Appendix A: Qualitative Habitat Evaluation Index Evaluation Sheet

Ohio EPA Qualitative Habitat Evaluation Index Field Sheet QHEI Score: ☐

River Code: ___________ ***RM:*** _______ ***Stream:*** ______________________

Date: _______________ ***Location:*** ______________________

Scorers Full Name: ________________ ***Affiliation:*** ______________________

1] SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % present

TYPE	POOL	RIFFLE	TYPE	POOL	RIFFLE	SUBSTRATE ORIGIN	SUBSTRATE QUALITY
						Check ONE (OR 2 & AVERAGE)	Check ONE (OR 2 & AVERAGE)
☐☐-BLDR /SLBS[10]	____	____	☐☐-GRAVEL [7]	____	____		
☐☐-BOULDER [9]	____	____	☐☐-SAND [6]	____	____	☐ -LIMESTONE [1]	SILT: ☐- SILT HEAVY [-2]
☐☐-COBBLE [8]	____	____	☐☐-BEDROCK[5]	____	____	☐ -TILLS [1]	☐ -SILT MODERATE [-1]
☐☐-HARDPAN [4]	____	____	☐☐-DETRITUS[3]	____	____	☐ -WETLANDS[0]	☐ -SILT NORMAL [0]
☐☐-MUCK [2]	____	____	☐☐-ARTIFICIAL[0]	____	____	☐ -HARDPAN [0]	☐ -SILT FREE [1]
☐☐-SILT [2]	____	____	NOTE: Ignore Sludge Originating From Point Sources			☐ -SANDSTONE [0]	EMBEDDEDNESS: ☐ -EXTENSIVE [-2]
						☐ -RIP/RAP [0]	☐ -MODERATE [-1]
NUMBER OF SUBSTRATE TYPES: (High Quality Only, Score 5 or >)			☐-4 or More [2]			☐ -LACUSTRINE [0]	☐ -NORMAL [0]
			☐-3 or Less [0]			☐ -SHALE [-1]	☐ -NONE [1]
						☐ -COAL FINES [-2]	

Substrate ☐ Max 20

COMMENTS______________________________________

2] INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions) (Structure) **TYPE:** Score All That Occur

			AMOUNT: (Check ONLY One or check 2 and AVERAGE)
___UNDERCUT BANKS [1]	___POOLS> 70 cm [2]	___OXBOWS, BACKWATERS [1]	☐ - EXTENSIVE > 75% [11]
___OVERHANGING VEGETATION [1]	___ROOTWADS [1]	___AQUATIC MACROPHYTES [1]	☐ - MODERATE 25-75% [7]
___SHALLOWS (IN SLOW WATER) [1]	___BOULDERS [1]	___LOGS OR WOODY DEBRIS [1]	☐ - SPARSE 5-25% [3]
___ROOTMATS [1]	COMMENTS:____________		☐ - NEARLY ABSENT < 5%[1]

Cover ☐ Max 20

3] CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS/OTHER	
☐ - HIGH [4]	☐ - EXCELLENT [7]	☐ - NONE [6]	☐ - HIGH [3]	☐ - SNAGGING	☐ - IMPOUND.
☐ - MODERATE [3]	☐ - GOOD [5]	☐ - RECOVERED [4]	☐ - MODERATE [2]	☐ - RELOCATION	☐ - ISLANDS
☐ - LOW [2]	☐ - FAIR [3]	☐ - RECOVERING [3]	☐ - LOW [1]	☐ - CANOPY REMOVAL	☐ - LEVEED
☐ - NONE [1]	☐ - POOR [1]	☐ - RECENT OR NO RECOVERY [1]		☐ - DREDGING	☐ - BANK SHAPING
				☐ - ONE SIDE CHANNEL MODIFICATIONS	

Channel ☐ Max 20

COMMENTS:______________________________________

4]. RIPARIAN ZONE AND BANK EROSION (check ONE box per bank or check 2 and AVERAGE per bank) River Right Looking Downstream

RIPARIAN WIDTH L R (Per Bank)	FLOOD PLAIN QUALITY (*PAST 100 Meter RIPARIAN*) L R (Most Predominant Per Bank)	L R	BANK EROSION L R (Per Bank)
☐☐- WIDE > 50m [4]	☐ ☐-FOREST, SWAMP [3]	☐ ☐-CONSERVATION TILLAGE [1]	☐ ☐-NONE/LITTLE [3]
☐☐- MODERATE 10-50m [3]	☐ ☐-SHRUB OR OLD FIELD [2]	☐ ☐-URBAN OR INDUSTRIAL [0]	☐ ☐-MODERATE [2]
☐☐- NARROW 5-10 m [2]	☐ ☐-RESIDENTIAL,PARK,NEW FIELD [1]	☐ ☐-OPEN PASTURE,ROWCROP [0]	☐ ☐-HEAVY/SEVERE[1]
☐☐- VERY NARROW <5 m[1]	☐ ☐-FENCED PASTURE [1]	☐ ☐-MINING/CONSTRUCTION [0]	
☐☐- NONE [0]			

Riparian ☐ Max 10

COMMENTS:______________________________________

5.]POOL/GLIDE AND RIFFLE/RUN QUALITY

MAX. DEPTH (Check 1 ONLY!)	MORPHOLOGY (Check 1 or 2 & AVERAGE)	CURRENT VELOCITY [POOLS & RIFFLES!] (Check All That Apply)	
☐- >1m [6]	☐-POOL WIDTH > RIFFLE WIDTH [2]	☐-EDDIES[1]	☐-TORRENTIAL[-1]
☐- 0.7-1m [4]	☐-POOL WIDTH = RIFFLE WIDTH [1]	☐-FAST[1]	☐-INTERSTITIAL[-1]
☐- 0.4-0.7m [2]	☐-POOL WIDTH < RIFFLE W. [0]	☐-MODERATE [1]	☐-INTERMITTENT[-2]
☐- 0.2- 0.4m [1]		☐-SLOW [1]	☐-VERY FAST[1]
☐- < 0.2m [POOL=0]	COMMENTS:____________		

Pool/Current ☐ Max 12

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
☐-*Best Areas >10 cm [2]	☐ - MAX > 50 [2]	☐-STABLE (e.g.,Cobble, Boulder) [2]	☐ - NONE [2]
☐ - Best Areas 5-10 cm[1]	☐ - MAX < 50[1]	☐-MOD. STABLE (e.g.,Large Gravel) [1]	☐ - LOW [1]
☐ - Best Areas < 5 cm [RIFFLE=0]		☐-UNSTABLE (Fine Gravel,Sand) [0]	☐ - MODERATE [0]
			☐ - EXTENSIVE [-1]

Riffle/Run ☐ Max 8

COMMENTS:______________________________________ ☐ - NO RIFFLE [Metric=0]

6] GRADIENT (ft/mi): _______DRAINAGE AREA (sq.mi.) :_______

%POOL: ☐ %GLIDE: ☐

%RIFFLE: ☐ %RUN: ☐

Gradient ☐ Max 10

Best areas must be large enough to support a population of riffle-obligate species

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Appendix B: TMDL Development for the Lower Alum Creek and Lower Big Walnut Creek Watersheds

B.1 Nutrients

Nutrient enrichment was assessed to be a cause of impairment in the McKenna Creek, Rocky Fork, and Blacklick Creek sub-watersheds of the lower Big Walnut watershed. As discussed in chapter 3 of this report, phosphorus was used as an indicator of the degree of nutrient enrichment. TMDL development required the definition of the existing load, calculation of the loading capacity, and allocation of the TMDL to the identified sources.

The existing load was defined as the sum of the individual source loads. For the purpose of this study, surface runoff, point source discharge, home sewage treatment systems, and groundwater were considered potential sources. Individual source loads were estimated by the methods described below.

Surface Runoff

Phosphorus contributed via surface runoff was estimated using the Metropolitan Washington Council of Governments' Simple Method (EPA, 1997). The Simple Method approximates surface runoff volume based upon annual precipitation. The phosphorus load is then calculated as the product of annual runoff volume and an event mean concentration (EMC). The Simple Method is described by the following equation:

$$L_i = P \bullet P_j \bullet R_v \bullet C_i \bullet A_i \bullet K_R$$

Where:

L_i = Pollutant load from land use *i* (lb/year)
P = Annual rainfall (inches)
P_j = Correction factor for storms that produce no runoff
R_v = Runoff coefficient
C_i = EMC for land use *i*
A_i = Acreage for land use *i* (acres)
K_R = unit correction factor (2.72/12)
R_v = $0.05 + 0.009 \bullet PI_i$
Where PI = Percent imperviousness for land use *i*

The phosphorus load for each sub-watershed is the sum of the phosphorus loads from each land use. The phosphorus load for each sub-watershed is described by the following equation:

$$L = L_f + L_a + L_l + L_h + L_c + L_w$$

Where:

L	= Total phosphorus load per sub-watershed (lbs/year)
L_f	= Load from forest/urban open areas
L_a	= Load from agricultural/pasture areas
L_l	= Load from low density residential areas
L_h	= Load from high density residential areas
L_c	= Load from commercial/industrial areas
L_w	= Load from open water/wetland areas

Of the input parameters described above P and P_j are common values applied to all land uses. PI, R_v, C, and A are land use specific. P (annual rainfall) was calculated from Midwest Regional Climate Center (MRCC) data. MRCC station number 331786, located at Port Columbus Airport, was used. Daily precipitation from 01 January 1990 to 31 December 2003 was compiled to determine rainfall for each year. P_j (unitless correction factor to account for storms that produce no runoff) was set at 0.9 based upon a literature value (CDM, 1998). Values and sources used for land use specific input parameters are presented in Table B-1.

Table B-1: Simple method input values and sources

Simple Method Land Use Class	A[1] *(acres)*			NLCD Class[2]	**PI**[3]	**R_v**	**C** *(mg-TP/l)*	
	McKenna	Rocky	Blacklick				Value	Source
Forest/Urban Open	223	5,031	9,302	33, 41, 42, 43	5%	0.05045	0.23	(CDM, 1998)
Ag/Pasture	488	12,925	24,320	81, 82, 85	30%	0.05270	0.39	(Richards, 2001)
Low Density Residential[4]	109	1,372	3,910	21	40%	0.05360	0.47	(CDM, 1998)
High Density Residential[4]	4	140	700	22	60%	0.05510	0.47	(CDM, 1998)
Com/Ind	6	143	1,703	23	65%	0.05585	0.24	(CDM, 1998)
Water/Wetland	11	435	557	11, 32, 91, 92	100%	0.05900	0.03	(CDM, 1998)

1. Land use acreage was derived from the National Land Cover Dataset (NLCD) using GIS analysis. The NLCD is a product of the USGS and was complied from Landsat™ satellite imagery (circa 1992).
2. NLCD land use categories were reclassified to correspond with the Simple Method's land use classes.
3. Percent imperviousness values were referenced from the Watershed Management Model User's Manual (CDM, 1998). These literature values were adapted for use in the Big Walnut watershed via calibration to estimations of surface runoff predicted by the HYSEP model. For a description HYSEP and its implementation, see the following section describing the calculation of the groundwater source load.
4. Residential land use area determined from the NLCD was adjusted to reflect 2003 conditions by the application of a growth rate. Growth rate was determined on a sub-basin specific basis by comparing 1990 and 2000 census demographic information regarding population and number of households.

Results of the simple method are presented in the following tables. Table B-2, B-3, and B-4 present results from McKenna Creek, Rocky Fork, and Blacklick Creek, respectively.

Table B-2: Annual phosphorus runoff loads to McKenna Creek

Year	Rainfall (*in/yr*)	Annual Phosphorus Load *(lb-TP/year)*						
		Forest/Urban Open	Ag/Pasture	LD Residential	HD Residential	Com/Ind	Water/Wetland	Total
1990	53.16	53	661	228	12	10	3	963
1991	32.74	33	407	141	7	6	2	593
1992	39.60	39	492	170	9	7	2	718
1993	37.85	38	470	162	9	7	2	686
1994	31.62	31	393	136	7	6	2	573
1995	45.30	45	563	194	10	8	3	821
1996	45.56	45	566	196	10	8	3	826
1997	38.16	38	474	164	9	7	2	692
1998	37.57	37	467	161	8	7	2	681
1999	27.59	27	343	118	6	5	2	500
2000	42.89	43	533	184	10	8	3	777
2001	36.85	37	458	158	8	7	2	668
2002	40.21	40	500	173	9	7	2	729
2003	49.03	49	609	210	11	9	3	889
						Median:		705

Table B-2: Annual phosphorus runoff loads to Rocky Fork

Year	Rainfall *(in/yr)*	Annual Phosphorus Load *(lb-TP/year)*						
		Forest/Urban Open	Ag/Pasture	LD Residential	HD Residential	Com/Ind	Water/Wetland	Total (lbs\yr)
1990	53.16	1,192	17,493	2,867	422	237	134	22,346
1991	32.74	734	10,774	1,766	260	146	83	13,762
1992	39.6	888	13,031	2,136	314	177	100	16,646
1993	37.85	849	12,455	2,042	300	169	96	15,910
1994	31.62	709	10,405	1,706	251	141	80	13,291
1995	45.3	1,016	14,907	2,443	360	202	114	19,042
1996	45.56	1,022	14,992	2,457	362	203	115	19,151
1997	38.16	856	12,557	2,058	303	170	96	16,040
1998	37.57	842	12,363	2,026	298	168	95	15,792
1999	27.59	619	9,079	1,488	219	123	70	11,597
2000	42.89	962	14,113	2,313	341	191	108	18,029
2001	36.85	826	12,126	1,988	293	164	93	15,490
2002	40.21	902	13,232	2,169	319	179	102	16,902
2003	49.03	1,099	16,134	2,645	389	219	124	20,610
						Median:		16,343

Table B-3: Annual phosphorus runoff loads to Blacklick Creek

Year	Rainfall *(in/yr)*	Annual Phosphorus Load *(lb-TP/year)*						
		Forest/Urban Open	Ag/Pasture	LD Residential	HD Residential	Com/Ind	Water/Wetland	Total (lbs\yr)
1990	53.16	2,204	32,915	8,171	2,106	2,814	172	48,382
1991	32.74	1,357	20,272	5,032	1,297	1,733	106	29,797
1992	39.60	1,642	24,519	6,086	1,569	2,096	128	36,041
1993	37.85	1,569	23,436	5,817	1,499	2,004	123	34,448
1994	31.62	1,311	19,578	4,860	1,253	1,674	102	28,778
1995	45.30	1,878	28,048	6,962	1,794	2,398	147	41,228
1996	45.56	1,889	28,209	7,002	1,805	2,412	148	41,465
1997	38.16	1,582	23,627	5,865	1,512	2,020	124	34,730
1998	37.57	1,558	23,262	5,774	1,488	1,989	122	34,193
1999	27.59	1,144	17,083	4,241	1,093	1,461	89	25,110
2000	42.89	1,778	26,556	6,592	1,699	2,270	139	39,035
2001	36.85	1,528	22,816	5,664	1,460	1,951	119	33,538
2002	40.21	1,667	24,897	6,180	1,593	2,129	130	36,596
2003	49.03	2,033	30,358	7,536	1,942	2,596	159	44,623
						Median:		36,041

<u>Point Source Dischargers</u>:

Phosphorus contributed via point source discharge was estimated by the following equation:

$$PL_i = Q_i \bullet [TP_i] \bullet K_P$$

Where:

P_i = Point source phosphorus load from discharger *i* (lbs-TP/year)
Q_i = Effluent flow rate for discharger *i* (MGD)
$[TP_i]$ = Effluent total phosphorus concentration for discharger *i* (mg/l)
K_P = unit conversion factor (3046.071)

Values used, along with their sources, are presented in Table B-4. The annual phosphorus load for each discharger and sub-watershed are also presented in the table. Note that there are no permitted dischargers to McKenna Creek.

Table B-4: Point source effluent flow rate and quality; Point source load

Stream	Point Source	Type	Flow Rate **Q**			Phosphorus Conc. **[TP]**			Phosphorus Load **P**	
			Value *MDG*	POR[1]	Source	Value *mg/l*	POR[1]	Source	Point *lb/yr*	Sub-basin *lb/yr*
Blacklick	Blacklick Estates	Major WWTP	0.887	1998-2002	LEAPS[2] Median	1.43	8/03-1/04	MOR[4]	3864	7461
	Tussing Rd.	Major WWTP	1.177	1998-2002	LEAPS[2] Median	0.85	8/03-12/03	MOR[4]	3047	
	JWSD - Wengert Rd.	WWTP	0.142	1998-2002	LEAPS[2] Median	1.10	1998-2002	LEAPS[2] Median	476	
	Modern MHP	P.P[6]	0.004	NA	Design Flow	3.00	NA	Temp.[5]	37	
	By Willow	P.P[6]	0.004	NA	Design Flow	3.00	NA	Temp.[5]	37	
Rocky Fork	JWSD - Windrush	P.P[6]	0.038	1998-2002	LEAPS[2] Median	3.00	NA	Temp.[5]	347	850
	Westerville Est. MHP	P.P[6]	0.043	1998-2002	LEAPS[2] Median	3.00	NA	Temp.[5]	393	
	Taylor Estates	P.P[6]	0.012	1998-2003	LEAPS[2] Median	3.00	NA	Temp.[5]	110	

1. Period of record.
2. Liquid Effluent Analysis Processing System, an Ohio EPA data system that maintains an inventory of discharger information, including effluent quantity and quality. The data system follows protocols established by Ohio EPA for the analysis and reduction of effluent monitoring information.
3. AEP effluent is predominantly once-through cooling water pumped from a groundwater well. The concentration of phosphorus in groundwater was therefore used to represent AEP effluent quality. See the following section regarding the calculation of the groundwater phosphorus load for more information on how this number was derived.
4. Obtained directly from discharger's monthly operating report.
5. No phosphorus monitoring data available. Concentration is the best professional judgement Ohio EPA Division of Surface Water staff based upon knowledge of operations at the discharging facility. The concentration is to serve as temporary representation of effluent quality until such time that monitoring data is available.
6. Package Plant

Home Sewage Treatment Systems:

The phosphorus load from home sewage treatment systems (HSTSs) was estimated via the following method. First, areas served by central sewer systems were differentiated from areas that were not. Area not served by central sewer systems were assumed unsewered. The number of parcel lots in unsewered areas were counted, and one HSTS per parcel lot was assumed. HSTSs were then identified as either discharging or septic systems. Phosphorus loads were calculated for both off-lot and septic systems.

