were scaled down based on the ratio of drainage area at each water quality station. The drainage area of this gage is approximately 1203 square miles. Table G-2 summarizes the drainage area to each water quality station as well as the total drainage area of each tributary and shoreline drainage. It is acknowledged that this gage has an extremely large drainage area relative to the lake tributaries which may result in errors associated with the estimated flows. However, no other nearby gage with a smaller drainage area and recent flow data was identified and the use of the Little Miami River at Milford gage is believed to be an appropriate surrogate for determining relative conditions (e.g., when flows are high on the Little Miami River they are also likely high in the lake tributaries).

Table G-2. Drainage Areas of Water Quality Stations and Tributaries of the Harsha Lake Watershed

Tributary	Downstream Water Quality Station	Drainage Area at Station (mi^2)	Drainage Area at Lake (mi^2)
East Fork Little Miami River	EF3480	237	249
Kain Run	KAIN18	4.10	6.84
Cabin Run	CABIN1.5	1.71	1.72
Ulrey Run	ULREY13	1.90	3.22
Poplar Creek	POPLAR21	17.50	23.36
Cloverlick Creek	CLOVER5.1	21.90	29.95
Barnes Run	BARNS1.9	7.90	8.49
Shoreline Drainage	-	-	20.39

Note: The shoreline drainage area represents all drainages not associated with one of the major tributaries listed in this table. There are currently no stations that monitor water quality from these areas.

Loads passing each water quality station were estimated based on the daily flow and regression equation for each nutrient species. For tributaries with no upstream permitted discharges, total loads to the lake were scaled up by drainage area to account for the downstream portion. For tributaries that receive inputs from permitted discharges of nutrients, (e.g., wastewater treatment plants), scaling up the load would result in an over-estimation of the total load. To account for watershed inputs from drainages downstream of the water quality stations on these tributaries, an average daily loading rate (on an areal basis) was calculated from the four tributaries that do not have a contributing point source. This rate was then multiplied by the downstream drainage area to estimate the additional loading. Average areal loading rates were also used to estimate the loading from the unmonitored shoreline drainages.

Additional Watershed Loads

Two wastewater package plants discharge effluent to unmonitored drainage areas in the Harsha Lake watershed: the Holly Town Mobile Home Park and the Clermont Christian Assembly Camp. Holly Towne Mobile Home Park (HTMHP) discharges to Back Run under NPDES permit OH0047961. This package plant is an extended aeration system with a permitted flow rate of 0.035 MGD. Water quality sampling conducted during the summer of 2006 was used to estimate average effluent concentrations of nitrate plus nitrite, ortho-phosphate, and total phosphorus. Organic nitrogen and ammonia concentrations were each assumed 2 mg-N/L based on information presented in USEPA's Wastewater Technology Fact Sheet for Package Plants (USEPA, 2000).

The Clermont Christian Assembly (CCA) operates Woodland Lakes Camp and Retreat Center. This facility operates a trickling filter wastewater treatment system which discharges to Back Run. No NPDES permit is currently required for this facility. Water quality sampling conducted during the summer of 2006 was used to estimate average effluent concentrations of nitrate plus nitrite, ortho-phosphate, and total phosphorus. Organic nitrogen and ammonia concentrations were assumed 2 mg-N/L, similar to the Holly Towne Mobile Home Park. Flow rates from this facility were estimated based on the number of people typically present at various times during the year. For approximately 11 weeks during the summer, the camp houses approximately 2,500 campers and employees, or 227 people per week. In the spring and fall, the camp is used for weekend retreats serving approximately 5000 people over the course of a year (Jim Hudson, personal communication with Alix Matos March 27, 2007). Assuming 23 retreat weekends, approximately 208 people use the facility each weekend during the spring and fall. Wastewater generation rates were assumed 100 gallons per capita per day.

The flow rates and nutrient concentrations assumed for these two package plants are summarized in Table G-3.

Table G-3. Nutrient Concentrations and Average Daily Flow Rates from Package Plants Discharging to Unmonitored Areas of Harsha Lake

Parameter	HTMHP	CCA
Average Daily Flow (MGD)	0.035	0.023 (summer) 0.021 (spring and fall weekends)
Nitrate plus Nitrite (mg/L)	30	50.4
Organic Nitrogen (mg/L)	2	2
Ammonia Nitrogen (mg/L)	2	2
Ortho-phosphate (mg-P/L)	2.9	2.75
Total Phosphorus (mg/L)	3.1	2.91

G.1.2 Atmospheric Deposition

The BATHTUB model includes rates of direct deposition to the lake surface for total nitrogen and total phosphorus. The EPA Clean Air Status and Trends Network (CASTNET) database reports annual average total nitrogen deposition rates at two sites relatively close to Harsha Lake. Site DCP114 is located in Fayette County, OH and site OXF122 is located in Butler County, OH (Figure G-2). Table G-4 lists the reported total nitrogen deposition rate at each site from 1996 through 2004. The average of the rates reported for these two stations was used to estimate the deposition rate to Harsha Lake. If only one rate was reported, no average was taken. The CASTNET site does not report measurements for 2005 or 2006, so the overall average total nitrogen deposition rate of 8.5 lb/ac/yr was used to represent atmospheric loading for these years.

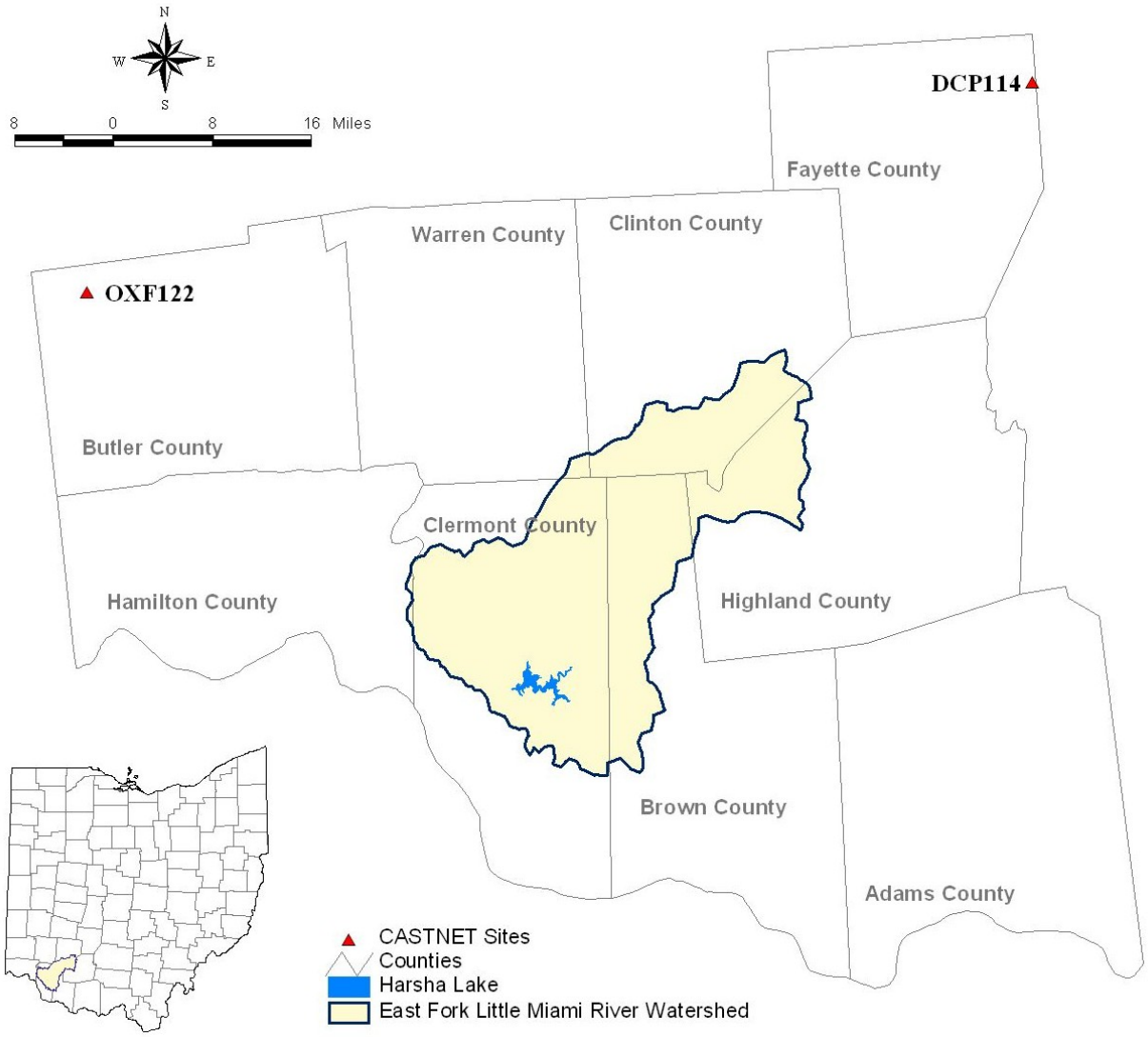

Figure G-2. Location of CASTNET Sites Relative to Harsha Lake

Table G-4. Total Nitrogen Deposition Rates at Two CASTNET Monitoring Stations

Year	TN Deposition at OXF122 (lb/ac/yr)	TN Deposition at DCP114 (lb/ac/yr)	Average TN Deposition (lb/ac/yr)
1996	9.8	NA	9.8
1997	7.9	8.9	8.4
1998	10.1	8.9	9.5
1999	7.0	8.8	7.9
2000	8.4	8.8	8.6
2001	9.2	9.5	9.3
2002	7.6	7.7	7.6
2003	8.7	9.1	8.9
2004	6.2	8.3	7.2
Average	8.3	8.8	8.5

Direct atmospheric deposition of phosphorus to a lake surface is generally considered insignificant compared to watershed loading rates. In studying phosphorus inputs to Lake Michigan, the USGS determined that atmospheric deposition rates in agricultural areas were approximately 0.18 lb/ac/yr (Robertson, 1996). This rate was used for all simulation years (1996 through 2006).

G.2 Estimating Loads to the Lake Under the Load Reduction Scenario

The preliminary load reduction estimates for the Harsha Lake watershed recommend variable total phosphorus and nitrate/nitrite reductions for each major tributary under five flow regimes. Table G-5 summarizes the reductions at the most downstream water quality station on each major tributary. These reductions were applied to the existing loads to estimate the loads to the lake under the load reduction scenario.

Table G-5. Draft Reductions for Total Phosphorus and Nitrate/Nitrite Loads by Flow Regime

Tributary	Monitoring Station	Parameter	High	Moist Conditions	Mid-Range	Dry Conditions	Low
East Fork Little Miami River	EF3480	TP	90	83	61	65	72
		NO23	45	36	0	0	0
Kain Run	KAIN18	TP	90	86	69	64	48
		NO23	45	0	0	0	0
Cabin Run	CABIN1.5	TP	53	0	0	0	0
		NO23	0	0	0	0	0
Ulrey Run	ULREY13	TP	61	59	67	62	64
		NO23	0	56	47	52	47
Poplar Creek	POPLAR21	TP	71	0	50	11	46
		NO23	ND	ND	ND	ND	ND
Cloverlick Creek	CLOVER5.1	TP	73	74	99	0	23
		NO23	ND	ND	ND	ND	ND
Barnes Run	BARNS1.9	TP	70	0	56	0	67
		NO23	ND	ND	ND	ND	ND

ND: No water quality samples were available to develop reductions for this flow regime.

