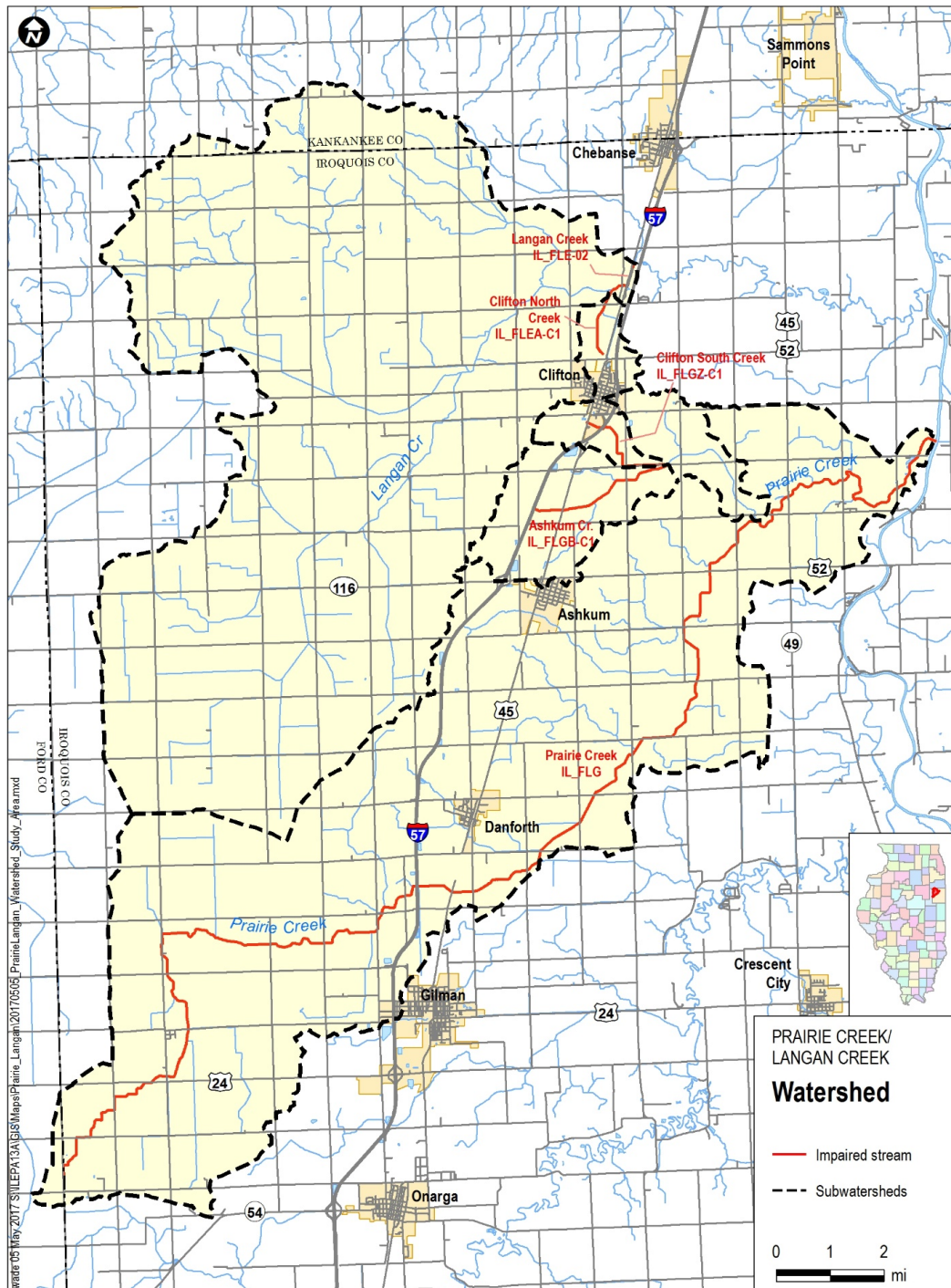




IEPA/BOW/18-001-WIP

Prairie Creek/Langan Creek Watershed Implementation Plan



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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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BRUCE RAUNER, GOVERNOR ALEC MESSINA, ACTING DIRECTOR

217/782-3362

FEB - 7 2018

Iroquois County Soil & Water Conservation District
Ford County Soil & Water Conservation District
Kankakee County Soil & Water Conservation District

Dear Sir/Madam:

Re: *Prairie Creek/Langan Creek Watershed Implementation Plan
To Achieve the Load Reduction Strategy for Phosphorus (total)*

The Illinois Environmental Protection Agency (Illinois EPA) has completed the *Prairie Creek/Langan Creek Watershed Implementation Plan (WIP)*, in accordance with U.S. Environmental Protection Agency's (EPA) watershed-based plan guidance found in Appendix C of the Nonpoint Source Program and Grants Guidelines for States and Territories dated April 12, 2013 and is available on the Agency's website: <http://www.epa.illinois.gov/topics/water-quality/watershed-management/tmdls/reports/index>.

The watershed is primarily in Iroquois County, and small portions are in Ford and Kankakee Counties in northeastern Illinois.

The original watershed plan started as a draft Total Maximum Daily Load (TMDL) watershed project report. As a result of the Stage 1 TMDL Report - (watershed characterization, land use, topography, data analysis, and the Stage 2 Report - (additional monitoring data collected), the study concluded that impairment in the watershed was related primarily to nonpoint source pollution, and the draft TMDL report was replaced with the WIP designed to meet the total phosphorus reductions needed to meet designated uses of the impaired waterbody segments.

Accomplishing the goals of the WIP will rely on the success of voluntary measures and can only be implemented through the leadership of local stakeholders within the watershed. In order, to assist local stakeholders in implementing the recommendations, the Agency strongly encourages the formation of watershed groups. These groups can direct planning efforts for implementing management practices that are both practical and feasible for the watershed.

4302 N. Main St., Rockford, IL 61103 (815)987-7760
575 S. State, Elgin, IL 60123 (847)608-3131
2125 S. First St., Champaign, IL 61820 (217)278-5300
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2209 W. Main St., Suite 115, Marion, IL 62959 (618)993-7200
100 W. Randolph, Suite 1000, Chicago, IL 60601

The Illinois Nonpoint Source Management Program, administered by the Illinois EPA, was developed to meet the requirements of Section 319 in the Clean Water Act (CWA), in order to financially assist watershed planning and implementation efforts. Section 319 focuses on the importance of controlling nonpoint sources of pollution through best management practices and education. The program encourages local entities to develop watershed implementation plans that will identify specific measures to achieve water quality-based objectives. Cost share monetary assistance is available through this program for watershed planning, best management practices implementation, and education. For more information, visit the web site at: <http://www.epa.illinois.gov/topics/water-quality/watershed-management/nonpoint-sources/grants/index>)

The Illinois EPA recommends that the Prairie Creek/Langan Creek WIP should be reviewed ten years after implementation plan development to assess if any revisions should be considered. Illinois EPA's Section 319(h) funding resources may be available to update these plans if revisions are needed.