Areas served by central sewer systems were identified by examining the service area maps of various municipal and private collection systems. The City of Columbus is the only entity providing sewer service in the McKenna Creek sub-watershed. In the Rock Fork sub-watershed sewer service is provided by Blacklick Estates, the City of Columbus, and Jefferson Township. In the Blacklick Creek sub-watershed sewer service is provided by Blacklick Estates, the City of Columbus, Fairfield County, Jefferson Township, the City of Pickerington, and the Southwest Licking County Water & Sewer. As previously stated, any watershed area not covered by one of the entities listed above was assumed unsewered. The number of parcel lots in unsewered areas were counted, and one HSTS per parcel lot was assumed.

In Delaware County an additional step was required to determine the number of HSTS. No service area map was provided for Delaware County's collection system, so census data was used to estimate the number of HSTS. In Delaware County the number of parcel lots in each sub-watershed was determined. Next, the 1990 census block group in which each parcel resides was identified. From the 1990 census block group demographics, the percent of homes in the block group that were unsewered was determined. This percentage was applied to the number of parcel lots in the block group to calculate the number of HSTSs.

Next, discharging systems were differentiated from septic systems. In Franklin County the number of discharging systems in each 14-digit HUC was provided by the Franklin County Board of Health (Franklin BOH). In Licking County the number of discharging systems was referenced from the Scioto River Basin and Blacklick Creek Water Quality Management Plan (Ohio EPA, 2002). In Delaware County the number of discharging systems was estimated as the product of the total number of HSTSs in each 14-digit HUC and the ratio of discharging to septic systems in Delaware County. The ratio of discharging systems in Delaware County was referenced from the Delaware County HSTS Management Plan (Delaware County, 2005). In all counties, the number of septic systems was estimated as the difference of the number of HSTS and the number of discharging systems. In 14-digit HUCs where the number of discharging systems was greater than estimated number of HSTSs, it was assumed that there were no septic systems. Table B-5 presents the estimated number of HSTS, the number of discharging systems, and the number of septic systems per sub-watershed.

The next step required failing systems to be differentiated from systems that are operating normally. For the purpose of this report, all discharging systems were assumed to be failing. The number of failing septic systems was estimated as the product of the number of septic systems in each 14-digit HUC and a failure rate. The failure rate, 20%, was referenced from the U.S. EPA's Onsite Wastewater Treatment Systems Manual (U.S. EPA, 2002).

Finally, the phosphorus load was calculated as the product of the number of failing systems, the number of person per system, a daily per capita phosphorus loading rate, and the number of days in a year. The number of persons per system was determined from census block group demographic data. The per capita phosphorus loading rate was referenced from *Wastewater Engineering: Treatment, Disposal, Reuse* (Metcalf & Eddy, 1991). The value used, 0.009 lbs-P per capita per day, is the sum of the rates quoted in Table 14-4 (p. 1022) for inorganic and organic phosphorus. Table B-6 presents the HSTS phosphorus loads.

Table B-5: HSTS, discharging systems, and septic systems per county

Sub-Watershed	Total HSTSs			Discharging Systems			Septic Systems			Total Systems	
	DELAWARE	FRANKLIN	LICKING	DELAWARE	FRANKLIN	LICKING	DELAWARE	FRANKLIN	LICKING	DISCHARGING	SEPTIC
McKenna Creek	-	24	-	-	12	-	-	12	-	12	12
Rock Fork Creek	159	213	-	28	523	-	131	-	-	551	131
Blacklick Creek	2	192	394	-	506	350	2	42	44	856	88

Table B-6: Discharging systems, septic systems, and total HSTS phosphorus loads

14-Digit HUC	Total Systems		Failed Systems		PERSONS/SYSTEM	Phosphorus Load (*lbs/year*)		
	Discharging	SEPTIC	Discharging	SEPTIC		Discharging	SEPTIC	TOTAL
McKenna Creek	12	12	12	2	2.83	112	22	134
Rocky Fork Creek	551	131	551	26	2.83	5124	244	5368
Blacklick Creek	856	88	856	18	2.38	6692	137	6830

Groundwater:

The phosphorus load from groundwater was quantified by: 1) estimating annual baseflow volume per sub-watershed, and 2) multiplying by the concentration of phosphorus in groundwater. Annual baseflow volume was estimated using the USGS program HYSEP. HYSEP is used to separate streamflow hydrographs into baseflow and surface runoff components. HYSEP provides three methods of hydrograph separation: fixed-interval, sliding-interval, and local-minimum (USGS, 1996). The fixed-interval method was used in this analysis.

HYSEP requires a continuous daily record of mean streamflow as input. Typically, USGS long-term stream gaging stations are used to provide the streamflow record. No long-term gaging station is located on McKenna Creek, Rocky Fork, or Blacklick Creek, so daily mean streamflow was estimated from an index gage. *Low-Flow Characteristics of Streams in Ohio through Water Year 1997* names the Licking River gage (#03146500), located at Newark, as the index gage for the Blacklick Creek (USGS, 2001). Index gages are selected based upon hydrological similarities between watersheds, and are believed to provide a reasonable estimation of low-flow in un-gaged streams. Due to the proximity of the Blacklick Creek, Rock Fork, and McKenna Creek sub-watersheds, the Licking River gage at Newark was used as the index for all three streams.

A record of daily mean streamflow for USGS gage #03146500, Licking River at Newark, was retrieved from USGS's NWISWeb data system. The period of record for the retrieval was 01 January 1990 to 31 December 2003. Daily mean streamflow values were converted to WATSTORE format for input to HYSEP. Hydrograph separation was then performed by HYSEP, and the output file contained a daily accounting of baseflow and surface runoff in cubic feet per second (cfs). Daily groundwater discharge and surface runoff values were converted from cfs to million gallons per day (MDG), and summed for each year on record. The result was a yearly estimation of total baseflow and surface runoff volumes for the Licking River watershed above the gage at Newark.

The next step in the groundwater analysis was the extrapolation of the Licking River discharge volumes to the McKenna Creek, Rocky Fork, and Blacklick Creek sub-watersheds. Licking River values were converted to per unit area yields (million gallons/mi^2) based upon the drainage area above the gage at Newark. Unit area yields were then applied to the McKenna Creek, Rocky Fork, and Blacklick Creek drainage areas to approximate the annual baseflow volume for each sub-watershed.

Table B-8 presents the values used in determining the annual baseflow volume in the McKenna Creek, Rock Fork, and Blacklick sub-basins.

Table B-8: Annual baseflow volume per sub-watershed

Year	Licking[1]		McKenna[2]	Rocky[2]	Blacklick[2]
	MG/yr	*MG/yr•mi²*	*MG/yr*	*MG/yr*	*MG/yr*
1990	140,229	261.13	343	8,179	16,522
1991	75,560	140.71	185	4,407	8,902
1992	53,757	100.11	132	3,136	6,334
1993	76,260	142.01	187	4,448	8,985
1994	65,627	122.21	161	3,828	7,732
1995	73,663	137.17	180	4,297	8,679
1996	104,398	194.41	255	6,089	12,300
1997	77,847	144.97	190	4,541	9,172
1998	69,654	129.71	170	4,063	8,207
1999	64,405	119.94	158	3,757	7,588
2000	55,717	103.76	136	3,250	6,565
2001	55,576	103.49	136	3,242	6,548
2002	60,312	112.31	148	3,518	7,106
2003	83,087	154.72	203	4,846	9,789
Median	71,658	133	175	4,180	8,443

1. Per unit area discharge is based upon a drainage area of 537 mi^2 (USGS, 2001).
2. Sub-basin drainage areas were determined via GIS analysis. The drainage areas for McKenna Creek, Rocky Fork, and Blacklick creek used to determine annual groundwater discharge were 1.31 mi^2, 31.32 mi^2, and 63.27 mi^2 respectively.

The groundwater phosphorus concentration was obtained from the DRINK database. DRINK stores the results of ambient groundwater quality information collected by the Ohio EPA Division of Drinking and Groundwater (DDAGW). Two DRINK ambient stations are located within the Blacklick sub-basin. The two stations are located at the Jefferson Water and Sewer District (JWSD) public supply well (Station #39FRA00234), and a well at a private residence (Station #39FRA00236). Of the two stations, the JWSD well was determined to be more representative of groundwater discharge to the sub-basins because of its geologic setting. The JWSD well resides in the sand and gravel buried valley aquifer that runs longitudinally along the general path of Blacklick Creek and Big Walnut Creek. The private residence well is in a sandstone aquifer. Overlay of the Big Walnut Creek stream network on the Ohio Dept. of Natural Resource's aquifer map reveals that while the uppermost reaches of Blacklick Creek may receive some groundwater discharge from a sandstone aquifer, the majority of groundwater discharge in all likelihood originates from the buried valley aquifer. As a result the JWSD station was used to represent the quality of groundwater discharge to

Blacklick Creek. Since no stations were located in the McKenna Creek or Rock Fork sub-watersheds, the JWSD was used to represent discharge quality in these sub-watersheds as well. Extrapolation out of the immediate sub-watershed is reasonable because very little variation in groundwater phosphorus concentration is expected.

Annual phosphorus loads were calculated via the following equation. Results of the calculations are presented in Table B-9.

$$L_G = V \bullet [TP_G] \bullet K_G$$

Where:

V	= Annual baseflow volume (MG/yr)
$[TP_G]$	= total phosphorus concentration in ground water (0.025 mg/l)
K_G	= unit conversion factor (8.3454)

Table B-9: Annual phosphorus groundwater load per sub-basin

Year	*lbs-TP/year*		
	McKenna[1]	**Rocky[1]**	**Blacklick[1]**
1990	72	1706	3447
1991	39	920	1857
1992	27	654	1321
1993	39	928	1875
1994	33	799	1613
1995	38	896	1811
1996	53	1270	2566
1997	40	947	1914
1998	36	848	1712
1999	33	784	1583
2000	28	678	1370
2001	28	676	1366
2002	31	734	1483
2003	42	1011	2042
Median:	37	872	1761

1. Loads are based upon a groundwater phosphorus concentration of 0.025 mg/l.

<u>Existing Load</u>:

The total existing load is the sum of the individual source loads. The surface runoff, point source, HSTS, and groundwater loads are summed to calculate the total quantity of phosphorus contributed to each sub-watershed in a year. For the source loads that are driven by precipitation (surface runoff and groundwater) the median annual load from the period 1990 to 2003 was used. The total existing load is therefore representative of a typical year, rather than one that is exceptionally wet or dry.

Table B-10 summarizes the individual source loads to each sub-watershed, and presents the total phosphorus load.

Table B-10: Annual phosphorus load to sub-basins

Sub-basin	*lbs-TP/year*					
	Surface Runoff[1]	**Point Source**	**Off-Lot Systems**	**Septic Systems**	**Ground-water[1]**	**Total**
McKenna	705	0	112	22	37	876
Rocky Fork	16,343	850	5,124	244	872	23,433
Blacklick	36,041	7,461	6,692	137	1,761	52,092

1. Median of 1990 to 2003 annual loads.

Loading Capacity:

The loading capacities of McKenna Creek, Rocky Fork, and Blacklick Creek were calculated as the product of the annual discharge volume for each sub-watershed and the phosphorus target concentration. This method only accounts for physical dilution as a means of assimilation. The method makes no attempt to account for the chemical and biological cycling of phosphorus through the system that could potentially increase the loading capacity of the streams. No accurate prediction of instream processing is possible without the development of a receiving stream model or extensive empirical data. For the purpose of this TMDL study, a receiving stream model was judged to be unnecessary, and available water quality data is insufficient for empirical methods. Any biological or chemical processing of phosphorus that occurs in the sub-basins is therefore considered an instrument of conservatism built into the method.

Annual discharge was estimated for each sub-watershed as the sum of the median surface runoff predicted by the Simple Method, the median groundwater discharge predicted by HYSEP, and total point source discharge volume. The contributions, total discharge volume, and loading capacity for each sub-watershed is presented in Table B-11.A. The percent reduction needed in each sub-watershed is presented in Table B-11.B.

Table B-11.A: Loading capacity per sub-basin

Sub-basin	*MG/year*				**Loading Capacity** *lbs-TP/year*
	Surface Runoff	**Ground-water Discharge**	**Point Source Discharge**	**Total Discharge**	
McKenna Creek[1]	226	175	0	401	368
Rocky Fork[2]	5,477	4,180	35	9,692	8,897
Blacklick Creek[2]	11,683	8,443	1,534	21,660	19,884

1. Loading capacity based upon target concentration of 0.07 mg-TP/l (Ohio EPA, 1999).
2. Loading capacity based upon target concentration of 0.11 mg-TP/l (Ohio EPA, 1999).

Table B-11.B: Percent reduction needed per sub-watershed			
Sub-basin	**Total Existing Load** *lbs-TP/year*	**Loading Capacity** *lbs-TP/year*	**Percent Reduction Needed**
McKenna Creek	876	368	58%
Rocky Fork	23,433	8,897	62%
Blacklick Creek	52,092	19,884	62%

TMDL and Allocation Calculation:

Total Maximum Daily Loads (TMDLs) can be expressed in mass per time, toxicity, or other appropriate measures. TMDLs can also be expressed in at varying temporal resolutions based upon the nature of the pollutant. Phosphorus TMDLs for the McKenna Creek, Rocky Fork Creek, and Blacklick Creek sub-watersheds are expressed in terms of mass per year, rather than per day as the TMDL nomen implies. This method of expression is consistent with the character of phosphorus, because it is the chronic, rather than acute, effect of nutrients that results in the degradation of water quality.

TMDLs are required to be allocated amongst known sources, both point and non-point. The load reserved for point sources is referred to as a wasteload allocation (WLA). The load reserved for non-point sources is a load allocation (LA). The TMDL is therefore the sum of the WLAs, LAs, and a margin of safety (MOS). The MOS is a portion of the TMDL set-aside to account for uncertainly in the method of calculation.

In the McKenna Creek, Rocky Fork Creek, and Blacklick Creek sub-watersheds WLAs were established for individual point source dischargers. The LAs include individual allocations for groundwater, surface runoff (including allocations for municipal separate storm sewer systems (MS4s)) and HSTSs. The method of calculation for each allocation is described in Table B-12.

Table B-12: Method of Allocation by Source

Source	Method of Allocation
Point Sources	Product of design effluent flow rate and 1.0 mg/l or 0.5 mg/l technology based phosphorus limit.
HSTSs	Home septic systems are allocated an annual phosphorus load of zero. The allocation for home aerator systems is the product of the existing load from aerators and the percent load reduction needed in the sub-watershed to achieve the TMDL.
Ground-water	Phosphorus loading from groundwater recharge is considered a natural condition. The groundwater phosphorus allocation is therefore equal to the existing groundwater load.
Surface Runoff	Allocation is equal to the sum of the point source WLA, HSTS allocation, groundwater allocation, and margin of safety subtracted from the loading capacity.
MS4s	MS4s are allocated a portion of the total surface runoff allocation. MS4s allocations are the product of the percentage of the sub-basin area occupied by MS4s and the sub-basin surface runoff allocation.
MOS	Ten percent of the loading capacity.

Allocated load are presented in the following three tables. Table B-13 presents point source WLAs, Table B-14 summarizes the all allocations and TMDLs, and Table B-15 presents the MS4 Allocations.

Table B-13: Phosphorus WLAs

Facility Name *NPDES* *Permit #*	**Design Q** *MDG*	**Permit Limit** TP *mg/l*	**WLA** TP *lbs/year*
Taylor Estates *4PA00001*	.025	1.0	76
Westerville Estates MHP *4PA00011*	0.07	1.0	213
Jefferson WSD WWTP Windrush Rd. *4PQ00001*	0	-	0
Jefferson WSD WWTP Wengert Rd. *4PQ00000*	0	-	0
Fairfield County WWTP Tussing Rd. 4PU00004	3.0	0.5	4,569
Modern MHP *4PV00114*	.004	1.0	12
By-Willow MHP *4PV00117*	0	-	0
Ohio-American Water Co. Blacklick Estates WWTP *4PU00002*	1.2	0.5	1,828

Table B-14: Summary of phosphorus allocations and TMDLs

Sub-basin	*lbs-TP/year*						
	Point Source	**Discharging Systems**	**Septic Systems**	**Surface Runoff**	**Ground-water**	**MOS**	**TMDL**
McKenna Creek	0	47	0	247	37	37	368
Rocky Fork	289	1,947	0	4,899	872	890	8,897
Blacklick Creek	6,409	2,543	0	7,183	1,761	1,988	19,884

Table B-15: MS4 phosphorus allocations

Sub-Watershed	MS4 Entity	HUC Area *mi^2*	Urbanized Area *mi^2*	Percent Urbanized	Surface Runoff LA *lbs/year*	MS4 Allocation *lbs/year*
McKenna Creek	-City of Columbus -City of Gahanna	1.3	1.3	100.0%	247	247
Rock Fork Creek	-City of Columbus -Village of New Albany -City of Gahanna -Jefferson Twsp. -Plain Twp.	31.3	16.4	52.3%	4,899	2,562
Blacklick Creek	-City of Columbus -Village of New Albany -Village of Brice -City of Gahanna -City of Pataskala -City of Reynoldsburg -City of Pickerington -Jefferson Twp. -Etna Twp.	63.3	35.4	55.6%	7,183	3,993

B.2 Pathogens

In the lower Big Walnut Creek watershed pathogen TMDLs were developed for 14-digit HUCs in which one or more stream segments were in non-attainment of their recreational use designation. Pathogen TMDLs were developed using fecal coliform bacteria as an indicator of the degree of pathogenic organism loading. TMDL development required the definition of the existing load, calculation of the loading capacity, and the allocation of the TMDL to the identified sources.

Recreational use designations are only applicable during the recreation season. The recreation season is defined as the period May 1 to October 15. Pathogen TMDLs for the lower Big Walnut Creek Watershed were developed for the stated recreation season, and are expressed in counts per recreation season.

The existing load was defined as the sum of the individual source loads. For the purpose of this study, surface runoff, point source discharge, home sewage treatment systems, cattle in stream, combined sewer overflow, sanitary sewer overflow, and upstream flow were considered potential sources. The method used to estimate each source load is presented below.

Surface Runoff

The method used to estimate the fecal coliform load from surface runoff assumes that the load is primarily dependent on three factors: surface accumulation, surface die-off, and the transport capacity of surface runoff.

