SECTION 4: IDENTIFY CRITICAL AREAS

Estimating Critical Loads - Non-point Source Pollution Modeling

At various conferences organized by the American Water Resources Association (AWRA) and the Environmental Protection Agency (EPA) it was pointed out that the nonpoint sources are the main causes for more than fifty percent of the pollution entering the watercourses, and are responsible for almost two-thirds of the pollution that adversely affects the water quality and prevent achievement of quality standards.

Nonpoint source pollution is a type of the pollution generated from diffused sources in both: public and private domains. As defined by EPA, the pollution from nonpoint sources originates from urban runoff, construction activities, manmade modification of hydrologic regime of a watercourse (i.e. retention, detention, channelization, etc.), silviculture, mining, agriculture, irrigation return flows, solid waste disposal, atmospheric deposition, stream bank erosion, and individual or zonal sewage disposal. Therefore, nonpoint pollution sources have their origin in a wide spectrum of public and private activities and, when not known or properly controlled, could affect, in a large percentage, the water and quality of living in a certain area.

Nonpoint source pollution management is highly dependent on hydrologic simulation models, and use of computer modeling is often the only viable means of providing useful input information for adopting the best management decisions.

As previously mentioned, the nonpoint pollution sources are generated by activities that are spatially distributed on the analyzed watershed or study area. Due to this spatial distribution of nonpoint pollution sources, the computation models used to study pollutant transport and stream bank erosion require large amounts of data for analysis in even a small watershed. However, the development of the Geographic Information System (GIS) and Database Management System (DBMS) and their use in hydrologic and water pollution modeling represented a milestone point in the development of efficient computer models that could provide useful information regarding pollution from nonpoint sources to the public and to decision-makers.

Since runoff from the rainfall flows over or through the land and collects pollutants and nutrients prior to entering waterways, the overall characteristics and landuse types of a watershed greatly influences the water quality. Each landuse type includes the cumulative effects of various land covers, and natural and man-made activities. Therefore, each landuse type can have an adverse affect on water quality, by contributing different pollutant amounts and concentrations. The cumulative effect of this pollution throughout the watershed represents the contribution of nonpoint source pollution.

For the Elkhart River Watershed, a GIS based pollution loading model was built to assess the nonpoint source pollution of four main pollutant parameters that have been identified as elements of concern by both stakeholders and water sampling events.

- Total Suspended Solids
- Pathogen/Bacteria
- Total Phosphorus

- Total Nitrogen

A simple pollution loading methodology was used to calculate loading from all four parameters. The pollutant load calculation is a function of the runoff coefficient and other watershed hydrologic parameters as shown in the following relationship:

$$Lp = \sum_U (P * P_J * R_{VU} * C_U * A_U * 2.72 / 12)$$

Where:

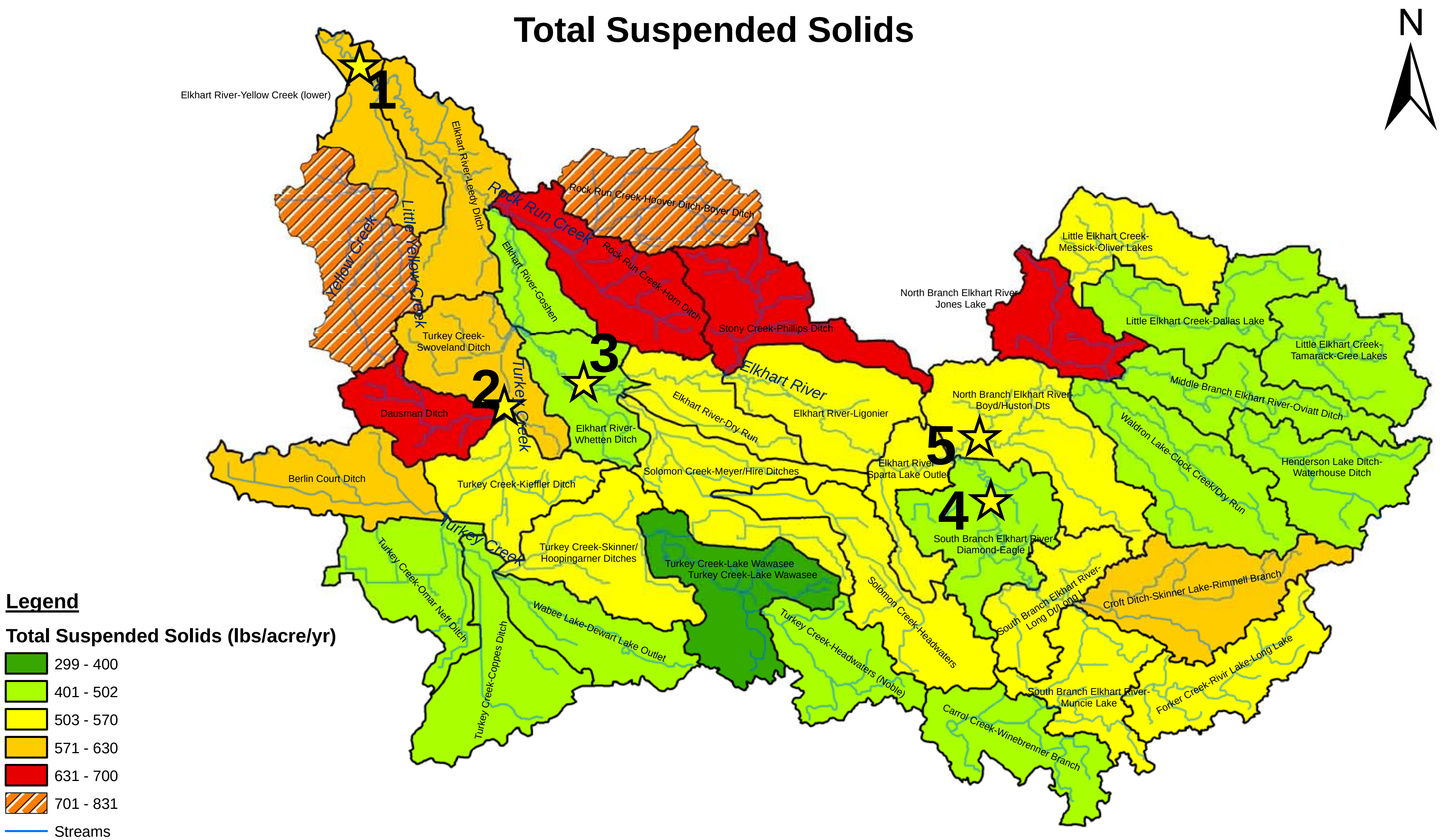
Lp	=	Pollutant load, lbs
P	=	Precipitation, inches/year
P_J	=	Ratio of storms producing runoff
R_{VU}	=	Runoff Coefficient for landuse type u, $inches_{run}/inches_{rain}$
C_U	=	Event mean concentration for landuse type u, milligrams/liter
A_U	=	Area of landuse type u, acres