The approval of the Prairie Creek/Langan Creek WIP makes projects identified in the plan eligible to apply for and receive Section 319 grant funds as part of the Illinois EPA's competitive grant program.

We look forward to working with the Prairie Creek/Langan Creek Watershed stakeholders during the implementation of the approved watershed implementation plan.

Paper copies of the *Prairie Creek/Langan Creek Watershed Implementation Plan* are available upon request by contacting Abel Haile by email (Abel.Haile@Illinois.gov) or by phone at 217/782-3362.

Questions regarding this *Watershed Implementation Plan* can be directed to the Watershed Management Section – Nonpoint Source Unit by phone at the above indicated number or by contacting Abe Haile (see contact information above).

Sincerely,



Amy Walkenbach
Manager, Watershed Management Section
Bureau of Water

AW AH TS N bow/planning/plandoc/tmdl/Prairie Creek/Langan Creek Watershed Implementation

cc: Illinois Farm Bureau
~~Joquios/Ford/Kankakee - County Farm Bureau~~
USEPA – Region 5 (Watershed Management Section) – Matt Gluckman
Limno-Tech, Inc. - Penelope Muskus
IEPA/BOW/WMS/TMDL – File



Watershed Implementation Plan and Stage 3 Report for the Prairie Creek/Langan Creek Watershed

Prepared for:
Illinois EPA

February 2, 2018

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Watershed Implementation Plan and Stage 3 Report for the Prairie Creek/Langan Creek Watershed

**Prepared for:
Illinois EPA**

February 2, 2018

**Prepared by:
LimnoTech**

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4 Development of Water Quality Models

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Attachment 2: IEPA Watershed Management Load Reduction Strategy

Attachment 3: QUAL2E inputs and outputs



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Watershed Implementation Plan

To Achieve the Load Reduction Strategy
for Phosphorus in the
Prairie Creek/Langan Creek Watershed

Prepared for:
Illinois EPA

July 19, 2017

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Water | Scientists
Environment | Engineers

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**Watershed Implementation Plan
To Achieve the Load Reduction Strategy
for Phosphorus in the
Prairie Creek/Langan Creek Watershed**

**Prepared for:
Illinois EPA**

July 19, 2017

**Prepared by:
LimnoTech**

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1 Introduction to the Implementation Plan

The Prairie Creek/Langan Creek watershed is located mainly (97.5%) in Iroquois County, Illinois, with small areas in the adjacent counties of Kankakee County (2.2%) and Ford County (0.3%). However, all water quality issues addressed by this watershed implementation plan are within Iroquois County. This watershed implementation plan was prepared to document the conditions causing water body impairments and the plan to address those impairments. Specifically the plan is intended to address only those impairments identified in the State of Illinois 2012 Integrated Water Quality Report and Section 303(d) List¹, and refined based on IEPA direction, resulting from additional data collection subsequent to the 2012 list. The map in Figure 1-1 shows the Prairie Creek/Langan Creek watershed and identifies the impaired stream reaches that are the focus of this plan.

Section 303(d) of the Clean Water Act and USEPA's Water Quality Planning and Management Regulations (40 CFR Part 130) requires states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (USEPA, 1991). Load Reduction Strategies (LRSs) are being completed for causes that do not have numeric standards. LRSs for causes of impairment with target criteria consist of loading capacity and the percent reduction needed to meet the target criteria. This watershed implementation plan is intended to address the five LRSs for phosphorus in the Prairie Creek/Langan Creek watershed.

The LRS process and results for the Prairie Creek/Langan Creek watershed are documented elsewhere (LimnoTech, 2017). The waterbody segments and impairments that are the focus of this implementation plan are shown in Table 1-1.

Table 1-1. Impaired Waterbody Summary

Waterbody/Segment Name	Impaired Designated Use	Size (mile)	Impairment Cause	TMDL or LRS?
Langan Cr / IL_FLE-02	Aquatic Life	0.78	Phosphorus (Total)	LRS
Clifton N / IL_FLEA-C1	Aquatic Life	1.31	Phosphorus (Total)	LRS
Prairie Cr / IL_FLG	Aquatic Life	29.72	Phosphorus (Total)	LRS
Ashkum Cr / IL_FLGB-C1	Aquatic Life	2.84	Phosphorus (Total)	LRS
Clifton South Cr / IL_FLGZ-C1	Aquatic Life	2.18	Phosphorus (Total)	LRS

As described in the Stage 3 report, a total phosphorus load capacity and percent reduction were calculated for each impaired stream segment. This information is summarized in Table 1-2.

¹ Section 303(d) of the 1972 Clean Water Act requires States to define impaired waters and identify them on a list, called the 303(d) list. The final State of Illinois 2014 Integrated Water Quality Report and Section 303(d) List - 2014 (IEPA, 2014) is available on the web at: <http://www.epa.state.il.us/water/tmdl/303d-list.html>. This work began before the 2014 report was available, and therefore focuses on assessments based on the 2012 303(d) list, modified to reflect IEPA's recent sampling that resulted in the removal of several impairment causes.



Table 1-2. Total Phosphorus Load Reduction Strategies

Stream (Segment)	Current load (lbs/day)	Load capacity (lbs/day)	Percent Reduction
Langan Creek (IL_FLE-02)	450	225	50%
Clifton N. Creek (IL_FLEA-C1)	8.2	0.5	94%
Prairie Creek (IL_FLG)	448	332	26%
Ashkum Creek (IL_FLGB-C1)	32	4	87%
Clifton S. Creek (IL_FLGZ-C1)	9	2	78%

In summary, it is important to note that this watershed implementation plan is specifically intended to address excess phosphorus loading the stream reaches identified above and not intended to address other watershed conditions that may exist in the Prairie Creek/Langan Creek watershed. A comprehensive watershed characterization was developed and is presented in Section 2 of this plan, which provides a solid baseline of relevant information necessary to understand the sources of identified impairments and identify appropriate and effective actions to address them. Sections 3 through 11 are organized and written to address the nine key watershed plan elements identified by USEPA in the *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* for achieving improvements in water quality (USEPA, 2008).