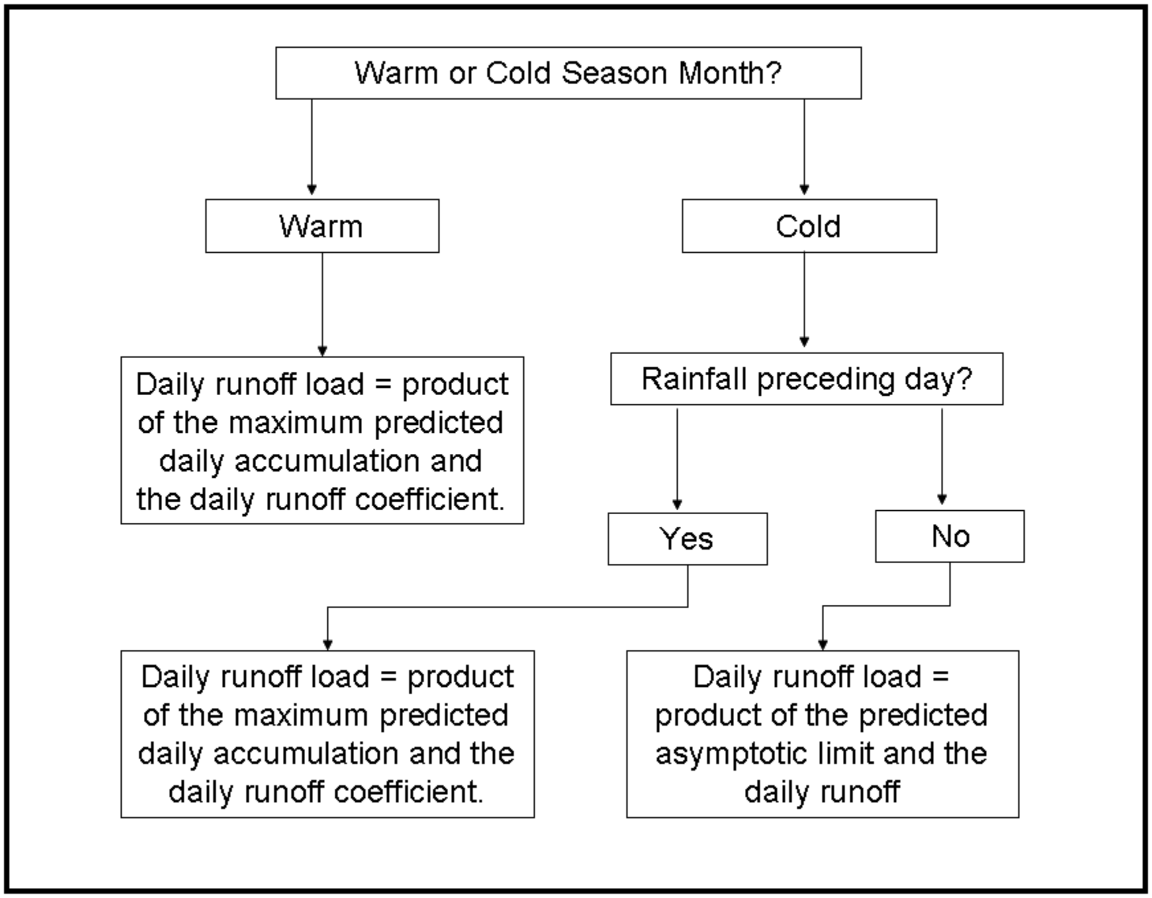
The accumulation, or build-up, of fecal coliform in each 14-digit HUC was estimated using the U.S. EPA's Bacteria Indicator Tool (BIT). The tool estimates the accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland). Although the output from BIT is designed to be used as an input to HSPF or BASINS, it was used in a stand-alone capacity for this study. See Section 4.2.2 for a full description of the implementation of BIT.

Surface die-off is approximated within BIT via a first order decay equation. Literature values for warm-weather (April - September) and cold-weather (October - March) die-off rate constants were used to calculate daily decay rates. The accumulation rate and decay rate were then used to calculate the asymptotic limit of build-up should no washoff occur.

The transport capacity of surface runoff was represented by a daily runoff coefficient. The runoff coefficient is a value between zero and one that represents the portion of accumulated bacteria that runs-off. The runoff coefficient is derived from daily precipitation data. Daily precipitation from the Midwest Regional Climate Center station number 331786, located at Port Columbus Airport, was used. Daily precipitation measurements from the period 1990 - 2003 were assigned a percentile rank based upon relative magnitude. A percentile rank of zero represents a day with no rainfall, while a rank of one represents the day of greatest rainfall. The percentile rank was then transformed to a runoff coefficient via a regression equation. The regression equation was defined by percentile rank endpoints at 0.10 and 0.75. Based upon literature values, and the best professional judgement of Ohio EPA staff, it was assumed that no washoff occurs during rain events of a magnitude less than 0.10 percentile rank. Additionally, it was assumed that during rain events of a magnitude greater than 0.75 percentile rank all accumulated bacteria will washoff. Using these two endpoints, runoff coefficients were interpolated for all other percentile rank values based upon an exponential relationship.

The fecal coliform load reaching the stream was calculated on a daily basis as the product of the runoff coefficient and the quantity of bacteria accumulated on the surface. The quantity of bacteria accumulated on the surface is dependent upon season and antecedent rainfall. Based upon the predictions of BIT, the cold-season asymptotic limit is 1.2 times the daily accumulation rate of fecal coliform; meaning should no washoff occur the previous day, the asymptotic limit will be reached. In warm-season months BIT predicts that the daily decay rate is greater than the daily accumulation rate, and therefore the quantity of fecal coliform available for washoff will never exceed the maximum daily accumulation. Based upon these predictions the algorithm depicted in Figure B-16 was developed to determine the daily fecal coliform load from surface runoff.

Figure B-16: Algorithm used to determine daily fecal coliform load from runoff



The fecal coliform load contributed via surface runoff was calculated for each day in the period 1990 to 2003. Daily loads were summarized by month, and the median monthly load was used to represent the existing condition. Median monthly loads for the period May to October were summed to determine the seasonal load. Fecal coliform loads from surface runoff are presented in Table B-17.

Table B-17: Monthly fecal coliform loads from surface runoff

Sub-Basin *14-Digit HUC*	*count/month*[1]						**Total** *count/season*
	May	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	4.70E+13	8.96E+12	8.35E+12	6.68E+12	8.17E+12	4.64E+13	**1.26E+14**
Rock Fork Creek *05060001-140-020*	1.14E+14	1.80E+13	1.68E+13	1.34E+13	1.65E+13	1.16E+14	**2.94E+14**
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	5.85E+13	1.32E+13	1.23E+13	9.88E+12	1.20E+13	7.43E+13	**1.80E+14**
Mason Run *05060001-140-040*	3.35E+13	7.68E+12	7.16E+12	5.74E+12	6.96E+12	4.23E+13	**1.03E+14**
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	1.93E+14	3.02E+13	2.81E+13	2.25E+13	2.77E+13	2.88E+14	**5.89E+14**
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	3.08E+13	6.84E+12	6.38E+12	5.10E+12	6.24E+12	4.01E+13	**9.55E+13**
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	1.53E+14	2.00E+13	1.86E+13	1.49E+13	1.84E+13	2.39E+14	**4.63E+14**
Alum Creek RM 19.80 to Mouth *05060001-160-020*	1.52E+14	3.19E+13	2.97E+13	2.38E+13	2.90E+13	2.03E+14	**4.70E+14**

1. Loads are median values for the period 1990-2003.

Point Source Dischargers:

The monthly fecal coliform load contributed via point source discharge was estimated by the following equation:

$$PL_i = Q_i \bullet [FC_i] \bullet K_P \bullet d_m$$

Where:

PL_i = Point source load from discharger *i* (cfu/month)
Q_i = Effluent flow rate for discharger *i* (MGD)
$[FC_i]$ = Effluent fecal coliform concentration for discharger *i* (cfu/100 ml)
K_P = unit conversion factor (3.7884×10^7)
d_m = days in month *m*

Monthly loads for the period May to October were summed to determine the seasonal load. Values used in the load calculation, along with their sources, are presented in Table B-18. The monthly and seasonal loads from each discharger are also presented in the table. Table B-19 aggregates the seasonal fecal coliform loads by 14-digit HUC.

Table B-18: Point source fecal coliform loads by discharger

Facility *STORET ID*	**Receiving Stream** *14-Digit HUC*	**Flow Value Used** *MGD*	**Flow Source**	**Month**	**[FC]** *cfu/ 100 ml*	**n[1]**	**[FC] Source**	**Load** *count/ month*	**Load** *count/ season*
Delaware County Alum Creek WWTP *4PK00003*	Alum Creek *05060001-160-020*	2.24	LEAPS[2] 50th Percentile 1998-2002	May	1	62	SWIMS Geometric Mean 2001-2003	3.38e+09	4.12E+10
				Jun	4	71		1.02e+10	
				Jul	4	93		9.48e+09	
				Aug	3	93		8.13e+09	
				Sep	2	90		4.82e+09	
				Oct	2	93		5.19e+09	
Ohio-American Water Co. Huber Ridge WWTP *4PU00000*	Alum Creek *05060001-160-020*	0.777	LEAPS[2] 50th Percentile 1998-2002	May	156	80	SWIMS Geometric Mean 1998-2003	1.42e+11	6.11E+11
				Jun	133	76		1.17e+11	
				Jul	112	80		1.02e+11	
				Aug	64	66		5.84e+10	
				Sep	108	77		9.57e+10	
				Oct	106	82		9.65e+10	
Jefferson WSD WWTP Windrush Rd. *4PQ00001*	Rocky Fork *05060001-140-020*	0.038	LEAPS[2] 50th Percentile 1998-2002	May	14	7	SWIMS Geometric Mean 1998-2003	6.07e+08	4.78E+09
				Jun	14	5		6.07e+08	
				Jul	10	6		4.50e+08	
				Aug	29	6		1.31e+09	
				Sep	33	7		1.41e+09	
				Oct	9	8		3.94e+08	
Taylor Estates *4PA00011*	Rocky Fork *05060001-140-020*	0.012	LEAPS[2] 50th Percentile 1998-2003	May	5	9	SWIMS Geometric Mean 1998-2003	7.24e+07	1.72E+09
				Jun	20	13		2.68e+08	
				Jul	9	13		1.23e+08	
				Aug	35	12		4.95e+08	
				Sep	10	13		1.43e+08	
				Oct	4	12		6.17e+07	
Westerville Estates MHP *4PV00002*	Rocky Fork *05060001-140-020*	0.043	LEAPS[2] 50th Percentile 1998-2002	May	46	5	SWIMS[3] Geometric Mean 1998-2003	2.31e+09	3.41E+10
				Jun	40	5		1.96e+09	
				Jul	411	6		2.07e+10	
				Aug	124	4		6.28e+09	
				Sep	17	5		8.11e+08	

Table B-18: Point source fecal coliform loads by discharger

Facility *STORET ID*	**Receiving Stream** *14-Digit HUC*	**Flow Value Used** *MGD*	**Flow Source**	**Month**	**[FC]** *cfu/ 100 ml*	**n[1]**	**[FC] Source**	**Load** *count/ month*	**Load** *count/ season*
				Oct	40	4		2.01e+09	
Jefferson WSD WWTP Wengert Rd. *4PQ00000*	Blacklick Creek *05060001-140-050*	0.142	LEAPS[2] 50th Percentile 1998-2002	May	116	27	SWIMS[3] Geometric Mean 1998-2003	1.93e+10	5.42E+10
				Jun	22	19		3.61e+09	
				Jul	78	20		1.30e+10	
				Aug	23	22		3.84e+09	
				Sep	37	21		5.99e+09	
				Oct	50	21		8.41e+09	
Fairfield County WWTP - Tussing Rd. *4PU00004*	Blacklick Cr. *05060001-140-050*	1.177	LEAPS[2] 50th Percentile 1998-2002	May	14	79	SWIMS[3] Geometric Mean 1998-2003	1.93e+10	2.83E+11
				Jun	14	74		1.87e+10	
				Jul	1	80		1.85e+09	
				Aug	46	78		6.30e+10	
				Sep	53	76		7.12e+10	
				Oct	79	81		1.09e+11	
Modern MHP *4PV00114*	Trib. To Blacklick Cr. RM 12.89 *05060001-140-050*	0.004	Design Flow	May	200	-	Temp.[4]	9.39e+08	5.58E+09
				Jun	200	-		9.08e+08	
				Jul	200	-		9.39e+08	
				Aug	200	-		9.39e+08	
				Sep	200	-		9.08e+08	
				Oct	200	-		9.39e+08	
By-Willow MHP *4PV00117*	Trib. To Blacklick Cr. RM 12.89 *05060001-140-050*	0.004	Design Flow	May	200	-	Temp.[4]	9.39e+08	5.58E+09
				Jun	200	-		9.08e+08	
				Jul	200	-		9.39e+08	
				Aug	200	-		9.39e+08	
				Sep	200	-		9.08e+08	
				Oct	200	-		9.39e+08	
Ohio-American Water Co. Blacklick Estates WWTP *4PU00002*	Blacklick Cr. *05060001-140-060*	0.887	LEAPS[2] 50th Percentile 1998-2002	May	268	79	SWIMS[3] Geometric Mean 1998-2003	2.78e+11	1.82E+12
				Jun	322	65		3.25e+11	
				Jul	402	78		4.19e+11	
				Aug	291	79		3.03e+11	
				Sep	334	78		3.37e+11	
				Oct	156	67		1.62e+11	

1. Number of observation
2. Liquid Effluent Analysis Processing System, an Ohio EPA data system that maintains an inventory of discharger information, including effluent quantity and quality. The data system follows protocols established by Ohio EPA for the analysis and reduction of effluent monitoring information.
3. Surface Water Information Management Systems, an Ohio EPA data system that tracts information regarding NPDES permits and facilities including effluent monitoring information.
4. No fecal coliform monitoring data available. Concentration is the best professional judgement Ohio EPA Division of Surface Water staff based upon knowledge of operations at the discharging facility. The concentration is to serve as temporary representation of effluent quality until such time that monitoring data is available.

Table B-19: Fecal coliform loads from point source dischargers by 14-digit HUC

Sub-Basin *14-Digit HUC*	**Dischargers**	**Load** *count/season*
Rock Fork Creek *05060001-140-020*	•Jefferson W&SD Windrush WWTP •Taylor Estates WWTP •Westerville Estates MHP WWTP	**4.06E+10**
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	•Jefferson W&SD Wengert WWTP •Tussing Rd. WWTP •By Willow MHP WWTP •Modern WWTP	**3.49E+11**
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	•Blacklick Estates WWTP	**1.82E+12**
Alum Creek RM 19.80 to Mouth *05060001-160-020*	•Alum Creek WWTP •Huber Ridge WWTP	**6.52E+11**

Home Sewage Treatment Systems

The method used to determine the fecal coliform load from HSTSs involved the following steps. Areas served by central sewer systems were differentiated from areas that were not. Areas not served by central sewer systems were assumed unsewered. The number of parcel lots in unsewered areas were counted, and one HSTS per parcel lot was assumed. HSTSs were then identified as either discharging or septic systems. Finally, the fecal coliform load from failing off-lot and septic systems was calculated.

Areas served by central sewer systems were identified by examining the service area maps of various municipal and private collection systems. The municipal and private collection systems considered in each 14-digit HUC are listed in Table B-20.A. As previously stated, any watershed area not covered by one of the entities listed was assumed unsewered. The number of parcel lots in unsewered areas were counted, and one HSTS per parcel lot was assumed.

In Delaware County an additional step was required to determine the number of HSTS. No service area map was provided for Delaware County's collection system, so census data was used to estimate the number of HSTS. In Delaware County the number of parcel lots in each sub-watershed was determined. Next, the 1990 census block group in which each parcel resides was identified. From the 1990 census block group demographics, the percent of homes in the block group that were unsewered was determined. This percentage was applied to the number of parcel lots in the block group to calculate the number of HSTSs.

The second step was to differentiate between discharging and septic systems. In Franklin County the number of discharging systems in each 14-digit HUC was provided by the Franklin County Board of Health (Franklin BOH). In Licking County the number of discharging systems was referenced from the Scioto River Basin and Blacklick Creek Water Quality Management Plan (Ohio EPA, 2002). In Delaware County the number of discharging systems was estimated as the product of the total number of HSTSs in each 14-digit HUC and the ratio of off-lot to septic systems in Delaware County. The ratio of discharging systems in Delaware County was referenced from the Delaware County HSTS Management Plan (Delaware County, 2005). In all counties, the number of septic systems was estimated as the difference of the number of HSTS in each 14-digit HUC and the number of discharging systems. In 14-digit HUCs where the number of discharging systems was greater than estimated number of HSTSs, it was assumed that there were no septic systems. Table B-20.B presents the estimated number of HSTS, the number of discharging systems, and the number of septic systems per 14-digit HUC.

The third step required failing systems to be differentiated from systems that are operating normally. For the purpose of this report, all discharging systems were assumed to be failing. The number of failing septic systems was estimated the product of the number of septic systems in each 14-digit HUC and a failure rate. The failure rate, 20%, was referenced from the U.S. EPA's Onsite Wastewater Treatment Systems Manual (U.S. EPA, 2002).

Calculation of the seasonal fecal coliform load from failing HSTSs was the final step. The seasonal fecal coliform load was calculated as the product of the number of failed systems, the number of persons per system, a daily per capita fecal coliform loading rate, and the number of days in the recreation season. The number of persons per systems was determined from block group census data. The per capita fecal coliform loading rate, $1x10^8$ counts/day, was a literature value (Metcalf & Eddie, 1991). The number of days in the recreation season, 168, is the number of days between May 1st and October 15th. The discharging, septic, and total fecal-coliform loads are presented in Table B-20.C.

