6.0 Identifying Sources of Pollution

6.1 Problems, Potential Causes, and Potential Sources

From the list of problems and potential causes, the UWRBC members and steering committee developed a list of potential sources; or in other words, the location or activity that the pollutant(s) come from, lack of awareness, or loss of a particular land use.

Table 6-1: Problems, potential causes, and potential sources of water quality impairments in the Upper Wabash River Phase 2 project area.

Problem:	Restricted/redirected flow within the stream or river.
Potential Causes:	• Log jams and debris in the river and streams. • In-stream sand and silt bars. • Lack of floodplain management.
Potential Sources:	• 7 locations where the trees are falling into the streams and river due to unstable banks or diseased and dying trees: Mossburg Ditch-Rock Creek; Johns Creek, Dowty Ditch, and Griffin Ditch-Wabash River, and Moser Lake, Big Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds. • Unanchored cut trees and cut fire wood observed in the Johns Creek-Wabash River and Elkenberry Ditch-Rock Creek subwatersheds during the windshield survey.
Problem:	Sediment and increased levels of turbidity threatens the water quality health of the streams and river in the watershed.
Potential Causes:	• Turbidity levels exceed the target established for fish and macroinvertebrate health. • Sediment, organic matter and algae in the streams and river.
Potential Sources:	• 50 locations of in-stream, stream bank and gully erosion were observed in all subwatersheds. The most sites are located in the Stites Ditch-Rock Creek, Mossburg Ditch-Rock Creek, and Elkenberry Ditch-Rock Creek subwatersheds; followed by the Griffin Ditch-Wabash River, Dowty Ditch-Wabash River, and Johns Creek-Wabash River subwatersheds. • 100 miles of streams and river lack forested buffers and grass filter strips. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch -Wabash River subwatersheds need buffers on more than 40% of their stream miles. • Low adoption rates of conservation tillage. Conventional tillage is used on 56% of the agricultural acres in all subwatersheds. The Stites Ditch and Headwaters-Rock Creek, and Johns Creek and Bender Ditch-Wabash River subwatersheds are estimated to have conventional tillage on 50% or more of the cropland acres. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters-Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • 32% of watershed is HEL/PHEL soils. The subwatersheds with the highest percentage of HEL/PHEL soils are: Big Creek-Eight Mile Creek; Mossburg Ditch and Elkenberry Ditch-Rock Creek; and Dowty Ditch-Wabash River subwatersheds. • Observed that cropland buffer areas (fence rows and fence borders) were lacking in all watersheds. • USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek.

Problem:	Increased surface and subsurface flow throughout the watersheds threatens water quality.
Potential Causes:	• Wetlands drained and forests cleared. • Loss of ponding areas in the watershed and floodplain storage. • Lack of floodplain management causing flooding along the river and streams. • Increase of tile installation. • Traditional ditch maintenance. • Lack of green space, native habitat and trails.
Potential Sources:	• USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek. • 100 miles of streams and river lack forested buffers and grass filter strips. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch -Wabash River subwatersheds need buffers on more than 40% of their stream miles. • Low adoption rates of conservation tillage that could reduce run-off. Conventional tillage is used on 56% of the agricultural acres in all subwatersheds. The Stites Ditch and Headwaters-Rock Creek, and Johns Creek and Bender Ditch-Wabash River subwatersheds are estimated to have conventional tillage on 50% or more of the cropland acres. • Increase of tile installation in the watersheds; 4 new installation sites observed in the Headwaters, Stites Ditch, Mossburg Ditch and Elkenberry Ditch-Rock Creek subwatersheds. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters-Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • Ditch maintenance is preformed on nearly all streams, and was observed in the Headwaters-Rock Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds. • Lack of green space and native habitat in urban areas observed in urban landscapes.

Problem:	Excess nutrients increase aquatic plants and algae, and algal blooms in the river and streams threaten aquatic communities and can pose a human health risk.
Potential Causes:	• Excess nutrients – nitrogen and phosphorus in the water. • Nitrate and total nitrogen levels exceed state targets. • Total phosphorus levels exceed state targets.
Potential Sources:	• Unknown amount of over application of fertilizer on cropland and residential areas, and limited use of soil testing and variable rate fertilizer applications based on responses to social surveys. • Lack of buffer areas at tile inlets. 296 miles of county tile plus private tile are in the project area. Only a few buffer areas were observed, and tile inlet buffers are needed in all subwatersheds. The Stites Ditch, Elkenberry Ditch and Headwaters subwatersheds of the Rock Creek, and Maple Creek-Eight Mile Creek subwatershed contain the most miles of drainage tile. • Increase of tile installation in watersheds; 4 new installation sites observed in the four Rock Creek subwatersheds: Headwaters, Stites Ditch, Mossburg Ditch and Elkenberry Ditch. • Observed that cropland buffer areas (fence rows and fence borders) were lacking in all watersheds. • 27 CFOs in the project area; 24 located within a ½ mile of the streams and river, and 3 located within 1 mile of the streams and river. The highest number of CFOs is in the Johns Creek-Wabash River, Stites Ditch-Rock Creek, and Maple Creek-Eight Mile Creek subwatersheds. • Animal waste runoff from land applications, manure stock piles, and 1,050 hobby farms. Two manure distribution lines were observed in the Stites Ditch-Rock Creek subwatershed, three manure stockpiles were observed in the Stites Ditch-Rock Creek, Dowty Ditch-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. An estimated 1,050 hobby farms are located throughout all subwatersheds, with the heaviest concentrations located in the Pleasant Run Ditch, and Big Creek subwatersheds of the Eight Mile Creek, Dowty Ditch-Wabash River subwatershed, and Headwaters-Rock Creek subwatershed. • 100 miles of streams and river lack forested buffers and grass filter strips. Tillage goes to the edge of banks. All subwatersheds lack buffers. The Maple Creek, and Moser Lake-Eight Mile Creek subwatersheds and Bender Ditch and Griffin Ditch - Wabash River subwatersheds need buffers on more than 40% of their stream miles. • 12 documented municipal wastewater treatment plant sanitary sewer overflows to the Headwaters-Rock Creek, Dowty Ditch and Griffin Ditch-Wabash River subwatersheds, and Moser Lake-Eight Mile Creek subwatershed. • Over 3,900 on-site septic systems on severely limited soils throughout all watersheds. It is likely that failing and/or lack of maintenance, and outdated direct connect on-site septic systems are present in all watersheds. The subwatersheds with the heaviest concentration of septic systems based on subwatershed area are: Pleasant Run Ditch, Big Creek and Moser Lake-Eight Mile Creek, and Dowty Ditch-Wabash River. • USDA verification of removal and lack of wetlands and riparian areas throughout all watersheds. The subwatersheds with the less than 5% wetlands and woodlands are: Headwaters, and Stites Ditch-Rock Creek; and Maple Creek-Eight Mile Creek.