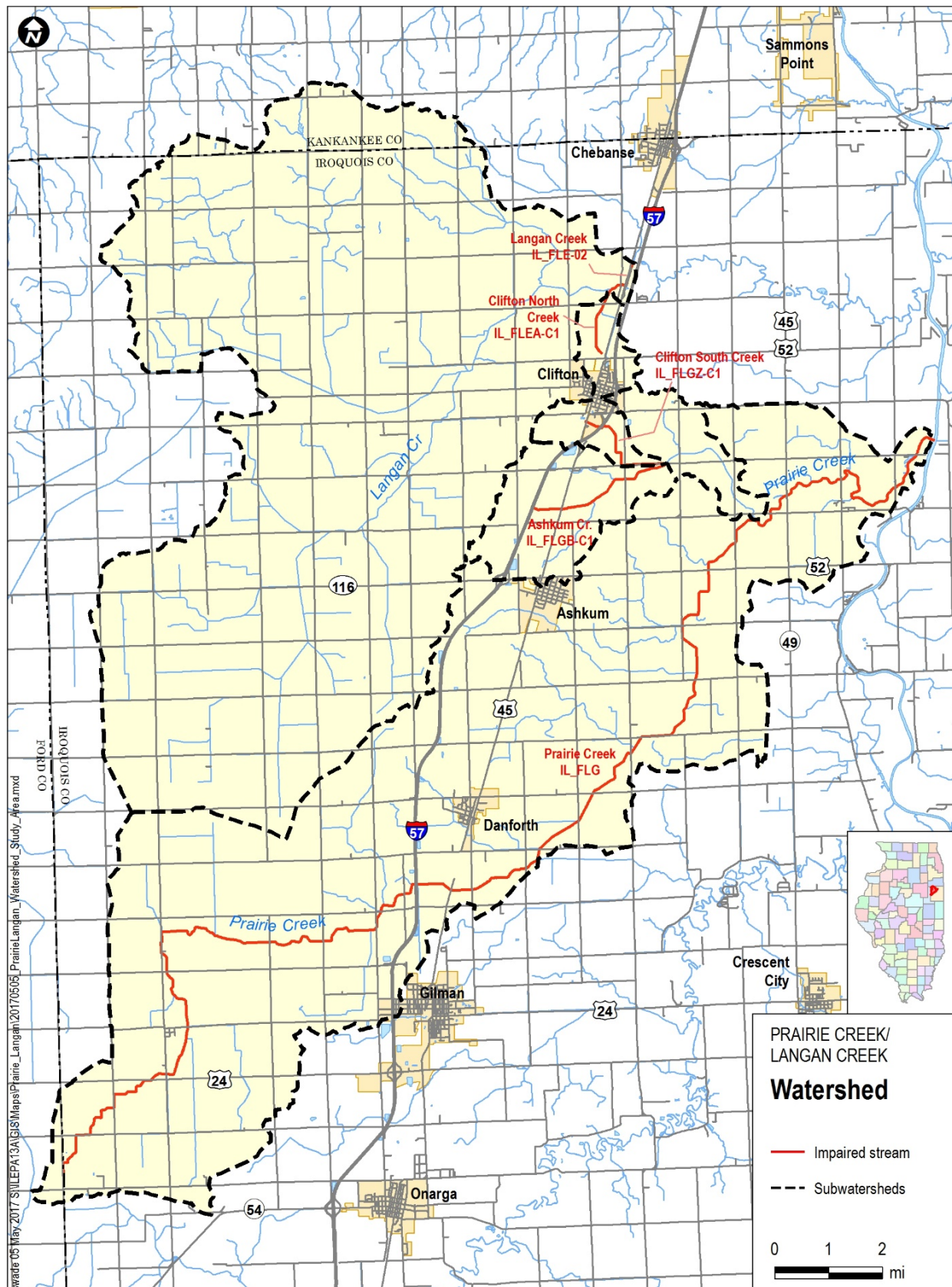


Figure 1-1. The Prairie Creek/Langan Creek Watershed, Showing Impaired Stream Reaches



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2 Watershed Characterization

As stated in Section 1, this implementation plan was prepared to address excess phosphorus loading to specific stream reaches in the Prairie Creek/Langan Creek watershed identified by the State of Illinois. The sections that follow provide a broad overview of the characteristics of the Prairie/Langan watershed.

2.1 Watershed Boundaries and Geographic Focus of the Plan

The Prairie Creek/Langan Creek watershed covers 110,979 acres in eastern Illinois, with more than 97% (108,223 acres) of the watershed area and all of the impaired stream reaches lying within Iroquois County. It lies entirely within the 07120002 8-digit hydrologic unit The Prairie Creek subwatershed includes the 071200021201 and 071200021202 12-digit HUCs and covers 57,261 acres. The Langan Creek subwatershed includes the 071200020901 and 071200020902 12-digit HUCs and covers 53,718 acres. The impaired stream reaches are identified on the map in Figure 2-1, along with their 12-digit hydrologic unit codes (HUCs).

2.2 Watershed Characteristics

The Prairie Creek/Langan Creek watershed was characterized by compiling and analyzing data and information from various sources. Where available, data were obtained in electronic or Geographic Information System (GIS) format to facilitate mapping and analysis. To develop a better understanding of land management practices in the watershed, local agencies are being contacted to obtain information on cropping practices, tillage practices and best management practices (BMPs), and other land uses employed.

After the watershed boundaries for the impaired waterbodies in the project watershed were delineated from topographic and stream network (hydrography) information, other relevant information was obtained. This spatial information was supplemented from various other publicly available sources. The following watershed characteristics are described in this section:

- Topography
- Climate and Hydrology
- Geology
- Soils
- Demographics and Urbanization
- Land Cover

2.2.1 Topography

Historically, much of this watershed was prairie, having nearly level to gently sloping topography, and poor drainage. Broad moraines, deposited by the receding glaciers, add some gently rolling features (Knapp, 1992). Currently, the Prairie Creek/Langan Creek watershed is dominated by relatively flat, prairie farmland. The highest elevation in the study area is approximately 756 ft, along the northern



boundary of the Langan Creek subwatershed, which contains the small tributary, Clifton North Creek. Higher elevations in the Prairie Creek subwatershed, which include tributaries Clifton South Creek and Ashkum Creek, range up to 695 ft. at its southern and western boundaries. The lowest elevation in the study area is approximately 602 ft., at the Prairie Creek confluence with the Iroquois River to the east. Slopes in the Prairie Creek/Langan Creek watershed range from 0% to 46%, with an area-weighted average slope of 0.71%. A topographic map of the watershed is presented as Figure 2-2.