Table B-20.A: Sewer service areas considered

14-Digit HUC	Sewer Service Area
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	•City of Columbus •Huber Ridge •Jefferson Twp.
Rock Fork Creek *05060001-140-020*	•City of Columbus •Jefferson Twp.
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	•Blacklick Estates •City of Columbus •Jefferson Twp.
Mason Run *05060001-140-040*	•City of Columbus
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	•City of Columbus •Fairfield County - Tussing Road •Jefferson Twp. •City of Pickerington •SW Licking County
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	•Blacklick Estates •City of Columbus
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	•City of Columbus
Alum Creek RM 19.80 to Mouth *05060001-160-020*	•Huber Ridge •City of Columbus

Table B-20.B: HSTS, off-lots systems, and septic systems per county

14-Digit HUC	Total HSTSs			Discharging Systems			Septic Systems			Total Systems	
	DELAWARE	FRANKLIN	LICKING	DELAWARE	FRANKLIN	LICKING	DELAWARE	FRANKLIN	LICKING	DISCHARGING	SEPTIC
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	-	389	-	-	168[2]	-	-	221	-	168	221
Rock Fork Creek *05060001-140-020*	159	213	-	28[1]	523[2]	-	131	-	-	551	131
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	-	571	-	-	43[2]	-	-	528	-	43	528
Mason Run *05060001-140-040*	-	54	-	-	33[2]	-	-	21	-	33	21
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	2	10	394	-	366[2]	350[3]	2	-	44	716	46
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	-	182	-	-	140[2]	-	-	42	-	140	42
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	2764	-	-	488[1]	-	-	22761	-	-	488	2276
Alum Creek RM 19.80 to Mouth *05060001-160-020*	1034	308	-	182[1]	202[2]	-	852	106	-	384	958

1. Product of the number of HSTSs and the ratio of off-lots to septic systems in Delaware Co. (3,000:17,000)
2. Quoted by Franklin BOH
3. Referenced from Scioto River Basin and Blacklick Creek Water Quality Management Plan (Ohio EPA, 2002)

Table B-20.C: Off-lot system, septic system, and total HSTS fecal coliform loads

14-Digit HUC	Total Systems		Failed Systems		PERSONS/SYSTEM	Fecal Coliform Load (*count/season*)		
	DISCHARGING	SEPTIC	DISCHARGING	SEPTIC		DISCHARGING	SEPTIC	TOTAL
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	168	221	168	44	2.27	6.41E+12	1.69E+12	8.10E+12
Rock Fork Creek *05060001-140-020*	551	131	551	26	2.83	2.62E+13	1.25E+12	2.74E+13
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	43	528	43	106	2.23	1.61E+12	3.96E+12	5.57E+12
Mason Run *05060001-140-040*	33	21	33	4	2.22	1.23E+12	1.57E+11	1.39E+12
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	716	46	716	9	2.88	3.46E+13	4.41E+11	3.51E+13
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	140	42	140	8	2.45	5.77E+12	3.46E+11	6.11E+12
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	488	2276	488	455	2.98	2.44E+13	2.28E+13	4.72E+13
Alum Creek RM 19.80 to Mouth *05060001-160-020*	384	958	384	192	2.89	1.86E+13	9.29E+12	2.79E+13

<u>Cattle in Stream</u>:

The fecal coliform load from cattle in stream, which refers to grazing cattle with stream access, was calculated within the BIT model. For a detailed description of the implementation of the BIT model, please see Section x.x. The fecal coliform load from cattle in stream is the product of the number of animals and a per animal fecal coliform loading rate. The number of animals was estimated from county wide figures. The per animal loading rate is a literature value. Table B-21 presents the fecal coliform load from cattle in streams. Note that cattle in stream was considered a significant source of fecal coliform loading in only HUCs 05060001140020, 05060001140050, and 05060001160010.

Table B-21: Fecal coliform load from cattle in stream by 14-digit HUC

Month	**05060001-140-020**		**05060001-140-050**		**15060001-160-010**	
	Cattle in Stream[1]	Load[2] *count/month*	Cattle in Stream[1]	Load[2] *count/month*	Cattle in Stream[1]	Load[2] *count/month*
May.	11	3.55E+13	18	5.80E+13	12	3.87E+13
Jun.	16	4.99E+13	27	8.42E+13	18	5.61E+13
Jul.	16	5.16E+13	27	8.70E+13	18	5.80E+13
Aug.	16	5.16E+13	27	8.70E+13	18	5.80E+13
Sep.	11	3.43E+13	18	5.61E+13	12	3.74E+13
Oct.	11	3.55E+13	18	5.80E+13	12	3.87E+13
Total:	**-**	**2.58E+14**	**-**	**4.30E+14**	**-**	**2.87E+14**

1. Values are estimations based upon information entered into the grazing worksheet of BIT.
2. Values are based upon a per animal loading rate of 1.04E+13 counts per animal •day (ASAE, 1998).

<u>Combined Sewer Overflows</u>:

One combined sewer overflow (CSO) outfall exists in the lower Big Walnut Creek watershed. The CSO outfall is located on Alum Creek at RM 7.10 in HUC 05060001160020. During storm events the outfall may become active, discharging effluent with limited primary treatment from the Alum Creek Storm Tanks. The CSO outfall has been monitored since 1986 as part of the Columbus Southerly WWTP NPDES requirements. Table B-22 presents reported overflow volume and estimated fecal coliform loads from the CSO outfall (Columbus Southerly outfall 006) summarized by month for 1990-2003. The monthly fecal coliform load contributed by overflow events is the product of the average monthly overflow volume, and a literature value for the concentration of fecal coliform in combined sewage. The seasonal load is the sum of the monthly loads from the period May to October.

Table B-22: Reported overflow volume from Columbus Southerly outfall

Year	*Million Gallons*						Season Total
	May	**June**	**July**	**August**	**Septembe**	**October**	
1990	0.44	24.20	11.32	0.06	0.32	0.53	
1991	0.41	0.07	0.47	0.00	0.12	0.00	
1992	0.06	0.00	16.90	4.86	0.00	0.00	
1993	0.00	0.24	20.90	0.00	0.00	0.00	
1994	0.00	0.00	0.80	0.00	0.00	0.00	
1995	1.00	3.20	17.52	48.30	0.00	0.00	
1996	6.00	0.00	15.40	0.00	4.70	0.00	
1997	1.40	83.50	0.00	6.30	0.00	0.00	
1998	0.00	7.90	0.00	0.00	0.00	0.00	
1999	0.00	1.00	0.00	1.00	0.00	0.00	
2000	2.90	0.40	1.70	3.80	2.80	0.00	
2001	14.40	0.00	2.40	7.20	0.00	0.00	
2002	4.90	7.60	18.60	1.60	0.58	1.30	
2003	1.50	7.45	0.00	6.21	16.00	0.00	
Average Overflow: *MG*	2.36	9.68	7.57	5.67	1.75	0.13	27.16
Fecal Coliform: Load[2] *count/month*	6.23E+13	2.56E+14	2.00E+14	1.50E+14	4.62E+13	3.45E+12	**6.68E+14**

1. NPDES permit number 4PF0001
2. Load is based upon 650,000 cfu in combined sewage (Metcalf & Eddie, 1991).

Sanitary Sewer Overflow:

In 2002 the City of Columbus Division of Sewerage and Drainage (DSD) implemented a “chalk and block” system to monitor the occurrence of sanitary sewer overflow (SSO) events from their sewage collection system. Based upon this system the Columbus DSD reported 19 overflow events occurred in 2002 that discharged to HUC 05060001-1600-20 (Col. Dept. Of Public Utilities, 2003). Limited overflow volume information is available to characterize these events. In 2003 the Columbus DSD installed electronic flow monitoring devices in 40 of its known sanitary sewer overflow points, 10 of which discharge to HUC 05060001-160-020. Based upon the “chalk and block” system and information from the flow monitoring devices, the Columbus DSD reported 91 overflow events to HUC 05060001-160-020 in 2003 (Col. Dept. Of Public Utilities, 2004). Overflow volume information characterizing these events is presented in Table B-23.

The total overflow volume reported in Table B-23 does not equal the total volume discharged to Alum Creek in 2003. Overflow events occurred that were not measured and consequently not reported with the results. However, the volume measurements presented in Table C-8 are the best data available to quantify the magnitude of SSO events. The results also represent a substantial improvement in the reporting of SSO events from previous years. While the data is limited, and only reflective of 2003, it was used to estimate the fecal coliform load contributed to HUC 05060001-160-020. Columbus DSD is currently collecting additional data, and has also contracted the modeling of its collection system to more accurately predict overflow activation and magnitude. Completion of the modeling project and future data collection may allow for a more accurate calculation of the fecal coliform load from SSO.

SSO may be composed of both municipal sewage and rain derived infiltration/inflow (RDI). RDI could potentially dilute the overall fecal coliform concentration in SSO; however, it is impossible to determine relative fractions of municipal sewage and RDI based on available information. As a result, the fecal coliform load from SSO is the product of reported SSO volume and the concentration of fecal coliform in municipal sewage. The concentration of fecal coliform in municipal sewage is a literature value. Dilution due to RDI is considered a measure of conservatism in the method. Monthly fecal coliform loads from SSO to HUC 05060001160020 are presented in Table B-24.

Table B-23: Reported SSO event volumes to HUC 05060001160020 in 2003

Date	**Reported Overflow Volume** (*gallons*)								
	SSO 177	SSO 185	SSO 199	SSO 224	SSO 279	SSO 305	SSO 306	SSO 312	SSO 315
4/30	50,392	-	-	-	-	-	-	-	-
5/7	143,480	-	-	-	-	-	-	-	-
5/20	-	-	-	-	-	16,558	-	-	-
6/13	327,863	1,253	27,602	-	-	-	-	-	-
6/14	84,158	-	-	-	-	-	-	-	-
8/3	4,133	-	-	-	-	162,176	-	-	-
8/4	185,406	-	-	-	-	542,592	4,811	-	1,811
8/6	-	-	-	-	-	171,706	-	-	-
8/15	129,874	19,265	1,071	8,377,401	-	-	-	-	-
8/27	-	-	-	-	-	280,757	-	-	-
8/29	19,088	-	-	-	-	-	-	-	-
8/30	1,215,084	192,920	332,207	1,055,710	57,667	2,500,211	56,365	30,108	42,083
9/1	414,662	-	5,832	-	-	1,652,293	39,279	7,096	26,834
9/2	141,940	-	-	-	-	1,170,329	18,673	-	11,563
9/3	-	-	-	-	-	420,769	7,099	-	2,485
9/22	10,142	-	-	-	-	204,828	-	-	-
9/26	17,999	-	-	-	-	-	-	-	-
9/27	79,780	-	-	-	-	797,264	6,105	-	4,086
Total:	2.82	0.21	0.37	9.43	0.06	7.92	0.13	0.04	0.09

Table B-24: Monthly fecal coliform loads from SSO to HUC

Month	Overflow Volume *MG*	Fecal Coliform Load[1] *count/month*
May	0.16	6.506E+12
June	0.44	1.67E+13
July	0.00	0.00
August	15.38	6.25E+15
September	5.04	1.91E+15
October	0.00	0.00
Total:	21.02	**8.54E+15**

1. Load based upon 1E+07 cfu in municipal sewage (Metcalf & Eddie, 1991)

Upstream Load:

The fecal coliform load contributed to each HUC is the product of upstream flow volume and the instream fecal coliform target. Upstream flow volume was determined either directly from a USGS gage or estimated via a per unit area yield calculation for the contributing drainage area. The instream fecal coliform target was used to represent upstream water quality in order to balance the calculated existing load with the upstream TMDL allocation. Were a receiving model employed, and each load was distributed rather than lumped, the existing upstream load could be more accurately represented by using observed instream data. However, considering the limitations of the method described herein (which defines attainment by the water quality target), the upstream load must be calculated using the target so the impact of local loads are not diminished by that of upstream loads. Additionally, use of the target concentration rather than the observed concentration adds conservatism to the method, because the observed instream concentrations were lower than the target in all instances.

The method used to determine upstream flow volume is presented in Table B-25. The observed instream fecal coliform concentrations and the target concentrations used in the load calculation are presented in Table B-26. The estimated fecal coliform loads from upstream flow are presented in Table B-27.

Table B-25: Method used to determine upstream flow

Sub-Basin *14-Digit HUC*	**Origin of Upstream Flow**	**Calculation of Upstream Flow**
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001140010*	•Hoover Reservoir	•Measured directly at USGS gage#03228500, Big Walnut Creek at Central College, OH.
Big Walnut Creek RM 29.00 to RM 15.50 *05060001140030*	•Hoover Reservoir •05060001140010 •05060001140020	•Upstream flow equals the sum of flow from Hoover Reservoir and runoff from the contributing drainage area. Runoff calculated as the product of the contributing drainage area and a per unit area yield. Per unit area yield calculated at downstream gage #03228690.
Blacklick Creek Rm 8.2 to Mouth *05060001140060*	•05060001140050	•Upstream flow equals the runoff from the contributing drainage area. Runoff calculated as the product of the contributing drainage area and a per unit area yield. Per unit area yield calculated at downstream gage #03228690.
Alum Creek Alum Creek Lake to RM 19.80 *05060001160010*	•Alum Creek Lake	•Measured directly at USGS gage #03228805, Alum Creek at Africa, OH.
Alum Creek RM 19.8 to Mouth *05060001160020*	•Alum Creek Lake •05060001140010	•Upstream flow equals the sum of flow from Alum Creek Lake and runoff from the contributing drainage area. Runoff calculated as the product of the contributing drainage area and a per unit area yield. Per unit area yield calculated at downstream gage #03229000.

Table B-26: Upstream observed instream fecal coliform concentrations

	Instream Fecal Coliform in cfu				
Represents Flow From:	**Alum Creek Lake**	**05060001-160-010**	**Hoover Reservoir**	**05060001-040-010**	**05060001-140-050**
Site Location:	Alum Cr. RM 22.10	Alum Cr. RM 19.80	BWC RM 37.20	BWC RM 28.30	Blacklick Cr. RM 8.80
STORET ID:	V05W25	V05W24	V05S47	V05S45	V05P15
06/23/2000	220	320	70	50	-
06/27/2000	-	-	-	-	845
07/12/2000	-	-	-	-	-
07/13/2000	-	-	30	135	-
07/17/2000	-	-	-	-	470
07/26/2000	700	170	-	-	-
07/31/2000	-	-	10	1800	1100
08/09/2000	360	320	-	-	-
08/15/2000	-	-	-	-	290
08/10/2000	-	-	2500	20000	-
08/23/2000	500	300	140	450	-
08/28/2000	-	-	-	-	1000
Geometric Mean:	408	269	95	642	662
Target Concentration Used:	**1000**	**1000**	**1000**	**1000**	**1000**

Table B-27: Monthly fecal coliform loads from upstream flow

Sub-Basin *14-Digit HUC*	Month	Observed Upstream Flow	Upstream DA	Unit Area Yield[1] *MGM/ mi²*	Discharge Volume *MGM*	Total Upstream Flow *MGM*	Fecal Coliform Load	
		MGM	*mi²*				*count/ month*	*count/ season*
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	May	6188	-	-	-	6188	2.34E+1	9.79E+14
	Jun	6373		-	-	6373	2.41E+1	
	Jul	4475		-	-	4475	1.69E+1	
	Aug	3567		-	-	3567	1.35E+1	
	Sep	2576		-	-	2576	9.75E+1	
	Oct	2677		-	-	2677	1.01E+1	
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	May	6188	46.4	26.55	1232	7421	2.81E+1	1.18E+15
	Jun	6373		25.76	1195	7568	2.86E+1	
	Jul	4475		29.08	1349	5824	2.20E+1	
	Aug	3567		17.69	821	4388	1.66E+1	
	Sep	2576		6.93	321	2897	1.10E+1	
	Oct	2677		9.61	446	3123	1.18E+1	
Blacklick Creek Rm 8.2 to Mouth *0506000-114-0060*	May	-	50.6	26.55	1344	1344	5.08E+1	2.21E+14
	Jun	-		25.76	1304	1304	4.93E+1	
	Jul	-		29.08	1471	1471	5.57E+1	
	Aug	-		17.69	895	895	3.39E+1	
	Sep	-		6.93	350	350	1.33E+1	
	Oct	-		9.61	487	487	1.84E+1	
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	May	3330	-	-	-	3330	1.26E+1	4.01E+14
	Jun	2541		-	-	2541	9.62E+1	
	Jul	2618		-	-	2618	9.91E+1	
	Aug	664		-	-	664	2.51E+1	
	Sep	265		-	-	265	1.00E+1	
	Oct	1167		-	-	1167	4.42E+1	
Alum Creek RM 19.8 to Mouth *05060001-160-020*	May	3330	24.5	37.65	923	4253	1.61E+1	5.49E+14
	Jun	2541		41.19	1009	3551	1.34E+1	
	Jul	2618		37.60	921	3539	1.34E+1	
	Aug	664		20.71	507	1171	4.43E+1	
	Sep	265		10.24	251	516	1.95E+1	
	Oct	1167		12.41	304	1471	5.57E+1	

1. Value is calculated at a downstream gage. Flow record for the period Jan. 1990 to Sep. 1998 was used. More recent flow data was unavailable because the downstream Alum Creek gage was discontinued in 1998.

Existing Load:

The total existing load is equal to the sum of the individual source loads. A summary of the individual source loads and the total existing load is presented in Table B-28.

Table B-28: Summary of fecal coliform source loads

Sub-Basin *14-Digit HUC*	*count/season*								
	Surface Runoff	**Point Source**	**Dis-charging Systems**	**Septic Systems**	**Cattle**	**CSO**	**SSO**	**Up-Stream**	**Total**
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	1.26E+14	-	6.41E+12	1.69E+12	-	-	-	9.79E+14	1.11E+15
Rock Fork Creek *05060001-140-020*	2.94E+14	4.06E+10	2.62E+13	1.25E+12	2.58E+14	-	-	-	5.79E+14
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	1.80E+14	-	1.61E+12	3.96E+12	-	-	-	1.18E+15	1.37E+15
Mason Run *05060001-140-040*	1.03E+14	-	1.23E+12	1.57E+11	-	-	-	-	1.04E+14
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	5.89E+14	3.49E+11	3.46E+13	4.41E+11	4.30E+14	-	-	-	1.05E+15
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	9.55E+13	1.82E+12	5.77E+12	3.46E+11	-	-	-	2.21E+14	3.24E+14
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	4.63E+14	-	2.44E+13	2.28E+13	2.87E+14	-	-	4.01E+14	1.20E+15
Alum Creek RM 19.80 to Mouth *05060001-160-020*	4.70E+14	6.52E+11	1.86E+13	9.29E+12	-	6.68E+14	8.54E+15	5.49E+14	1.03E+16

Loading Capacity:

The fecal coliform loading capacity represents the load each 14-digit HUC can receive and still maintain instream water quality standards. Loading capacity was calculated as the product of the discharge volume from each 14-digit HUC and the fecal coliform target concentration. The monthly discharge volume from each 14-digit HUC is the sum of the upstream flow to the HUC, surface runoff, and discharged effluent volume. The fecal coliform target concentration is derived from OAC 3745-07-01 Table 7-1. The monthly fecal coliform loading capacity for each 14-digit HUC is presented in Table B-29.A. The percent reductions are shown in Table B-29.B

This method only considers physical dilution as a means of assimilation. The method makes no attempt to account for the effect of instream processes such as growth, die-off, settling, and re-suspension. No accurate prediction of such processes is possible without extensive empirical data of the implementation of a receiving stream model. Insufficient empirical data was available for a more detailed analysis, and a receiving stream model was judged unnecessary for the purpose of this study.