The computation model was executed for each HUC 14 subwatershed within the Elkhart River Watershed. The results are illustrated graphically in Exhibits 29 through 32 and in Table 40 (Appendix A). Appendix J provides a summary of the model parameters and literature sources that were incorporated into the analysis.

It is important to note that all computation models have assumptions and limitations. Therefore, the provided analytical results may not represent the *exact* pollution loads, since the entire Elkhart River Watershed was modeled with the same input. In these conditions, even if the results are relative, they still can provide useful information for targeting and prioritizing subwatersheds.

It is also important to note that the above presented nonpoint source modeling does not specifically include bank erosion and mass wasting, which can contribute with additional pollutant loads of sediment, nitrogen, and phosphorus. However, certain landuses within the model have input values that incorporate some bank erosion that is typical for that land practice.

Total Suspended Solids



V3 Companies
7325 Janes Avenue
Woodridge, IL 60517
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630.724.9202 fax
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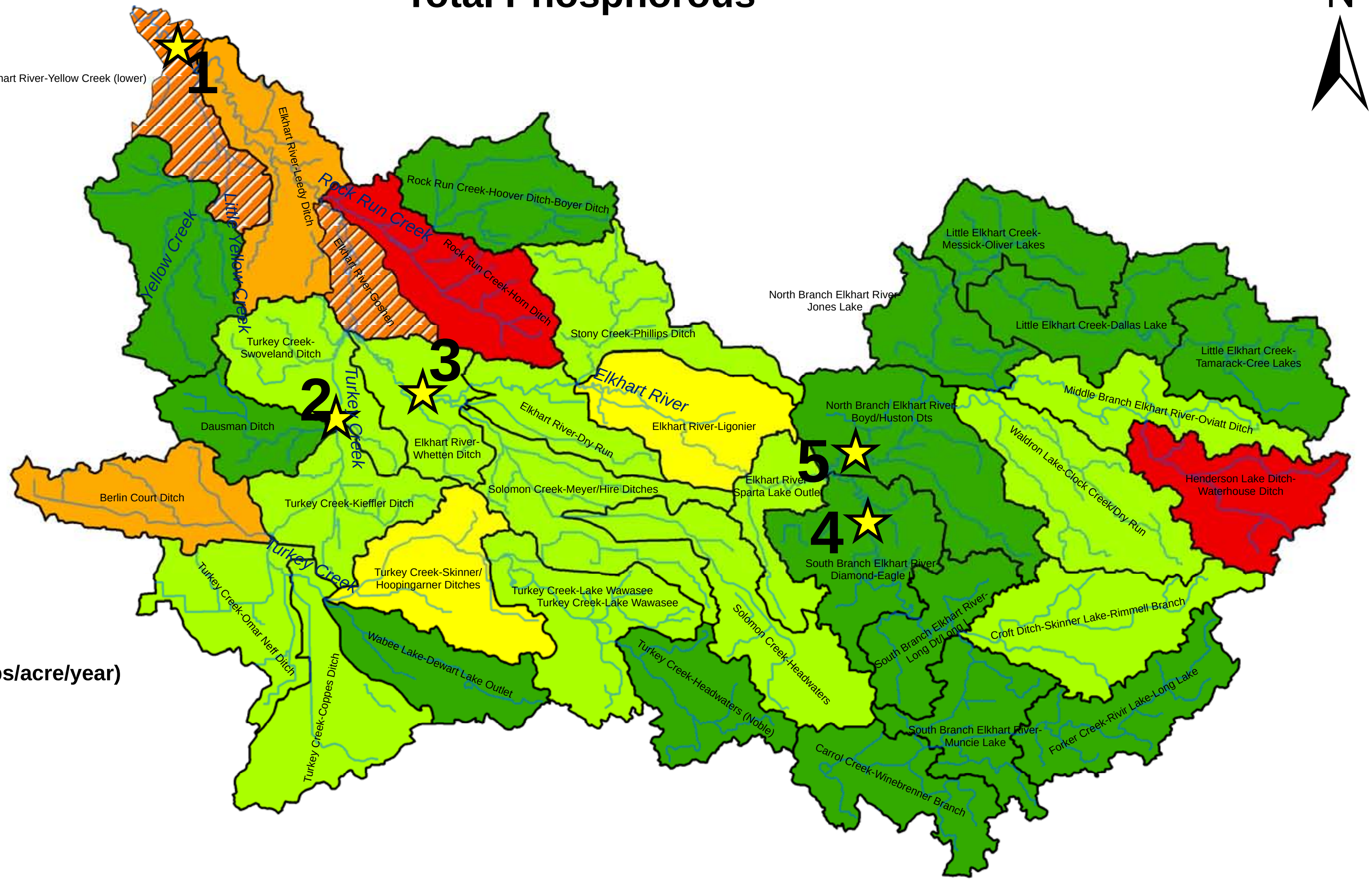
TITLE:	**Total Suspended Solids**
BASE LAYER:	N/A
CLIENT:	Elkhart River Restoration Association 305 Carter Road Goshen, Indiana 46526