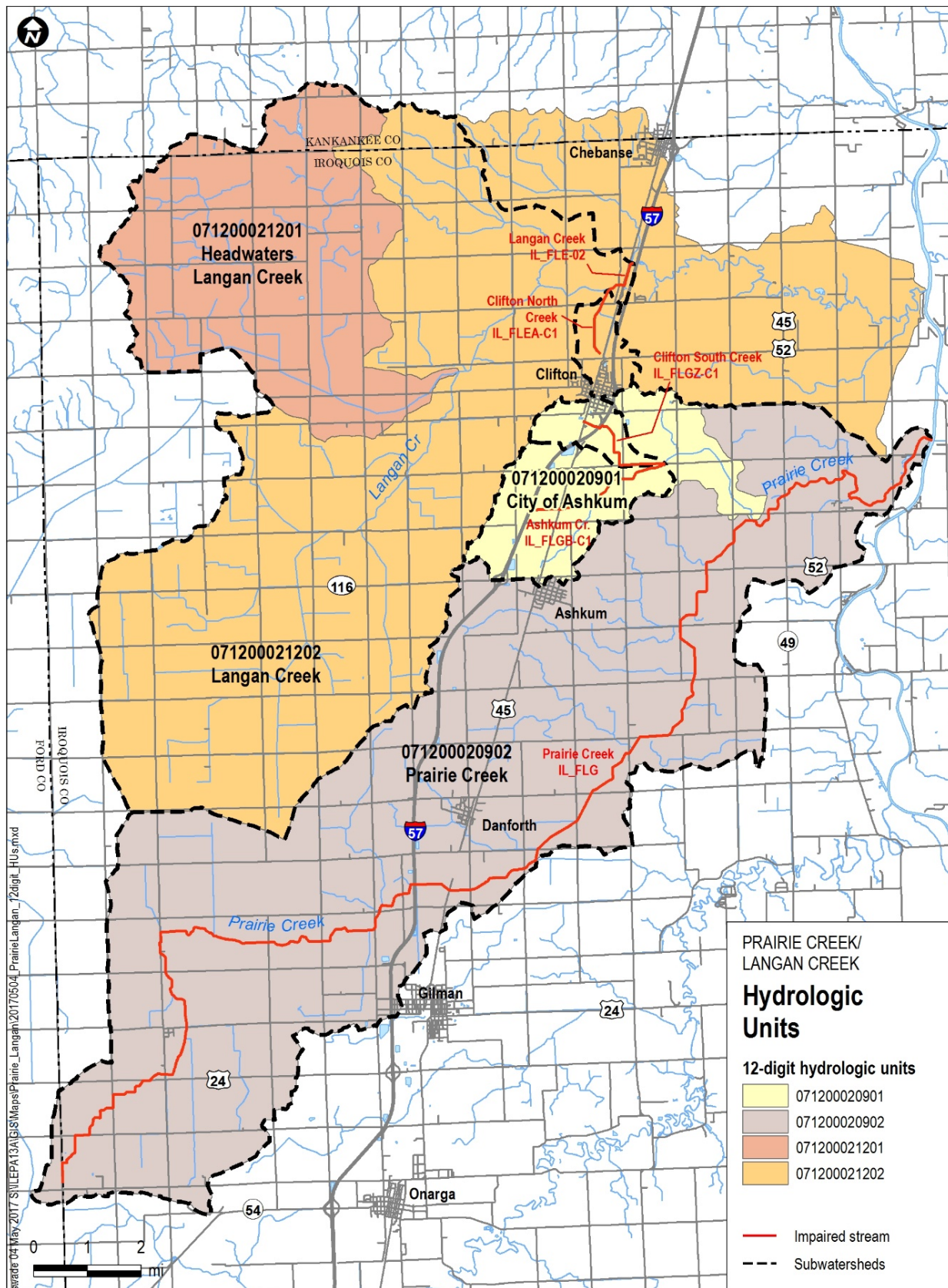


Figure 2-1. Hydrologic Units of the Prairie Creek/Langan Creek Watershed



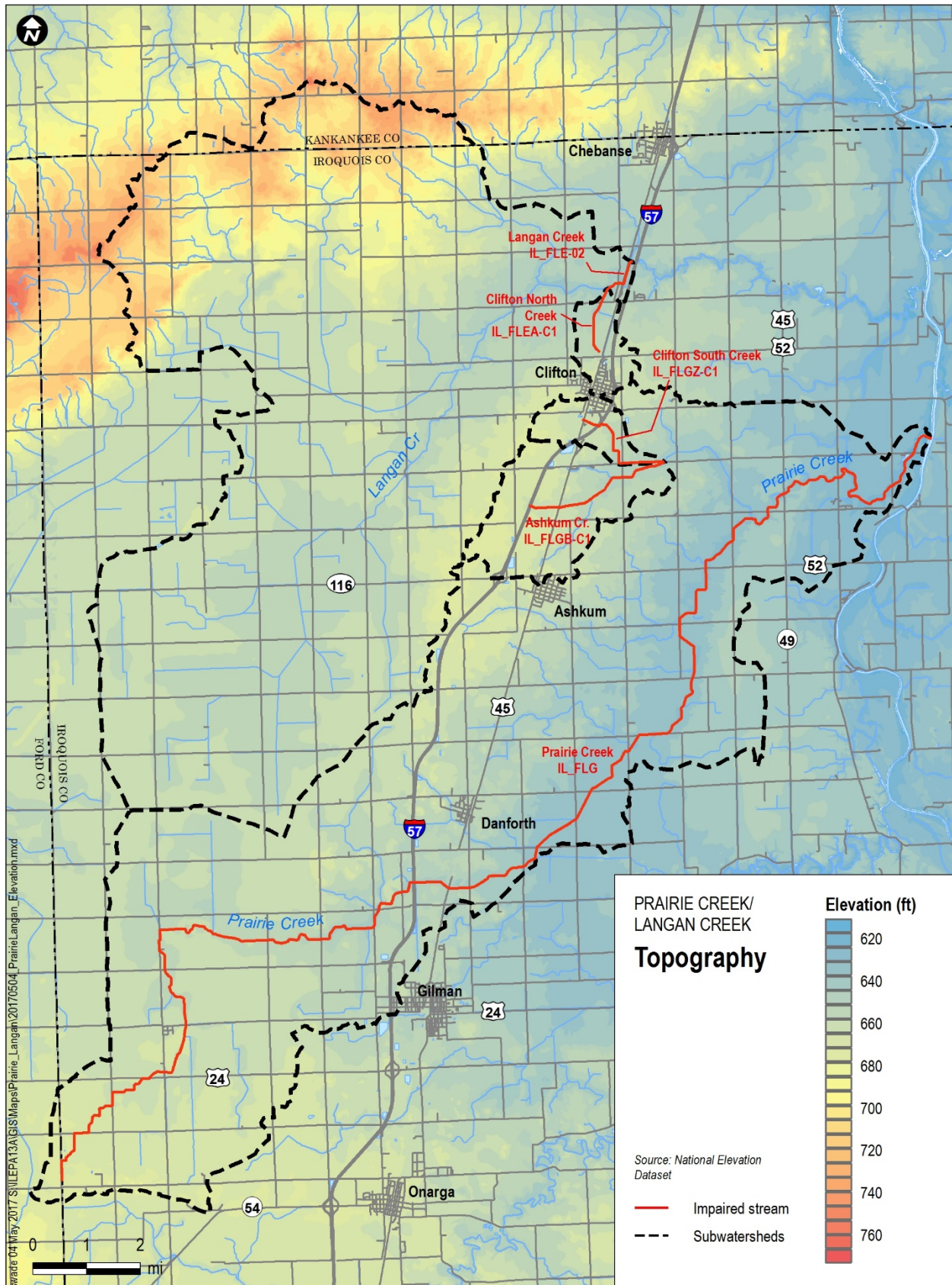


Figure 2-2. Topography of the Prairie Creek/Langan Creek Watershed



2.2.2 Climate and Hydrology

Prairie Creek and Langan Creek are both tributaries to the Iroquois River. According to Knapp (1992), areas along the Iroquois River generally flood 2 to 3 times a year. The Prairie/Langan watershed lies in a temperate climate zone with cold, snowy winters and hot, wet summers. There are no National Weather Service (NWS) weather stations in the watershed. The nearest station is in Kankakee County just to the north of the watershed. This station is expected to reflect the general climate conditions are in the region.

Precipitation data at the Kankakee County Station are available for a few years in the 1940s and 1950s, and from 1973 through present. The 38 years of historical precipitation data for Station 114603 in Kankakee County average 38.0 inches of precipitation each