Table B-29.A: Fecal coliform loading capacity

Sub-Basin *14-Digit HUC*	**Month**	*MG*				**Loading Capacity**[1]	
		Upstream Flow	**Surface Runoff**	**NPDES Discharge Volume**	**Total**	*count/ month*	*count/ season*
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	May	6188	422	0	6610	2.5E+14	1.05E+15
	Jun	6373	409	0	6782	2.57E+14	
	Jul	4475	462	0	4937	1.87E+14	
	Aug	3567	281	0	3848	1.46E+14	
	Sep	2576	110	0	2686	1.02E+14	
	Oct	2677	153	0	2830	1.07E+14	
Rocky Fork Creek *05060001-140-020*	May	0	809	3	812	3.07E+13	1.34E+14
	Jun	0	785	3	788	2.98E+13	
	Jul	0	886	3	889	3.37E+13	
	Aug	0	539	3	542	2.05E+13	
	Sep	0	211	3	214	8.1E+12	
	Oct	0	293	3	296	1.12E+13	
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	May	7768	607	0	8375	3.17E+14	1.34E+15
	Jun	7905	589	0	8494	3.22E+14	
	Jul	6205	665	0	6870	2.6E+14	
	Aug	4621	404	0	5025	1.9E+14	
	Sep	2990	158	0	3148	1.19E+14	
	Oct	3251	220	0	3471	1.31E+14	
Mason Run *05060001-140-040*	May	0	346	0	346	1.31E+13	5.70E+13
	Jun	0	336	0	336	1.27E+13	
	Jul	0	379	0	379	1.43E+13	
	Aug	0	231	0	231	8.74E+12	

Table B-29.A: Fecal coliform loading capacity

Sub-Basin *14-Digit HUC*	**Month**	*MG*				**Loading Capacity**[1]	
		Upstream Flow	**Surface Runoff**	**NPDES Discharge Volume**	**Total**	*count/ month*	*count/ season*
	Sep	0	90	0	90	3.41E+12	
	Oct	0	125	0	125	4.73E+12	
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	May	0	1343	41	1384	5.24E+13	2.31E+14
	Jun	0	1303	40	1343	5.08E+13	
	Jul	0	1470	41	1511	5.72E+13	
	Aug	0	894	41	935	3.54E+13	
	Sep	0	350	40	390	1.48E+13	
	Oct	0	486	41	527	1.99E+13	
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	May	1384	341	93	1818	6.88E+13	3.07E+14
	Jun	1313	331	90	1734	6.56E+13	
	Jul	1511	374	93	1978	7.49E+13	
	Aug	935	227	93	1255	4.75E+13	
	Sep	390	89	90	569	2.15E+13	
	Oct	527	124	93	744	2.82E+13	
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	May	3330	923	0	4253	1.61E+14	5.49E+14
	Jun	2541	1009	0	3550	1.34E+14	
	Jul	2618	921	0	3539	1.34E+14	
	Aug	664	507	0	1171	4.43E+13	
	Sep	265	251	0	516	1.95E+13	
	Oct	1167	304	0	1471	5.57E+13	
Alum Creek RM 19.80 to Mouth *05060001-160-020*	May	4253	1978	342	6573	2.49E+14	9.44E+14
	Jun	3551	2164	331	6046	2.29E+14	
	Jul	3540	1976	342	5858	2.22E+14	
	Aug	1171	1088	342	2601	9.85E+13	
	Sep	516	538	331	1385	5.24E+13	
	Oct	1471	652	342	2465	9.33E+13	

1. Based upon target concentration of 1000 cfu per 100 ml.

Table B-29.B: Percent reduction needed

Sub-Basin *14-Digit HUC*	**Existing Load** *count/season*	**Loading Capacity** count/season	**Percent Reduction Needed**
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	1.11E+15	1.05E+15	5.4%
Rock Fork Creek *05060001-140-020*	5.79E+14	1.34E+14	76.9%
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	1.37E+15	1.34E+15	2.2%
Mason Run *05060001-140-040*	1.04E+14	5.70E+13	45.2%
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	1.05E+15	2.31E+14	78.0%
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	3.24E+14	3.07E+14	5.3%
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	1.20E+15	5.49E+14	54.3%
Alum Creek RM 19.80 to Mouth *05060001-160-020*	1.03E+16	9.44E+14	90.8%

TMDLs and Allocations:

Total Maximum Daily Loads (TMDLs) can be expressed in mass per time, toxicity, or other appropriate measures. TMDLs can also be expressed in at varying temporal scales based upon the nature of the pollutant. Fecal coliform TMDLs for 14-digit HUCs in the lower Big Walnut Creek watershed are expressed in terms of counts per season, rather than per day as the TMDL nomen implies. This method of expression was chosen because of the temporal compatibility with the fecal coliform water quality standards outlined in OAC 3745-1-07.

TMDLs are required to be allocated amongst known sources; both point and non-point. The load reserved for point sources is referred to as a wasteload allocation (WLA). The load reserved for non-point sources is a load allocation (LA). The TMDL is the sum of the WLAs, LAs, and a margin of safety (MOS). The MOS is a portion of the TMDL set-aside to account for uncertainly in the method of calculation.

In the lower Big Walnut Creek watershed fecal coliform WLAs were established for individual point source dischargers, HSTSs, CSO, and SSO. LAs were established for surface runoff, including a separate allocation for municipal separate storm sewer systems (MS4s). Additionally, a portion of the TMDL was set-aside for fecal coliform loading from upstream flow. The method of calculation for each allocation is described in Table B-30.

Table B-30: Method of Allocation by Source

Source	Method of Allocation
Point Sources	Product of design effluent flow rate and 1000 counts/100 ml permit limit.
HSTSs	Home septic systems are allocated load of zero. The allocation for discharging systems is the product of the existing load from discharging systems and the percent load reduction needed in the sub-watershed to achieve the TMDL.
CSO	The allocation for CSO is the product of the existing CSO load and the percent reduction needed in the 14-digit HUC.
SSO	SSO is allocated a fecal coliform load of zero.
Surface Runoff	LA is equal to the sum of the allocations for point sources, HSTSs, and upstream flow subtracted from the loading capacity.
Upstream Flow	Product of monthly upstream flow volume and the fecal coliform WQS of 1000 counts/100 ml.
MS4s	MS4s are allocated a portion of the total LA. MS4s allocations are the product of the percentage of the sub-basin area occupied by MS4s and the sub-basin surface runoff allocation.

The WLAs for individual point sources, and the aggregate WLA for each 14-digit HUC are presented in Table B-31. The TMDL set-aside for loading from upstream flow is presented in Table B-32. Fecal coliform allocations and TMDLs are summarized in Table B-33. Finally, fecal coliform allocations for MS4s are presented in Table B-34.

Table 5.2.F: Point Source Allocations for HUC 05060001-140

Facility Name *NPDES* *Permit #*	**Design Q** *MDG*	FC Permit Limit *cfu*	FC WLA *count/season*
Taylor Estates *4PA00001*	.025	1000	1.59E+11
Westerville Estates MHP *4PA00011*	0.07	1000	4.45E+11
Jefferson WSD WWTP Windrush Rd. *4PQ00001*	0	-	0
Jefferson WSD WWTP Wengert Rd. *4PQ00000*	0	-	0
Fairfield County WWTP Tussing Rd. 4PU00004	3.0	1000	1.91E+13
Modern MHP *4PV00114*	.004	1000	2.54E+10
By-Willow MHP *4PV00117*	0	-	0
Ohio-American Water Co. Blacklick Estates WWTP *4PU00002*	1.2	1000	7.63E+12
Delaware Co. Alum Creek WWTP *4PK00003*	10	1000	6.36E+13
Ohio-American Water Co. Huber Ridge WWTP *4PU00000*	1.03	1000	6.55E+12
Alum Creek Storm Tanks (CS0) *4PF00001-006*	NA	NA	6.01E+13

Table B-32: Allowable fecal coliform load from upstream flow

Sub-Basin *14-Digit HUC*	Month	Upstream Flow *MG*	Allowable Load	
			count/month	count/season
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	May	6188	2.34E+14	9.79E+14
	Jun	6373	2.41E+14	
	Jul	4475	1.69E+14	
	Aug	3567	1.35E+14	
	Sep	2576	9.75E+13	
	Oct	2677	1.01E+14	
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	May	7768	2.81E+14	1.18E+15
	Jun	7905	2.86E+14	
	Jul	6205	2.20E+14	
	Aug	4621	1.66E+14	
	Sep	2990	1.10E+14	
	Oct	3251	1.18E+14	
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	May	1384	5.08E+13	2.21E+14
	Jun	1313	4.93E+13	
	Jul	1511	5.57E+13	
	Aug	935	3.39E+13	
	Sep	390	1.33E+13	
	Oct	527	1.84E+13	
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	May	3330	1.26E+14	4.01E+14
	Jun	2541	9.62E+13	
	Jul	2618	9.91E+13	
	Aug	664	2.51E+13	
	Sep	265	1.00E+13	
	Oct	1167	4.42E+13	
Alum Creek RM 19.80 to Mouth *05060001-160-020*	May	4253	1.61E+14	5.49E+14
	Jun	3551	1.34E+14	
	Jul	3540	1.34E+14	
	Aug	1171	4.43E+13	
	Sep	516	1.95E+13	
	Oct	1471	5.57E+13	

Table B-33: Fecal coliform allocations and TMDLs

Sub-Basin *14-Digit HUC*	*cfu/season*								
	Surface Runoff	**Point Source**	**Discharging Systems**	**Septic Systems**	**Cattle**	**CSO**	**SSO**	**Upstream**	**TMDL**
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	6.49E+13	-	6.06E+12	0.0	-	-	-	9.79E+14	**1.05E+15**
Rocky Fork Creek *05060001-140-020*	1.27E+14	6.04E+11	6.06E+12	0.0	0.0	-	-	-	**1.34E+14**
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	1.58E+14	-	1.57E+12	0.0	-	-	-	1.18E+15	**1.34E+15**
Mason Run *05060001-140-040*	5.63E+13	-	6.74E+11	0.0	-	-	-	-	**5.70E+13**
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	2.04E+14	1.91E+13	7.61E+12	0.0	0.0	-	-	-	**2.31E+14**
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	7.29E+13	7.63E+12	5.47E+12	0.0	-	-	-	2.21E+14	**3.07E+14**
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	1.37E+14	-	1.12E+13	0.0	0.0	-	-	4.01E+14	**5.49E+14**
Alum Creek RM 19.80 to Mouth *05060001-160-020*	2.63E+14	7.02E+13	1.70E+12	0.0	-	6.01E+13	0.0	5.49E+14	**9.44E+14**

Table B-34: Fecal coliform MS4 allocations

Sub-Basin *14-Digit HUC*	**MS4** **Entity**	**HUC Area** *mi²*	**Urbanized Area** *mi²*	**Percent Urbanized**	**Remaining Loading Capacity** *count*	**MS4 Allocation** *count /season*
Big Walnut Creek Hoover Reservoir to RM 29.00 *05060001-140-010*	-City of Columbus -City of Westerville -City of Gahanna	15.9	13.0	82.0%	6.49E+13	5.32E+13
Rock Fork Creek *05060001-140-020*	-City of Columbus -Village of New Albany -City of Gahanna -Jefferson Twsp. -Plain Twp.	31.3	16.4	52.3%	1.27E+14	6.66E+13
Big Walnut Creek RM 29.00 to RM 15.50 *05060001-140-030*	-City of Columbus -City of Gahanna -City of Reynoldsburg -City of Whitehall -Village of Brice	22.9	22.9	100.0%	1.58E+14	1.58E+14
Mason Run *05060001-140-040*	-City of Columbus -City of Whitehall -City of Bexley	13.0	13.0	100.0%	5.63E+13	5.63E+13
Blacklick Creek Headwaters to RM 8.20 *05060001-140-050*	-City of Columbus -Village of New Albany -City of Gahanna -City of Pataskala -City of Reynoldsburg -City of Pickerington -Jefferson Twp. -Etna Twp.	50.4	25.6	50.8%	2.04E+14	1.04E+14
Blacklick Creek RM 8.20 to Mouth *05060001-140-060*	-City of Columbus -City of Reynoldsburg -Village of Brice -Village of Groveport -Madison Twp.	12.9	9.6	74.7%	7.29E+13	5.44E+13
Alum Creek Alum Creek Lake to RM 19.80 *05060001-160-010*	-City of Columbus -City of Westerville -Orange Twp. -Genoa Twp.	24.4	16.3	66.8%	1.37E+14	9.14E+13
Alum Creek RM 19.80 to Mouth *05060001-160-020*	-City of Columbus -City of Westerville -City of Worthington -Huber Ridge CDP -City of Bexley	52.5	52.4	99.7%	2.63E+14	2.62E+14

Appendix C: Model Development for Upper Alum Creek and Upper Big Walnut Creek

Description of Model

The numerical model HSPF includes a set of computer codes for algorithms used to simulate the hydrologic response of land areas to precipitation and flow through stream channels in a basin. The algorithms used to simulate these processes are described in detail by Bicknell and others (2001). The rainfall-driven simulation of streamflow includes responses from pervious land areas and routing of water in the stream channel. Pervious land areas are assigned hydrologic-response parameters on the basis of land use and other characteristics, such as slope. Streamflow routing is controlled by channel characteristics of model reaches. The HSPF model can be used to simulate free-flowing streams and well-mixed reservoirs.

The HSPF model structure requires dividing the basin into multiple elements whose number and size reflect the range of selected hydrologic characteristics and the scope of available input data. A first step in structuring the model is segmenting the basin. Segmentation commonly is delimited by differences in climatological or physical characteristics that would determine specific hydrologic response to precipitation. When little differences are apparent in physical characteristics, segmentation may be determined by the number and location of precipitation stations available for input. The basin also is subdivided into characteristic pervious (PERLND) land-use types. Within each segment, each PERLND is assigned hydrologic-response parameters. These parameters control the partitioning and magnitude of hydrologic outputs in response to input precipitation. The stream channel is then partitioned into reaches (RCHRES). A model reach (RCHRES) generally is delimited by major flow inputs (tributaries, discharges), calibration locations (streamflow gages, water-quality sites), and time-of-travel considerations. Each model reach receives flow from land draining to that reach and from upstream model reaches. Runoff, interflow, and ground water from each PERLND is directed to a model reach. Point-source withdrawals and discharges can be specified for the model reaches where they are located. The overall model structure, including assignment of time-series data (meteorological, streamflow, point-source withdrawals and discharges), reach connections, land-area to reach relations, channel characteristics, and hydrologic response parameters, are described in the user control input (UCI) file.

The hydrologic response of PERLNDs is handled by its respective modules. The water budget, or predicted total runoff, for pervious land is simulated using the PWATER section of the PERLND module. Total runoff is the sum of base flow (ground-water discharge to streams), interflow, and surface runoff. The hydrologic processes modeled by PWATER include infiltration of precipitation, interception by plant materials, evapotranspiration, surface runoff, interflow, and ground-water flow. Precipitation may be evaporated from, move through, and (or) remain in storage in surface interception, surface detention, interflow, upper soil zone, lower soil zone, and active ground water.

Runoff derived from snowfall, snow accumulation, and snow melt is simulated using the SNOW module. Meteorological data are used to determine when precipitation is rain or snow, calculate an energy balance for the snow pack, and determine the effect of heat fluxes on the snow pack.

The routing of water in the stream channel is simulated by the HYDR section of the RCHRES module. Routing is based on kinematic-wave or storage-routing methods, where flow is assumed to be unidirectional. HYDR calculates rates of outflow and change in storage for a free-flowing reach or completely mixed reservoir. RCHRES inflows include runoff from PERLND land areas draining to that reach, water from upstream RCHRES, precipitation falling directly on the RCHRES surface area, and other discharges to the reach. RCHRES outflows include flow to the downstream reach, withdrawals from the reach, and evaporation. A series of reaches are used to represent the actual network of stream channels.

For each RCHRES, a relation between depth, surface area, volume, and outflow (discharge) is specified in an FTABLE. Where available, data for the FTABLE's were derived from EPA's BASINS FTABLE default values, using a simple three-channel representation to calculate the depth-discharge relation. FTABLEs for tributaries were similarly derived by assuming USGS determined two-year flood values (Koltun, 2003) could define bankfull values of depth and width.

The water-quality component of HSPF simulates contributions from pervious land areas and accounts for chemical reactions in the stream reaches. The model includes algorithms to describe the transport of constituents from the land to the stream reach, chemical reactions affecting constituents in the reach, sediment exchange between channel bed and water column, and the temperature of runoff to, and water in, a reach. Contributions of constituents from land areas may vary by land-use category in the model. Water quality simulation requires a calibrated hydrologic model.

Water temperature, dissolved oxygen, and carbon dioxide in surface runoff, interflow, and ground-water outflows from pervious land areas are simulated in the PSTEMP and PWTGAS sections of the PERLND module. Water temperature in each reach is simulated by the HTRCH section of the RCHRES module and includes heat transported by PERLND outflows and point-source discharges. The main heat-transfer processes considered are transfer by advection, where water temperature is treated as a thermal concentration, and transfer across the air-water interface. Heat gain and loss by radiation is also simulated. Meteorological data, such as air temperature and wind speed, are used in the simulation of stream temperature. In-stream dissolved oxygen concentrations are simulated by the OXRX section of the RCHRES module, which includes advection, aeration, and consumption of oxygen by biochemical oxygen demand.

The simulation of sediment and nutrients includes transport of sediment and nutrients from land areas and transport within the stream channel. Sediment release from pervious areas is simulated in the SEDMNT module. Sediment available for transport is generated by detachment associated with rainfall. Detached sediment is transported to the stream as washoff. Scour also may be simulated for pervious areas. Sediment transport in the stream channel is simulated in the SEDTRN module. The channel simulation includes scour and deposition of bed material but not bank material.

The transport of bacteria from the land to the stream is simulated in the PQUAL module for pervious areas, whereas fate of nitrogen and phosphorus are modeled in agrichemical sections NITR and PHOS. NITR performs a nearly complete system simulation of nitrogen transport and soil reactions. PHOS likewise performs a nearly complete system simulation of phosphorus transport and soil reactions. Both nutrient sections are similar and model the transport, plant uptake, adsorption/desorption, immobilization,and mineralization of the various chemical forms. Section NITR allows the simulation to further distinguish denitrification and plant uptake of nitrate/nitrite and ammonium.