Problem:	E. coli and other pathogens pose a health risk for recreational activities throughout the watersheds.
Potential Causes:	E. coli levels exceed state standard.
Potential Sources:	• Lack of wastewater treatment in 10 unincorporated communities in all of the Rock Creek subwatersheds, Johns Ditch and Dowty Ditch-Wabash River, and Maple Creek-Eight Mile Creek subwatersheds. • Over 3,900 on-site septic systems on severely limited soils throughout all watersheds. It is likely that failing and/or lack of maintenance, and outdated direct connect on-site septic systems are present in all watersheds. The subwatersheds with the heaviest concentration of septic systems based on subwatershed area are: Pleasant Run Ditch, Big Creek and Moser Lake-Eight Mile Creek, and Dowty Ditch-Wabash River. • Animal waste runoff from land applications and 1,050 hobby farms. Two manure distribution lines were observed in the Stites Ditch-Rock Creek subwatershed. An estimated 1,050 hobby farms are located throughout all subwatersheds, with the heaviest concentrations located in the Pleasant Run Ditch, and Big Creek subwatersheds of the Eight Mile Creek, Dowty Ditch-Wabash River subwatershed, and Headwaters-Rock Creek subwatershed. • Abundance of animal waste generated and brought into the watershed. Three manure stockpiles were observed in the Stites Ditch-Rock Creek, Dowty Ditch-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. • 12 documented municipal wastewater treatment plant sanitary sewer overflows to the Headwaters-Rock Creek, Dowty Ditch and Griffin Ditch-Wabash River subwatersheds, and Moser Lake-Eight Mile Creek subwatershed.
Problems:	1) Lack of education on the economic benefit of BMPs. 2) Competing land uses limit BMP implementation that would/could improve water quality. 3) Individuals lack knowledge of BMPs, where they could/should be implemented and how to fund practices. 4) General public's lack of understanding or sense of responsibility for how and why their actions impact water quality.
Potential Causes:	• Lack of appreciation for and understanding of environmental benefits versus financial benefits. • Lack of education to land users, funders and the general public on the use of BMPs. • Lack of education to the public about their contribution to the health of the streams and river. • Lack of understanding and appreciation for natural areas.
Potential Sources:	• Lack of education to land users on the economic and environmental value of BMPs evidenced by project social surveys. • Lack of avenues to get the public to participate in educational activities. • Limited community involvement in environmental activities as evidenced by lack of participation in river clean-up and monitoring events. • Competition from other causes. • Lack of stewardship for Mother Nature.

6.2 Pollutant Load Estimates

Nonpoint source pollution comes from many sources found throughout the watershed on public and private lands. As rainfall and snowmelt runoff moves over and through the ground it picks up and carries away natural and human-made pollutants depositing them into streams, lakes, rivers, wetlands and ground waters.

The water quality targets listed in Table 3-4 (page 85) represent the quantitative value used to measure whether or not the applicable water quality standard is attained for each pollutant of concern. Those numeric water quality targets are then translated into the loading capacity of a stream or river. EPA defines loading capacity as "the greatest amount of loading that a water can receive without violating water quality standards". The loading capacity provides a reference, which helps guide pollutant reduction efforts needed to bring a stream or river into compliance with water quality standards. Two methods have been used to understand the loading of nutrients and pathogens in the water bodies in the project area; measured results from the water quality monitoring events and hydrologic simulation models.

Measured Results from Water Quality Monitoring

The water quality monitoring data collected throughout the project shows the actual levels of contaminants in the streams and river at a specific time. The parameter test results are often related to stream flow rates. For instance, sediment and turbidity concentrations typically increase with rising flows as a result of factors such as channel scour from higher velocities. Other parameters, such as nitrogen or *E. coli*, may be more concentrated at low flows and more diluted by increased water volumes at higher flows.

The monitoring data results for nutrients and *E. coli* can be combined with the flow data to estimate the current loads and target loads in the water bodies. Current loading estimates for each monitoring site is calculated by multiplying the average pollutant concentration, the stream flow measurement, and a conversion factor to transform each concentration measurement into "load" for that point in time. The estimated target loads are calculated by multiplying the stream flow by the water quality target (Table 3-4, page 85) for the individual parameter, and the conversion factor.

Most of the 12-digit HUC subwatersheds have a water monitoring site located near the outlet of that drainage area; therefore, the water monitoring locations were assigned to each subwatershed based on their location (Table 6-2). The exceptions are the Mossburg Ditch-Rock Creek, Bender Ditch-Wabash River, and Big Creek-Eight Mile Creek subwatersheds. Monitoring site 13 has been assigned to the Mossburg Ditch-Rock Creek subwatershed. The Bender Ditch and Griffin Ditch-Wabash River subwatersheds will be treated as a single drainage area at monitoring site 9, and the Big Creek and Pleasant Run Ditch-Eight Mile Creek subwatersheds will be treated as a single drainage area at monitoring site 1. Site 11 on the Elkenberry Ditch, a tributary to the Rock Creek channel only takes into consideration the drainage from the western portion of the subwatershed; and site 12 is a total of all of the Wabash River and Rock Creek subwatersheds. These sites are shown for comparison purposes and to provide for further evaluation across the project area.

Table 6-2: Monitoring Sites Used for Load Estimates

Monitoring Sites	Subwatershed Name	12-digit HUC
1	Pleasant Run/Big Creek-Eight Mile Creek	051201010904 & 051201010903
2	Moser Lake-Eight Mile Creek	051201010902
3	Maple Creek-Eight Mile Creek	051201010901
6	Johns Creek-Wabash River	051201010801
7	Dowty Ditch-Wabash River	051201010802
9	Bender Ditch/Griffin Ditch-Wabash River	051201010803 & 051201010804
10	Elkenberry Ditch-Rock Creek	051201010704
13	Mossburg Ditch-Rock Creek	051201010702
14	Stites Ditch-Rock Creek	051201010703
15	Headwaters-Rock Creek	051201010701
11	Western portion of Elkenberry Ditch subwatershed	
12	Total of all of the Wabash River and Rock Creek subwatersheds	

There are some limitations in using the measured data to estimate loads and load reductions. The sampling methods did not allow for continuous flow measurements at each site, and the only USGS gage in the project area is located on the Wabash River at the most upstream point. Due to its location, it does not allow for accurate estimations of continuous flow for the subwatersheds or take into consideration the impoundment area in the J.E. Roush Fish and Wildlife area (site 8) on the Wabash River; which is too deep and wide to conduct flow measurements. Additionally, the UWRBC used turbidity as a measurement of the cloudiness of the water versus monitoring for total suspended solids; therefore, we were not able to estimate sediment loads in the project area which would have been useful in determining the effects of gully, stream bank and in-stream erosion in the project area.

The measured current load estimates and target loads in the following table are expressed in pounds per year (lbs/yr) for nutrients, and billions of organisms per year (G-org/yr) for *E.coli*.

Table 6-3: Measured Current Load and Target Load Estimates – pounds per year or billions of organisms per year.

Red text indicates values exceed current water quality targets.