year. The highest monthly average precipitation tends to occur from May to July, when more than four inches per month can be expected. The lowest monthly average occurs in February (1.8 inches). Monthly average precipitation is shown in Figure 2-3. The most intense storms, based upon the daily maximum precipitation, may come during spring, summer or fall; precipitation events are typically milder during winter. Average monthly temperatures are depicted in Figure 2-4.

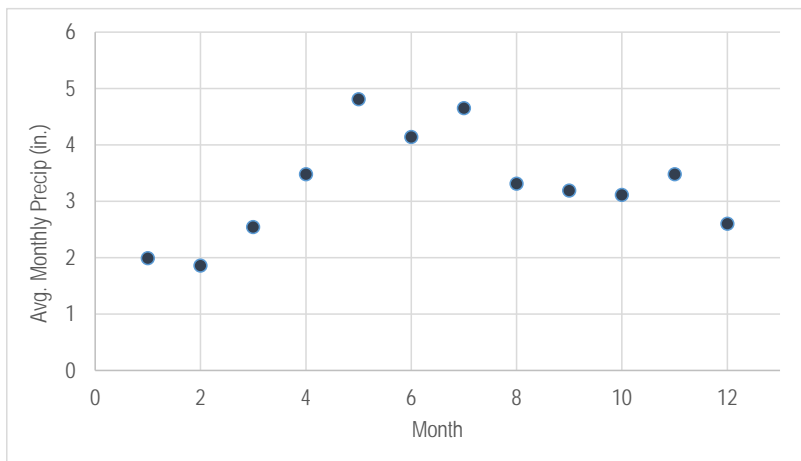


Figure 2-3. Average Monthly Precipitation in the Prairie Creek/Langan Creek Watershed

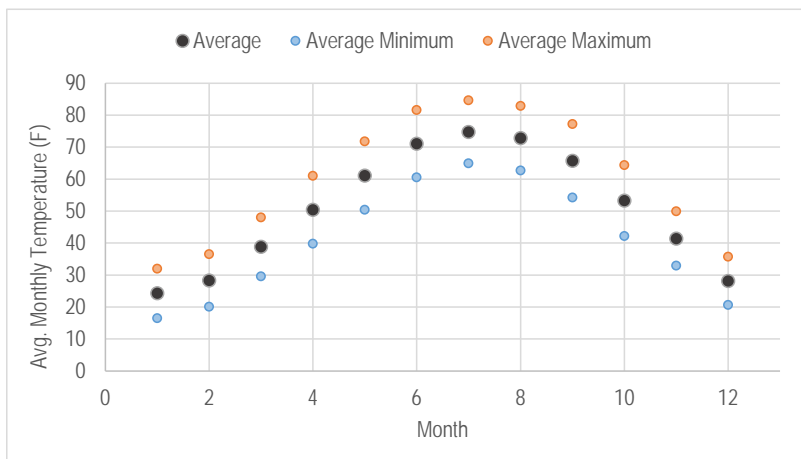


Figure 2-4. Average Monthly Air Temperature in the Prairie Creek/Langan Creek Watershed



2.2.3 Geology

Bedrock geology in the Prairie Creek/Langan Creek watershed is predominantly (76%) Silurian dolomite limestone. Other minor geologic units include Pennsylvanian shale, Ordovician shale and Devonian limestone (Figure 2-5). There is little, if any exposed surface bedrock in the watershed.