As discussed previously, daily flows at each water quality station were estimated based on USGS flows reported on the Little Miami River at Milford, Ohio. Daily flows were categorized by flow regime and the appropriate reduction applied for total phosphorus and nitrate plus nitrite. Loads from the two package plants and the shoreline drainages were not included in the reductions. For this scenario, loads from these sources remain at existing levels.

Impacts of the reductions on the total phosphorus and total nitrogen loads to Harsha Lake are shown in Table G-6 and Table G-7, respectively. On average, the reductions will result in an 11.8 percent reduction in total nitrogen loading and a 77.5 percent reduction in total phosphorus loading.

Table G-6. Total Nitrogen Loads to Harsha Lake

Year	Existing TN (ton/yr)	Reduced TN (ton/yr)	Percent Reduction
1996	1,537.4	1,331.5	13.4
1997	761.5	674.6	11.4
1998	880.4	774.3	12.1
1999	334.6	304.4	9.0
2000	636.8	567.7	10.9
2001	771.9	684.8	11.3
2002	1,024.3	901.0	12.0
2003	1,078.1	952.0	11.7
2004	939.5	830.0	11.7
2005	914.2	802.3	12.2
2006	839.2	748.2	10.8
Average	**883.4**	**779.2**	**11.8**

Table G-7. Total Phosphorus Loads to Harsha Lake

Year	Existing TP (ton/yr)	Reduced TP (ton/yr)	Percent Reduction
1996	264.3	53.6	79.7
1997	126.7	29.3	76.9
1998	147.7	32.6	77.9
1999	52.7	13.9	73.6
2000	104.7	25.1	76.0
2001	127.6	29.4	76.9
2002	170.8	37.6	78.0
2003	177.9	40.2	77.4
2004	156.5	35.9	77.0
2005	154.5	34.0	78.0
2006	137.2	32.8	76.1
Average	**147.3**	**33.1**	**77.5**

G.3 BATHTUB Modeling for Harsha Lake

G.3.1 Model Setup

BATHTUB is a steady state model that predicts eutrophication response based on empirical formulas developed for nutrient balance calculations and algal response. The model requires nutrient loading inputs from the upstream watershed and atmospheric deposition, morphometric data for the lake, and estimates of mixing depth and nonalgal turbidity. For Harsha Lake, samples of nutrients, chlorophyll *a*, and Secchi depth are only available during 2005 though limited sampling of chlorophyll a and Secchi depth were conducted in 2006. No measurements of mixing depth or nonalgal turbidity are available. The BATHTUB User's Manual (Walker, 1987) lists equations for estimating these parameters.

Lake morphometry information was acquired from the USACE and USGS. The homepage for William H. Harsha Lake maintained by USACE reports a normal pool surface area of 2,160 ac. The storage volume of the normal pool is 90,400 ac-ft (USGS, 2000). The average depth of the lake (volume divided by surface area) is approximately 42 ft.

The BATHTUB User's Manual (Walker, 1987) provides an equation for estimating the mixed depth of a lake when direct measurements are not available. For Harsha Lake, the caculated mixed depth is 24 ft. Nonalgal turbidity can be estimated from measurements of Secchi depth and chlorophyll *a*. The BATHTUB User's Manual suggests a minimum value of 0.08/m. Assuming a typical Secchi depth of 40 inches and typical chlorophyll *a* concentration of 30 µg/L, the calculated nonalgal turbidity is 0.25/m.

BATHTUB allows the user to choose the period of time over which its calculations will be carried out. This averaging period is typically a summer season or complete year. In the case of Harsha Lake, an annual simulation is most appropriate based on the mass residence time and nutrient turnover calculations described in the User's Manual (Walker, 1987).

G.3.2 Simulation of Inlake Nitrogen, Phosphorus, and Chlorophyll *a* Concentrations

The BATHTUB model allows the user to choose among several sedimentation functions for nitrogen and phosphorus. For Harsha Lake, the model defaults of second order available phosphorus and nitrogen were chosen to simulate nutrient concentrations in the lake.

Phosphorus

Phosphorus data have been collected in Harsha Lake since 1978. Tetra Tech obtained total phosphorus data from FTN from 1978 through 1997. The units were not specified in the data file, though based on the parameter code description, the data should have been entered as mg-P/L. From 1978 through 1991, the values ranged from 10 to 720 (though one value was reported as 0.095). From 1993 through 1997, the values ranged from 0.01 to 17.3. The USACE collected total phosphorus data in the lake in 2005 with values ranging from < 0.01 to 1.09 mg/L. Because the pre-1997 data appear to be out of range and total nitrogen data are only available for 2005, only the 2005 total phosphorus data were used for model setup and calibration.

The USACE collected water quality data at two stations in the main body of Harsha Lake. Station EFR20001 is located approximately 0.5 mi upstream of the dam; station EFR20024 is located near the center of lake at river mile 24 (Figure G-3).

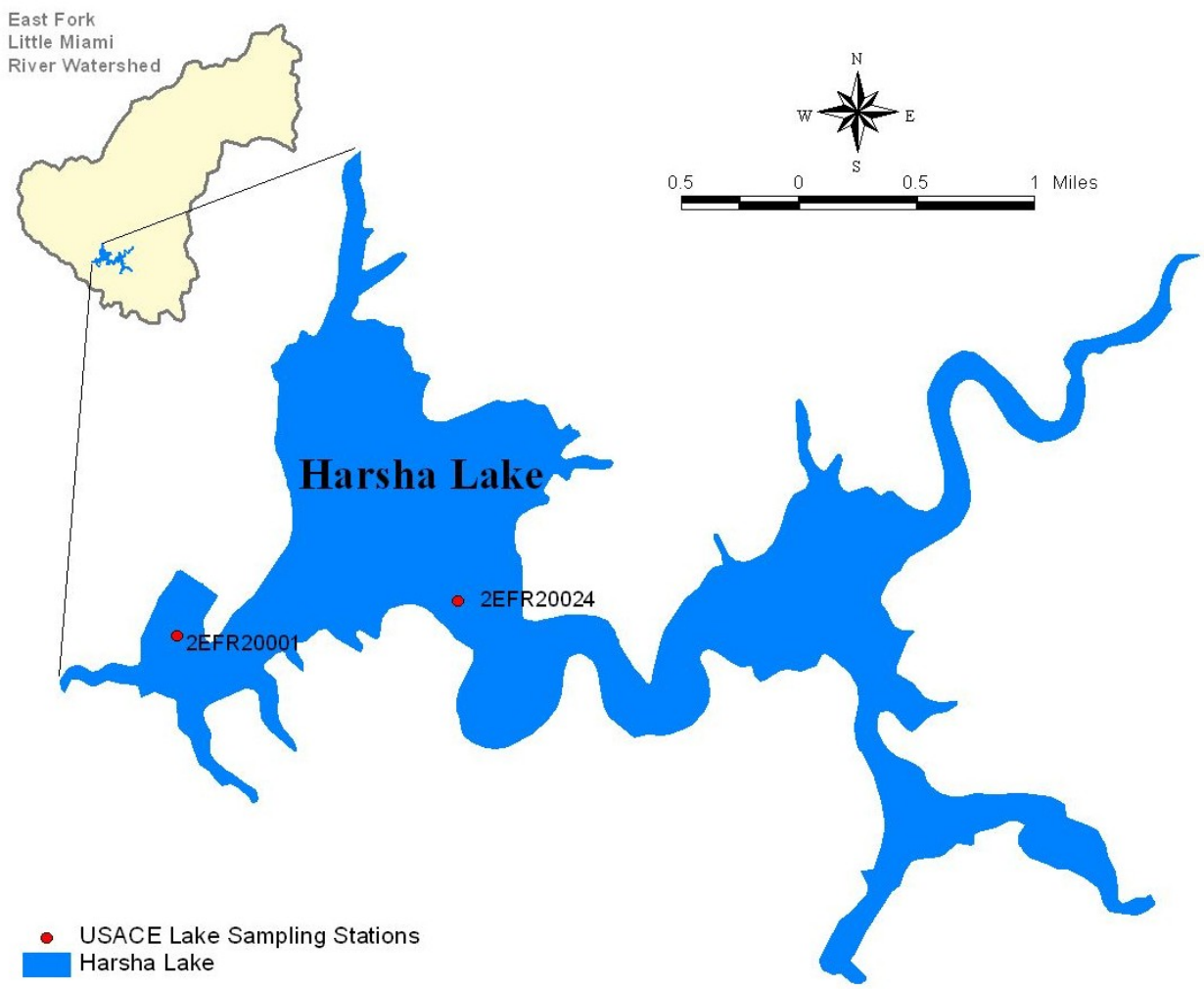

Figure G-3. USACE Lake Sampling Locations

Water quality samples were collected over the entire depth of the lake at these two stations, as shown in Figure G-4. At depths greater than approximately 35 ft, the concentrations show a significant increase with depth, likely due to phosphorus settling and resuspension near the lake bottom.

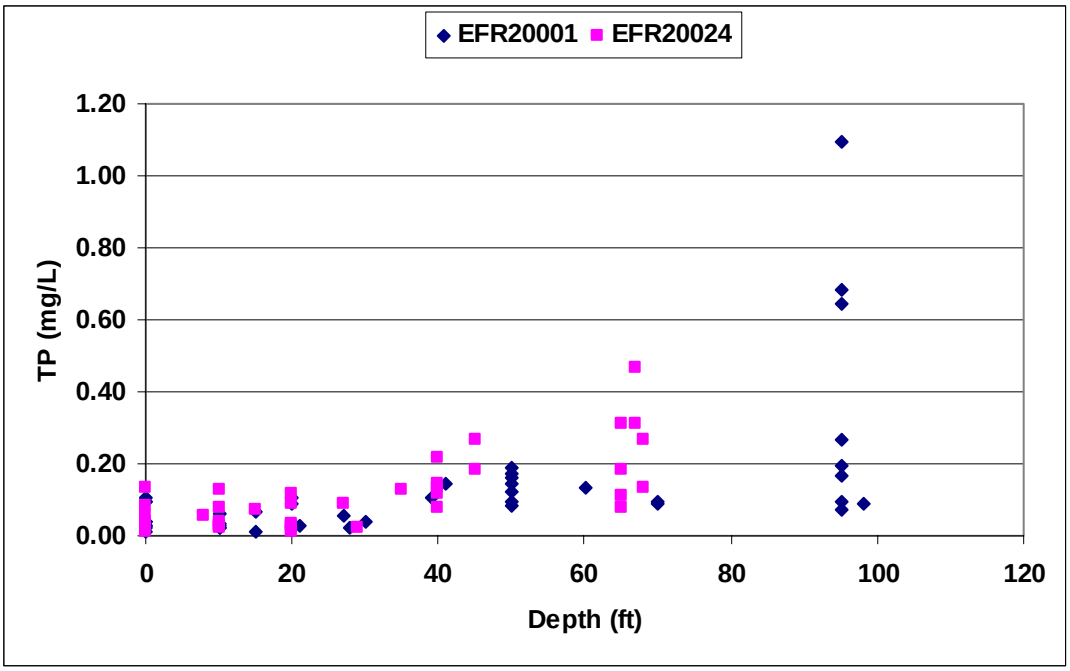

Figure G-4. Phosphorus Concentrations Observed in 2005 in Harsha Lake

The BATHTUB model allows the user to calibrate the phosphorus sedimentation rate by applying a factor ranging from 0.33 to 3. For Harsha Lake, a calibration factor of 1 (model default) resulted in average annual total phosphorus concentrations ranging from 0.056 to 0.098 mg/L. Because these values are near the middle of those observed in 2005 over the average depth of the lake (the modeling depth used by BATHTUB), and because only one year of data were available for calibration, the factor was left at 1. Figure G-5 shows the total phosphorus concentrations over the average depth of the lake.