PROJECT: **Elkhart River Watershed Management Plan & Implementation**		
PROJECT NO.: 07041	EXHIBIT: 29	SHEET: 1 OF: 1
QUADRANGLE: N/A	DATE: 11/15/07	SCALE: 1"=27,500'

Total Phosphorous



Legend

Total Phosphorous (lbs/acre/year)

- 0.13 - 0.16
- 0.17 - 0.20
- 0.21 - 0.25
- 0.26 - 0.30
- 0.31 - 0.40
- 0.41 - 0.62
- Streams

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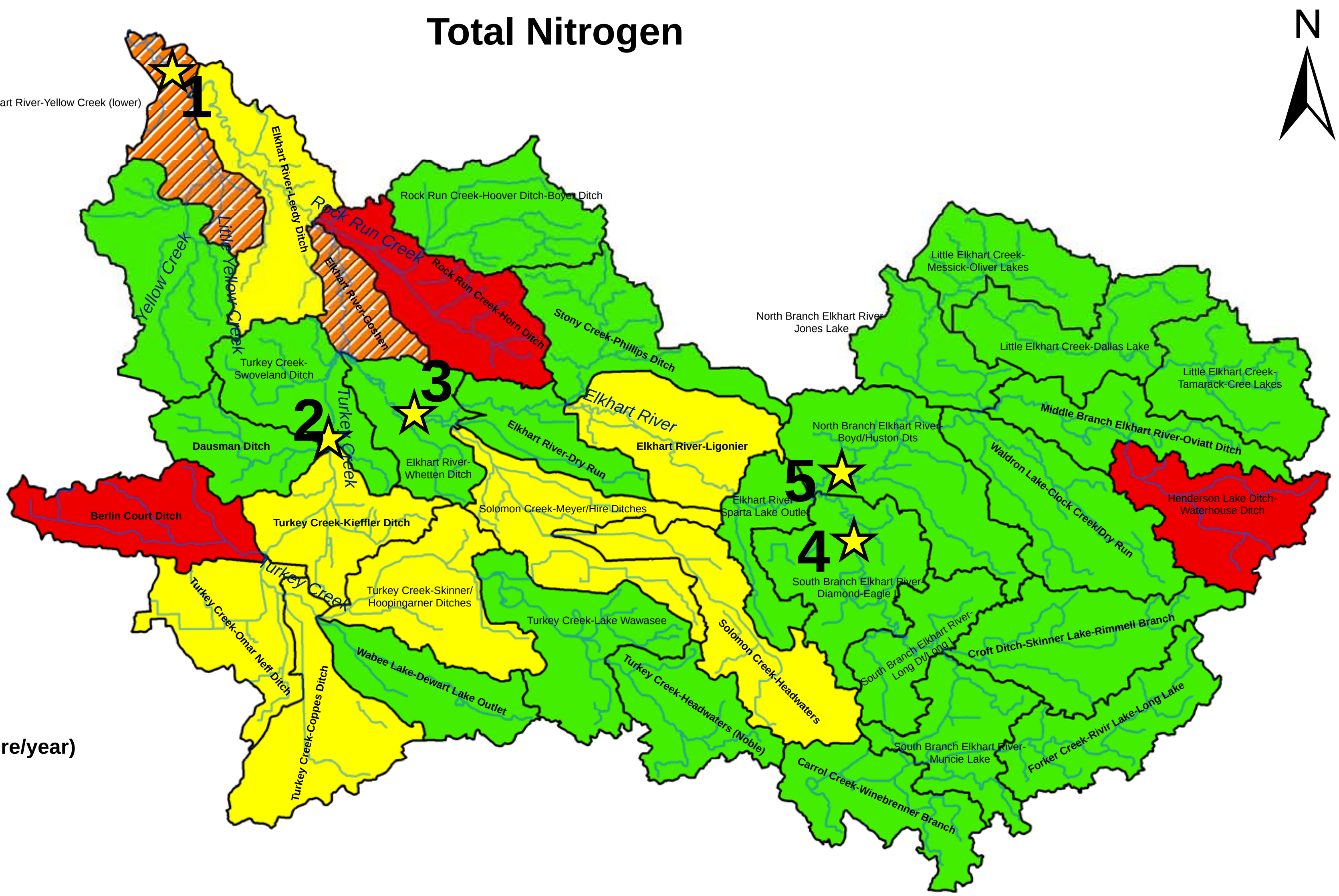
TITLE: **Total Phosphorous**		PROJECT: **Elkhart River Watershed Management Plan & Implemenation**	
BASE LAYER: N/A	PROJECT NO.: 07041	EXHIBIT: 30	SHEET: 1 OF: 1
CLIENT: Elkhart River Restoration Association, 305 Carter Road, Goshen, Indiana 46526	QUADRANGLE: N/A	DATE: 11/15/07	SCALE: 1"=27,500'

Total Nitrogen



Legend

Total Nitrogen (lbs/acre/year)