Subwatershed	Site	Nitrate	Nitrite	Total Nitrogen	Total Phosphorus	*E. coli*
		Current Load *Target Load* *(lbs/yr)*	*Current Load* *Target Load* *(lbs/yr)*	*Current Load* *Target Load* *(lbs/yr)*	*Current Load* *Target Load* *(lbs/yr)*	*Current Load* *Target Load* *(G-org/yr)*
Pleasant Run/Big Creek-Eight Mile Creek	1	1,409,182 1,508,760	7,242 150,876	765,696 1,508,760	41,189 45,262	340,402 160,900
Moser Lake-Eight Mile Creek	2	1,792,180 519,773	4,366 51,977	500,282 519,773	57,123 15,593	130,271 55,431
Maple Creek-Eight Mile Creek	3	551,299 328,154	2,953 32,815	200,436 328,154	8,171 9,845	65,759 34,996
Johns Creek-Wabash River	6	28,164,811 13,984,514	160,822 1,398,451	12,749,681 13,984,514	707,616 419,535	3,842,636 1,491,362
Dowty Ditch-Wabash River	7	24,761,037 12,173,568	121,736 1,217,357	10,398,662 12,173,568	613,547 365,207	3,222,276 1,298,235
Bender Ditch/Griffin Ditch-Wabash River	9	34,007,873 18,031,746	230,806 1,803,175	13,949,359 18,031,746	741,105 540,952	4,115,982 1,922,974
Elkenberry Ditch-Rock Creek	10	3,312,657 2,056,274	17,889 205,627	1,376,058 2,056,274	46,883 61,688	479,477 219,289
Mossburg Ditch-Rock Creek	13	1,617,006 1,434,788	7,317 143,479	667,177 1,434,788	25,682 43,043	317,788 153,011
Stites Ditch-Rock Creek	14	1,358,611 864,256	14,347 86,426	551,914 864,256	15,643 25,927	115,865 92,168
Headwaters-Rock Creek	15	598,785 478,262	2,056 47,826	230,379 478,262	9,230 14,348	69,940 51,004
TOTALS		97,573,441 51,380,095	569,534 5,138,009	41,389,644 51,380,095	2,266,189 1,541,400	12,700,396 5,479,370
Western portion of Elkenberry Ditch subwatershed	11	210,986 159,355	24,030 15,936	77,558 159,355	2,709 4,780	36,151 16,994
Total Wabash River & Rock Creek subwatersheds	12	29,751,032 19,356,559	174,209 1,935,656	11,402,949 19,356,559	526,498 580,696	3,805,875 2,064,257

In total, the measured current load is predicted to be 97,573,441 pounds of nitrate, 569,534 pounds of nitrite, 41,389,644 pounds of total nitrogen, 2,266,189 pounds of total phosphorus, and 12,700,396 billions of organisms of E. coli annually in the project area.

Based on the annual measured load the largest contributors of nitrate, nitrite, total nitrogen, total phosphorus and *E. coli* in the project area are the Wabash River subwatersheds; Bender Ditch/Griffin Ditch, Johns Creek, and Dowty Ditch. The Elkenberry Ditch-Rock Creek subwatershed also ranked high as a contributor of nitrate, nitrite, total nitrogen and *E. coli*, while the Moser Lake-Eight Mile Creek subwatershed is a major contributor of total phosphorus.

The annual measured loading estimates were then normalized by the total area draining to the sample location and represented in pounds per acre per year or billions of organisms per acre per year. The total drainage area for each sample location was derived from the L-THIA watershed delineator tool developed by Purdue University, Agricultural and Biological Engineering department with support from USEPA, USDA, US Army CERL, and the Corps of Engineers.

Table 6-4: Measured Current Load and Target Load Estimates – pounds per acre per year or billions of organisms per acre per year.

Red text indicates values exceed current water quality targets.

Subwatershed (Acres*) *Based on Purdue University L-THIA watershed delineator.	**Site**	**Nitrate** *Current Load Target Load (lbs/ac/yr)*	**Nitrite** *Current Load Target Load (lbs/ac/yr)*	**Total Nitrogen** *Current Load Target Load (lbs/ac/yr)*	**Total Phosphorus** *Current Load Target Load (lbs/ac/yr)*	***E. coli*** *Current Load Target Load (G-org/ac/yr)*
Pleasant Run/Big Creek-Eight Mile Creek (50,338 acres)	1	27.99 29.97	0.14 3.00	15.21 29.97	0.81 0.90	6.76 3.20
Moser Lake-Eight Mile Creek (21,530 acres)	2	83.24 24.14	0.20 2.41	23.24 24.14	2.65 0.72	6.05 2.57
Maple Creek-Eight Mile Creek (15,108 acres)	3	36.49 21.72	0.20 2.17	13.27 21.72	0.54 0.65	4.35 2.32
Johns Creek-Wabash River (370,754 acres)	6	75.97 37.72	0.43 3.77	34.39 37.72	1.91 1.13	10.36 4.02
Dowty Ditch-Wabash River (381,733 acres)	7	64.86 31.89	0.32 3.19	27.24 31.89	1.61 0.96	8.44 3.40
Bender Ditch/Griffin Ditch-Wabash River (410,719 acres)	9	82.80 43.90	0.56 4.39	33.96 43.90	1.80 1.31	10.02 4.68
Elkenberry Ditch-Rock Creek (66,637 acres)	10	49.71 30.86	0.27 3.09	20.65 30.86	0.70 0.93	7.20 3.29
Mossburg Ditch-Rock Creek (53,208 acres)	13	30.39 26.97	0.14 2.70	12.53 26.97	0.48 0.81	5.97 2.88
Stites Ditch-Rock Creek (29,944 acres)	14	45.37 28.86	0.48 2.89	18.43 28.86	0.52 0.87	3.87 3.08
Headwaters-Rock Creek (20,089 acres)	15	29.81 23.81	0.10 2.38	11.47 23.81	0.46 0.71	3.48 2.54
Western portion of Elkenberry Ditch subwatershed (6,136 acres)	11	34.38 25.97	3.92 2.60	12.64 25.97	0.44 0.78	5.89 2.77
Total Wabash River & Rock Creek subwatersheds (477,393 acres)	12	62.32 40.55	0.36 4.06	23.89 40.55	1.10 1.22	7.97 4.32

When the loading is based on the per acre rate, the greatest contributor of nitrate and total phosphorus is the Moser Lake-Eight Mile Creek subwatershed. The Wabash River subwatersheds; Johns Creek, Dowty Ditch, and Bender Ditch/Griffin Ditch are significant contributors of all nutrients and *E. coli.* The Stites Ditch-Rock Creek is a major contributor of nitrite, and the Elkenberry Ditch-Rock Creek is a major contributor of *E. coli*.

Hydrologic Simulation Model Results

Various hydrologic simulation models were compared and evaluated for use in determining estimates of the pollutant loads in the water bodies. The load duration curve (LDC) approach was selected because it uses the project monitoring sites which allows for comparison between the measured load and modeled load for each subwatershed. It also provides a way to characterize the water quality concentrations at the full range of flow conditions. With this model the frequency and magnitude of water quality standard exceedances, allowable loadings, and the size of load reductions are more easily understood. The pattern of impairment can be examined to see if it occurs across all flow conditions, corresponds strictly to high flow events, or conversely, only to low flows.