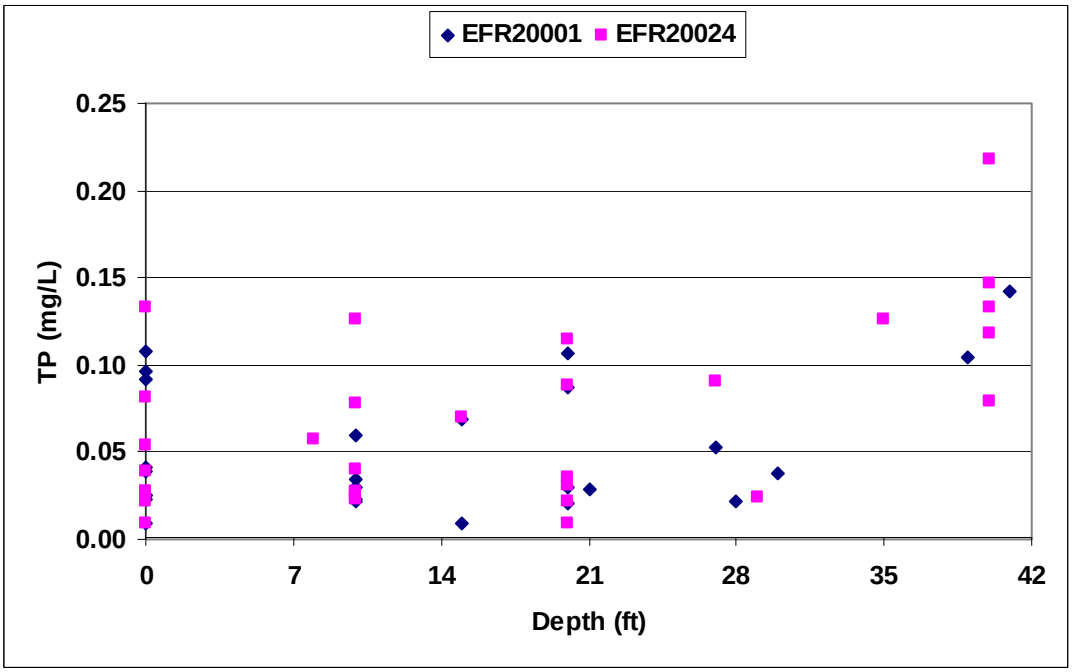

Figure G-5. Phosphorus Concentrations Observed Over the Average Depth of Harsha Lake

Nitrogen

The USACE collected total Kjeldahl nitrogen and nitrate plus nitrite samples in 2005 at the two lake stations. These values were summed to estimate total nitrogen concentrations for model calibration. Figure G-6 shows the total nitrogen concentrations observed in the lake over the entire depth during the 2005. As with phosphorus, at depths greater than 35 ft the nitrogen concentrations show a consistent increase. Calibration of the nitrogen sedimentation factor was not required, as average simulated values were near the middle of range observed over the simulated depth. Simulated concentrations ranged from 0.7 to 1.1 mg/L.

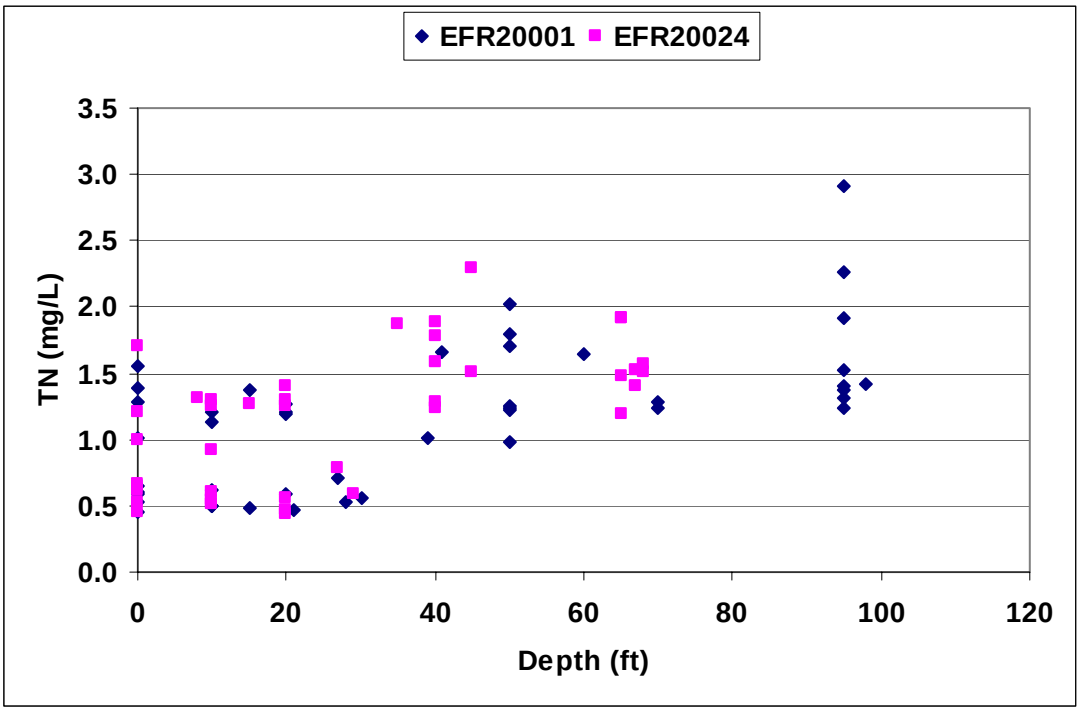

Figure G-6. Nitrogen Concentrations Observed in 2005 in Harsha Lake

Secchi Depth

Secchi depth data are available at the two lake stations in 2005 and 2006 (Figure G-7). From March through August 2005, the average Secchi depth in was 31 inches. From September 2005 through September 2006, the average Secchi depth was 62 inches.

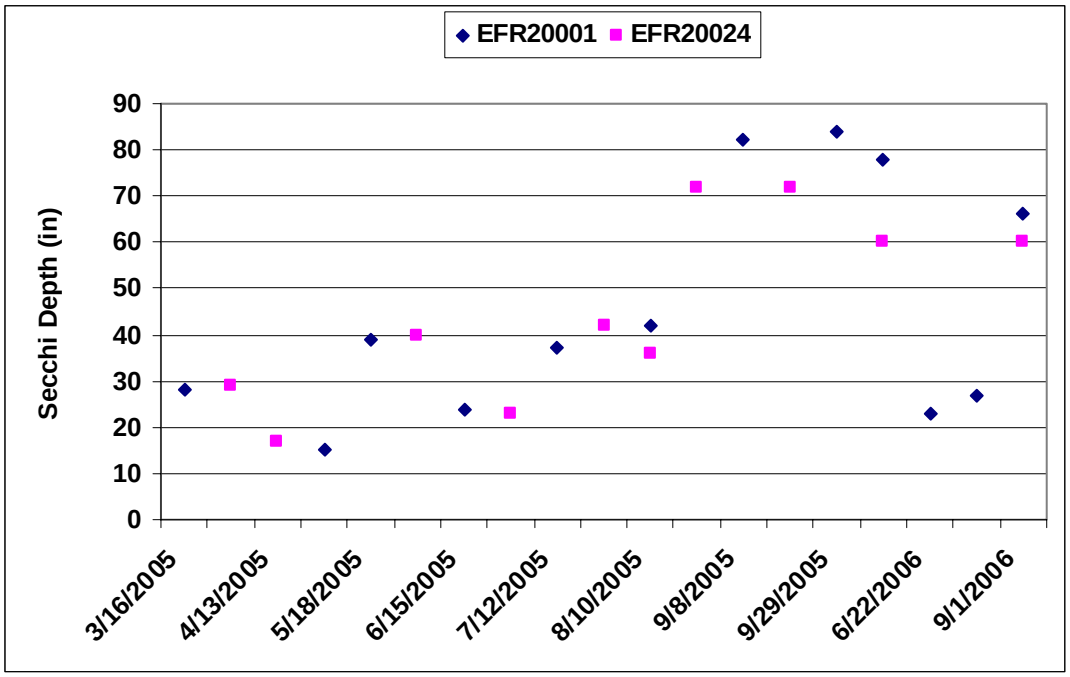

Figure G-7. Secchi Depth Observed in 2005 and 2006 in Harsha Lake

Chlorophyll *a*

The USACE collected chlorophyll *a* data in five foot increments over the first 40 ft of depth. Figure G-8 shows the chlorophyll *a* concentrations observed in 2005 (plus 3 days during the summer of 2006) at the two lake stations. Over the first ten feet, concentrations range from 1.3 to 45 µg/L based on samples collected from March through November 2005 and June through September 2006. Concentrations decrease significantly at depths greater than 10 ft.

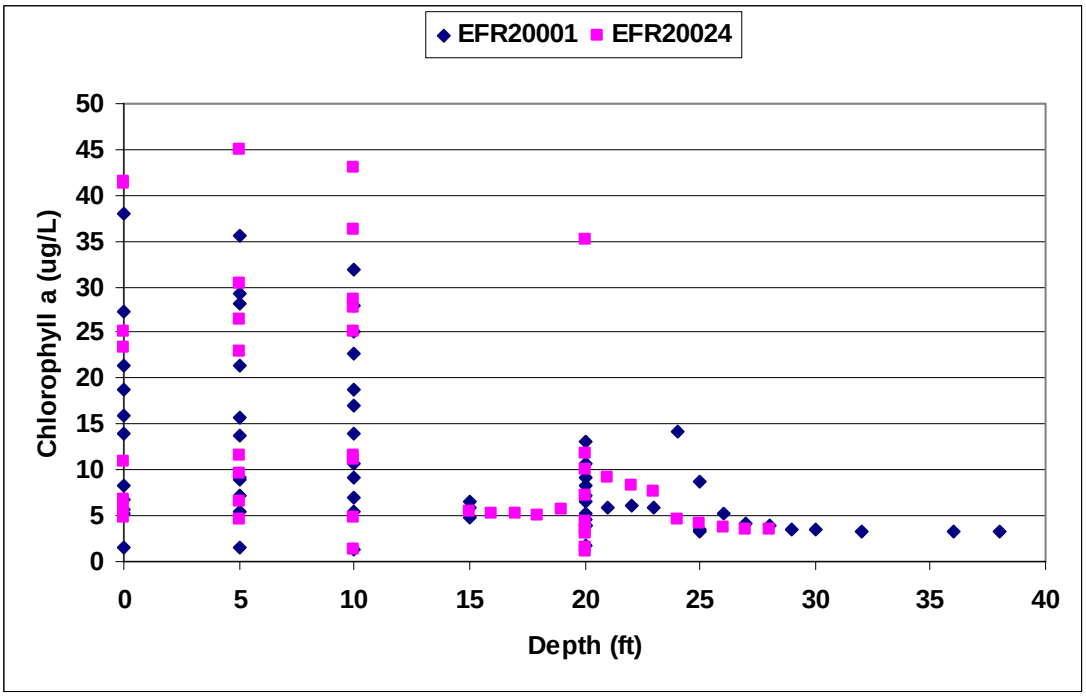

Figure G-8. Chlorophyll *a* Concentrations Observed in 2005 and 2006 in Harsha Lake

Figure G-9 shows the average value collected on each sampling day from the surface to 10 ft. The summer of 2005 had much higher chlorophyll *a* concentrations with an average observed value of 29 µg/L. The average observed during the summer of 2006 was 9 µg/L. Simulated hydrologic and nutrient inputs were fairly similar in 2005 and 2006. Based on the limited data set, it is difficult to know which of these two summers is most typical of algal response in Harsha Lake.