- 1.55 - 2.09
- 2.10 - 2.50
- 2.51 - 3.00
- 3.01 - 3.71
- Streams

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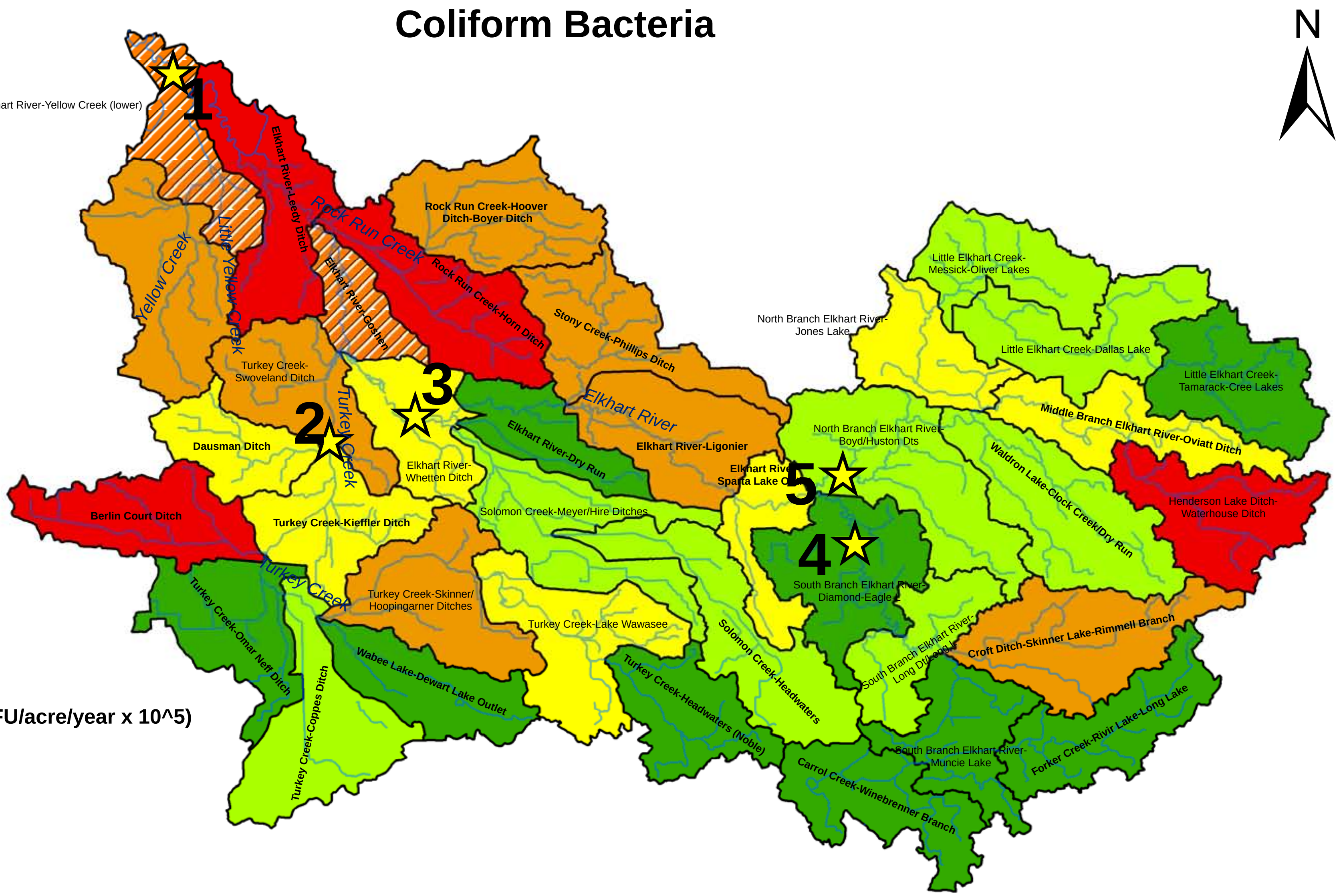
630.724.9202 fax
www.v3co.com

TITLE: **Total Nitrogen**		PROJECT: **Elkhart River Watershed Management Plan & Implemenation**	
BASE LAYER: N/A	PROJECT NO.: 07041	EXHIBIT: 31	SHEET: 1 OF: 1
CLIENT: Elkhart River Restoration Association, 305 Carter Road, Goshen, Indiana 46526	QUADRANGLE: N/A	DATE: 11/15/07	SCALE: 1"=27,500'

Coliform Bacteria



Legend

Streams

Coliform Bacteria (CFU/acre/year x 10^5)

- 1585 - 1693
- 1694 - 1817
- 1818 - 2066
- 2067 - 2549
- 2550 - 4427
- 4428 - 7801

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TITLE: **Coliform Bacteria**	PROJECT: **Elkhart River Watershed Management Plan & Implemenation**		
BASE LAYER: N/A	PROJECT NO.: 07041	EXHIBIT: 32	SHEET: 1 OF: 1
CLIENT: Elkhart River Restoration Association, 305 Carter Road, Goshen, Indiana 46526	QUADRANGLE: N/A	DATE: 11/15/07	SCALE: 1"=27,500'

Total Suspended Solids (TSS)

Exhibit 29 and Table 40 (Appendix A) show the TSS model results. The sediment model results range from 300 to 830 lbs/acre/year (0.15 to 0.42 tons/acre/year) for the HUC 14 subwatersheds. It is important to note that this modeling does not directly incorporate bank erosion and mass wasting. In the Midwestern United States, bank erosion and mass wasting can make up between 5 and 25 percent of the annual sediment loads.

The top ten sediment contributing subwatersheds are shown in Table 41 (Appendix A) and illustrated in Exhibit 33. It is apparent that the lower portion of the Elkhart River Watershed contributes the most nonpoint source sediment. The average suspended sediment loading for the entire Watershed is 543 lbs/acre/year and the lowest loading occurs in the 14,270 acre, *Turkey Creek/Lake Wawasee* subwatershed (299 lbs/acre/year). In addition, the highest loading occurs in the 13,666 acre, *Rock Run Creek-Hoover Ditch-Boyer Ditch* subwatershed (831 lbs/acre/year).

Pathogens/Bacteria

The pathogen/bacteria load model results are shown in Exhibit 32 and Table 40 (Appendix A). The load results show a very similar spatial trend as the nitrogen and phosphorus analyses, with the downstream subwatersheds being the most significant nonpoint source pollution contributors. The Watershed bacteria loading ranges from $1.6x10^8$ to $7.8x10^8$ cfu/acre/year and the Watershed average is approximately $2.4x10^8$ cfu/acre/year. The two highest bacteria loads come from the 5,897 acre *Elkhart River – Goshen* and the 9,326 acre *Elkhart River/Lower Yellow Creek* subwatersheds. Both of these subwatersheds are at the downstream end of the Elkhart River Watershed.