The LDC presents the flow conditions plotted as a percent of time that a given flow occurs within the stream (curve). The flow ranges fall into five flow zones; high flow (0-10), moist conditions (10-40), mid-range flow (40-60), dry conditions (60-90), and low flow (90-100). Each parameter sample result (points) is plotted against the "percent of time" for the day of sampling; and a pattern develops which describes the characteristics of the water quality impairment. The points (sample results) that plot above the curve indicate an exceedance of the water quality target, while those below the curve show compliance. Exceedances observed in the high (0-10) and moist range (10-40) generally reflect potential nonpoint source contributions associated with surface runoff or storm water loads, while exceedances in the low flow zone (90-100) indicates the influence of point sources.

When using the LDC method, EPA recommends that the 90^{th} percentile of the measured load be used as a "margin of safety" to account for the uncertainty associated with water quality that varies across different flow conditions. For example, the loading capacity as calculated at the mid-point of each of the five flow zones and the loading capacity calculated at the minimum flow in each zone can vary greatly.

In some cases, an overall load reduction value results in no reduction needed, but with further review of the waste load allocation over time, loads above the target during a specific flow condition are often offset by loads significantly under the target during the other flow conditions resulting in a no net load reduction. When this is the case, it is necessary to look at the load allocations under the various flow conditions to identify a link between the source of the pollutant and delivery mechanism to determine under what conditions reductions may be needed.

The modeled target load, observed load, required reduction for each flow regime, and overall required reduction are displayed in the load reduction reports. *E. coli* load reduction reports only provide the target load, observed loads and required reduction information by flow regime, and do not give the overall loads and required reduction.

For the subwatersheds with more than one monitoring location, the downstream location is used to indicate the load for the entire or combined subwatersheds. Again, site 11 on the Elkenberry Ditch, a tributary to the Rock Creek channel only takes into consideration the drainage from the western portion of the subwatershed; and site 12 is a total of all of the Wabash River and Rock Creek subwatersheds. Table 6-5 shows the overall modeled load and target load estimates for each subwatershed.

Table 6-5: LDC Modeled Load and Target Load Estimates – pounds per year.

Red text indicates values exceed modeled water quality targets.

Subwatershed	Site	Nitrate	Nitrite	Total Nitrogen	Total Phosphorus
		Modeled Load *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*	*Modeled Load* *Target Load* *(lbs/yr)*
Pleasant Run/Big Creek-Eight Mile Creek	1	1,487,908 1,509,877	7,201 150,990	179,675 1,509,877	16,918 45,297
Moser Lake-Eight Mile Creek	2	1,594,802 520,202	4,745 52,020	276,090 520,202	74,325 15,607
Maple Creek-Eight Mile Creek	3	678,400 328,380	4,008 32,839	128,987 328,380	7,147 9,851
Johns Creek-Wabash River	6	27,559,471 13,994,279	192,319 1,399,428	7,519,949 13,994,279	195,312 419,827
Dowty Ditch-Wabash River	7	28,978,795 12,182,025	222,541 1,218,202	8,513,552 12,182,025	315,572 365,460
Bender Ditch/Griffin Ditch-Wabash River	9	28,415,443 18,044,268	231,844 1,804,425	11,509,972 18,044,268	433,043 541,328
Elkenberry Ditch-Rock Creek	10	7,354,746 2,057,782	22,156 205,780	1,797,362 2,057,782	27,120 61,732
Mossburg Ditch-Rock Creek	13	3,440,337 1,435,874	12,370 143,587	548,226 1,435,874	112,938 43,077
Stites Ditch-Rock Creek	14	1,218,490 1,119,010	21,889 111,902	399,084 1,119,010	6,388 33,569
Headwaters-Rock Creek	15	922,293 478,657	2,154 47,866	215,124 478,657	6,183 14,359
TOTALS		101,650,685 51,670,354	721,227 5,167,039	31,088,021 51,670,354	1,194,946 1,550,107
Western portion of Elkenberry Ditch subwatershed	11	283,777 159,498	50,538 15,951	79,789 159,498	9,231 4,785
Total Wabash River & Rock Creek subwatersheds	12	27,108,477 19,369,962	304,994 1,936,997	6,196,934 19,369,9624	116,253 581,098

The total load duration curve loading is estimated to be 101,650,685 pounds of nitrate, 721,227 pounds of nitrite, 31,088,021 pounds of total nitrogen, and 1,194,945 pounds of total phosphorus.

Based on the annual modeled load estimates, the Bender Ditch/Griffin Ditch, Dowty Ditch, and Johns Creek subwatersheds are the largest contributors of all nutrients. The Elkenberry Ditch-Rock Creek subwatershed is a major contributor of nitrate, nitrite and total nitrogen; and the Mossburg Ditch-Rock Creek subwatershed is a major contributor of total phosphorus.

The annual modeled loading estimates were also normalized by the total area draining to the sample location and represented in pounds per acre per year. The total drainage area for each sample location was derived from the L-THIA watershed delineator tool developed by Purdue University, Agricultural and Biological Engineering department with support from USEPA, USDA, US Army CERL, and the Corps of Engineers.

Table 6-6: LDC Modeled Load and Target Load Estimates – pounds per acre per year.

Red text indicates values exceed current water quality targets.

Subwatershed (Acres*) *Based on Purdue University L-THIA watershed delineator.	**Site**	**Nitrate**	**Nitrite**	**Total Nitrogen**	**Total Phosphorus**
		Modeled Load Target Load (lbs/ac/yr)	*Modeled Load Target Load (lbs/ac/yr)*	*Modeled Load Target Load (lbs/ac/yr)*	*Modeled Load Target Load (lbs/ac/yr)*
Pleasant Run/Big Creek-Eight Mile Creek (50,338 acres)	1	29.56 29.99	0.14 3.00	3.57 29.99	0.34 0.90
Moser Lake-Eight Mile Creek (21,530 acres)	2	74.07 24.16	0.22 2.42	12.82 24.16	3.45 0.73
Maple Creek-Eight Mile Creek (15,108 acres)	3	44.90 21.74	0.27 2.17	8.54 21.74	0.47 0.65
Johns Creek-Wabash River (370,754 acres)	6	74.33 37.75	0.52 3.77	20.28 37.75	0.53 1.13
Dowty Ditch-Wabash River (381,733 acres)	7	75.91 31.91	0.58 3.19	22.30 31.91	0.83 0.96
Bender Ditch/Griffin Ditch-Wabash River (410,719 acres)	9	69.18 43.93	0.56 4.39	28.02 43.93	1.05 1.32
Elkenberry Ditch-Rock Creek (66,637 acres)	10	110.37 30.88	0.33 3.09	26.97 30.88	0.41 0.93
Mossburg Ditch-Rock Creek (53,208 acres)	13	64.66 26.99	0.23 2.69	10.30 26.99	2.12 0.81
Stites Ditch-Rock Creek (29,944 acres)	14	40.69 37.37	0.73 3.74	13.33 37.37	0.21 1.12
Headwaters-Rock Creek (20,089 acres)	15	45.91 23.83	0.11 2.38	10.71 23.83	0.31 0.72
Western portion of Elkenberry Ditch subwatershed (6,136 acres)	11	46.25 25.99	8.24 2.60	13.00 25.99	1.50 0.78
Total Wabash River & Rock Creek subwatersheds (477,393 acres)	12	56.78 40.57	0.64 4.06	12.98 40.57	0.24 1.22