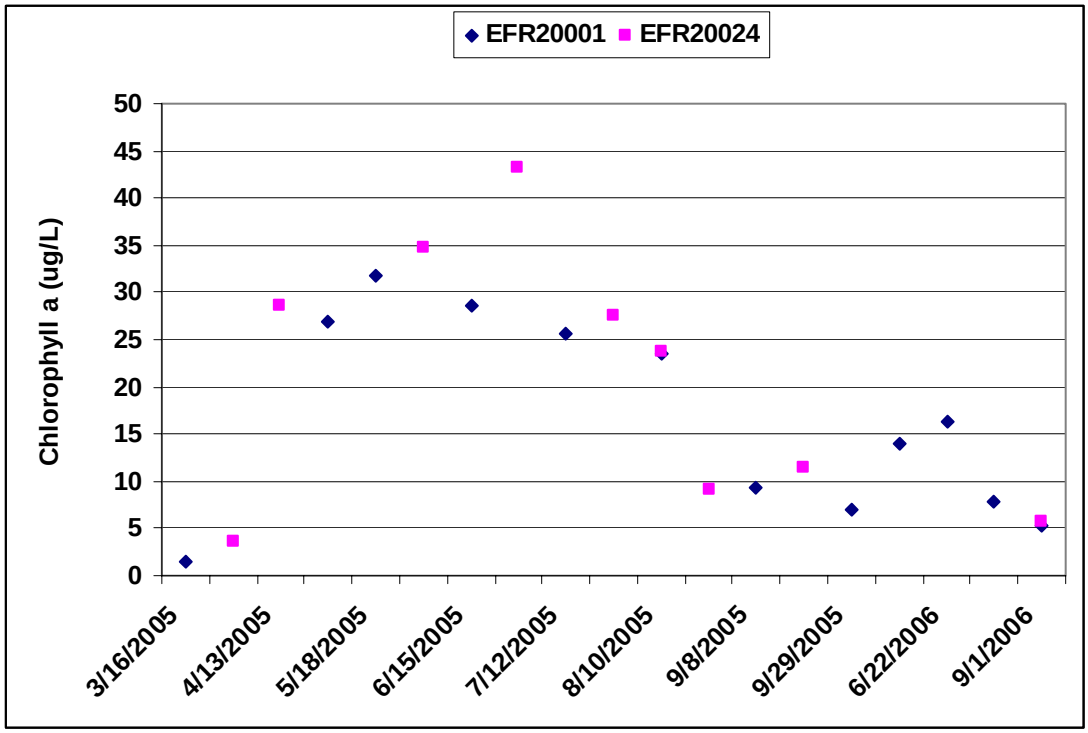

Figure G-9. Average Chlorophyll *a* Concentrations Over the First Ten Feet of Depth

The BATHTUB User's Manual (Walker, 1987) describes several variables that assess the sensitivity of a lake to nitrogen, phosphorus, light, and flushing rates. Based on comparison of nutrient ratios, inorganic fractions, and measured values of chlorophyll *a*, Secchi depth, and total phosphorus concentrations, the lake is likely more sensitive to phosphorus compared to nitrogen, light availability, or flushing rate. Therefore, the linear phosphorus chlorophyll *a* model was chosen to simulate algal response in Harsha Lake. Average annual simulated concentrations from 1996 through 2006 range from 16 to 28 µg/L when the calibration factor is left at one (model default). Years 2005 and 2006 had average simulated concentrations of 23 and 21 µg/L, respectively. These results are near the average observed chlorophyll *a* concentration for both summers combined (20 µg/L), but are not reflective of the year to year variability seen in the data. Three seasonal models were also tested, but no improvement in year to year variability was seen.

G.3.3 Model Results for Existing and Load Reduction Scenarios

The BATHTUB model was set up from 1996 to 2006 to simulate eutrophication under existing loading conditions and under a reduced loading scenario. Table G-8 through Table G-11 compare the nutrient, chlorophyll *a*, and Secchi depth results for both scenarios. The load reductions result in an average decrease in total nitrogen concentrations of 12 percent, an average decrease in total phosphorus concentration of 59 percent, an average decrease in chlorophyll *a* concentration of 59 percent, and an average increase in the Secchi depth of 67 percent.

Table G-8. Simulated Total Nitrogen Concentrations in Harsha Lake

Year	Existing TN (mg/L)	Reduced TN (mg/L)	Percent Reduction
1996	1.12	0.96	14
1997	0.90	0.79	12
1998	0.94	0.83	12
1999	0.70	0.64	9
2000	0.85	0.76	11
2001	0.90	0.79	11
2002	0.98	0.85	13
2003	0.98	0.86	12
2004	0.95	0.83	12
2005	0.95	0.83	13
2006	0.91	0.81	11
Average	**0.92**	**0.81**	**12**

Table G-9. Simulated Total Phosphorus Concentrations in Harsha Lake

Year	Existing TP (mg/L)	Reduced TP (mg/L)	Percent Reduction
1996	0.098	0.036	63
1997	0.075	0.032	58
1998	0.079	0.032	60
1999	0.056	0.026	53
2000	0.070	0.030	57
2001	0.075	0.031	58
2002	0.083	0.033	60
2003	0.084	0.034	60
2004	0.081	0.033	59
2005	0.081	0.032	60
2006	0.076	0.032	58
Average	**0.078**	**0.032**	**59**

Table G-10. Simulated Chlorophyll *a* Concentrations in Harsha Lake

Year	Existing Chlorophyll *a* (ug/L)	Reduced Chlorophyll *a* (ug/L)	Percent Reduction
1996	27.6	10.2	63
1997	21.1	8.8	58
1998	22.2	9.0	60
1999	15.8	7.4	53
2000	19.7	8.5	57
2001	21.0	8.8	58
2002	23.3	9.3	60
2003	23.4	9.4	60
2004	22.6	9.3	59
2005	22.5	9.1	60
2006	21.3	9.0	58
Average	**21.9**	**9.0**	**59**

Table G-11. Simulated Secchi Depth in Harsha Lake

Year	Existing Secchi Depth (in)	Load Reduction Scenario Secchi Depth (in)	Percent Increase
1996	42	78	86
1997	51	84	65
1998	49	83	70
1999	61	90	48
2000	53	85	61
2001	51	84	65
2002	47	82	73
2003	47	81	72
2004	48	82	69
2005	48	83	71
2006	50	83	65
Average	**50**	**83**	**67**

G.4 Conclusions

A BATHTUB model was developed for Harsha Lake to simulate algal response from 1996 through 2006. Calibration factors for phosphorus, nitrogen, and chlorophyll *a* were left at default values because of the relative lack of data to better calibrate the model. Though the model does not currently predict the year to year variability of chlorophyll *a* observed in the summers of 2005 and 2006, it does reflect the average eutrophication response fairly well. Continuous monitoring of the lake over the next couple of summers would be necessary to determine whether typical summer concentrations were best represented by the 2005 data or the 2006 data. Once more data is available, the model could be better calibrated to represent existing conditions in the lake.

For now, the model should be used to assess general trends in water quality rather than to predict exact inlake concentrations of nutrients or chlorophyll *a*. Based on the current model, the simulated load reductions of total phosphorus and nitrate/nitrite may reduce the chlorophyll *a* concentrations by approximately 60 percent and increase the Secchi depth by 67 percent.

G.5 References

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USEPA. 2000. Wastewater Technology Fact Sheet Package Plants. Office of Water, U.S. Environmental Protection Agency, Washington, DC. EPA 832-F-00-016, September 2000.

Walker, W. W., Jr. 1987. Empirical Methods for Predicting Eutrophication in Impoundments: Report 4—Phase III: Applications Manual. Technical Report E-81-9. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS.

APPENDIX H: BMPS

H.1 Agricultural BMPs

H.1.1 Nutrient Management Planning

Over application of chemical or manure-based fertilizer is a significant source of nutrient loading from crop lands. The primary BMP for reducing loading from excessive fertilization is development of a nutrient management plan to ensure that fertilizer or manure application does not exceed crop needs. This level of planning requires calculation of field scale nutrient balances. Direct measurements of soil nutrient concentrations provide a starting point for the balance. Inputs from decaying crops, irrigation water, atmospheric deposition, and wildlife are considered along with losses due to plant uptake and harvesting. The resulting nutrient content is then compared to local guidelines to determine if fertilizer should be added to support crop growth. In some cases, the nutrient content of the soil is sufficient to maintain crop growth for several years and no fertilizer should be added until stores are depleted. Local agricultural extension offices will often test the nutrient content of the soil, plant material, manure, and irrigation water for use in the nutrient balance. The resulting plan should address fertilizer application rates, methods, and timing.

The effectiveness of nutrient management plans in reducing loading from agricultural land will be site specific. Average reductions of nitrogen and phosphorus have been reported at 15 and 35 percent, respectively (USEPA, 2003). No direct impact on sediment, fecal coliform, or hydrologic function should be expected from application of chemical fertilizer. Use of manure, however, improves the soil profile and has been shown to reduce soil erosion and runoff (USEPA, 2002a).

Nutrient management plans typically cost $5 to $15/ac and should be performed at least once every five years or whenever major changes in farm operation or manure composition occur (USEPA, 2002a). In many cases, nutrient management plans result in reduced fertilizer costs and may lead to a net savings. Actual savings (or costs) depend on the reduction (or increase) in fertilizer application rates required by the nutrient management plan as well as other farm management recommendations.

H.1.2 Manure Handling, Storage, and Treatment

To prevent contamination of surface and ground water by pathogens, nutrients, and sediment, manure should be properly collected, stored, and disposed. The short-term manure storage facility should be located at least 100 feet from wells or surface water and should accommodate six months of manure production. For smaller farms, a temporary storage facility can consist of a high and dry location with a plastic cover. For larger farms, a more permanent storage facility with an impermeable floor is needed to protect water quality; protecting the pile from contact with rainwater will prevent delivery of nutrients and pathogens to streams (Norris, 2006).

Livestock operations either consist of confinement or pasture systems. If a confined operation is greater than 1000 animal units or is determined to threaten water quality, the operation requires a federal Concentrated Animal Feeding Operation (CAFO) permit. CAFOs are required to develop a nutrient management plan (NMP) as part of the CAFO permitting process (USEPA, 2003). The CAFO NMP consists of manure management and disposal strategies that minimize the release of excess nutrients into surface and ground water. The CAFO NMPs are based on NRCS standards and technical expertise.