Total Phosphorus

The phosphorus load model results are shown in Exhibit 28 and Table 40 (Appendix A). The pollution load results show a very similar trend to that of nitrogen. Four subwatersheds contribute an average phosphorus load greater than 0.30 lbs/acre/year. Three of those subwatersheds are located in the downstream portion of the Watershed and include the following HUC 14 subwatersheds: *Elkhart River – Goshen*, *Lower Yellow Creek* and *Rock Run Creek/Horn Ditch*. The 12,786 acre headwater subwatershed of *Henderson Lake Ditch/Waterhouse Ditch* completes the top four phosphorus contributors of the watershed. The average phosphorus loading in the Elkhart River Watershed is approximately 0.20 lbs/acre/year. The lowest phosphorus loading occurs in the 8,908 acre *North Branch of the Elkhart River/Jones Lake* subwatershed at 0.127 lbs/acre/year.

Total phosphorus loading for subwatersheds can also be expressed in pounds per year and is included in Table 40. The total phosphorus loading for the Elkhart River Watershed is 88,846 lbs/year and the average for all 37 subwatersheds is 2,401 lbs/year. The three subwatersheds that contribute the greatest amounts of phosphorus are *Elkhart River- Lower Yellow Creek* 4,994 lbs/year, *Henderson Lake Ditch/Waterhouse Ditch* 4,590 lbs/year, followed by *Rock Run Creek/Horn Ditch* 4,345 lbs/year.

Pollutant loads are represented in the WMP by both lbs/year and lbs/acre/year. Both of these presentations are necessary as lbs/year will be used in discussing improvement in each critical area. The use of lbs/acre/year demonstrates loading differences between critical areas of varying sizes, as the critical areas are not the same size.

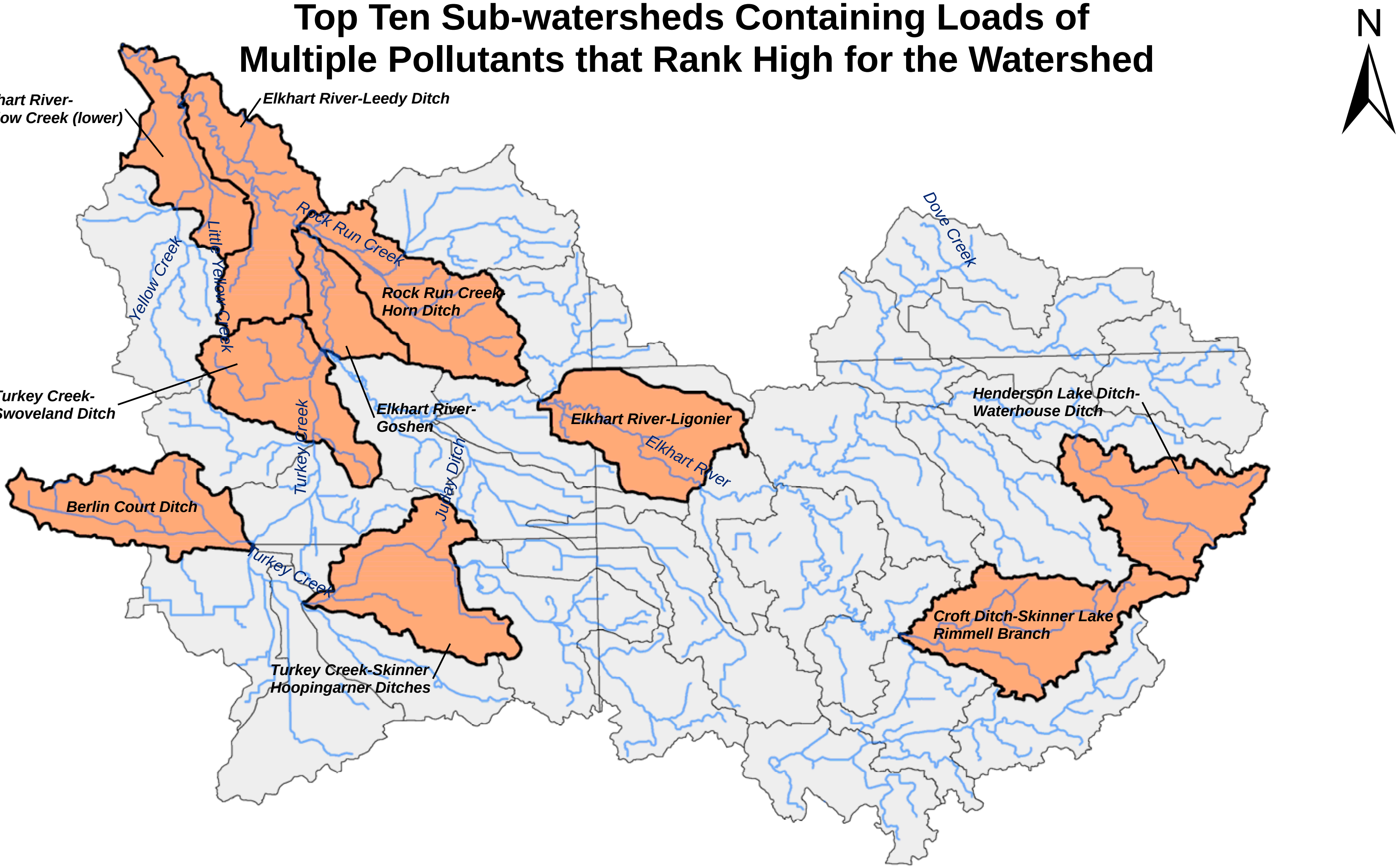
Total Nitrogen

The nitrogen load model results are shown spatially in Exhibit 31. A majority of those subwatersheds are in the downstream portion of the Watershed near Elkhart. The *Elkhart River – Goshen* subwatershed and the *Lower Yellow Creek* subwatershed contribute the highest nitrogen loading within the entire Watershed (Exhibit 31). The headwater subwatershed of *Henderson Lake Ditch/Waterhouse Ditch* contributes the third highest nitrogen loading in the Watershed. The average nitrogen loading in the Elkhart River Watershed is approximately 2.09 lbs/acre/year. The lowest nitrogen loading exists at the *North Branch of the Elkhart River/Jones Lake* subwatershed (1.55 lbs/acre/year).