Based on the annual modeled load estimates per acre, the Elkenberry Ditch-Rock Creek subwatershed is the largest contributor of nitrate; followed by the Dowty Ditch-Wabash River, Johns Creek-Wabash River, and Moser Lake-Eight Mile Creek subwatersheds. The Stites Ditch-Rock Creek is the leading contributor of nitrite. The Dowty Ditch, Bender Ditch/Griffin Ditch, and Johns Creek-Wabash River subwatersheds are also major contributors. The Bender Ditch-Wabash River subwatershed is the highest contributor for total nitrogen; followed by the Elkenberry Ditch-Rock Creek subwatershed and Dowty Ditch and Johns Creek subwatersheds of the Wabash River. The Moser Ditch-Eight Mile Creek is the largest contributor of total phosphorus. Additional major contributors include the Mossburg Ditch-Rock Creek, Bender Ditch/Griffin Ditch and Dowty Ditch-Wabash River subwatersheds.

Measured vs. Modeled Loads

Tables 6-7 through 6-11 compare the loads derived from the measured data and the modeled data. Because the LDC model does not estimate an overall load or target load for E. coli, our measured estimates are the only source to estimate *E. coli* concentrations in the project area. The *E. coli* annual and per acre estimates are based on billions of organisms per year and billions of organisms per acre per year.

Table 6-7: Measured Loads vs. Modeled Loads - Nitrate.

Subwatershed	Site	Nitrate				
		Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Pleasant Run/Big Creek-Eight Mile Creek	1	1,409,182	1,487,908	94%	27.99	29.56
Moser Lake-Eight Mile Creek	2	1,792,180	1,594,802	112%	83.24	74.07
Maple Creek-Eight Mile Creek	3	551,299	678,400	91%	36.49	44.90
Johns Creek-Wabash River	6	28,164,811	27,559,471	102%	75.97	74.33
Dowty Ditch-Wabash River	7	24,761,037	28,978,795	85%	64.86	75.91
Bender Ditch/Griffin Ditch-Wabash River	9	34,007,873	28,415,443	120%	82.80	69.18
Elkenberry Ditch-Rock Creek	10	3,312,657	7,354,746	45%	49.71	110.37
Mossburg Ditch-Rock Creek	13	1,617,006	3,440,337	47%	30.39	64.66
Stites Ditch-Rock Creek	14	1,358,611	1,218,490	111%	45.37	40.69
Headwaters-Rock Creek	15	598,785	922,293	65%	29.81	45.91
Western portion of Elkenberry Ditch subwatershed	11	210,986	283,777	74%	34.38	46.25
Total Wabash River & Rock Creek subwatersheds	12	29,751,032	27,108,477	110%	62.32	56.78

Table 6-8: Measured Loads vs. Modeled Loads - Nitrite.

Subwatershed	Site	Nitrite				
		Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Pleasant Run/Big Creek-Eight Mile Creek	1	7,242	7,201	101%	0.14	0.14
Moser Lake-Eight Mile Creek	2	4,366	4,745	92%	0.20	0.22
Maple Creek-Eight Mile Creek	3	2,953	4,008	74%	0.20	0.27
Johns Creek-Wabash River	6	160,822	192,319	84%	0.43	0.52
Dowty Ditch-Wabash River	7	121,736	222,541	55%	0.32	0.58
Bender Ditch/Griffin Ditch-Wabash River	9	230,806	231,844	99.5%	0.56	0.56
Elkenberry Ditch-Rock Creek	10	17,889	22,156	81%	0.27	0.33
Mossburg Ditch-Rock Creek	13	7,317	12,370	59%	0.14	0.23
Stites Ditch-Rock Creek	14	14,347	21,889	66%	0.48	0.73
Headwaters-Rock Creek	15	2,056	2,154	95%	0.10	0.11
Western portion of Elkenberry Ditch subwatershed	11	24,030	50,538	48%	3.92	8.24
Total Wabash River & Rock Creek subwatersheds	12	174,209	304,994	57%	0.36	0.64

Table 6-9: Measured Loads vs. Modeled Loads – Total Nitrogen.

Subwatershed	Site	Total Nitrogen				
		Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Pleasant Run/Big Creek-Eight Mile Creek	1	765,696	179,675	426%	15.21	3.57
Moser Lake-Eight Mile Creek	2	500,282	276,090	181%	23.24	12.82
Maple Creek-Eight Mile Creek	3	200,436	128,987	155%	13.27	8.54
Johns Creek-Wabash River	6	12,749,681	7,519,949	170%	34.39	20.28
Dowty Ditch-Wabash River	7	10,398,662	8,513,552	122%	27.24	22.30
Bender Ditch/Griffin Ditch-Wabash River	9	13,949,359	11,509,972	121%	33.96	28.02
Elkenberry Ditch-Rock Creek	10	1,376,058	1,797,362	77%	20.65	26.97
Mossburg Ditch-Rock Creek	13	667,177	548,226	122%	12.53	10.30
Stites Ditch-Rock Creek	14	551,914	399,084	138%	18.43	13.33
Headwaters-Rock Creek	15	230,379	215,124	107%	11.47	10.71
Western portion of Elkenberry Ditch subwatershed	11	77,558	79,789	97%	12.64	13.00
Total Wabash River & Rock Creek subwatersheds	12	11,402,949	6,196,934	184%	23.89	12.98

Table 6-10: Measured Loads vs. Modeled Loads – Total Phosphorus.

Subwatershed	Site	Total Phosphorus				
		Measured Load ***(lbs/yr)***	*Modeled Load* ***(lbs/yr)***	*Comparison: Measured/ Modeled*	*Measured Load* ***(lbs/ac/yr)***	*Modeled Load* ***(lbs/ac/yr)***
Pleasant Run/Big Creek-Eight Mile Creek	1	41,189	16,918	243%	0.81	0.34
Moser Lake-Eight Mile Creek	2	57,123	74,325	77%	2.65	3.45
Maple Creek-Eight Mile Creek	3	8,171	7,147	114%	0.54	0.47
Johns Creek-Wabash River	6	707,616	195,312	362%	1.91	0.53
Dowty Ditch-Wabash River	7	613,547	315,572	194%	1.61	0.83
Bender Ditch/Griffin Ditch-Wabash River	9	741,105	433,043	171%	1.80	1.05
Elkenberry Ditch-Rock Creek	10	46,883	27,120	173%	0.70	0.41
Mossburg Ditch-Rock Creek	13	25,682	112,938	23%	0.48	2.12
Stites Ditch-Rock Creek	14	15,643	6,388	245%	0.52	0.21
Headwaters-Rock Creek	15	9,230	6,183	149%	0.46	0.31
Western portion of Elkenberry Ditch subwatershed	11	2,709	9,231	29%	0.44	1.50
Total Wabash River & Rock Creek subwatersheds	12	526,498	116,253	452%	1.10	0.24

Table 6-11: Measured Loads – *E. coli*.