H.1.3 Manure Composting

Composting is the biological decomposition and stabilization of organic material. The process produces heat that, in turn, produces a final product that is stable, free of pathogens and viable plant seeds, and can be beneficially applied to the land. Like manure storage areas, composting facilities should be located on dry, flat, elevated land at least 100 feet from streams. The landowner should coordinate with a USDA agricultural extension agent to determine the appropriate design for a composting facility based on the amount of manure generated. Extension agents can also help landowners achieve the ideal nutrient ratios, oxygen levels, and moisture conditions for composting on their site. Composting can be accomplished by simply constructing a heap of the material or by constructing one or more bins to hold the material. Heaps should be 3 feet wide and 5 feet high with the length depending on the amount of manure being composted. Compost does not have to be turned, but turning will facilitate the composting process (University of Missouri, 1993; PSU, 2005). Machinery required for composting includes a tractor, manure spreader, and front-end loader (Davis and Swinker, 2004).

Composting results in a 30 to 70 percent loss of total nitrogen due to ammonia volatization (USEPA, 2002a). Heat produced during the process has been found to reduce fecal coliform concentrations by 99 percent (Larney et. al., 2003). The phosphorus content of manure is not impacted by composting.

The cost of composting manure for small animal operations should be minimal. Larger operations requiring additional equipment and storage-areas may require upfront capital.

H.1.4 Feeding Strategies

Use of dietary supplements, genetically enhanced feed, and specialized diets has been shown to reduce the nitrogen and phosphorus content of manure either by reducing the quantity of nutrients consumed or by increasing the digestibility of the nutrients. Manure with a lower nutrient content can be applied at higher rates to crop land, thus reducing transportation and disposal costs for excess manure.

Manure typically has high phosphorus content relative to plant requirements compared to its nitrogen content. Nitrogen losses due to ammonia volatilization begin immediately following waste excretion and continue throughout the stabilization process, whereas phosphorus remains conserved. In addition, most livestock animals are not capable of efficiently digesting phosphorus, so a large percentage passes through the animal undigested. Compounding the problem is over-supplementation of phosphorus additives relative to nutritional guidelines, particularly for dairy cattle (USEPA, 2002a).

Most feeding strategies work to reduce the phosphorus content of manure such that the end product has a more balanced ratio of nitrogen and phosphorus. The phosphorus content of swine manure may be reduced by approximately 40 percent if the animals are fed low-phytate corn or maize-soybean diets or given a phytase enzyme to increase assimilation by the animal. The phosphorus content of poultry manure can be reduced by 30 to 50 percent by supplementing feed with the phytase enzyme. Reducing dietary phosphorus inputs of dairy cattle to recommended levels may reduce the phosphorus content of manure by 27 percent and save approximately $20/cow/yr on feeding costs (USEPA, 2002a).

The nitrogen content of manure can also be reduced with feeding strategies, though losses due to volatilization and a desire for a more balanced manure in terms of nutrient ratios usually negate the need to reduce the nitrogen content (USEPA, 2002a). A one percent reduction in the nitrogen content of swine feed has reduced the manure nitrogen content by 10 percent in two separate studies, and the maize-soybean diet has been shown to reduce the nitrogen content by 25 to 32 percent, depending on animal age. Reducing the particle size of swine feed from 1,100 microns to approximately 700 microns reduces manure nitrogen content by 24 percent, but increases the cost of feed production and may result in

increased stomach ulcers in some animals. No data regarding nitrogen reductions from poultry and cattle manure were reported.

H.1.5 Cattle Exclusion from Streams

Cattle manure is a substantial source of nutrient and fecal coliform loading to streams. This is particularly problematic when cattle feeding structures are located adjacent to riparian areas. Direct deposition of feces into streams may be a primary mechanism of nutrient and fecal coliform loading during baseflow periods. During storm events, overbank and overland flow may entrain manure accumulated in riparian areas resulting in pulsed loads of nutrients, TOC, BOD, and fecal coliform bacteria into streams. In addition, cattle with unrestrained stream access typically cause severe streambank erosion. The impacts of cattle on stream ecosystems are shown in Figure H-1 and Figure H-2.

Figure H-1. Typical stream bank erosion in pastures with cattle access to stream.

Figure H-2. Cattle-induced streambank mass wasting and deposition of manure into stream.

Fencing cattle from streams and riparian areas using vegetative or fencing materials will reduce streambank trampling and direct deposition of fecal material in the streams. By increasing the distance from the deposition site to the water body, total nitrogen loads have been reduced by 15 percent and total phosphorus loads by 15 to 49 percent (USEPA, 2003). In addition, a reduction of 29 to 46 percent of fecal coliform concentrations is reported (USEPA, 2003).

Allowing limited or no animal access to streams will provide the greatest water quality protection. On properties where cattle need to cross streams to have access to pasture, stream crossings should be built so that cattle can travel across streams without degrading streambanks and contaminating streams with manure. Figure H-3 shows an example of a reinforced cattle access point to minimize time spent in the stream and mass wasting of streambanks.

Figure H-3. Restricted cattle access point with reinforced banks.

Fencing materials vary by installation cost, useful life, and annual maintenance cost as presented in Table H-1. The Iowa State University Cooperative Extension Service published fencing costs in 1999 on the internet. An average annual inflation rate of 3 percent was used to determine year 2006 costs.

Table H-1. Installation and Maintenance Costs of Fencing Material

Material	Construction Costs (per ft)	Annual Maintenance Costs (per ft)	Useful Life (yr)
Woven Wire	$1.32	$0.11	20
Barbed Wire	$1.02	$0.08	20
High tensile (non-electric) 8-strand	$0.93	$0.05	25
High tensile (electric) 5-strand	$0.70	$0.04	25

H.1.6 Alternative Drinking Sources for Cattle

A primary management tool for pastures is supplying cattle watering systems away from streams and riparian areas. Livestock producers who currently rely on streams to provide water for their animals must develop alternative watering systems, or controlled access systems, before they can exclude cattle from streams and riparian areas. One method of providing an alternative water source is the development of off-stream watering using wells with tank or trough systems. These systems are often highly successful, as cattle often prefer spring or well water to surface water sources.

Landowners should work with an agricultural extension agent to properly design and locate watering facilities. One option is to collect rainwater from building roofs (with gutters feeding into cisterns) and use this water for the animal watering system to reduce runoff and conserve water use (Tetra Tech, 2006a). Whether or not animals are allowed access to streams, the landowner should provide an alternative shady location and water source so that animals are encouraged to stay away from streams. Alternative watering locations used concurrently with cattle exclusion practices have shown reductions in pollutant loading of 15 percent for total nitrogen, 15 to 49 percent for total phosphorus, and 29 to 46 percent for fecal coliform. Some researchers have studied the impacts of providing alternative watering sites without structural exclusions and found that cattle spend 90 percent less time in the stream when alternative drinking water is furnished (USEPA, 2003).

Costs associated with providing alternative drinking water for cattle include pipeline installation costs, pump and water storage device costs, energy cost to run the pump, the vertical and total distances from the water source to the end location, as well as the quantity of fresh water required for the operation. Reported pipeline costs range from $0.30 per ft to $2.50 per ft; water pumps may cost $200 to $400 each; storage tanks or troughs range from $200 to $1000; annual operating costs range from $10 to $25 per year for electricity (USEPA, 2003; Marsh, 2001).

H.1.7 Grazing Land Protection

While erosion rates from pasture areas are generally lower than those from row-crop areas, a poorly managed pasture can approach or exceed a well-managed row-crop area in terms of erosion rates. Grazing land protection is intended to maximize ground cover on pasture, reduce soil compaction resulting from overuse, reduce runoff concentrations of nutrients and fecal coliform, and protect streambanks and riparian areas from erosion and fecal deposition. Figure H-4 shows an example of a pasture managed for land protection.

Figure H-4. Example of a well managed grazing system.

Maintaining sufficient ground cover on pasture lands requires a proper density of grazing animals and/or a rotational feeding pattern among grazing plots. An increase in ground cover from 60 percent to 95 percent may reduce sediment loading by 88 percent based on USLE estimates of cover factors and rates of erosion (Haith et. al., 1992). The EPA nonpoint source guidance for agricultural areas estimates that nitrogen loading may be reduced by 60 percent, phosphorus loading by 49 to 60 percent, and fecal coliform loading by 29 to 46 percent with grazing land protection measures (USEPA, 2003).
The costs associated with grazing land protection include acquiring additional land if current animal densities are too high (or reducing the number of animals maintained), fencing (Section H.1.5) and seeding costs, and developing alternative water sources (Section H.1.6). Establishment of vegetation costs from $42/ac to $73/ac is based on data presented in the EPA nonpoint source guidance for agriculture (USEPA, 2003) and an assumed inflation rate of 3 percent per year. Annual costs for maintaining vegetative cover will likely range from $6/ac to $11/ac.

H.1.8 Controlled Drainage

This practice involves placing simple water control structures at various locations in the tiling system to raise the water elevation. Decreases in nitrate losses have been attributed primarily to reductions in the volume of water drained and, to a somewhat lesser extent, by increased denitrification in the soil. If managed properly, controlled drainage has the potential to improve crop yields by making more water available to plants.

H.1.9 Conservation Tillage

Conservation tillage is defined as a reduced tillage practice that results in at least 30 percent of the soil surface covered by crop residuals after planting. The residuals provide erosion control and a nutrient source to growing plants, and continued use of conservation tillage results in a more productive soil with higher organic and nutrient content. Figure H-5 shows a comparison of ground cover under conventional and conservation tillage practices.

Figure H-5. Comparison of conventional (left) and conservation (right) tillage practices.

Conservation tillage practices in the Illinois River Basin resulted in an 88 percent reduction in soil loss rates (USDA, 2004). In Indiana, conservation tillage decreased total phosphorus loads by 1.7 lb/ac (Palmer and Loomis, 2006). Average reductions reported in the EPA nonpoint source guidance for agriculture are 75 percent for sediment, 55 percent for nitrogen, and 45 percent for phosphorus (USEPA, 2003). Conservation tillage also decreases runoff velocity and allows for greater rates of infiltration, reducing peak flow and runoff volumes.

Conservation tillage practices generally require less trips to the field, saving on labor, fuel, and equipment repair costs. Increased weed production does result in higher pesticide costs relative to conventional till. Conservation tillage tends to save money on corn production (approximately $17/ac/yr) and cost money on soybean production ($21/ac/yr). These costs do not account for long-term increases in crop yields due to improved soil quality (USDA, 1999). The EPA guidance for agricultural nonpoint source pollution reports that conservation tillage practices typically result in a net cost of zero, and sometimes result in net savings (USEPA, 2003).

H.1.10 Cover Crop

Use of a cover crop between growth cycles of cash crops also reduces erosion and improves soil quality by providing organic materials and nutrients to the soil matrix. Cover crops have the added benefit of suppressing weeds and controlling insects, thus reducing the need for pesticides and fertilizers (OSUE, 1999).

In Oklahoma, use of cover crops resulted in a 70 to 85 percent reduction in total phosphorus loading and an 88 percent reduction in sediment loading (HRWCI, 2005). Use of a cover crop may reduce nitrogen loading by 30 percent based on data presented by Haith et. al. (1992). Planting cover crops also decreases runoff velocity and allows for greater rates of infiltration, which reduces peak flow and runoff volumes. Costs associated with this practice are approximately $15/ac when adjusted for inflation to year 2006 (USEPA, 2003).