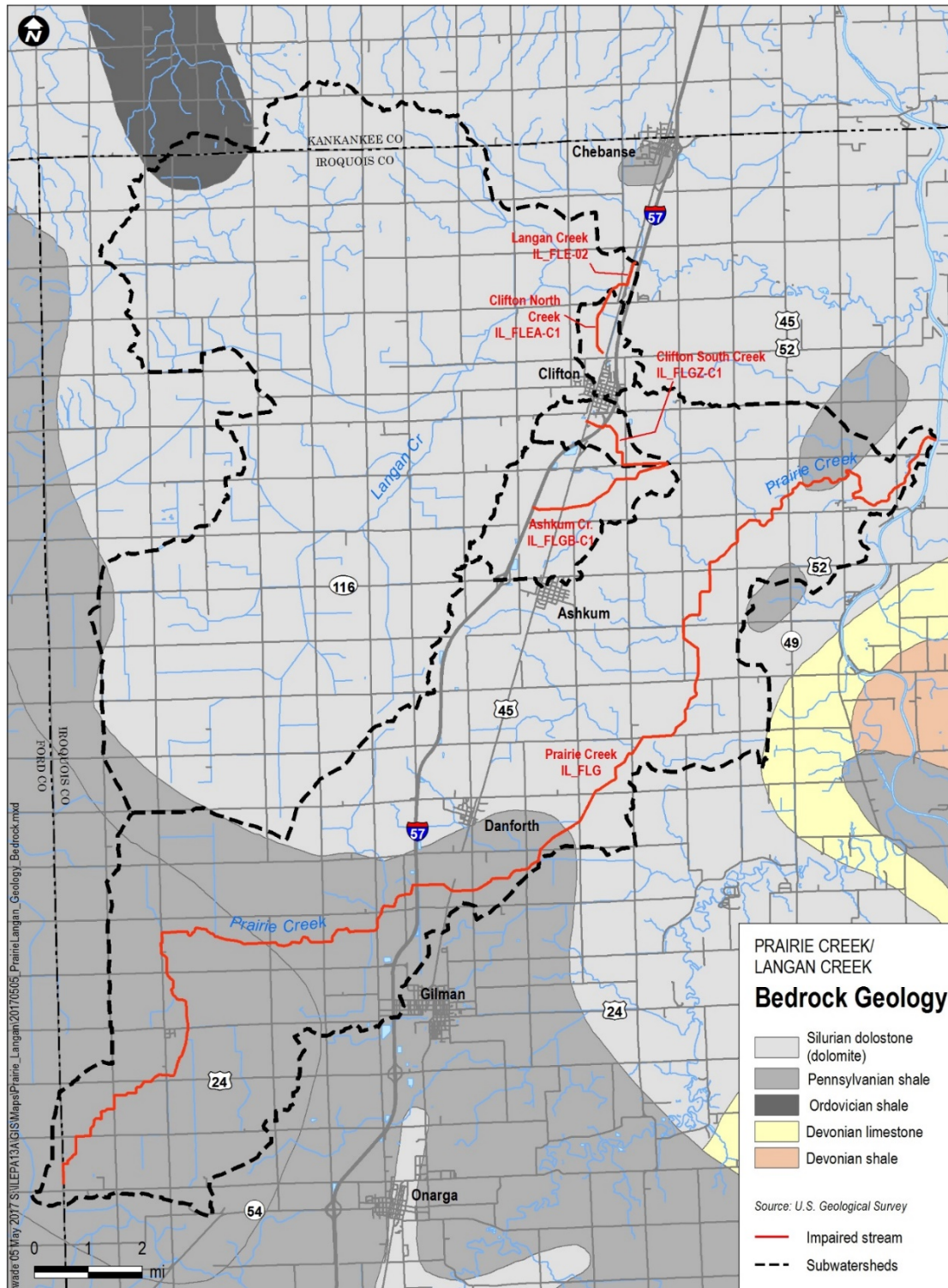


Figure 2-5. Geologic Units in the Prairie Creek/Langan Creek Watershed



Surface geology of the Prairie Creek/Langan Creek watershed, like most of Illinois, is dominated by glacial drift that is up to hundreds of feet thick. Glacial drift thickness in the entire watershed measures at least 25 feet (see Figure 2-6). Approximately 64% of the watershed has glacial drift more than 100 feet thick.

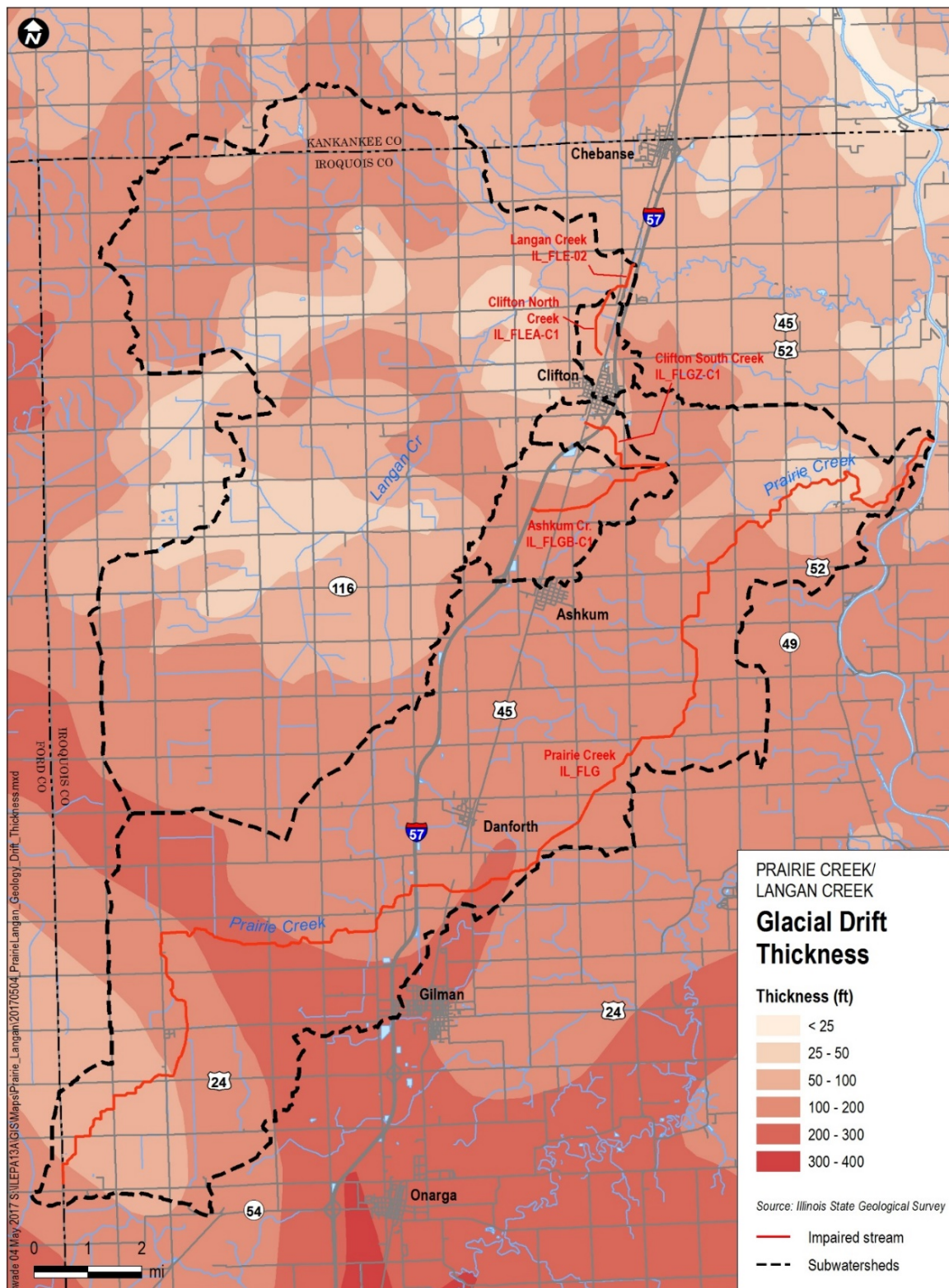


Figure 2-6. Glacial Drift Thickness in the Prairie Creek/Langan Creek Watershed



2.2.4 Soils

Together with topography, the nature of soils in a watershed play an important role in the amount of runoff generated and soil erosion. The soils in this watershed were deposited by glaciers and generally consist of a heterogeneous mix of silts or clays (Knapp, 1992). The Prairie Creek/Langan Creek watershed consists primarily of poorly drained silty and loamy soils that lay on slopes less than 2% (Kiefer, 1982). The most common soil types in the watershed are silty clay loam and clay loam (56%), silt loam (14%), silty clay (14%), and loam (12%). Soil texture distribution is shown in Figure 2-7 and a map of soil texture classes in the Prairie Creek/Langan Creek watershed is shown in Figure 2-9.