Subwatershed	Site	*E. coli*	
		Measured Load (G-org/yr)	*Measured Load (G-org/ac/yr)*
Pleasant Run/Big Creek-Eight Mile Creek	1	340,402	6.76
Moser Lake-Eight Mile Creek	2	130,271	6.05
Maple Creek-Eight Mile Creek	3	65,759	4.35
Johns Creek-Wabash River	6	3,842,636	10.36
Dowty Ditch-Wabash River	7	3,222,276	8.44
Bender Ditch/Griffin Ditch-Wabash River	9	4,115,982	10.02
Elkenberry Ditch-Rock Creek	10	479,477	7.20
Mossburg Ditch-Rock Creek	13	317,788	5.97
Stites Ditch-Rock Creek	14	115,865	3.87
Headwaters-Rock Creek	15	69,940	3.48
Western portion of Elkenberry Ditch subwatershed	11	36,151	5.89
Total Wabash River & Rock Creek subwatersheds	12	3,805,875	7.97

6.3 Target Load Reductions Needed

Based on a review of the measured versus modeled loads, the measured load data was used to rank the subwatersheds by the current loading per acre for nitrate, total phosphorus and *E. coli*. Nitrite and total nitrogen does not require any reductions. The phosphorus reduction of 32% will exceed the Wabash River TMDL of a 4% reduction for phosphorus; however, the reduction of 57% for *E. coli* will meet the target load for the project area but is below the TMDL reduction of 87%. These load reductions are used in addition to other characteristics in the subwatershed, such as land use, to identify critical areas in the project area and also used in determining long-term goals.

Table 6-12: Measured vs. Modeled Load Reduction Estimates – Nitrate.

Subwatershed	Site	Nitrate					
		Measured Reduction (lbs/yr)	*Measured Reduction (lbs/ac/yr)*	*%*	*Modeled Reduction (lbs/yr)*	*Modeled Reduction (lbs/ac/yr)*	*%*
Pleasant Run/Big Creek-Eight Mile Creek	1	-	-	-	-	-	-
Moser Lake-Eight Mile Creek	2	1,272,407	59.10	71%	1,074,600	49.91	67%
Maple Creek-Eight Mile Creek	3	223,145	14.77	40%	350,020	23.17	52%
Johns Creek-Wabash River	6	14,180,297	38.25	50%	13,565,192	36.59	49%
Dowty Ditch-Wabash River	7	12,587,469	32.97	51%	16,796,770	44.00	58%
Bender Ditch/Griffin Ditch-Wabash River	9	15,976,127	38.90	47%	10,371,175	25.25	37%
Elkenberry Ditch-Rock Creek	10	1,256,383	18.85	38%	5,296,964	79.49	72%
Mossburg Ditch-Rock Creek	13	182,218	3.42	11%	2,004,463	37.67	58%
Stites Ditch-Rock Creek	14	494,355	16.51	36%	99,480	3.32	8%
Headwaters-Rock Creek	15	120,523	6.00	20%	443,636	22.08	48%
Western portion of Elkenberry Ditch subwatershed	11	51,631	8.41	24%	124,279	20.25	44%
Total Wabash River & Rock Creek subwatersheds	12	10,394,473	21.77	35%	7,738,515	16.21	29%
>50 lbs/ac/yr	30-50 lbs/ac/yr	10-30 lbs/ac/yr	0-10 lbs/ac/yr	No reduction required			

THE MEASURED AND MODELED NITRITE AND TOTAL NITROGEN RESULTS REQUIRE NO REDUCTIONS.

Table 6-13: Measured vs. Modeled Load Reduction Estimates – Total Phosphorus.

Subwatershed	Site	Total Phosphorus					
		Measured Reduction (lbs/yr)	*Measured Reduction (lbs/ac/yr)*	*%*	*Modeled Reduction (lbs/yr)*	*Modeled Reduction (lbs/ac/yr)*	*%*
Pleasant Run/Big Creek-Eight Mile Creek	1	-	-	-	-	-	-
Moser Lake-Eight Mile Creek	2	41,530	1.93	73%	58,718	2.73	79%
Maple Creek-Eight Mile Creek	3	-	-	-	-	-	-
Johns Creek-Wabash River	6	288,081	0.78	41%	-	-	-
Dowty Ditch-Wabash River	7	248,340	0.65	40%	-	-	-
Bender Ditch/Griffin Ditch-Wabash River	9	200,153	0.48	27%	-	-	-
Elkenberry Ditch-Rock Creek	10	-	-	-	-	-	-
Mossburg Ditch-Rock Creek	13	-	-	-	69,861	1.31	62%
Stites Ditch-Rock Creek	14	-	-	-	-	-	-
Headwaters-Rock Creek	15	-	-	-	-	-	-
Western portion of Elkenberry Ditch subwatershed	11	-	-	-	4,446	0.72	48%
Total Wabash River & Rock Creek subwatersheds	12	-	-	-	-	-	-

>1.0 lbs/ac/yr | 0.5-1.0 lbs/ac/yr | 0-0.5 lbs/ac/yr | No reduction required

Table 6-14: Measured Load Reduction Estimates for *E. coli*.

Subwatershed	Site	*E. coli*		
		Measured Reduction G-org/yr	*Measured Reduction G-org/ac/ yr*	*%*
Pleasant Run/Big Creek-Eight Mile Creek	1	179,502	3.57	53%
Moser Lake-Eight Mile Creek	2	74,840	3.48	57%
Maple Creek-Eight Mile Creek	3	30,763	2.03	47%
Johns Creek-Wabash River	6	2,351,274	6.34	61%
Dowty Ditch-Wabash River	7	1,924,041	5.04	60%
Bender Ditch/Griffin Ditch-Wabash River	9	2,193,008	5.34	53%
Elkenberry Ditch-Rock Creek	10	260,188	3.90	54%
Mossburg Ditch-Rock Creek	13	164,777	3.10	52%
Stites Ditch-Rock Creek	14	23,697	0.79	20%
Headwaters-Rock Creek	15	18,936	0.94	27%
Western portion of Elkenberry Ditch subwatershed	11	19,157	3.12	53%
Total Wabash River & Rock Creek subwatersheds	12	1,741,618	3.65	46%

>5 G-org/ac/yr | 3-5 G-org/ac/yr | 2-3 G-org/ac/yr | 0-2 G-org/ac/yr

Target Reductions Based on Flow Events

Another advantage of the load duration curve framework is the ability to provide meaningful connections between the load allocations and implementation efforts that will most effectively address water quality concerns. In general, waste load allocations from waste water treatment plants can play a significant role in nutrient and *E. coli* levels during low flow conditions. Actions to address this might involve review of facility permits and compliance. Under high flow conditions, stream bank erosion and channel processes may account for higher loading of total sediment. Implementation efforts might include bank stabilization practices. Water quality concerns during mid-range flows and moist conditions may be the result of runoff from impervious surfaces in urban areas; while in agricultural watersheds the saturated soils and the larger drainage area are potentially contributing pollutants in runoff. Low impact development techniques might be used in urban areas and conservation practices such as cover crops would be appropriate in agricultural areas. Tables 6-15 through 6-19 display the subwatersheds with exceedances during the various flow zones.