H.1.11 Filter Strips

Filter strips are used in agricultural and urban areas to intercept and treat runoff before it leaves the site. Filter strips will require maintenance, including grading and seeding, to ensure distributed flow across the strip as well protection from erosion of the strip itself. Periodic removal of vegetation will encourage plant growth and uptake and remove nutrients stored in the plant material. Filter strips also serve to reduce the quantity and velocity of runoff. Filter strip sizing is dependent on site specific features such as climate and topography, but at a minimum, filter strip area should be no less that 2 percent of the drainage area for agricultural land (OSUE, 1994). The minimum filter strip width suggested by NRCS (2002) is 30 ft. The strips are assumed to function properly with annual maintenance for 30 years before requiring replacement of soil and vegetation.

Filter strips have been found to effectively remove pollutants from agricultural runoff. Reductions in sediment loading of 60 to 65 percent, nitrogen loading of 70 percent, phosphorus removal of 65 percent, and fecal coliform of 55 percent are reported (USEPA, 2003; Kalita, 2000).

Grassed filter strips cost approximately $0.34 per sq. ft. to construct and $0.01 per sq. ft per year to maintain (USEPA, 2002b). Use of level spreaders to disperse flow will insure the efficiency of the filter strips, and costs approximately $13 per linear foot (Hunt et al., 2001). Using RS Means Cost Data (2005), Tetra Tech estimated maintenance of level spreaders to cost $0.39 per linear ft. per year.

H.1.12 Grass Swales

A grass swale is a vegetated runoff conveyance that is designed to reduce peak runoff velocity by storing water for a period of time, usually 24 hours. The slope and width of the swale allow for storage of runoff, which reduces transport velocity and increases rates of sedimentation and plant uptake. Established vegetation significantly reduces rates of erosion compared to bare ditches. Swales are assumed to operate effectively for 30 years before soil, vegetation, and drainage material need to be replaced.

The effectiveness of grass swales for treating agricultural runoff has not been quantified. In urban settings, reported removal rates of sediment, nitrogen, phosphorus, and fecal coliform are 93, 92, 83, and 5 percent, respectively (Winer, 2000).

Grass swales costs $0.56 per sq. ft to construct, and maintenance of grass swales is estimated at $0.02 per sq. ft. (Rouge River, 2001).

H.1.13 Riparian Area Improvements

Riparian corridors, including both the stream channel and adjacent land areas, are important components of watershed ecology. The streamside forest slowly releases nutrients as twigs and leaves decompose. These nutrients are valuable to the fungi, bacteria, and invertebrates that form the basis of a stream's food chain. Tree canopies of riparian forests also cool the water in streams which can affect the composition of the fish species in the stream, as well as the rate of biological reactions. Channelization or widening of

streams moves the canopy farther apart, decreasing the amount of shaded water surface and increasing water temperature.

Preserving natural vegetation along stream corridors can effectively reduce water quality degradation associated with development. The root structure of the vegetation in a buffer enhances infiltration of runoff and subsequent trapping of nonpoint source pollutants. However, the buffers are only effective in this manner when the runoff enters the buffer as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully will quickly pass through the buffer offering minimal opportunity for retention and uptake of pollutants.

Even more important than the filtering capacity of the buffers is the protection they provide to streambanks. The rooting systems of the vegetation serve as reinforcements in streambank soils, which helps to hold streambank material in place and minimize erosion. Due to the increase in stormwater runoff volume and peak rates of runoff associated with agriculture and development, stream channels are subject to greater erosional forces during stormflow events. Thus, preserving natural vegetation along stream channels minimizes the potential for water quality and habitat degradation due to streambank erosion and enhances the pollutant removal of sheet flow runoff from developed areas that passes through the buffer. Figure H-6 shows a riparian buffer separating agricultural fields from the stream system.

Figure H-6. Riparian buffer protecting the stream from adjacent agricultural fields.

In situations where the riparian cover is minimal and streambanks are moderately to severely eroding restoration of the streambanks and riparian zone will be necessary. Restoration of eroding streambanks will decrease sediment loading in the stream channel, and establishment of permanent vegetation on the banks will provide some stability as well as habitat and food sources. Placement of converted land adjacent to streams for the creation of riparian buffers will provide additional benefits of stream shading and nutrient uptake and trapping from adjacent treated areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. NCSU (2002) reports sediment removal rates of 97 percent and nitrogen and phosphorus removal rates of approximately 80 percent for 90 ft. wide buffers. Riparian corridors typically treat a maximum of 300 ft. of adjacent land before runoff forms small channels that short circuit treatment.

Restoration of riparian areas costs approximately $106 per ac to construct and $503.59 per ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004). The use of level spreaders to disperse flow will insure the efficiency of the buffers and costs approximately $13 per linear foot (Hunt et al., 2001).

H.1.14 Land Acquisition

Land acquired for the protection of water quality can be obtained through donation, direct purchase, or establishment of conservation easements (payment to original land owner under a contract that prevents

certain uses from occurring in the easement zone). The acquisition typically occurs adjacent to a water body with the intent of permanently protecting the area from human influences such as agriculture or urban development. Preservation of undisturbed vegetation reduces pollutant delivery through trapping and plant assimilation. Increased rates of infiltration will reduce peak flows in the channel and result in less bank erosion and subsequent sediment deposition.

If the land acquired is currently in a well-vegetated condition, the acquired land may reduce pollutant loading of nearby adjacent areas similar to that of a riparian buffer. Conversion from a highly erodible condition, such as row crop production, may reduce sediment loading from the easement zone by 98 percent and reduce nitrogen and phosphorus loading by approximately 90 percent (Haith et. al., 1992).

The costs associated with land acquisition will vary based on the conditions with which the land was obtained and local real estate prices. Undisturbed land should require no additional funding. Conversion from a highly disturbed land use to permanent vegetation may cost approximately $98 per ac to seed and up to $500 per ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004).

H.2 Residential and Urban Land Uses

Both regulatory and non-regulatory options employ development BMPs for stormwater management on lands disturbed by human activities (e.g., agriculture, forestry, and urban and suburban development). Structural practices require construction, installation, and maintenance. The types of practices recommended for a given area will depend on several factors including watershed characteristics, physical site constraints, maintenance requirements, administrative resources, and cost. The following list describes commonly used structural BMPs. Removal efficiency and cost comparison tables are placed at the end of this section.

Bioretention

Bioretention areas are depressions filled with 2 to 4 feet of sandy soil and planted with drought and flood tolerant plants. Stormwater drains into the surface of the bioretention area and, as the water infiltrates through the sandy soil, the soil and plants remove a portion of pollutants. In areas with sandy loam or other highly permeable soils, the water treated by the bioretention cell will infiltrate into the native soil. In areas that have soils with low permeability (typically clay-dominated soils), a gravel layer and underdrain pipe are placed below the sandy soil layer. Once the stormwater infiltrates through the treatment cell's sandy soil, it is drained out of the device through the underdrain pipe. Most bioretention areas are designed so that up to a foot of water can pond in the cell during a rain event. A weir is included in the bioretention area to bypass excess water above the ponding depth. Since bioretention areas use mulch and a variety of shrubs and small trees, they can be easily incorporated into existing landscaping.

Cisterns/Rain Barrels

Cisterns are tanks that hold rainwater for irrigation and other uses. The cistern pictured to the right can hold over 200 cubic feet of water. These BMPs can be pre-manufactured or constructed on-site. They also can be incorporated inconspicuously into the side of a building. Rain barrels typically hold less water than cisterns, about 8 cubic feet per rain barrel. If these devices are designed properly and if water is reused frequently, they can be used to control stormwater runoff, reduce stormwater flow, and remove some pollutants.

Conventional Dry Detention

Conventional dry detention ponds are typically grass-lined basins that are dry between storm events. These devices store stormwater runoff and reduce stormwater peak flow rates. Stormwater enters the device through an inlet, which may be a grass-lined channel or stormwater pipe. An embankment detains stormwater, and an outlet riser controls the downstream release rate of the impounded water. Stormwater is detained for a shorter period of time than for dry extended detention ponds.

Extended Dry Detention

Extended dry detention ponds are designed similarly to conventional dry detention. These devices store stormwater runoff and reduce stormwater peak flow rates. Stormwater enters the device through an inlet, which may be a grass-lined channel or stormwater pipe. An embankment detains stormwater, and an outlet riser controls the downstream release rate of the impounded water. Stormwater is detained for a longer period of time than in conventional dry detention ponds; the longer detention time allows for more removal of TSS and nutrients from the stormwater.

Grass Swale

A grass swale is a grass-lined channel with sloped banks. Culverts are used to pass stormwater under driveways and streets. Unlike water quality swales, grass swales do not have a sandy soil layer or gravel underdrains. Grass swales are used to convey stormwater runoff and slow stormwater flow. They are an alternative to storm sewer pipes, which produce higher stormwater flows than grass swales, especially for smaller storm events. Grass swales also remove some sediment if the stormwater flow is controlled.

Green Roof

Green roofs are grassy areas or gardens installed on a roof. Rainfall infiltrates into the soil of a green roof, and a net reduction of stormwater runoff is achieved as the plants use the collected water and facilitate evaporation. Depending on the types of plants and soil provided, green roofs may also remove a portion of the pollutants from the stormwater. Green roofs vary in design depending on the type of vegetation and how the roof will be used. Extensive green roofs are simple, low maintenance designs that do not allow public access to the roof. Intensive green roofs allow safe, public access to the roof and tend to have more elaborate, higher maintenance gardens than extensive green roofs.

Infiltration Trench

An infiltration trench is a concrete chamber or ditch filled with crushed rock. An infiltration trench fills with stormwater runoff and allows the water to infiltrate into the soil, providing a net reduction in surface runoff, and stormwater pollutants.

Water Quality Swale

A water quality swale (also called "Maryland dry swale") is a channel designed to control stormwater flow and encourage infiltration and removal of pollutants. Similar to a bioretention cell, a bed of sandy soil is installed in the channel and planted. A gravel underdrain can be installed below the sandy soil if the native soil does not allow for sufficient infiltration. Small structures called check dams may be used to control water flow.

Parking Lot Underground Storage

Underground storage involves a structure – such as a tank or series of large pipes – that detains stormwater beneath a parking lot. As an alternative to wet ponds or dry detention, this BMP reduces the above ground space used by stormwater BMPs and maximizes the available space for buildings, parking lots, and other site uses. Underground storage can be designed to meet a variety of hydrologic and pollutant removal requirements. The picture to the right depicts underground storage during the construction phase.

Permeable Pavement

Permeable pavement differs from conventional asphalt and concrete in that it allows for infiltration of water during a rainfall event. Permeable pavement types include porous asphalt, porous concrete (shown to the right), and paving stones interspersed with sandy soil or other porous fill. These types of pavement vary in vehicular traffic capacity. Grass parking lots, reinforced with plastic rings, are typically used for overflow parking, while some permeable pavement can be designed to handle more frequent traffic.

Sand Filter (DE Design)

A sand filter is a two-chambered structure in which water first flows into an empty sedimentation chamber. As the chamber fills with water, the sediment suspended in the water settles into the bottom of the chamber. The water, then, flows into a sand-filled chamber, and as the water infiltrates through the sand, a portion of pollutants is removed. Sand filters can be easily incorporated into parking lots and space-restricted locations, as shown to the right, but do require frequent inspection and maintenance.

Stormwater Wetland

A stormwater wetland treats runoff through a series of shallow pools that support wetland plants. This device stores some stormwater runoff and reduces stormwater outflow. The detention of stormwater allows excess sediment to settle out of the water. The wetland conditions encourage bacteria and plants to use excess nutrients. Portions of other pollutants may also be removed. The permanent pool varies in depth, but is generally no deeper than 3 feet. An outlet structure controls the flow of water out of the wetland. Large stormwater wetlands may have a forebay, which is a small depression lined with rocks that slows the incoming stormwater flow and settles out larger soil particles.