For pervious areas, nutrients associated with soil are transported with sediment in surface runoff. Nutrients also enter the stream in interflow and ground-water discharge. Once in the stream, the transport and chemical interactions of nutrients are simulated by the NUTRX, OXRX, and PLANK modules. The NUTRX module includes physical transport and inorganic chemical reactions affecting nutrients. The OXRX module includes processes affecting dissolved oxygen and biochemical oxygen demand, constituents that affect reactions involving nutrients. The PLANK module simulates the role of phytoplankton and benthic algae in the stream and includes uptake and release of nutrients.

Data for Model Input and Calibration

HSPF requires a large amount of data to characterize effectively the hydrologic and water quality response of the watershed to precipitation and other inputs (Donigian and others, 1984). Data used in creating and defining the model structure and parameters were derived principally from GIS spatial analysis of basin characteristics and previously published information. Spatial data analyzed for model construction include land use, land-surface slope, and soil associations. Time-series input for streamflow and water-quality simulation include meteorologic, precipitation quality, water-use, and discharge quantity and quality data. Calibration data consisted of observed streamflow for the hydrologic simulation and observed water temperatures and laboratory analyses of grab and composite stream samples for the water-quality simulation.

Time-series data for model input and model output were processed and stored in the binary format Watershed Data Management (WDM) database. The WDM format is the standard format for input to and output from HSPF. The computer programs ANNIE (Flynn and others, 1995), IOWDM (Lumb and others, 1990), and WDMUtil (U.S. Environmental Protection Agency, 2001) were used in the processing of WDM time-series data. Parameter and model-structure data were processed independently of the time-series data and are defined in the UCI, an ASCII text file.

Model-Input Data

The types, resolution, and quantity of the data needed for input are determined by (1) the hydrologic and water-quality processes to be included in the model, (2) the time step selected for simulation, (3) the length of the simulation period, and (4) the spatial scale of interest. For example, simulation of streamflow requires time-series inputs of precipitation, potential evaporation, withdrawals from streams, and discharges to streams, and when snowmelt is simulated, additional meteorological data are needed.

The upper Big Walnut Creek and upper Alum Creek models were run on a 1-hour time step. Time-series data at time intervals greater than hourly required disaggregation. Daily-to-hourly disaggregation of meteorological data was completed using WDMUtil. Daily-to-hourly disaggregation of point source data was done by the HSPF model at the time of simulation. For the simulation period of January 1, 1990 through October 31, 2002, about 13 years of reported or estimated hourly or daily values were needed for the time-series input data sets. Simulation of stream-water quality requires, in addition to estimates of chemical-input parameters for pervious land areas, timeseries inputs of flow and constituent concentrations for point-source discharges. The simulation of water temperature requires input of additional meteorological data, including solar radiation, cloud cover, wind speed, and air and dewpoint temperatures. Inputs from point sources include water chemistry, temperature, and rate of discharge.

Meteorologic data simulation of mean hourly streamflow in HSPF required inputs of hourly precipitation and potential evapotranspiration. The hourly precipitation data were taken from hourly and fifteen minute data collected at OARDC/USDA stations at Mt. Vernon and Delaware, and NOAA meteorological station Centerburg 2 SE. These stations were selected because their corresponding Thiessen polygons included most of the modeled basins. Air temperature was taken mainly from the Delaware site. Other meteorological data, used in the calculation of evaporation, snowmelt, and stream and land surface temperatures, include solar radiation, cloud cover, and wind velocity data. Evaporation and solar radiation data came primarily from the Delaware OARDC site, while cloud cover data (used in calculating stream temperature) was only available at the Port Columbus weather site. Daily potential evapotranspiration was calculated using the Jensen and Penman routines available in WDMUtil, and then disaggregated to an hourly time step during the simulation run. Dewpoint was determined indirectly from relative humidity and temperature. Snow simulation was also included. Simulation of snow cover and snow melt – to account for the delay between winter precipitation and runoff – was expected to result in more accurate streamflows.

Spatial data input to the HSPF model are used primarily to define the structure and "fixed" characteristics of the model. The principal structural unit of the HSPF model is the hydrologic response unit (such as PERLND). Hydrologic-response units for the basin were determined from analysis of digital spatial data consisting of land use, elevation, and soil associations.

The digital spatial data were compiled from 1992 National Land Cover Dataset (NLCD) data and were processed with a geographic information system (GIS) for model input.

The data were combined and reclassified into eight basic pervious land-use categories that were assumed to have distinct hydrologic and nonpoint-source water-quality signatures. In order to better incorporate agricultural census data, seven of these (cropland and pasture/hay) land uses were split between Delaware and Morrow Counties, resulting in a total of fifteen PERLNDS.

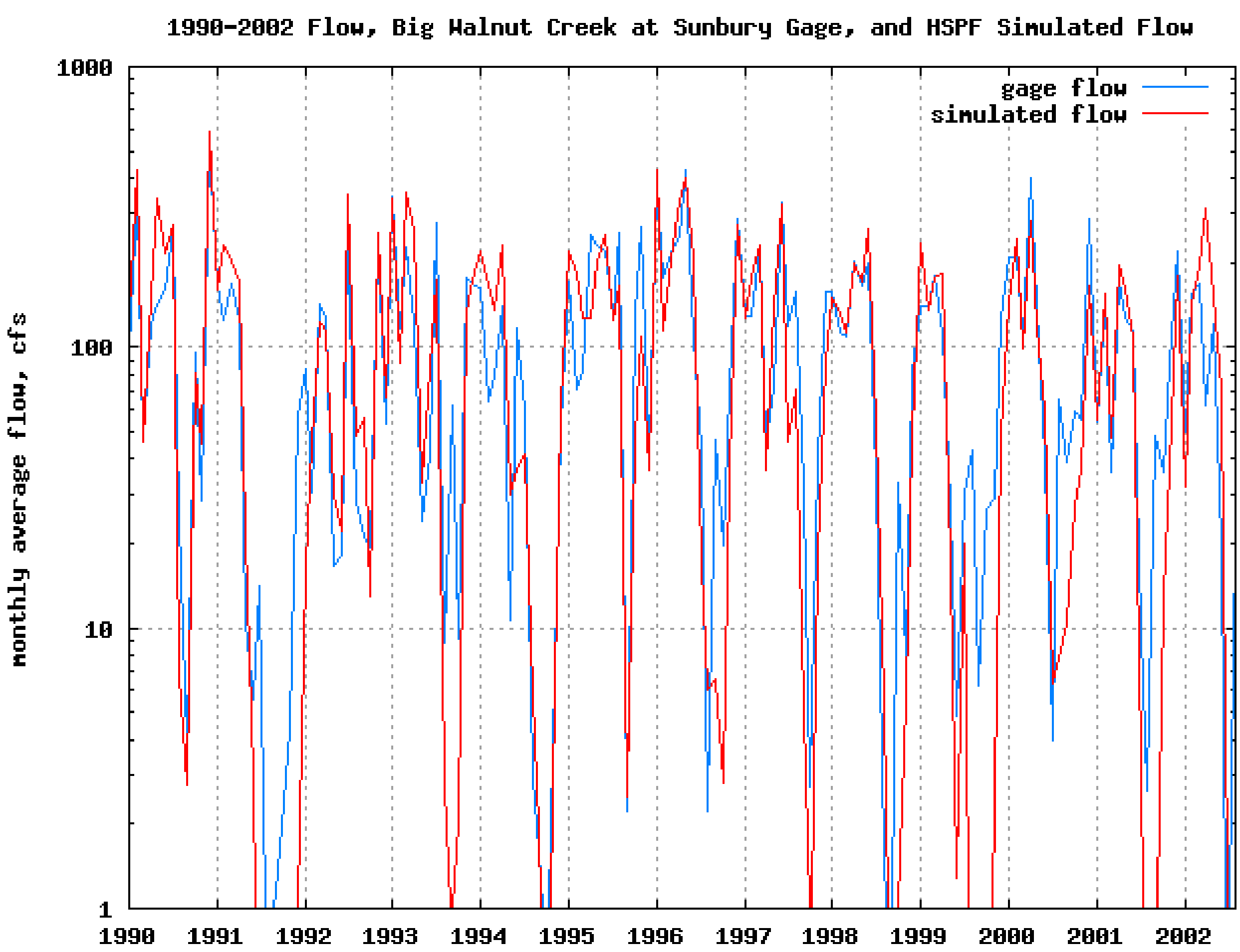
Langmuir isotherm phosphorus adsorption was predicted from soil properties of percent clay, percent organic matter, and pH using regression equations developed by Novotny and Chesters (1981). The results were then curve-fitted into the Freundlich isotherms used by HSPF.

Since residential land in the basins are a small percentage of the total, no impervious land segments were simulated in the HSPF model.

The effects of the Ashley and Sunbury drinking water intakes were included in the instream mass balance. A time series for the effects of Ashley's drinking water well intake near West Branch Alum Creek was also created using the USGS STRMDEPL program, which calculates time-varying streamflow depletion caused by a pumped well.

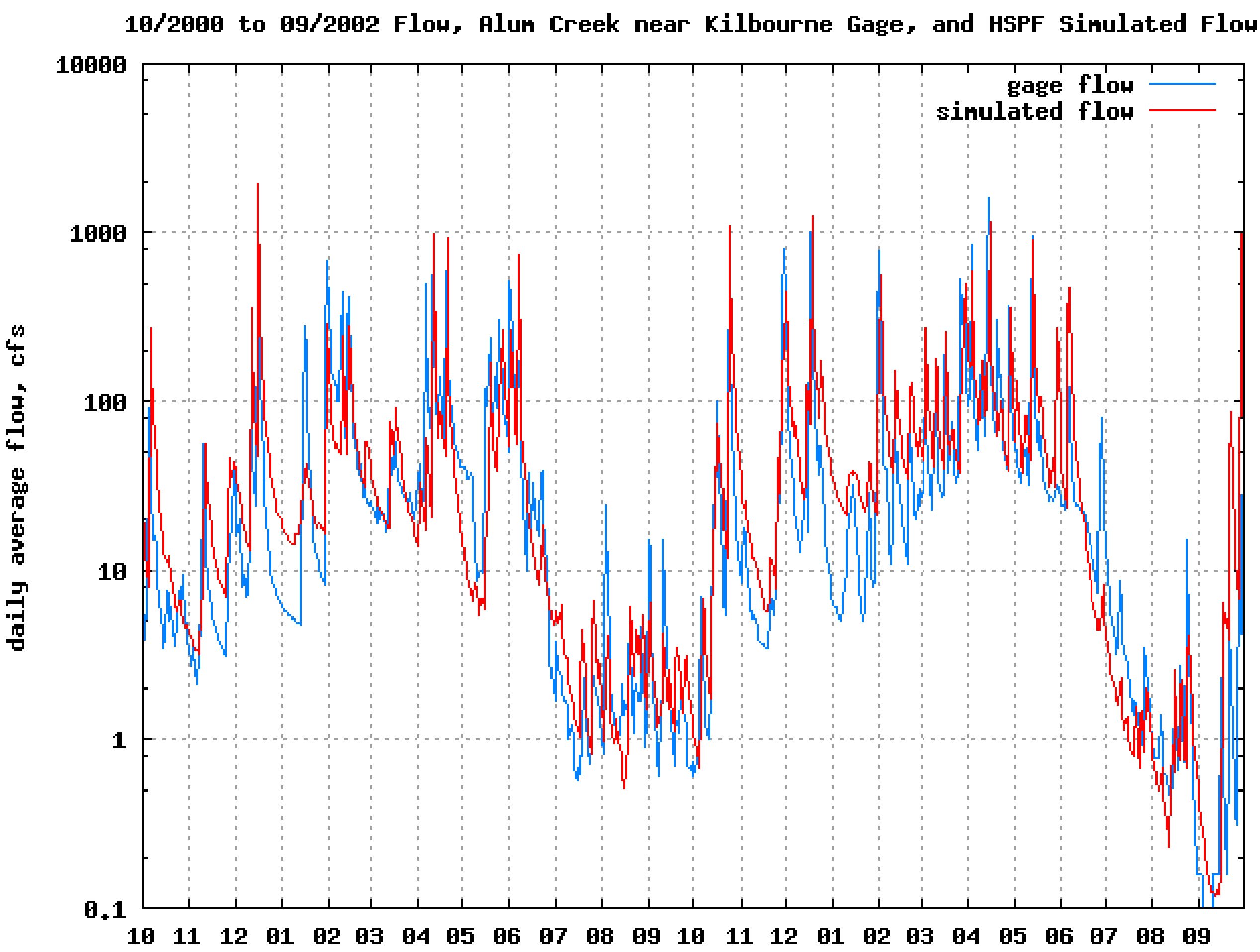
Model-Calibration Data

Observed streamflow and water-quality data are needed to calibrate the hydrologic and water quality components of the HSPF model, respectively. These data are available at streamflow-measurement stations and water-quality monitoring sites established in the basin for this study and for other purposes. The period of record and frequency of observations differ among these gages and monitoring locations. In general, fewer water quality data are available than streamflow data. Hydrologic data from USGS streamflow-measurement (gaging) stations at Sunbury and near Kilbourne were used for the hydrologic calibrations of upper Big Walnut Creek and upper Alum Creek, respectively. Sunbury has a continuous record for the period 1990 to present, while data from the Kilbourne gage is only available since October 2000. The results of the hydrologic curve-fits for both gages are shown in the charts.



<u>Summary</u>

The Upper Alum Creek and Upper Big Walnut Creek watersheds were modeled using HSPF and data from a wide range of sources. The predicted bacterial, sediment, and nutrient loadings and flow compare reasonably well with observed data, and the model can be relied upon to give credible results for its intended applications. The model results are based on 1990-2002 instream flow and water quality data collected mainly in 2000 and 2002. The model was used to determine the existing and projected loadings for phosphorus and bacteria in the Upper Alum and Upper Big Walnut Creek watersheds.



Appendix D.
Big Walnut Creek TMDL
2004 Integrated Report Listing

HUC 11	**WAU Description**	**WAU Size (mi^2):** 189.6
05060001 130	Big Walnut Creek (headwaters to Hoover Dam**)**	

Integrate Report Assessment Category: 5 **Priority Points: 7**
Next Scheduled Monitoring: 2010

Aquatic Life Use Assessment

Subcategories of ALU: WWH Sampling Year(s): 2000
Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	%Attainment: Full	%Attainment: Partial	%Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	16 Sites	5 Sites						
5-20 mi^2	15 Sites	7 Sites	36.2	8.0	55.8			
20-50 mi^2	3 Sites	1 Site				68	4	28
Large (Linear)	3 Sites							
50-500mi^2	8.4 Miles	8.4 Miles	100.0	0.0	0.0			

<u>High Magnitude Causes</u>

Cause Unknown
Unionized Ammonia
Nutrients
Siltation
Organic Enrichment/DO
Flow Alteration
Other Habitat Alterations
Suspended Solids
Pathogens

<u>High Magnitude Sources</u>

Nonirrigated Crop Production
Land Development/Suburbanization
Urban Runoff/Storm Sewers (NPS)
Onsite Wastewater Systems
Septage Disposal
Hydromodification - Agriculture
Source Unknown

Recreation Use Assessment

Subcategory of Use: Primary Contact
Impairment: Yes Geometric Mean: 476
No. Ambient Sites: 43 No. Ambient Sampling Records: 205 75^{th} %-ile: 1114
No. of NPDES MOR Sites: 1 No. of NPDES MOR Records: 26 90^{th} %-ile: 2900

Fish Consumption Advisory (FCA) Assessment

Waters within the WAU sampled and assessed:
FCA Issued:
(See 2004 Ohio FCA for more detailed information at: "www.epa.state.oh.us/dsw/fishadvisory/index.html")
Impairment Due to FCA: Pollutant (Waterbody):

Comments

TMDLs for pollutants impairing beneficial uses are in progress for the Big Walnut Creek watershed. Monitoring in support of the TMDL was conducted in 2000. The 2000 Big Walnut Creek Basin report (EAS/2003-11-10) is available at "http://www.epa.state.oh.us/dsw/document_index/psindex.html.