Table 6-15: Nitrate LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

NITRATE – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION						
Subwatershed	**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Pleasant Run/Big Creek-Eight Mile Creek	1	Moist	5,278,236	483,315	4,794,921	91%
		Mid-range	810,559	372,282	438,277	54%
Moser Lake-Eight Mile Creek	2	Moist	2,351,600	344,918	2,006,682	85%
		Mid-range	1,594,802	215,178	1,379,624	86%
		Dry	229,643	34,255	195,388	85%
		Low Flow	80,961	20,670	60,291	74%
Maple Creek-Eight Mile Creek	3	Moist	1,673,164	161,629	1,511,535	90%
		Mid-range	411,808	92,137	319,671	78%
Johns Creek-Wabash River	6	Moist	94,899,234	4,557,543	90,341,691	95%
		Mid-range	5,753,364	2,441,189	3,312,175	58%
		Dry	7,094,410	2,080,916	5,013,494	71%
Dowty Ditch-Wabash River	7	Moist	85,478,109	5,388,334	80,089,775	94%
		Mid-range	6,032,348	2,830,597	3,201,751	53%
		Dry	8,041,687	2,423,469	5,618,218	70%
		Low Flow	498,451	417,757	80,694	16%
Bender Ditch/Griffin Ditch-Wabash River	9	Moist	84,484,470	4,955,218	79,529,252	94%
		Mid-range	12,974,940	3,894,090	9,080850	70%
		Dry	5,610,181	2,720,742	2,889,439	52%
Elkenberry Ditch-Rock Creek	10	Moist	10,695,026	1,311,941	9,383,085	88%
		Mid-range	1,443,487	550,646	892,841	62%
Mossburg Ditch-Rock Creek	13	Moist	7,774,507	1,720,055	6,064,452	78%
		Mid-range	746,921	414,607	332,314	44%
Stites Ditch-Rock Creek	14	Mid-range	1,389,672	374,052	1,015,620	73%
Headwaters-Rock Creek	15	Moist	2,562,362	247,269	2,315,093	90%
		Mid-range	228,892	138,992	89,900	39%

Table 6-15: Nitrate LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions (continued).

Subwatershed	Site	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Western portion of Elkenberry Ditch subwatershed	11	Moist	591,789	188,406	403,383	68%
		Mid-range	238,060	49,020	189,040	79%
		Dry	91,947	9,647	82,300	90%
Total Wabash River & Rock Creek subwatersheds	12	Moist	99,640,766	6,075,410	93,565,356	94%
		Mid-range	13,371,322	4,260,269	9,111,053	68%
		Dry	3,177,380	1,560,196	1,617,184	51%

Modeled nitrate loads exceeded the target load in all subwatersheds during mid-range flow conditions; and eleven out of the twelve subwatersheds exceeded the target load during moist conditions. This suggests that nitrates are readily available in all watersheds from sources such as fertilizer and animal or human waste; and is washed into the streams and river by surface runoff and through subsurface tile drainage.

The Moser Lake-Eight Mile Creek; Johns Creek, Dowty Ditch and Bender Ditch-Wabash River subwatersheds; and western portion of the Elkenberry Ditch-Rock Creek and combined watersheds of the Wabash River and Rock Creek exceeded the target load during dry periods. The Moser Lake-Eight Mile Creek and Dowty Ditch-Wabash River subwatersheds also exceeded the target load during low flow, suggesting that there is a continuous source of nitrates available in those subwatersheds which could be from waste treatment facilities or on-site septic systems.

Table 6-16: Nitrite LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

NITRITE – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION						
Subwatershed	**Site**	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Pleasant Run/Big Creek-Eight Mile Creek	1	Moist	51,783	48,333	3,450	7%
Dowty Ditch-Wabash River	7	Moist	600,768	538,835	61,933	10%
Western portion of Elkenberry Ditch subwatershed	11	Moist	40,771	18,841	21,930	54%
		Dry	40,796	964	39,832	98%

Nitrite modeled loads exceeded the target load during moist conditions in the Pleasant Run Ditch-Eight Mile Creek and Dowty Ditch-Wabash River subwatersheds. The western portion of the Elkenberry Ditch-Rock Creek subwatershed exceeded the target load during both moist and dry conditions. Potential sources may be storm water runoff from agricultural activities during moist conditions and point sources, such as septic system inputs, during dry conditions.

Table 6-17: Total Nitrogen LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

TOTAL NITROGEN – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION						
Subwatershed	**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Pleasant Run/Big Creek-Eight Mile Creek	1	Moist	2,162,833	483,315	1,679,518	78%
		Dry	77,271	66,740	10,531	14%
Moser Lake-Eight Mile Creek	2	Moist	1,469,640	344,918	1,124,722	77%
		Mid-range	256,591	215,178	41,413	16%
		Dry	57,312	34,255	23,057	40%
		Low Flow	20,871	20,670	201	1%
Maple Creek-Eight Mile Creek	3	Moist	819,702	161,629	658,073	80%
Johns Creek-Wabash River	6	Moist	38,947,727	4,557,543	34,390,184	88%
Dowty Ditch-Wabash River	7	Moist	47,343,201	5,388,334	41,954,867	89%
Bender Ditch/Griffin Ditch-Wabash River	9	Moist	53,588,730	955,218	48,622,512	91%
Elkenberry Ditch-Rock Creek	10	Moist	5,466,058	1,311,941	4,154,117	76%
Mossburg Ditch-Rock Creek	13	Moist	3,148,023	1,720,055	1,427,968	45%
Headwaters-Rock Creek	15	Moist	1,213,961	247,269	966,692	80%
Western portion of Elkenberry Ditch subwatershed	11	Moist	341,030	188,406	152,624	45%
		Dry	15,213	9,647	5,566	37%
Total Wabash River & Rock Creek subwatersheds	12	Moist	50,655,138	6,075,410	44,579,728	88%
		Dry	1,799,618	1,560,196	239,422	13%

All of the subwatersheds in the project except for the Stites Ditch-Rock Creek subwatershed exceeded the modeled target load for total nitrogen during moist conditions. The Pleasant Run Ditch-Eight Mile Creek, western portion of the Elkenberry Ditch-Rock Creek, and the combined Wabash River and Rock Creek subwatersheds also exceeded the target load during dry conditions.

The Moser Lake-Eight Mile Creek requires load reductions across the various flow conditions suggesting sources such as fertilizer and animal waste in surface runoff and tile drainage; as wells as discharges from waste water treatment facilities or rural septic systems contribute to the cause of those levels. Based on the modeled load duration curves the Stites Ditch-Rock Creek subwatershed requires no load reductions for total nitrogen.

Table 6-18: Total Phosphorus LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reduction.