Vegetated Filter Strip and Level Spreader

A vegetated filter strip is a flat strip of land planted with grass or other vegetation. A level spreader is a structure that distributes stormwater runoff and releases the water as sheet flow onto the filter strip. When combined, these two devices reduce stormwater flow and remove a portion of sediment and pollutants from stormwater runoff.

Wet Pond

A wet pond maintains a permanent pool of water. This device stores stormwater runoff and reduces stormwater flow. The ponding of stormwater allows excess sediment to settle out of the water and encourages bacteria to use excess nutrients. Portions of other pollutants may also be removed. Stormwater first enters a forebay, which is a small depression lined with rocks that slows the incoming stormwater flow and settles out larger particles. The outlet structure and emergency spillway control the rate of water draining out of the pond.

Structural BMP Photographs from the following sources: Bioretention – Mecklenburg County, NC; Cistern/Rain Barrels – Clemson University; Conventional Dry Detention and Extended Dry Detention – Tetra Tech, Inc.; Grass Swale – USEPA; Green Roof – US General Services Administration; Infiltration Trench – Caltrans, Division of Environmental Analysis; Water Quality Swale – Prince George's County, MD; Parking Lot Underground Storage – StormTech®; Permeable Pavement – Greg McKinnon, Puget Sound Online; Sand Filter – NC State University; Stormwater Wetland – City of Charlotte, NC; Vegetated Filter Strip and Level Spreader – Caltrans, Division of Environmental Analysis; Wet Pond – Tetra Tech, Inc.

H.3 Wastewater Disposal

The transition to urban and residential land uses in the EFLRM watershed will require management of increased volumes of wastewater flow. According to information presented in the East Fork Little Miami River Watershed Action Plans, there are currently 7 permitted municipal wastewater treatment plants, 6 permitted package treatment plants, and approximately 9,517 individual onsite systems in the watershed (EFWC, 2003; 2006a; 2006b). This section describes the treatment processes, pollutant loading rates, and management practices for each system type.

Wastewater can be treated and dispersed to the environment through a variety of technologies which employ biological, physical, and chemical processes to digest, neutralize, or otherwise remove pollutants. Centralized wastewater facilities collect, transport, and treat sewage from dozens or hundreds of homes and businesses. These centralized facilities are usually public wastewater treatment plants serving large portions of a community. Decentralized facilities provide similar services to individuals or clusters of

buildings. A package treatment plant is a prefabricated unit that treats wastewater from one or more homes. An illustration comparing centralized and decentralized systems is provided in Figure H-7.

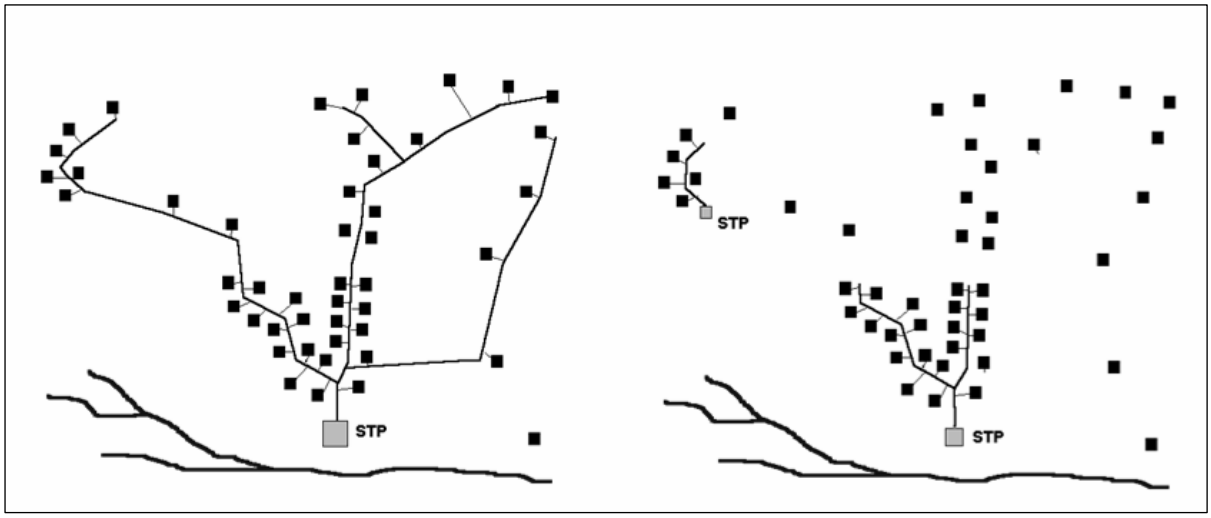

Figure H-7. Comparison of centralized (left) and decentralized (right) wastewater treatment.

Even properly designed and operated treatment systems do not remove all pollution. In the case of inland freshwater impoundments designated for recreational use and sources of drinking water, performance standards usually target nutrients – phosphorus, mostly, due to its role in promoting algal growth – and bacteria (i.e., pathogens), because of links to human illness associated with recreational contact from swimming, fishing, and boating, or through ingestion of organisms that are not removed through treatment. Household chemicals and pharmaceutical products can also pose risks to receiving waters (see Table H-2). Often systems are not maintained and increased loading to groundwater, streams, and lakes occurs.

Table H-2. Pollutants of concern associated with wastewater treatment systems.

Pollutant	Reason for Concern
Pathogens	Microorganisms such as parasites, bacteria, and viruses can cause communicable diseases through direct/indirect body contact or ingestion of contaminated water or shellfish. Pathogens pose a particular threat when partially treated sewage pools on ground surfaces or migrates to recreational waters. Transport distances for some pathogens in surface or groundwaters can be significant.
Nitrogen	Nitrogen is a plant nutrient that can contribute to eutrophication and depletion of dissolved oxygen in surface waters, especially in estuaries and coastal embayments. Excessive nitrate-nitrogen in drinking water can cause methemoglobinemia in infants and complications for pregnant women. Livestock also can suffer health impacts from drinking water high in nitrate.
Phosphorus	Phosphorus is a plant nutrient that can contribute to eutrophication of inland fresh waters and some marine waters and eventually deplete dissolved oxygen.
Household Chemicals	Chlorine, ammonia, and other cleaning compounds in high volumes may disrupt or disable biological activity in the septic tank. Wastes from hobby or craft activities (paints, solvents, etc.) and disposal of non-organic liquid wastes (old furniture polish, pesticides/herbicides, etc.) in onsite/cluster systems can have similar impacts.
Pharmaceuticals and Endocrine Disruptors	Disposal of large quantities of outdated antibiotics and other medicinal products in septic tank-based systems can impair or halt biological treatment processes. In some cases, disposal of products containing chemicals that disrupt endocrine system functions (e.g., regulation of metabolism, blood sugar, reproduction, embryonic development) in onsite systems might result in leaching of these chemicals into groundwater and surface waters and impair water quality and/or aquatic organisms. Research on this issue, including toxicology, transport, and fate of potential endocrine disruptors, is ongoing.

(Adapted from Tchobanoglous and Burton, 1991.)

Regardless of how wastewater is treated – centralized or decentralized, discharged to water or soil – management of all facilities is required to ensure that treatment systems are planned, selected, sited, designed, installed, operated, and maintained in a manner that meets performance expectations. Failure to provide for appropriate management has been linked to malfunctions of nearly every category and class of treatment facility, from the simplest gravity-flow home septic system to the most technologically advanced municipal sewage treatment plant.

Decision makers responsible for approving wastewater collection and treatment infrastructure for existing or new development usually require information and guidance on the various options available. Protection of public health and valued water resources and short-term/long-term costs are the primary considerations in most cases. Both centralized sewer service and decentralized options can protect public health and water resources, though treatment levels and cost may vary depending on the technology used, operational factors, system maintenance, and site-specific conditions (e.g., bypasses, nutrient removal requirements, geology, soils, climate, and other factors). This section discusses wastewater pollutants of concern, centralized wastewater treatment options, and decentralized wastewater treatment options.

H.3.1 Centralized Wastewater Treatment Plants

Centralized wastewater service is characterized by: 1) the system of piping which collects sewage at each home or facility and transports it to a central location, and 2) the central treatment facility, which typically discharges to a nearby body of water, but can discharge to the land (subsurface infiltration area, sprayfield) if conditions are favorable. Centralized and decentralized wastewater treatment both use similar biological, physical, and chemical technologies to process and treat sewage:

- Continuous flow, suspended growth aerobic treatment, usually in an open, aerated tank.
- Fixed film treatment, with wastewater distributed over rock, gravel, sand, fabric, peat, plastic, or other media.
- Sequencing batch reactors, sequential suspended growth treatment through an intermittent or continuous flow process.
- Ponds, lagoons, and wetlands, which combine suspended and attached growth biological treatment with physical and other processes.

In terms of cost, centralized treatment is less expensive to serve higher densities of housing (e.g., 2 to 6 homes per acre) with either decentralized cluster systems or centralized facilities, because there are more connections per mile of sewer line. Wastewater collection and treatment is more expensive in areas of low-density development (e.g., one or fewer homes per acre). Costs for providing centralized sewer service for areas of new or existing development vary widely, depending on density of housing, pipe trenching conditions, the need for manholes and pumping stations, and capital costs for the construction or expansion of the central sewage treatment plant. Treatment plant design and construction can cost $5,000 to $15,000 per connection (house), with sewer pipe costs adding $10,000 to $20,000 or more per house for development on large lots (e.g., 3-5 acres). The cost of a typical individual septic system and leachfield is about $3,000.

Centralized treatment is often viewed as providing more reliable and superior treatment, but upon closer examination both approaches – centralized and decentralized – offer substantial pollutant removal capabilities for the full range of pollutant parameters, at somewhat comparable costs. Monthly usage fees for centralized treatment are sometimes considered to be more accepted by the public, but most users know little about their wastewater treatment system and may be willing to pay regular operation/maintenance fees if they can avoid responsibility for large capital costs.

Factors to consider other than costs when deciding whether it is beneficial to use decentralized/onsite systems, construct a new treatment plant, or extend service lines from a nearby system include the following:

- Age and operational history of existing onsite systems in the area.
- The management entity's capacity and authority to properly manage existing onsite systems.
- Future housing and other development trends.
- Proximity and capacity of existing centralized collection lines and treatment facilities.
- Potential for acquiring (or revising, in the case of plant expansion) an NPDES discharge permit.
- Suitable financing, land area, and site conditions for construction of facilities and collection lines.
- Hydrologic impacts and catastrophic risk potential due to failure of collection systems and/or the centralized treatment plant.
- Secondary impacts associated with higher density development expected with centralized waste treatment systems.

If additional centralized treatment is proposed for new or existing development in the EFLMR drainage area, a detailed study regarding cost, effluent discharge location, potential for sprawl development, and other factors should be conducted to examine these issues in greater depth.
The existing facilities in the watershed will be undergoing various plant upgrades and sewer system improvements over the next several years to address known problems (EFWC, 2003; 2006a; 2006b). Further improvements may be required if Phase I management strategies for nonpoint sources do not result in attainment of use designations.