HUC 11	**WAU Description**	**WAU Size (mi^2):** 121.8
05060001 150	Alum Creek (headwaters to Alum Creek Dam)	

Integrate Report Assessment Category: 5 **Priority Points: 8**
Next Scheduled Monitoring: 2010

Aquatic Life Use Assessment

Subcategories of ALU: WWH Sampling Year(s): 2000
Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	%Attainment: Full	%Attainment: Partial	%Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	2 Sites	1 Site						
5-20 mi^2	8 Sites	2 Sites	37.5	43.8	18.7			
20-50 mi^2	2 Sites	1 Site				69	22	9
Large (Linear)	2 Sites							
50-500mi^2	1.6 Miles	1.6 Miles	100.0	0.0	0.0			

High Magnitude Causes	High Magnitude Sources
Cause Unknown	Nonirrigated Crop Production
Nutrients	Natural
Flow Alteration	Source Unknown
Other Habitat Alterations	

Recreation Use Assessment

Subcategory of Use: Primary Contact
Impairment: Yes Geometric Mean: 507
No. Ambient Sites: 17 No. Ambient Sampling Records: 87 75th %-ile: 1109
No. of NPDES MOR Sites: 1 No. of NPDES MOR Records: 24 90th %-ile: 2700

Fish Consumption Advisory (FCA) Assessment

Waters within the WAU sampled and assessed:
FCA Issued:
(See the 2004 Ohio FCA for more detailed information at: “www.epa.state.oh.us/dsw/fishadvisory/index.html”)
Impairment Due to FCA: Pollutant (Waterbody):

Comments

HUC 11	**WAU Description**	**WAU Size (mi^2):** 145.7
05060001 140	Big Walnut Creek (Downstream Hoover Dam to Upstream Alum Creek); Blacklick Creek	

Integrate Report Assessment Category: 5 **Priority Points: 7**
Next Scheduled Monitoring: 2010

Aquatic Life Use Assessment

Subcategories of ALU: EWH, WWH, MWH-C, LRW Sampling Year(s): 2000
Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	%Attainment: Full	%Attainment: Partial	%Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	13 Sites	2 Sites						
5-20 mi^2	7 Sites	2 Sites	46.7	16.3	37.0			
20-50 mi^2	7 Sites	5 Sites				67	15	18
Large (Linear)	7 Sites							
50-500mi^2	24.3 Miles	21.2 Miles	87.1	12.9	0.0			

High Magnitude Causes

Cause Unknown
Unknown Toxicity
Priority Organics
Metals
Copper
Unionized Ammonia
Nutrients
Siltation
Organic Enrichment/DO
Thermal Modifications
Flow Alterations
Other Habitat Alterations
Pathogens
Suspended Solids
Total Toxics

High Magnitude Sources

Industrial Point Sources
Minor Municipal Point Source
Removal of Riparian Veg. - Dev.
Land Development/Suburbanization
Contaminated Sediment
Urban Runoff/Storm Sewers (NPS)
Onsite Wastewater Systems
Channelization-Development
Upstream Impoundment
Habitat modifications O/than Hydromod.
Natural
Source Unknown

Recreation Use Assessment

Subcategory of Use: Primary Contact
Impairment: Yes
Geometric Mean: 457
No. Ambient Sites: 39 No. Ambient Sampling Records: 203
75th %-ile: 1148
No. of NPDES MOR Sites: 4 No. of NPDES MOR Records: 367
90th %-ile: 2710

Fish Consumption Advisory (FCA) Assessment

Waters within the WAU sampled and assessed:
FCA Issued:
(See the 2004 Ohio FCA for more detailed information at: "www.epa.state.oh.us/dsw/fishadvisory/index.html")
Impairment Due to FCA: Pollutant (Waterbody):

Comments

HUC 11	**WAU Description**	**WAU Size (mi^2):** 99.7
05060001 160	Big Walnut Creek (Alum Creek to mouth); Alum Creek (downstream Alum Creek Dam to mouth)	

Integrate Report Assessment Category: 5 **Priority Points: 8**
Next Scheduled Monitoring: 2010

Aquatic Life Use Assessment

Subcategories of ALU: EWH, WWH, LRW Sampling Year(s): 2000
Impairment: Yes

Stream Size Category	Raw Data: Data Available	Raw Data: No. Attaining	%Attainment: Full	%Attainment: Partial	%Attainment: Non	WAU Score: Full	WAU Score: Partial	WAU Score: Non
Small (Spatial)								
< 5 mi^2	2 Sites	0 Sites						
5-20 mi^2	1 Site	0 Sites	0.0	100.0	0.0			
20-50 mi^2	- Sites	- Sites				44	56	0
Large (Linear)	9 Sites							
50-500mi^2	18.3 Miles	8.0 Miles	43.5	56.5	0.0			

High Magnitude Causes	High Magnitude Sources
Cause Unknown	Combined Sewer Overflows
Siltation	Land Development/Suburbanization
Organic Enrichment/DO	Urban Runoff/Storm Sewers (NPS)
Flow Alteration	Channelization - Development
Other Habitat Alterations	Habitat modifications O/than Hydromod.

Recreation Use Assessment

Subcategory of Use: Primary Contact
Impairment: Yes Geometric Mean: 519
No. Ambient Sites: 16 No. Ambient Sampling Records: 73 75^{th} %-ile: 981
No. of NPDES MOR Sites: 2 No. of NPDES MOR Records: 76 90^{th} %-ile: 5567

Fish Consumption Advisory (FCA) Assessment

Waters within the WAU sampled and assessed:
FCA Issued:
(See the 2004 Ohio FCA for more detailed information at: "www.epa.state.oh.us/dsw/fishadvisory/index.html")
Impairment Due to FCA: Pollutant (Waterbody):

Comments

Appendix E: Responses to Public Comments

This document provides a summary of the comments received on the December 8, 2004 draft Big Walnut Creek TMDL report. Comments were reviewed by the Ohio Environmental Protection Agency (Ohio EPA) and addressed in the following manner.

Comments pertaining to editing-related issues, including identification of spelling and grammar errors, reference errors, and citation errors, were addressed as appropriate. In addition, some comments requested additional text clarifying a subject or item, word crafting, or other related issues. These edits did not result in changing the overall content or intent of the report. Ohio EPA thanks the comment authors for contributing to the overall clarity and accuracy of the report.

Comments posing a specific question or issue are responded to below. Parties who submitted comments on the Big Walnut Creek draft TMDL are the following:

- City of Columbus
- Ohio Farm Bureau Federation
- Friends of Big Walnut Creek
- Ohio Environmental Council
- Friends of Alum Creek and Tributaries
- Franklin County Board of Health.

City of Columbus

Comment 1:
Water Quality at Big Walnut Creek RM 37.2, immediately downstream of Hoover Reservoir Dam – Hypolimnetic Releases from Hoover Reservoir. The draft TMDL report, in section 7.1.4 (pp. 112-113) discusses water quality impacts resulting from what are referred to as "hypolimnetic releases" from Hoover Reservoir. The report states: "*Hypolimnetic releases from Hoover Reservoir are the sole cause of impairment in Big Walnut Creek downstream of the reservoir. This is because of the low DO levels in the water released from the reservoir during summer months . . . In addition, the City of Columbus is evaluating installation of piping parallel to Big Walnut Creek to provide the Hap Cremean Water Plant with intake water directly from Hoover Reservoir, as opposed to using flow released to Big Walnut Creek. This project would reduce existing flow levels in Big Walnut Creek dramatically, further heightening the impact of a hypolimnetic release."* The City believes this section is inaccurate and should be removed.

There are no low DO levels in the Big Walnut Creek immediately below the reservoir, and in fact DO levels typically exceed saturation levels at this location. DO concentrations are presented in Ohio EPA's 2003 technical support document (TSD) "*Biological and Water Quality Study of the Big Walnut Creek Basin 2000*". In Figure 8 (p. 80) of this report, it is seen that the median DO concentration immediately downstream of the Hoover Reservoir dam (at RM 37.2) is approximately 9.3 mg/l, and median DO saturation is approximately 105%. The measured DO levels at this station are well above the warmwater habitat DO criteria of 5 mg/l average and 4 mg/l minimum.

The high DO levels observed downstream of the dam are explained by the fact that all normal water release from the dam is discharged through a Howell-Bunger fixed cone energy dissipating valve. This type of valve, which is used to dissipate energy while controlling discharge flow from impoundments, produces a large conical spray which very effectively aerates the water. Since all the water released from the reservoir is aerated in this manner, it literally would be impossible to have low DO water in the Big Walnut Creek immediately downstream of Hoover Reservoir.

The 2003 Big Walnut Creek Basin TSD does refer to water quality impacts to biological communities at the sampling station immediately downstream of the Hoover Reservoir. The macroinvertebrate community index is reported as marginally good. (ICI value is 34, which is a nonsignificant departure from the warmwater habitat criterion of 36.) The 2003 TSD report notes on page 177 that *“Negative community responses are often observed for short reaches below large impoundments”*. The report notes that the ICI improves to good at the next station downstream (RM 34.9 at SR 161).

The fish communities are also reported in the 2003 TSD to be somewhat less diverse than desired. On page 190 of the TSD it is noted that *“the site immediately downstream from Hoover Reservior where the hypolimnetic release of cool reservoir water favored white suckers, a species adapted to cool water, over redhorse suckers, a warmwater species of fish. The outcome, due to the abundance of white suckers, resulted in lower than normal IBI scores,* ***but did not indicate pollution****.”* [Emphasis added.] The TSD appears to ascribe the relative predominance of the cool water-adapted sucker species to cool water presumed to be released from the Hoover Reservoir. However, the reported temperature data in this TSD indicates that there is only a minor lowering of in-stream temperature below the dam. Figure 8 on page 80 of the 2003 TSD indicates that the mean temperature immediately downstream of Hoover Reservoir is only about one-half degree centigrade below that of the closest station upstream of the reservoir (RM 49.0, which is downstream of Sunbury), and also only one-half degree below the next downstream station (RM 34.9 at SR 161). We question whether this slight temperature difference demonstrates any significant problem caused by purported “hypolimnetic releases” from the reservoir.

It should also be noted, as reported in the 2003 TSD, that the Lower Big Walnut Creek main stem showed significant fish communities’ improvement downstream of the sampling station below Hoover Reservoir. The TSD states on page 190 that several pollution intolerant fish species previously rare or absent were routinely present during the most recent water quality survey of the Lower Big Walnut Creek.

Based on the above discussion, we do not believe that there is a significant problem or issue resulting from water releases from the Hoover Reservoir dam that relates to development of a TMDL for any specific pollutant. If the City of Columbus does proceed with construction of the raw water line between the reservoir and the Hap Cremean Water Plant, it does not appear that this should result in any "*further heightening the impact of a hypolimnetic release*". We suggest that Section 7.1.4 of the draft TMDL report be removed in its entirety from the final TMDL report.

Response:
Ohio EPA has considered the comment carefully, and reexamined the data from the biological survey. Ohio EPA biologists have concluded that in this particular case, the biological results are a sampling artifact to be expected from a sample that is close to a large impoundment, rather than an impact from the hypolimnetic release. The report has been modified accordingly.

Comment 2:
Pathogen Loading Reduction (Table 7.1.B). On Table 7.1.B on page 111, the pathogen loading reduction for Big Walnut Creek (140-010) in Franklin County for Runoff is stated to be 89%. We double checked this value for accuracy and found the actual value to be 49%. The following equations show this value is obtained.

a. The fecal coliform source load for Surface Runoff as shown on Table B- 28 is 1.26E+14 cfu.
b. The percent urbanized value for Big Walnut Creek (140-0110) is 82% as shown on Table B-34
c. The MS4 existing load = 82% x 1.26E+14 = 1.03E+14
d. The allowable TMDL load for this stream segment as shown on Table B-34 = 5.26E+13
e. Allowable pathogen load divided by existing load = 5.26E+13 / 1.03E+14 = 51%
f. Thus the percent reduction = 100% - 51% = 49% not 89%.

Table 5.2G for Big Walnut Creek shows the value to be 49%. Thus, we believe the 89% is a typographical error.

Response:
MS4s receive wasteload allocations because they are permitted point sources. On the other hand, MS4 loads originate from overland flow and share some characteristics of non-point sources. These two facts create some ambiguity regarding how MS4 loads should be calculated. In this case, the method described by the preceding comment is not the method used in the report. In fact, nowhere in the report is a percent reduction specifically attached to an MS4 load. Rather the percent reduction quoted above applies to the total surface runoff load, of which the MS4 load is a part.

Coincidentally, the method described above does result in an accurate value, and the value of 89% presented in Table 7.1.B is a typographic error. The correct value, as stated in Table 5.2.G is 49%. Table 7.1.B was changed to reflect this.

Comment 3:
Contribution of SSOs to Bacteria Loading. The SSO discussion on page B-30 states that no dilution factor is used for the volume of SSO that discharges to the receiving waters. The TMDL states that a standard concentration for municipal waste of 1.0E+7 cfu/100 ml x the entire volume of discharge provides the total load. This number is likely over estimated since SSO discharges would be expected to be diluted. Ohio EPA's approach may increase the expected results from eliminating the SSOs. The annual load reduction from SSO elimination will likely be less than the draft report suggests.

Pursuant to its CSO consent order, the City is undertaking a very thorough Characterization Report of the receiving streams. This report, which will be submitted on July 1, 2005, will include data on in-stream water quality, SSOs, CSOs, and MS4 outfalls. We believe the Characterization Report will provide a much more accurate way to estimate the relative contribution of SSOs and CSOs to the impairment of this stream.

Response:
Ohio EPA concurs that SSO, in most instances, is diluted; however, it is not currently possible to determine the extent of the dilution. Given this fact, any application of a dilution factor to the SSO loadings would be arbitrary. Until such a time that a more accurate characterization of SSO from the collection system of the City of Columbus is available, any dilution of the sewage will be considered an instrument of conservatism in the method.

It should also be noted that the calculated SSO load presented in the TMDL report was based upon reported, measured overflow. SSO has been documented for which no information regarding the magnitude of the event is available. Therefore, in addition to the statement from the City of Columbus that annual load reduction from SSO elimination may be less than the report suggests, the annual load reduction from the elimination of SSO may also be more than the report suggests.

The purpose of the presented load is to provide an estimate of the relative magnitude of the SSO load in comparison to other sources of pathogens in the watershed. For this purpose the presented estimate is of sufficient accuracy.

Ohio EPA supports the efforts of the City of Columbus in the development of its Characterization Report. Ohio EPA will be evaluating the City of Columbus Characterization Report in its ongoing review of the Columbus Wet Weather Management Plan.

Comment 4:
TMDLs for Habitat, Sediment and QHEI. In section 4.1.1, Ohio EPA proposes to establish a TMDL for QHEI. While the City understands the importance of protecting habitat, and supports the efforts of watershed groups that are striving to improve water quality, we question Ohio EPA's authority to establish habitat as a TMDL. As noted in the introduction of this draft TMDL, the purpose of a TMDL is to calculate the maximum

amount of a pollutant, and then to allocate the load among sources. QHEI is not a pollutant.

We understand that the US EPA TMDL guidance document (1991) suggests the possibility of establishing control measures for quantifiable non-chemical parameters that prevent attainment of water quality criteria. The guidance document suggests that such control measures would be developed and implemented as a TMDL for such parameters in a manner similar to chemical loads. However, the QHEI components are not analogous to pollutant loads.

Response:
U.S. EPA TMDL guidance (1991) states: "EPA [U.S.] recognizes that it is appropriate to use the TMDL process to establish control measures for quantifiable non-chemical parameters that are preventing the attainment of water quality standards. Control measures, in this case, would be developed and implemented to meet a TMDL that addresses these parameters in a manner similar to chemical loads. As methods are developed to address these problems, EPA [U.S.] and the States will incorporate them into the TMDL process."

Ohio EPA agrees that QHEI components are not analogous to pollutant loads; however, the preceding excerpt from U.S. EPA guidance does not state they must be. Guidance states *control measures* for such parameters are to be developed and implemented in a manner similar to chemical loads. This is in fact the case. Non-point source control measures (for phosphorus as an example) are implemented by establishing a target and recommending management practice to achieve the target. Similarly, habitat TMDLs establish targets and implementation recommendations are designed to meet them. Ohio EPA believes development of habitat TMDLs is consistent with the intent of U.S. EPA guidance, and therefore respectfully disagrees with the preceding comment. Further, Ohio EPA believes it would be negligent not to include habitat TMDLs in the report. This would place undue focus upon other causes of impairment in a manner analogous to focusing all attention upon point sources of pollution while non-point sources may be of equal or greater significance.

Comment 5:
Sampling to Verify Loadings. It appears that Ohio EPA did not validate the estimated existing non-point source fecal coliform and total phosphorus loadings with any in-stream chemical sampling results in the lower portions of the Big Walnut Creek and Alum Creek watersheds. As noted above, the City's Characterization Report for its CSO receiving streams will be submitted on July 1, 2005. This includes the lower portions of the Big Walnut and all of Alum Creek.

Response:
Modeled non-point source loads were not calibrated to instream chemical sampling results in the lower Big Walnut Creek watershed. This was judged to be acceptable because of the intended use of the results. As permit recommendations were not based upon the water quality of the receiving stream (rather, they were guided by policy and

technical limitations), a greater amount of uncertainty was acceptable with regard to non-point source loads. The utility of the modeled non-point source loads is to make relative comparisons between sub-watersheds for use in guiding management decisions.

Comment 6:
MS4. It is unclear to us how the urban run-off allocation will be handled in this TMDL. While run-off is discussed (appropriately) as a non-point source, much of the City's run-off is discharged through the MS4. The implementation section should be clarified to explicitly state that the non-point source implementation strategy includes discharges from MS4.

Response:
USEPA has issued guidance for handling storm water flows in TMDLs[1]. This guidance states that the flows from an MS4 are to be included in the wasteload allocation (WLA), and are to be regarded as a point source discharge. Ohio EPA has changed the report to be consistent with USEPA guidance, and MS4 loads (including Phase II loads) are expressed as part of the WLA.

Comment 7:
Public Participation and Implementation. In addition to the Upper Big Walnut Creek CREP that is mentioned on pages 106 and 108 of the draft report, the recently approved (December 18, 2004) Scioto CREP will provide pollutant reductions for the Upper and Lower Alum Creek, and the Lower Big Walnut Creek which includes the Blacklick Creek. The City of Columbus has been, and will continue to be, supportive of both of these non point source reduction programs.

Response:
Ohio EPA acknowledges Columbus' past and ongoing support and investment in the Upper Big Walnut Creek in the interest of improving water quality.

Ohio Farm Bureau Federation

Comment 8:
The draft document discusses numerous potential pollutant sources such as home sewage treatment plants, land runoff, livestock and municipal wastewater treatment plants. One potential pollutant source for fecal coliform bacteria that is not discussed or considered is wildlife access to surface waters. Livestock are not the only animals that come into contact with streams, rivers, ponds and lakes. In fact, when detailed bacterial source tracking takes place as it has in the St. Joseph River, geese and other wildlife species are often identified as major contributors to water quality pollution. Because the Bacteria Indicator Tool (BIT) used to develop this TMDL does not consider wildlife

[1] Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs - Robert H. Wayland, III and James A. Hanlon, Nov 22, 2002 (available at http://www.epa.gov/owow/tmdl/policy.html)

access to surface waters it is inherently biased against animal agriculture. By not considering wildlife, the results of the BIT analysis will lead to an overestimation of the fecal coliform load due to livestock access to surface waters. What adjustments to the fecal coliform load estimates will be made to account for wildlife access to surface water?

Response:
The Bacteria Indicator Tool (BIT) does account for the contribution of fecal coliform from wildlife. The wildlife contribution of fecal coliform is part of the daily accumulation rate calculated by the model. In the upper Big Walnut Creek watershed the accumulation rate was input to HSPF to calculate loading. In the lower watershed a wash-off coefficient was applied to the accumulation rate to estimate loading. The fecal coliform contributions of deer and raccoons were considered in this manner.

Comment 9:
Section 7.0 (Page 108) of the document provides an overview of the Big Walnut Creek TMDL Implementation Strategy. Throughout the draft document, identified sources of phosphorous and fecal coliform bacteria in the Big Walnut Creek watershed include direct discharges from permitted wastewater treatment facilities, CSOs and SSOs. The implementation strategy addresses changes to NDPES permits and the long-term control plan for the City of Columbus CSOs but is silent when it comes to the SSOs. With the NPDES regulatory authority that Ohio EPA has, what mechanisms will be implemented to address the SSOs? How will SSO controls be incorporated into the TMDL implementation strategy?

Response:
On August 16, 2002, Ohio EPA and the City of Columbus entered into a consent order regarding the SSOs that occur in the Columbus collection system. In response to this Consent Order, the City of Columbus has submitted a Wet Weather Management Plan (WWMP) that gives details for SSO elimination. Ohio EPA is currently reviewing the WWMP.