Overall Summary

The top 40% highest loading subwatersheds based on each pollutant category were tabulated and statistically cross referenced to each other in order to provide an overall nonpoint source evaluation of the Watershed. All of the subwatersheds that had at least three of the four modeled pollutants within the upper 40% rank were pulled from the data sets. The ten HUC 14 subwatersheds that met this criterion and represent the most significant nonpoint source contributions from multiple modeled pollutants are illustrated in the Exhibit 33 and Table 42 (Appendix A).

Top Ten Sub-watersheds Containing Loads of Multiple Pollutants that Rank High for the Watershed



V3 Companies 7325 Janes Avenue Woodridge, IL 60517 630.724.9200 phone 630.724.9202 fax www.v3co.com	TITLE: **Top Ten Sub-watersheds Containing Loads of Multiple Pollutants that Rank High for the Watershed**	PROJECT: **Elkhart River Watershed Management Plan & Implemenation**		
	BASE LAYER: N/A	PROJECT NO.: 07041	EXHIBIT: 33	SHEET: 1 OF: 1
	CLIENT: Elkhart River Restoration Association 305 Carter Road Goshen, Indiana 46526	QUADRANGLE: N/A	DATE: 11/15/07	SCALE: 1"=27,500'

Elkhart River Watershed Critical Areas

On November 28, 2007, January 3, January 8, January 10, and January 17, 2008, the ERA Steering Committee discussed the designation of critical areas in light of the three pollutants of concern: sediment, *E. coli*, and nutrients (nitrogen and phosphorus). V3 presented a summary of the existing water quality data and loading models and the Elkhart County SWCD presented the findings of the windshield survey.

The ERA Steering Committee members located specific sites within the Watershed that would function as the critical areas of the Elkhart River WMP. These 26 critical areas, identified from all four of the Elkhart River Watershed's counties, are listed in Table 43 and depicted in Exhibit 34. They account for approximately 297,450 acres (golf courses and septic densities did not contribute acreages) or 66% of the Watershed by area. Each critical area is discussed below.

Critical Area #1, shown on Exhibit K-1 (Appendix K), is the Turkey Creek critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, degradation of open space, and degradation of fish populations. This area contains a Great Blue Heron rookery and a large wetland complex worthy of preservation for wildlife habitat and water quality improvement. The area south of Goshen Dam Pond is identified as having a sediment loading problem, which emanates in part from streambank erosion, and agricultural and residential erosional sources. The flow velocity of the Elkhart River slows down when it reaches the impoundment of the Goshen Dam Pond and suspended silts and clays that were being carried in the water column settle out as sediment deposits. There are 3,684 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #2, shown on Exhibit K-2, is the Upper Yellow Creek critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. The Steering Committee indicated problems with livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 15,941 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #3, shown on Exhibit K-3, is the Lower Yellow Creek critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee indicated problems with livestock entering the stream, septic system failure, obvious sediment deposits, streambank erosion, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 5,920 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #4, shown on Exhibit K-4, is the Upper Rock Run Creek critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee mentioned problems with lack of filter strips; lack of conservation tillage practices; livestock entering the stream; log jams; septic system failure;

obvious sediment deposits caused by severe streambank, agricultural and urban erosion; and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 13,665 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #5, shown on Exhibit K-5, is the Horn Ditch critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee mentioned problems with lack of filter strips, lack of conservation tillage practices, livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits caused by severe erosion, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 11,099 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #6, shown on Exhibit K-6, is the Papakeechie Subwatershed & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. Included in this critical area are Allen Lake, Rothenbeger Lake, Barrel-and-a-Half Lake, and Spear Lake, which are all tributaries to Papakeechie Lake. Also included in this critical area are the areas identified in The Wawasee Area WMP. There are 2,957 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #7, shown on Exhibit K-7, is the Knapp Lake Chain & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. Lakes along the Knapp Lake Chain include Harper Lake, Little Bause Lake, Little Knapp Lake, Knapp Lake, Moss Lake, Hindman Lake, Neal Lake, Gordy Lake, Rider Lake, Duely Lake, and Village Lake, which are all tributaries to Lake Wawasee. Also included in this critical area are the areas identified in The Wawasee Area WMP. There are 10,167 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #8, shown on Exhibit K-8, is the Stony Creek critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee indicated problems with livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 13,014 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #9, shown on Exhibit K-9, is the Elkhart urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from CSOs, pet waste, and wildlife. This area was also identified in the St. Joseph River WMP as a critical area for urban stormwater management. There are 8,779 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #10, shown on Exhibit K-10, is the Goshen urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from CSOs, pet waste, and wildlife. This area was also identified in the St. Joseph River WMP as a critical area for urban stormwater management. There are 20,925 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #11, shown on Exhibit K-11, is the Ligonier urban critical area. It contributes to the problems of *E. coli*, sediment loading, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from CSOs, pet waste, and wildlife. There are 18,412 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #12, shown on Exhibit K-12, is the Nappanee urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from CSOs, pet waste, and wildlife. There are 9,742 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #13, shown on Exhibit K-13, is the Kendallville urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from CSOs, pet waste, and wildlife. There are 18,077 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #14, shown on Exhibit K-14, is the Syracuse urban & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from pet waste and wildlife. Included in this critical area are the areas identified in The Wawasee Area WMP. There are 17,537 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #15, shown on Exhibit K-15, is the Millersburg urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from pet waste and wildlife. There are 12,506 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #16, shown on Exhibit K-16, is the Albion urban & LARE Study critical area. It contributes to the problems of sediment, *E. coli*, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from pet waste and wildlife. Also included in this critical area are the areas identified in the Skinner Lake Engineering Feasibility Study. There are 16,970 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #17, shown on Exhibit K-17, is the Rome City urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from pet waste and wildlife. There are 19,692 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #18, shown on Exhibit K-18, is the Milford urban critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee identified urban sources including: sedimentation from construction sites; pollutants from impervious surfaces; and nutrients and *E. coli* from pet waste and wildlife. There are 14,459 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #19, shown on Exhibit K-19, is the Jones Lake critical area. Jones Lake and the surrounding areas within Noble County contribute to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these problems from agricultural landuse practices will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. There are 5,885 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #20, shown on Exhibit K-20, is the South Branch Upper Reaches critical area. The Upper Reaches of the South Branch of the Elkhart River within York Township contribute to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. The Steering Committee mentioned problems with lack of filter strips, lack of conservation tillage practices, livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits caused by severe bank and overland erosion, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are