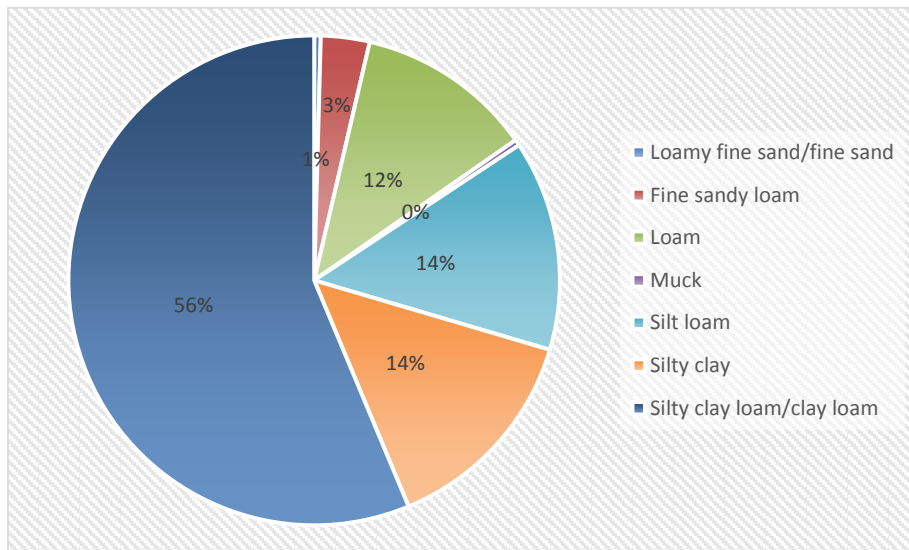


Figure 2-7. Distribution of Soil Texture Classes in the Prairie Creek/Langan Creek Watershed

The most predominant hydrologic soil group (Figure 2-8) is C/D (56%), followed by B/D (33%). According to the Iroquois County Soil Survey (Kiefer, 1982), the soils in this area are poor filters and experience slow percolation. As a result, tile drains are widely used within the study area. Nearly every farm in the region uses them due to the relatively impervious soils in the region (Iroquois County Natural Resource Conservation Service; NRCS). Hydrologic soil groups are mapped in Figure 2-10.

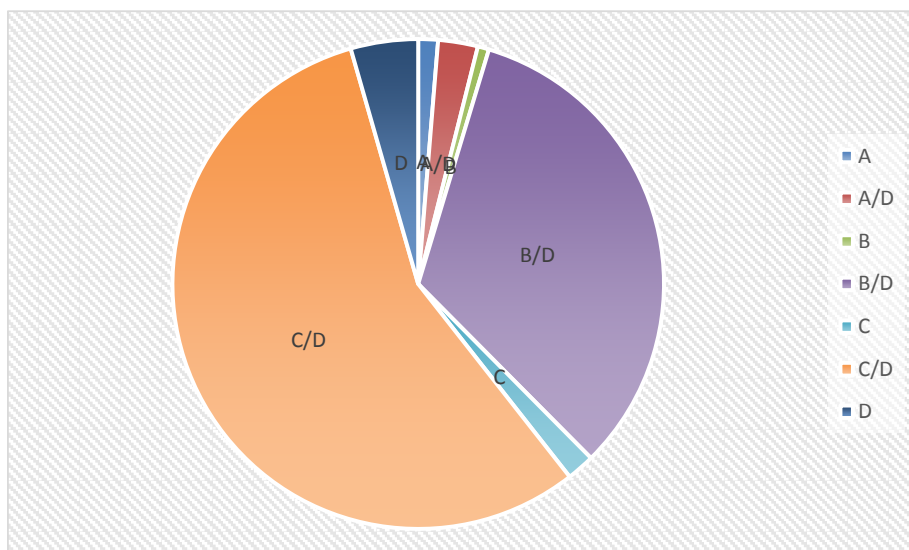


Figure 2-8. Distribution of Hydrologic Soil Groups in the Prairie Creek/Langan Creek Watershed