TOTAL PHOSPHORUS – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION						
Subwatershed	**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Pleasant Run/Big Creek-Eight Mile Creek	1	Moist	207,404	14,498	192,906	93%
		Low Flow	1,975	887	1,088	55%
Moser Lake-Eight Mile Creek	2	Moist	128,896	10,348	118,548	92%
		Mid-range	7,326	6,457	869	12%
		Dry	5,125	1,029	4,096	80%
		Low Flow	2,336	621	1,715	73%
Maple Creek-Eight Mile Creek	3	Moist	41,752	4,847	36,905	88%
		Mid-range	5,811	2,763	3,048	52%
Johns Creek-Wabash River	6	Moist	2,295,200	136,725	2,158,475	94%
		Mid-range	183,179	73,237	109,942	60%
		Dry	96,207	62,426	33,781	35%
		Low Flow	14,293	11,362	2,931	21%
Dowty Ditch-Wabash River	7	Moist	1,781,346	161,651	1,619,695	91%
		Mid-range	183,997	84,917	99,080	54%
		Dry	117,559	72,704	44,855	38%
		Low Flow	13,556	12,534	1,022	8%
Bender Ditch/Griffin Ditch-Wabash River	9	Moist	2,364,521	148,657	2,215,864	94%
		Mid-range	148,175	116,822	31,353	21%
		Dry	115,442	81,621	33,821	29%
		Low Flow	53,885	36,902	16,983	32%
Elkenberry Ditch-Rock Creek	10	Moist	215,051	39,358	175,693	82%
		Mid-range	17,786	16,520	1,266	7%
		Dry	11,957	7,245	4,712	39%
Mossburg Ditch-Rock Creek	13	Moist	159,834	51,600	108,234	68%
Headwaters-Rock Creek	15	Moist	47,560	7,417	40,143	84%
Western portion of Elkenberry Ditch subwatershed	11	Moist	15,078	5,654	9,424	63%
Total Wabash River & Rock Creek subwatersheds	12	Moist	2,545,240	182,263	2,362,977	93%
		Dry	71,029	46,808	24,221	34%
		Low Flow	38,730	29,996	35,734	23%

Total phosphorus target loads were exceeded during moist conditions in eleven out of the twelve subwatersheds. The Maple Creek-Eight Mile Creek and Elkenberry Ditch-Rock Creek subwatersheds also exceeded the target load during mid-range flows.

Moser Lake-Eight Mile Creek and Johns Creek, Dowty Ditch, and Bender Ditch-Wabash River subwatersheds exceeded the target load across the various flow conditions. This could be due to surface runoff from urban areas as well as agricultural activities, tile drainage, on-site septic system failure, and waste water treatment facility discharges.

The Elkenberry Ditch-Rock Creek subwatershed requires load reductions under dry conditions, and the Pleasant Run Ditch-Eight Mile Creek requires reductions during low flow. The western portion of the Elkenberry Ditch-Rock Creek and the combined drainage of the Wabash River and Rock Creek subwatersheds also require load reductions during dry conditions and low flow. The Stites Ditch-Rock Creek subwatershed does not require any reductions in total phosphorus loads.

Table 6-19: *E. coli* LDC Flow Zones - Modeled Loads Exceed Target Loads and Required Reductions.

***E. coli* – LDC FLOW ZONE LOADS, TARGET LOADS AND REQUIRED REDUCTION**						
Subwatershed	**Site**	***Flow Zone***	***90th Percentile Load (lbs/y)***	***Target Load (lbs/y)***	***Required Reduction (lbs/y)***	***%***
Pleasant Run/Big Creek-Eight Mile Creek	1	Moist	299,702	51,502	248,200	83%
		Mid-range	186,296	39,676	146,620	79%
		Dry	22,338	7,118	15,220	68%
		Low Flow	4,672	3,139	1,533	33%
Moser Lake-Eight Mile Creek	2	Moist	331,128	36,756	294,372	89%
		Mid-range	153,081	22,922	130,159	85%
		Dry	77,672	3,650	74,022	95%
		Low Flow	5,110	2,190	2,920	57%
Maple Creek-Eight Mile Creek	3	Moist	189,399	17,228	172,171	91%
		Mid-range	21,353	9,819	11,534	54%
		Dry	3,176	1,424	1,752	55%
Johns Creek-Wabash River	6	Moist	1,348,274	485,815	862,459	64%
		Mid-range	2,037,576	260,209	1,777,367	87%
		Dry	1,221,582	221,811	999,771	82%
		Low Flow	141,146	40,369	100,777	71%
Dowty Ditch-Wabash River	7	Moist	3,842,392	574,364	3,268,028	85%
		Mid-range	2,237,706	301,746	1,935,960	87%
		Dry	737,921	258,347	479,574	65%
		Low Flow	67,890	44,530	23,360	34%
Bender Ditch/Griffin Ditch-Wabash River	9	Moist	2,871,674	528,192	2,343,482	82%
		Mid-range	1,609,395	415,078	1,194,317	74%
		Low Flow	371,899	131,108	240,791	65%
Elkenberry Ditch-Rock Creek	10	Moist	623,347	139,832	483,515	78%
		Mid-range	366,752	58,692	308,060	84%
		Dry	205,313	25,733	179,580	87%
Mossburg Ditch-Rock Creek	13	Moist	796,941	183,340	613,601	77%
		Mid-range	302,074	44,205	257,869	85%
Stites Ditch-Rock Creek	14	Dry	77,380	25,368	52,012	67%
Headwaters-Rock Creek	15	Moist	65,080	26,353	38,727	60%
		Mid-range	63,620	14,819	48,801	76%
		Dry	3,833	2,884	949	24%
		Low Flow	6,351	1,862	4,489	71%

Table 6-19: *E. coli* LDC Flow Zone - Modeled Loads Exceed Target Loads And Required Reductions (continued)

Subwatershed	Site	*Flow Zone*	*90th Percentile Load (lbs/y)*	*Target Load (lbs/y)*	*Required Reduction (lbs/y)*	*%*
Western portion of Elkenberry Ditch subwatershed	11	Moist	223,380	20,075	203,305	91%
		Mid-range	7,665	5,220	2,445	32%
		Dry	2,081	1,022	1,059	51%
Total Wabash River & Rock Creek subwatersheds	12	Moist	2,838,496	647,620	2,190,876	77%
		Mid-range	1,479,272	454,133	1,025,139	69%
		Dry	369,818	166,294	203,524	55%
		Low Flow	763,726	106,580	657,146	86%

All subwatersheds in the project area exceeded the target load during at least one flow regime, requiring reductions to the *E. coli* loads in all subwatersheds. The most exceedances occurred during moist conditions and mid-range flow. The Pleasant Run Ditch-Eight Mile Creek, Moser Lake-Eight Mile Creek, Johns Creek-Wabash River, Dowty Ditch-Wabash River, Headwaters-Rock Creek, and the combined drainage of the Wabash River and Rock Creek subwatersheds all exceeded the target load across the various flow conditions. This indicates continuous sources of *E. coli* within the river and streams coming from a combination of waste water treatment plants, failing or illicit on-site septic systems, and animal waste handling and application.

The Maple Creek-Eight Mile Creek, Elkenberry Ditch-Rock Creek, and Stites Ditch-Rock Creek exceeded the target load during dry conditions, and the Bender Ditch-Wabash River exceeded the target load during low flow. Because those are more rural subwatersheds in the project area it is suspected that failing septic systems may be the cause of the inputs.