15,422 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #21, shown on Exhibit K-21, is the Solomon Creek Upper Watershed & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. Included in this critical area are the areas identified in the Whetten Ditch, Solomon Creek, and Dry Run Watersheds LARE Diagnostic Study. The Steering Committee identified that areas along Solomon Creek have limited canopy cover, instream habitat problems, and poor DO levels. The Steering Committee indicated problems with livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 15,156 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #22, shown on Exhibit K-22, is the Solomon Creek Lower Watershed & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, and degradation of fish populations. Included in this critical area are the areas identified in the Whetten Ditch, Solomon Creek, and Dry Run Watersheds LARE Diagnostic Study. The Steering Committee identified that areas along Solomon Creek have limited canopy cover, instream habitat problems and poor DO levels. The Steering Committee indicated problems with livestock entering the stream, log jams, streambank erosion, septic system failure, obvious sediment deposits, and concern regarding over-fertilization in agricultural, urban, and rural residential areas. There are 8,524 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

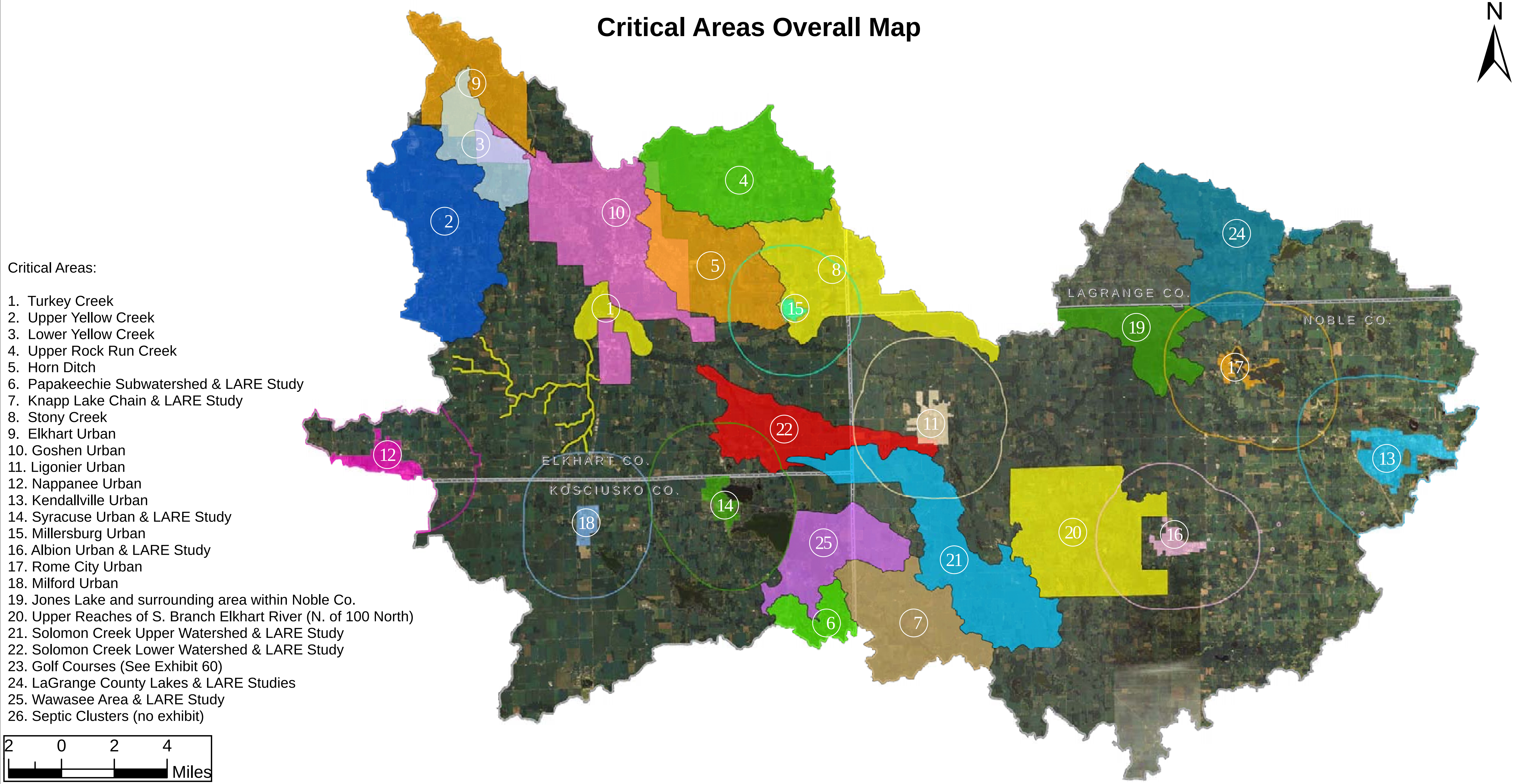
Critical Area #23, shown on Exhibit K-23, is the Golf Courses critical area. They contribute to the problems of nutrient loading. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and (in some instances) degradation of lakes. Eleven golf courses were identified which are adjacent to or near waterways within the Elkhart River Watershed. These golf courses include: Old Orchard Golf Course, Black Squirrel Golf Club, McCormick Creek Golf Course, Timber Ridge Golf Course, Big Boulder Golf Course, Maxwelton Golf Course, Wawasee Country Club, South Shore Country Club, Augusta Hills Golf Course, Limber Lost Golf Course and Cobblestone Golf Course. The implementation of BMPs and responsible use of fertilizers would improve the condition of the Watershed.