H.3.2 Decentralized Wastewater Treatment

Decentralized wastewater treatment is often proposed for areas of scattered and mixed large/small lot development due to lower costs, acceptable treatment performance, and other reasons. Decentralized systems include onsite systems that treat wastewater from individual homes or buildings, and cluster (community) systems that treat wastewater from groups of two or more homes. When properly planned, designed, sited, installed, operated, and maintained, individual or cluster systems can effectively remove or treat contaminants such as nutrients, pathogens, and biochemical oxygen demand in human sewage (USEPA, 2005).

Individual onsite treatment systems consist of a septic tank and a subsurface soil absorption field. Buried in the ground, septic tanks are essentially watertight single or multiple chamber sedimentation and anaerobic digestion tanks. They are designed to receive and pretreat domestic wastewater, mediate peak flows, and keep settleable solids, oils, scum, and other floatable material out of the absorption field. Wastewater effluent is discharged from the tank and passes to the soil via a series of underground perforated pipes, perforated pipe wrapped in permeable synthetic materials, leaching chambers, pressure drip irrigation pipes or tubing, or other distribution systems. From there, the partially treated effluent flows onto and through the developing biomat located at the soil infiltrative surface, and finally into the soil itself. Treatment occurs in the septic tank, on and within the biomat, in the soil, and continues as the effluent moves through the underlying soil toward groundwater or nearby surface waters.

Cluster (community) systems typically serve fewer than a hundred homes, but they can serve more. Under this approach, septic tank effluent from each home is collected and routed to another site for further treatment. Other designs where primary treatment occurs at the treatment site instead of at individual home septic tanks are also possible, but most designers prefer individual tanks due to a greater ability to detect problems that may affect biological treatment processes (e.g., dumping of toxic wastes). Collection and movement of effluent to the final treatment site can be accomplished by gravity flow or pumps. The off-site treatment facility resembles a downsized sewage plant, using similar technologies such as trickling (media) filters, aerobic lagoons, constructed wetlands, etc. Final dispersal of treated effluent is usually to the soil, due to greater treatment advantages and avoidance of NPDES permitting, monitoring, reporting, and other requirements. However, cluster systems can be designed and permitted to discharge to the surface.

Package treatment plants are prefabricated treatment units serving one or more households. Wastewater from the septic tank is collected and routed to the treatment facility, treated, then discharged to the surface or subsurface. Developers using large cluster systems typically construct their own plants rather than using package treatment plants.

Alternative or innovative systems such as mound systems, fixed-film contact units, wetlands, aerobic treatment units (“package plants”), low-pressure drip applications, and cluster systems, are used in areas where conventional soil-based systems cannot provide adequate treatment of wastewater effluent. Areas that might not be suitable for conventional systems are those with nearby nutrient-sensitive waters, high

densities of existing conventional systems, highly permeable or shallow soils, shallow water tables, large rocks or confining layers, and poorly drained soils.

Concerns over treatment system failure and malfunction over the past 30 years have led to significant improvements in system planning, design, and management. The result of these upgrades has been elevated performance both hydraulically and functionally, with a wider array of technologies capable of removing targeted pollutants. It should be noted that treatment occurring in the soil matrix – a characteristic of most onsite and cluster systems – is an important component of the overall pollutant removal/attenuation process, making soil type and depth a key consideration in siting these systems.

Onsite and cluster systems have malfunctioned due to system age, inappropriate design, hydraulic/ pollutant overloading, and poor maintenance (see Table H-3). Detrimental impacts from onsite systems can occur when they are sited in sensitive ecological areas (such as wellhead protection zones, near nitrogen/phosphorus limited waters, or near beaches or shellfish habitat) or when they are installed at densities that exceed the hydraulic and hydrologic assimilative capacities of regional soils and aquifers. Failure rates in the ELFMR watershed range from 20 to 70 percent depending on soil type, system density, and system age (EFWC, 2003; 2006a; 2006b).

Table H-3. Common causes of onsite and cluster system malfunction (USEPA, 2005).

Type of Malfunction	Contributing Causes
Hydraulic	Excessive hydraulic loadings to undersized systems, low soil permeability, excessive ponding at the infiltrative surface, poor maintenance. Increases in water usage over a period of years can exceed the design capacity of the wastewater treatment system.
Organic	Excessive organic loading from unpumped or sludge-filled tanks resulting in reductions in biomat infiltrative surface permeability.
Soil Depth to Groundwater Table or Bedrock	Insufficient soil depths (i.e., soil thickness between the subsurface wastewater infiltration system and groundwater tables, impermeable strata, or bedrock is less than the recommended depth for soil texture and structure). High groundwater is deleterious to pathogen removal and hydraulic performance.
System Age	Systems more than 25 to 30 years old generally experience more failures if not operated and maintained properly. Failure rates can more than triple for poorly managed older systems. Regular tank pumping and use of alternating absorption fields can prolong system life indefinitely.
Design Failure	Inappropriate system design for the site; failure to adequately consider or characterize wastewater strength and flow (average daily and/or peak flows); failure to identify and consider restrictive soil/rock layers (e.g., fragipan) or regional geology (e.g., karst features, creviced bedrock); failure to assess landscape position.
System Density	Cumulative effluent load from all systems in watershed or groundwater recharge area exceeds the hydrologic capacity of the area to accept and/or properly treat effluent.

Nitrogen in domestic wastewater can be removed through effective linking of aerobic and anaerobic biochemical transformation processes, but in general, most conventional septic systems are not considered effective in removing nitrogen without additional treatment in the soil. Septic tanks remove approximately 30 percent of the nitrogen in raw domestic wastewater. Percolation through 3 to 5 feet of soil can remove 0 to 20 percent of the total nitrogen in septic tank effluent. Additional nitrogen removal is possible under optimum soil and denitrification (e.g., anaerobic and carbon-rich) conditions.

Phosphorus loading rates from properly functioning onsite wastewater systems are typically insignificant due to adsorption to soil particles in the drainfield. However, if systems are placed on unsuitable soils, not maintained properly, or are connected to subsurface drainage systems, loading rates to receiving

waterbodies may be relatively high. Favorable phosphorus removal conditions exist for soil absorption systems in most soils of the United States, but some phosphorus loading problems might be encountered in areas with older systems, highly permeable soils (e.g., sands), mineral-poor soils, nearby surface waters, and high system densities.

Pathogenic microorganisms found in domestic wastewater, including bacteria, viruses, protozoa, and parasites, are removed or attenuated through chemical, physical, and biological processes occurring in the septic tank, within the biomat, and in the soil. The main methods of bacterial retention in unsaturated soil are filtration, sedimentation, and adsorption. Normal operation of septic tank/subsurface infiltration systems results in retention and die-off of most, if not all, observed pathogenic bacterial indicators within 2 to 3 feet of the infiltrative surface (USEPA, 2002c). With a mature biomat at the infiltrative surface of coarser soils, most bacteria are removed within the first foot vertically or horizontally from the trench-soil interface. Removal rates for other pathogens, such as viruses and protozoa, vary significantly depending on soil, climate, and other factors. Table H-4 summarizes wastewater constituents of concern and estimates of their effluent concentration from different treatment units.

Table H-4. Wastewater constituents of concern and representative estimates of concentrations in the effluent of various treatment units (adapted from Siegrist et al., 2000).

Constituents of Concern	Direct or Indirect Measures	Tank-based Treatment Unit Effluent Concentrations					Following Percolation Through 3 to 5 ft of Soil Drain Field (Percent Removal)
		Domestic STE[1]	Domestic STE with N-removal Recycle[2]	Aerobic Unit Effluent	Recirculating Sand Filter Effluent[3]	Recirculating Foam or Textile Filter Effluent[4]	
Oxygen Demand	BOD_5 (mg/L)	140-200	80-120	5-50	2-15	5-15	>90
Particulate Solids	TSS (mg/L)	50-100	50-80	5-100	5-20	5-10	>90
Nitrogen	Total N (mg N/L)	40-100	10-30	25-60	10-50	30-60	10-20
Phosphorus[4]	Total P (mg P/L)	5-15	5-15	4-10	3-9	4-10	0-100
Bacteria (e.g., *Clostridium perfringens, Salmonella, Shigella*)	Fecal coliform (organisms per 100 mL)	10^6-10^8	10^6-10^8	10^3-10^6	10^1-10^3	10^1-10^3	>99.99
Virus[5] (e.g., hepatitis, polio, echo, coxsackie, coliphage)	Specific virus (pfu/mL)	0-10^5	0-10^4	0-10^4	0-10^3	0-10^3	>99.9
Organic Chemicals (e.g., solvents, petro-chemicals, pesticides)	Specific organics or totals (µg/L)	0 to trace	0 to trace	0 to trace	0 to trace	0 to trace	>99
Heavy Metals (e.g., Pb, Cu, Ag, Hg)	Individual metals (µg/L)	0 to trace	0 to trace	0 to trace	0 to trace	0 to trace	>99

[1] Septic tank effluent (STE) concentrations given are for domestic wastewater. However, restaurant septic tank effluent (STE) is markedly higher, particularly in BOD_5, COD, and suspended solids, while concentrations in graywater STE are noticeably lower in total nitrogen.
[2] N-removal accomplished by recycling STE through a packed bed for nitrification with discharge into the influent end of the septic tank for denitrification.
[3] Operated in recirculating mode.
[4] P-removal by adsorption or precipitation is highly dependent on media capacity, P loading, and system operation.
[5] Episodically present at high levels.

Failing and poorly functioning decentralized wastewater treatment systems in the EFLMR watershed contribute nutrient and fecal coliform loading to the water bodies. Inspections of each onsite wastewater treatment system in the watershed should be performed to assess functionality and degree of maintenance. Systems older than 20 years and those located close to a lake or stream should be inspected first. A database containing the age and future maintenance records for each system in the watershed should be created and maintained. All tanks discharging to tile drainage systems should be disconnected immediately. Bacterial counts from systems directly connected to a subsurface drainage system have been reported at 90,000 per 100 mL (Bird, 2006). These systems pose a threat to water quality in the EFLMR watershed as well as a public health hazard. Repair or replacement of poorly functioning systems should be required and confirmed.

The cost of developing and maintaining a watershed wide database of the onsite wastewater treatment systems in the EFLMR watershed depends on the number of systems that need to be inspected. After the initial inspection of each system and creation of the database, agency inspections should occur once every three to five years to confirm that maintenance is occurring on a regular basis. Alternatively, licensed service providers can be required to submit maintenance records to ensure maintenance requirements are being met.

Education of owners concerning maintenance of onsite wastewater treatment systems is a crucial component of reducing pollution from these systems. Many owners are not familiar with USEPA recommendations concerning maintenance schedules. Septic systems, when not maintained properly, can cause the release of pathogens and excess nutrients into surface water. Good housekeeping measures relating to septic systems include (Goo, 2004; CWP, 2004):

- Inspect system annually and pump system every 3 to 5 years, depending on the tank size.
- Refrain from trampling the ground or using heavy equipment above a septic system (to prevent collapse of pipes).
- Prevent septic system overflow by conserving water, not diverting storm drains or basement pumps into septic systems, and not disposing of trash through drains or toilets.

Education of home and business owners that use onsite wastewater treatment systems should occur periodically. Public meetings, mass mailings, radio and TV announcements can all be used to remind and inform owners of their responsibility to maintain their systems.

The costs associated with education and inspection programs will vary depending on the level of effort required to communicate the importance of proper maintenance and the number of systems in the area.

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