Comment 10:
Appendix C of the draft TMDL document provides an overview of the HSPF computer simulation model used to develop the TMDL. The Model-Calibration section (Page C-6) does a very good job illustrating how closely the simulated stream flow and the actual values from the stream gage match. The text mentions that water quality predictions compared “reasonably well” to monitored data. How close is “reasonably well”? A table and/or set of graphs should be included in Appendix C to illustrate the match between simulated and monitored water quality data just as it was done for water quantity. Including this into the model calibration section will help build credibility in the model and TMDL.

Response:
Graphs showing a range of predicted values have been included in Appendix C.

Friends of Big Walnut Creek

Comment 11:
The City of Columbus has proposed that a Raw Water Line (RWL) be constructed from Hoover Reservoir to the Hap Cremean Water Treatment Plant. Currently, the treatment plant receives water from Hoover Reservoir primarily via hypolimnetic release. Partial attainment status of the main stem of Big Walnut below the dam is a direct result of this release. The Friends of Big Walnut strongly encourage the OEPA to designate specific guidelines to the City of Columbus to maintain current flow conditions if the RWL is initiated and that higher quality water be released to compensate for the lower flow regime. Furthermore, reducing the flow of water throughout the main stem of Big Walnut may have detrimental impacts to the lower stretches of the creek which could result in a lower designated use status.

Response:
Ohio EPA does not anticipate that the flow regime in the Big Walnut Creek will change for the lower reaches of the stream below the Hap Cremean Water Treatment Plant. This is due to the fact that the intake of water at this site has existed for some time. The only stretch of the stream that will be affected by the proposed raw water line will be upstream of the Hap Cremean WTP. However, Ohio EPA is concerned that a flow regime that is adequate to support aquatic life will be maintained upstream of Hap Cremean WTP if the new raw water line is installed. Ohio EPA will coordinate these concerns with Columbus during the plan review stage required under ORC 6109.07.

Comment 12:
The TMDL has addressed the tributary impairments, respectfully. All tributaries within the Big Walnut main stem watershed are in non-attainment status. Pathogens, sedimentation, habitat alteration, and NPS run-off contribute to the poor water quality within these sub-watersheds. However, the main stem is in full attainment. This could be attributed to a higher volume of water, from an increase in impervious surfaces, which mixes with the non-attainment waters from the tributaries and allows for a full-attainment status designation. Paragraph 7.1.4 on page 112 states the concerns of the release of the Hoover Reservoir waters. The RWL will reduce flow regimes throughout the watershed and impact the mixing of these non-attaining tributaries. The lower flow from the reservoir and the cumulative effect of these non-attaining waters could certainly result in the reduction of water quality of Big Walnut throughout the watershed. Therefore, the Friends of Big Walnut suggest that further study be done on the tributaries to isolate the sources of pollution so proper remediation efforts can be initiated.

Response:
Ohio EPA concurs that pollutant loading reductions in the tributaries are important for the health of the Big Walnut Creek mainstem. Watershed action planning is an appropriate venue to plan for implementation of the pollutant load reductions, and for protection and enhancement of riparian habitat.

Comment 13:
The TMDL draft specifically states that habitat alteration is a major cause of water degradation. However, it does not address the importance of keeping wetland filling and dredging to a minimum and maintaining the integrity of small tributaries by not culverting, channelizing, and removing the riparian buffer. Therefore, the Friends of Big Walnut ask that the EPA recognize the discrepancy in the EPA's policy in awarding wetland fill permits, and stream re-routing permits since these actions directly effect the water quality of Big Walnut and are inconsistent with achieving the desired TMDL recommendations of habitat alteration.

Response:
Habitat alteration refers not only to the filling of wetlands or rerouting of streams, but to a wide variety of impacts, many of which occur above the ordinary high water mark. Ohio EPA generally has little authority to regulate above the ordinary high water mark. For example, the clearing of forests, the creation of large volumes of impervious surfaces resulting in hydrologic changes in streams, floodplain filling and agricultural and county ditch maintenance programs which are exempt from the Clean Water Act can have dramatic effects on stream habitat.

The Clean Water Act Section 401 application review process evaluates the passive restoration occurring in streams, the projects proposed impacts and the best management practices and mitigative techniques proposed and the potential value to society from a project. For example, Ohio EPA evaluates the value to society of allowing a sewer crossing of the Big Walnut versus the temporary and long term impacts of the project.

The TMDL report contains the technical evaluation of the stream system. Where that technical evaluation directly supports action on an individual permit application, Ohio EPA will use the technical justification in the review of that permit.

<u>Ohio Environmental Council</u>

Comment 14:
Pathogen loads are identified as high throughout the basin and subsequent impairment of recreational uses throughout the watershed. While some correlation to HSTS discharge is noted and zero loading from HSTS discharges allowed, there is a significant need to define pathogen speciation and source identification for better and more discreet source understanding and risk estimation. Obviously this is a large research challenge nonetheless OEC encourages OEPA to call out this need and help the many governmental and watershed groups in the basin prioritized source tracking needs through their individual and organizational processes.

Response:
Ohio EPA agrees that an ability to define pathogen speciation is desirable, however it is important to note that previous attempts at this (e.g. fecal strep/fecal coliform ratios) have not met with success. Once an acceptable methodology for this type of testing is approved by USEPA, Ohio EPA will be able to take advantage of the method.

Comment 15:
Additionally OEPA comments that nutrient enrichment basin wide as an impairment cause. We agree that the total P target for the eastern corn belt regions are useful tools and encourage OEPA to develop Ohio reference values. Establishing these in-stream values can assist many groups working on similar issues across the state.

Response:
Ohio EPA has developed reference values for nutrients that are contained in the 1999 document "Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Stream" (1999, Ohio EPA Technical Bulletin MAS/1999-1-1). Those values are utilized in this TMDL.

Comment 16:
Similarly coordination permits on a watershed basis from the perspective of the TMDL impairment may be a way the build the TMDL implementation from within the OEPA. Watershed impaired by sediment would benefit from and adding special conditions to the specific 401 permits. NPDES discharge permits are similarly influenced in nutrient impaired stream segments, OEC encourages OEPA to look at a watershed based approach to all environmental permitting as a TMDL implementation strategy.

Response:
Ohio EPA has evaluated NPDES permits on a watershed basis, and where excess nutrients are an issue, permit limitations for nutrients have been developed.

Comment 17:
Lastly mainstem impairment below the Hoover dam is attributed to hypolimnetic dam releases during summer months. OEC believes that these poor quality water releases should be eliminated. Furthermore if stream floes are reduced due to installation of a raw water line the quality of water released to the mainstem should be high quality water since the flow regime will be greatly reduced. Maintaining sufficient high quality water in the main stem will be a critically important issue should the raw water line occur. OEC believes that Columbus should be given specific guidelines to assure that the use designation is supported for this reach of Big Walnut Cr.

Response:
Ohio EPA has re-evaluated the biological data down stream of the reservoir, and has concluded that the observed results are an artifact of the selection of the sample site more than a reflection of an impairment from the hypolimnetic discharge. While Ohio EPA shares your concern about reduced flows in the upper Big Walnut Creek due to the proposed raw water line, it is important to note that there is sufficient stream flow

downstream of the Hap Cremean Water Treatment Plant to sustain both warmwater habitat and exceptional warmwater habitat aquatic communities below the water withdrawal point. So long as Columbus maintains a flow regime in Big Walnut Creek that is similar to the current flow regime below the water treatment plant, aquatic life uses should be supported.

Friends of Alum Creek and Tributaries

Comment 18:
FACT is pleased with many components of the report, including the development of TMDLs on a 14-digit HUC scale and the innovative approach employed for developing habitat and sediment TMDLs. Specific load allocations and prescribed load reductions for pathogens also seem appropriate.

Response:
A goal of this TMDL was to produce information in a manner that was useful to local watershed groups.

Comment 19:
Although the Habitat TMDL described in Table 5.4.H (on page 105) applies to both 14 digit HUC units, "habitat alterations" is omitted as a cause of impairment for the lower 14 digit HUC unit (160 -020) in Table 1A and in other portions of the plan (such as "Causes and Sources of Impairment," section 5.4.2). This information should be added when the report is finalized.

Response:
Ohio EPA concurs, and the requested changes have been made.

Comment 20:
Similar to the above comment, the Sediment TMDL described in Table 5.4.H applies to both 14 digit HUC units, but "sedimentation" is omitted as a source of impairment for both sections of the Alum Creek mainstem in Table 1A and in other portions of the plan (such as "Causes and Sources of Impairment," section 5.4.2). This information should be added when the report is finalized.

Response:
Ohio EPA concurs, and the requested changes have been made.

Comment 21:
The TMDL report draws upon data collected for the 2003 Big Walnut Basin Technical Support Document (TSD). For the Alum Creek watershed, it also draws on the Middle Scioto River TSD published in 1999, which included Alum Creek. In both reports, sampling locations were found to be in non-attainment of standards, at river mile 8.6 in the 1999 report and at river mile 7.6 in the 2003 report. This information is included in table 5.4.A, and the likely sources of impairment, lowhead dams, are included in Table

2.B. However, the TMDL report fails to explicitly recognize the presence of nonattainment reaches and lowhead dams as its likely source (although it does list “no fast current” as a moderate influence attribute for two locations in this area). If lack of sufficient data is the cause of this omission, then a statement that nonattainment sites were found but their extent could not be extrapolated should be included in the report. Otherwise, FACT recommends that the nonattainment reach be included in Table 2.B.

Response:
The non-attainment sites listed in both technical support documents are for a single organism group, the macroinvertebrates, as represented by the ICI. In the more recent TSD, non-attainment was assigned in light of the partial attainment in the fish community at a nearby site. As such the entire segment was reported as in partial attainment. However, regardless of whether a stream is in non-attainment or partial attainment, the stream is still considered to be impaired and not achieving Clean Water Act goals. As such, action to eliminate the impairment is appropriate in either case.

Comment 22:
The TMDL report does not address the large quantities of litter in the stream as a violation of the “narrative free from” water quality criteria established in state law. Narrative criteria are summarized in Table 2.A but are not used elsewhere in the report. FACT has completed extensive documentation of the presence of this pollutant, which would be obvious to a casual observer from a roadway bridge. The information available suggests that most of this pollution is transported via stormwater conveyance systems. Litter impairs the beneficial uses of Alum Creek for recreation, aquatic life, and water supply. A Load Allocation (LA) of zero should be assigned for this pollutant in the TMDL.

Response:
At this time, Ohio EPA does not have the quantitative data necessary to establish a TMDL for litter. The point is well taken that the litter is detrimental to the stream, and, while it is a deterrent to recreation, the presence of litter does not necessarily cause the recreational use to be impaired.

NPDES permits for municipal separate storm sewer systems (MS4s) have conditions which may apply to the litter problem. Within the six minimum control measures, the Public Education and Outreach and Public Involvement/Participation components would be two areas where litter prevention/control BMPs could be utilized to satisfy some requirements of the MS4 general permit. Educational materials and activities targeted at litter would be examples that communities could utilize. The Pollution Prevention/Good Housekeeping for Municipal Operations minimum control measure, specifically Section 3.2.6.2.3.1, requires that a MS4 community develop and implement an O&M program that specifically addresses maintenance activities, maintenance schedules, and long-term inspection procedures for controls to reduce floatables and other pollutants to their MS4.

Comment 23:
While this report details habitat alterations as a major cause of impairment, it does not address a major *source* of this impairment that is permitted by the Ohio EPA: the dredging and filling of tributary streams and wetlands. As a primary implementer of the habitat TMDL for Alum Creek, FACT believes that the Ohio EPA's policies in granting dredge and fill permits without taking cumulative effects into account is inconsistent with reaching TMDL habitat targets and is an inefficient use of public and private resources. This is especially true given recent data indicating that wetland mitigation is not replacing the form and function of the wetlands they are being created to replace. Please see "An Inventory of Ohio Wetland Compensatory Mitigation," written by Deni Porej and available on the Ohio EPA website at http://www.epa.state.oh.us/dsw/wetlands/WetlandEcologySection.html.

Response:
Please see response to comment number 13 (comment by Friends of Big Walnut Creek).

Comment 24:
Please clarify whether SSOs are included with CSO load reduction allocations. These two sources are listed together in Table 5.4.D but not elsewhere in the report. For example, Table 5.4.C lists the CSO only, although the text for section 5.4.1 mentions "numerous minor SSOs." Ohio EPA should ensure that all available information on the locations and loadings from SSOs are included in the report.

Response:
A number of changes were made in Tables 5.4.D-G to clarify the SSO and CSO situation. Regarding the availability of information on SSO from the City of Columbus's collection system, please refer to Table B-23 of the TMDL report. If additional information is desired, a copy of the City of Columbus's Annual Report on Sanitary Sewer Overflow and Water in Basements is available upon request from Ohio EPA.

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Comment 25:
The BTI model assumes failed septic and leach systems due to poor soil or slopes. In reality, since the late 1970's, we have either permitted aeration systems; and when we permit a soil absorption system, our rules prevent us from siting these systems in hydric soils. This practice is not unique to all health departments. Therefore, the BTI model may be inflating the loading rates due to the proper siting of sewage systems.

Response:
The Bacteria Indicator Tool (BIT) was not used to calculate HSTS loads in the lower watersheds. HSTS loads were calculated outside of BIT; however, the comment writer is correct that the HSTS failure rate used in the draft report was based upon soil properties such as slope and drainage. Results from this method proved difficult to

corroborate because no information was available to ascertain the accuracy of the calculations. As a result, the HSTS failure rate based upon soil properties will not be used in the final report. In place of this, a failure rate of 20% will be used for all septic systems. This value was referenced from the U.S. EPA's Onsite Wastewater Treatment Manual. The report still maintains that all off-lot systems are failing.

Comment 26:
Due to complaints and real estate transfer inspections, we are made aware of surfacing of sewage from failed leach systems, and require the property owner to repair the system. Unfortunately, in some cases, the only fixes are discharging systems, pump and haul, or vacate the home. There is not enough political will to accomplish the latter two options at this time. Therefore the BIT model may be inflating the loading rates because systems that fail upward (on the surface) are the ones that get reported and are repaired.

Response:
The commenter states that the potential solutions to the problem of surfacing sewage from leach field systems are to install discharging systems, pump and haul, or vacate the home. The commenter goes on to state the latter two solutions are not feasible. This implies that if the problem of surfacing sewage is to be solved, then it will be solved via the installation of a discharging system. Since the method used to calculate the HSTSs load considers both ponding systems and discharging systems to be failing, replacing ponding systems with discharging systems in the model would not reduce the calculated load. Thus, the commenter's speculation that the HSTS load may be inflated based on the number of ponding systems is not correct since the BIT model sees both practices as essentially the same.

Comment 27:
I do not believe that there is one septic and leach system per lot in this watershed, because of the availability of central sewer, mostly in Jefferson Township.

Response:
The assumption of one HSTS per parcel lot was only applied to unsewered areas. The service area of Jefferson Township was considered as part of the analysis.

Comment 28:
The septic and leach systems with "cheater" lines connected underground and out-of-sight are more than likely directly being discharged into the watershed via farm tile or storm sewers. Because of the probable inflation of HSTS failures using the BTI model, I would not agree with your assessment of reasonable agreement between home aerators and failed septic and leach systems, as stated on page 41.

Response:
The statement referenced above attempted to explain that when the number of HSTSs (all types of systems) was multiplied by the probable failure rate (determined via soil analysis) there was a "reasonable agreement" between the product and then number of

off-lot systems. Since all off-lot systems were assumed to failing, the “reasonable agreement” theoretically served as a form of corroboration. There are two problems with this. First, the text failed to clearly convey the point. Second, the measure of “reasonable agreement” is relative and could, as this comment makes clear, be debated. For these reasons the method of HSTS load calculation has been changed and language referring to “reasonable agreement” has been deleted.

Comment 29:
A number of comments related to values in tables are combined for response:

- Table B-7, 899 aerators in the Blacklick, does not equal the Health Department estimate of aerators in Table B-20.A.

- Page B-25, it was stated that the 530 failed HSTS will be superceded by the number of aerators reported by the Health Department for 140-020, 140-050, and 140-040 (in this case, though, the number of failed HSTS was greater than the reported aerators.

- In Table B-20.B., 140-010, 140-030, and 140-060, why are you adding both septic and aerators to calculate the loading rates?

- Where septic numbers are larger than aerator estimates, shouldn't only the septic loading be calculated? Also in Table B-20.B. for 160-020, "persons served by failing septics and aerators" does not seem to be derived from "person per system from Census data" in B-20.A.

- In Table B-20.A. and B-20.B., why is the number of aerators(32) superceding the number of septics (55) in 140-040?

Response:
These comments all refer to specific values or procedures related to the method of HSTS load calculation in the draft report. In response to these comments, all HSTS numbers and methods were reviewed and revised. This was done to help resolve confusion regarding the method and correct errors in the tables. All tables and text related to HSTS loads have been replaced with the results of the updated analysis.

Comment 30:
I appreciate the comments about possible methods of rehabilitation on page 111. I agree that filtration and disinfection are methods that could be used to reduce pathogens. I hesitate, though, to place a new chlorination device or a new filtration system on a 50 year old crumbling aeration system that no longer is manufactured and using equipment from the hardware store. Many of the "failed" aerators are in areas with lower income populations.

Response:
No response required.

Comment 31:
The Federal EPA needs to relax its funding grip on prohibiting the use of discharging systems to repair existing aerators that do not meet current effluent quality standards.

Response:
No response required.

Comment 32:
Finally, could you publish the "literature values" used for calculating the nutrient and pathogen loading rates? Also, shouldn't there be some mention of BOD and SS enrichment?

Response:
The literature values used in the phosphorus and fecal coliform load calculation were daily per capita loading rates. The phosphorus loading rate used was 0.009 lbs-TP/(capita*day). This was referenced from *Wastewater Engineering: Treatment, Disposal, Reuse* (Metcalf & Eddy, 1991). The value used is the sum of the rates quoted for inorganic and organic phosphorus. The fecal coliform loading rate used was $1x10^8$ counts/(capita*day), and was referenced from the same source (Metcalf & Eddy, 1991). Appendix B has been updated to include this information.

Comment 33:
I understand how difficult it must be to predict pollution loading rates without field verified data using a one-size-fits-all model. I would like to work with the EPA if there are any local or Federal initiatives to improve the validity of the TMDL, especially in terms of HSTS loading rates.

Response:
The commenter provided valuable assistance and data to Ohio EPA staff in the preparation and revision of the final report. Ohio EPA appreciates the effort.