Critical Area #24, shown on Exhibit K-24, is the LaGrange County Lakes & LARE Study critical area. Addressing these problems will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. The Steering Committee mentioned problems including sediment in tributary ditches, lack of filter strips, and the need to maintain sediment basins. Also included in this critical area are the areas identified in the Five Lakes Engineering Feasibility Study and Pettit Mill Pond Sediment Control Project Design Report. There are 11,321 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #25, shown on Exhibit K-25, is the Wawasee Area & LARE Study critical area. It contributes to the problems of sediment loading, *E. coli*, and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and degradation of lakes. Also included in this critical area are the areas identified in The Wawasee Area WMP. There are 7,596 acres of critical area where the implementation of BMPs would improve the condition of the Watershed.

Critical Area #26, not shown on an exhibit, is the Septic Density critical area. Areas in the Watershed that have more than one on-site wastewater disposal system per one-half acre are identified as being a critical area as they contribute to the problems of *E. coli* and nutrient loading. Addressing these concerns will also impact concerns regarding hydrologic modification, loss of open space, degradation of fish populations, and (in some instances) degradation of lakes. The implementation of BMPs would improve the condition of the Watershed.

Critical Areas Overall Map



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Client: Elkhart River Restoration Association	Title: **Critical Areas Overall Map**	Project: **Elkhart River Watershed Management Plan and Implementation**					Sheet: 1 Of: 1
Address: 305 Carter Road Goshen, Indiana 46526	Base Layer: 2006 Aerial Indiana University Spatial Data Portal	Project No.: 07041	Quadrangle: N/A	Date: 1/28/08	Scale: NTS		Exhibit: 34

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Table 43: Summary of Critical Area Locations within the Elkhart River Watershed

Critical Area #	Exhibit #	Name	County(s)	Township(s)	Sediment	*E.Coli*	Nutrient	Critical Area Acreage
1	38	Turkey Creek	Elkhart	Elkhart, Jackson, and Union	X	X	X	3,684
2	39	Upper Yellow Creek	Elkhart	Concord, Harrison, Olive, and Union	X	X	X	15,941
3	40	Lower Yellow Creek	Elkhart	Concord, Elkhart, and Harrison	X	X	X	5,920
4	41	Upper Rock Run Creek	Elkhart	Clinton, Elkhart, Jefferson, and Middlebury	X	X	X	13,665
5	42	Horn Ditch	Elkhart	Benton, Clinton, and Elkhart	X	X	X	11,099
6	43	Papakeechie Subwatershed & LARE Study	Kosciusko and Noble	Sparta, Tippecanoe, Turkey Creek, and Washington	X	X	X	2,957
7	44	Knapp Lake Chain & LARE Study	Kosciusko and Noble	Sparta, Turkey Creek, and Washington	X	X	X	10,167
8	45	Stony Creek	Elkhart, LaGrange, and Noble	Benton, Clinton, Eden, and Perry	X	X	X	13,014
9	46	Elkhart Urban	Elkhart	Concord and Jefferson	X	X	X	8,779
10	47	Goshen Urban	Elkhart	Benton, Concord, Elkhart, Jackson, and Jefferson	X	X	X	20,925
11	48	Ligonier Urban	Noble	Perry and Sparta	X	X	X	18,412
12	49	Nappanee Urban	Elkhart and Kosciusko	Jefferson, Locke, and Union	X	X	X	9,742
13	50	Kendallville Urban	Noble	Allen, Jefferson, Orange, and Wayne	X	X	X	18,077
14	51	Syracuse Urban & LARE Study	Elkhart, Kosciusko, and Noble	Benton, Jackson, Turkey Creek, and Van Buren	X	X	X	17,537
15	52	Millersburg Urban	Elkhart, LaGrange, and Noble	Benton, Clinton, Eden, and Perry	X	X	X	12,506
16	53	Albion Urban & LARE Study	Noble	Albion, Allen, Jefferson, and York	X	X	X	16,970
17	54	Rome City Urban	LaGrange and Noble	Johnson, Orange, and Wayne	X	X	X	19,692
18	55	Milford Urban	Elkhart and Kosciusko	Jackson, Jefferson, Union, and Van Buren	X	X	X	14,459
19	56	Jones Lake & surrounding area within Noble County	Noble	Elkhart and Orange	X	X	X	5,885
20	57	Upper Reaches of S. Branch Elkhart River (N. of 100 North)	Noble	York	X	X	X	15,422
21	58	Solomon Creek Upper Watershed & LARE Study	Elkhart, Kosciusko, and Noble	Benton, Noble, Perry, Sparta, Turkey Creek, Washington, and York	X	X	X	15,156
22	59	Solomon Creek Lower Watershed & LARE Study	Elkhart and Noble	Benton and Perry	X	X	X	8,524
23	60	Golf Courses	Elkhart, Kosciusko, and Noble	(various)	-	-	X	N/A
24	61	LaGrange County Lakes & LARE Studies	LaGrange and Noble	Clearspring, Johnson, Milford, and Orange	X	X	X	11,321
25	62	Wawasee Area & LARE Study	Kosciusko and Noble	Sparta and Turkey Creek	X	X	X	7,596
26	n/a	Septic Density	N/A	N/A	-	X	X	N/A
				TOTALS:	**24**	**25**	**26**	**297,450**