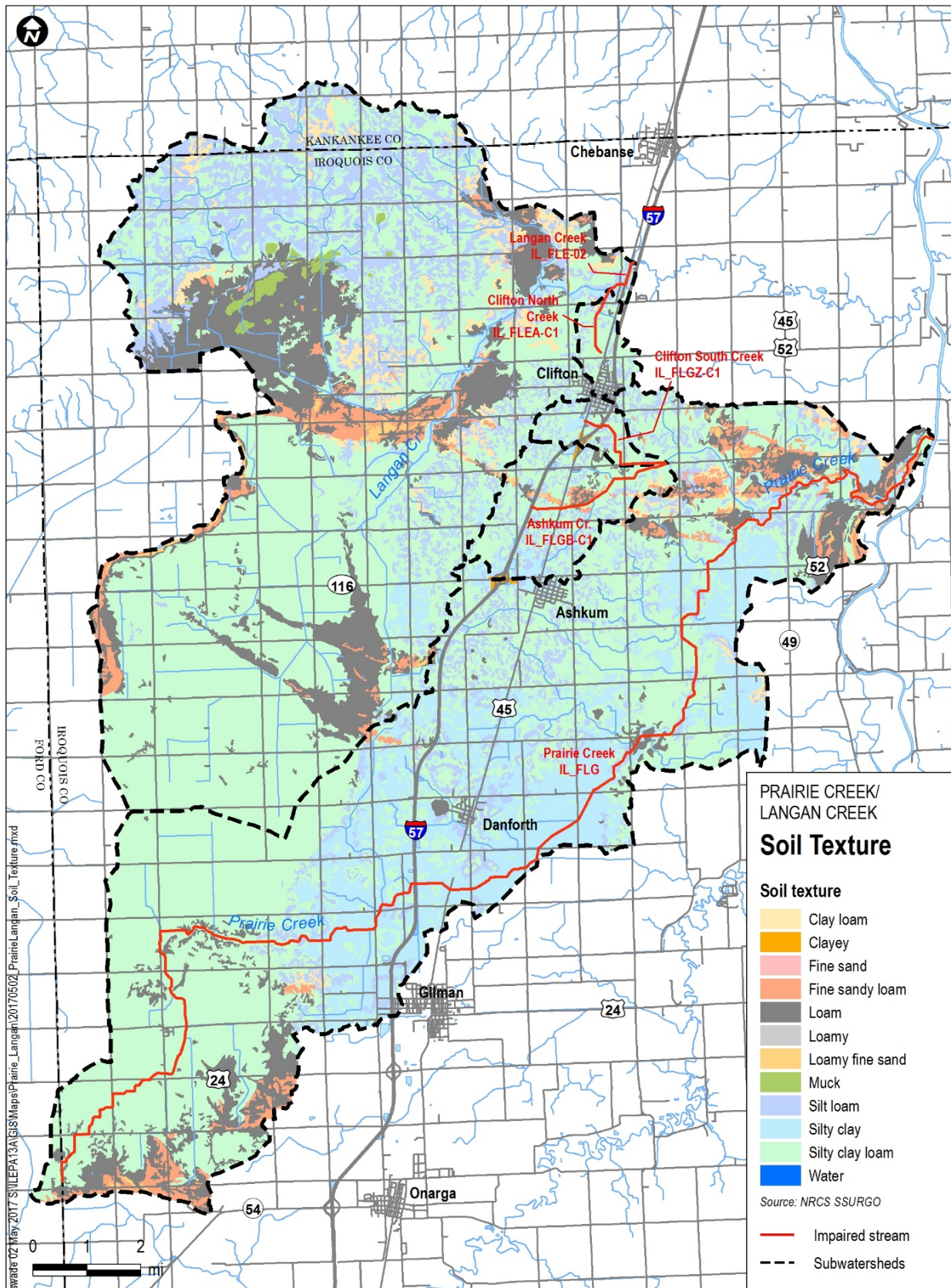


Figure 2-9. Soil Texture Classes in the Prairie Creek/Langan Creek Watershed



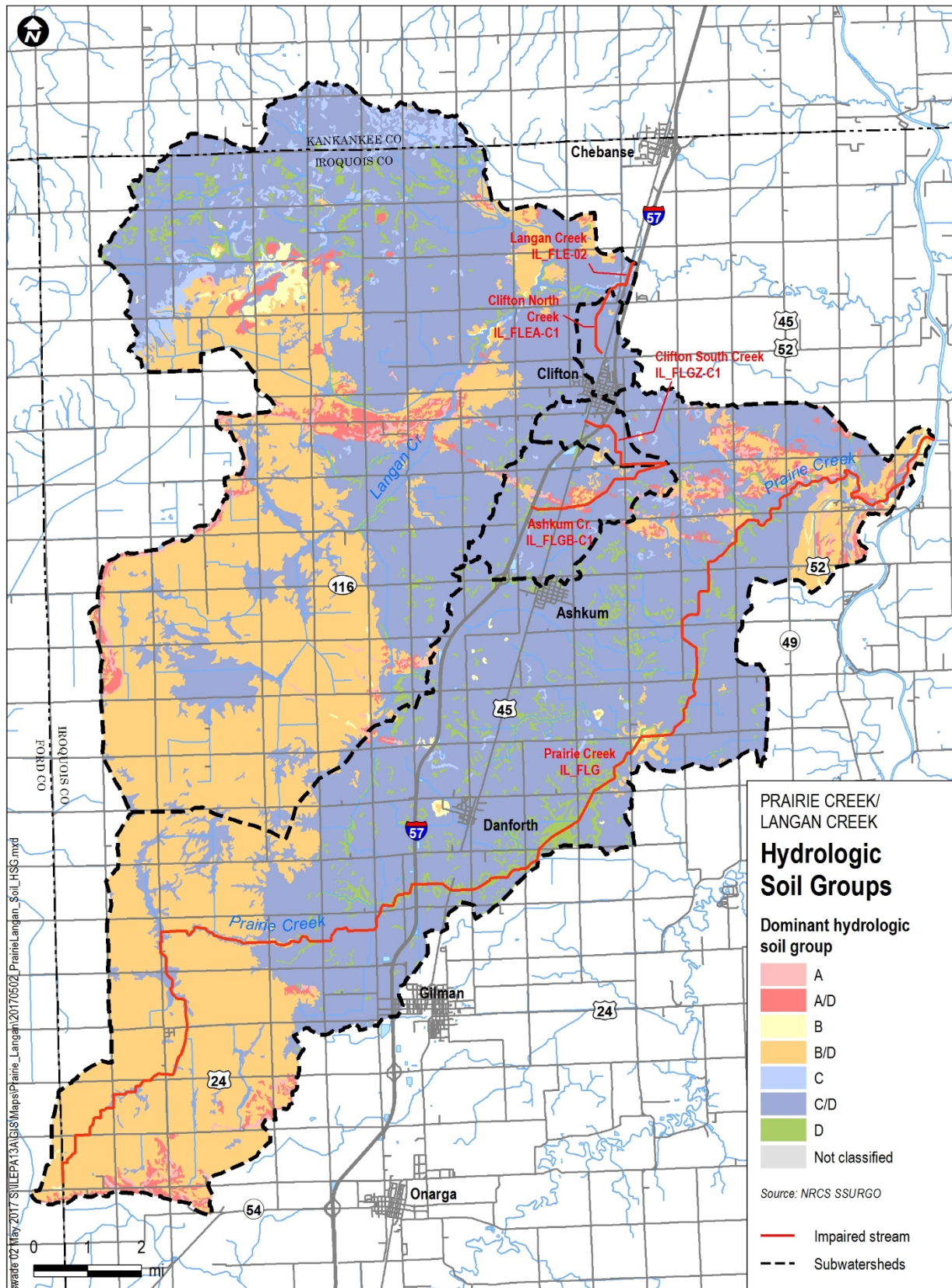


Figure 2-10. Hydrologic Soil Groups in the Prairie Creek/Langan Creek Watershed



The preceding discussion of topography, soil texture and hydrologic soil group classifications paint a picture of a watershed dominated by flat, poorly drained soil. In fact, according to soil drainage classification by the Natural Resource Conservation Service (NRCS, Figure 2-11), 71% of soil in the Prairie Creek/Langan Creek watershed is classified as “poorly drained”, with another 20% classified as “somewhat poorly drained”. Only 4% of soil in the watershed is classified as “well drained” or “somewhat well drained”.

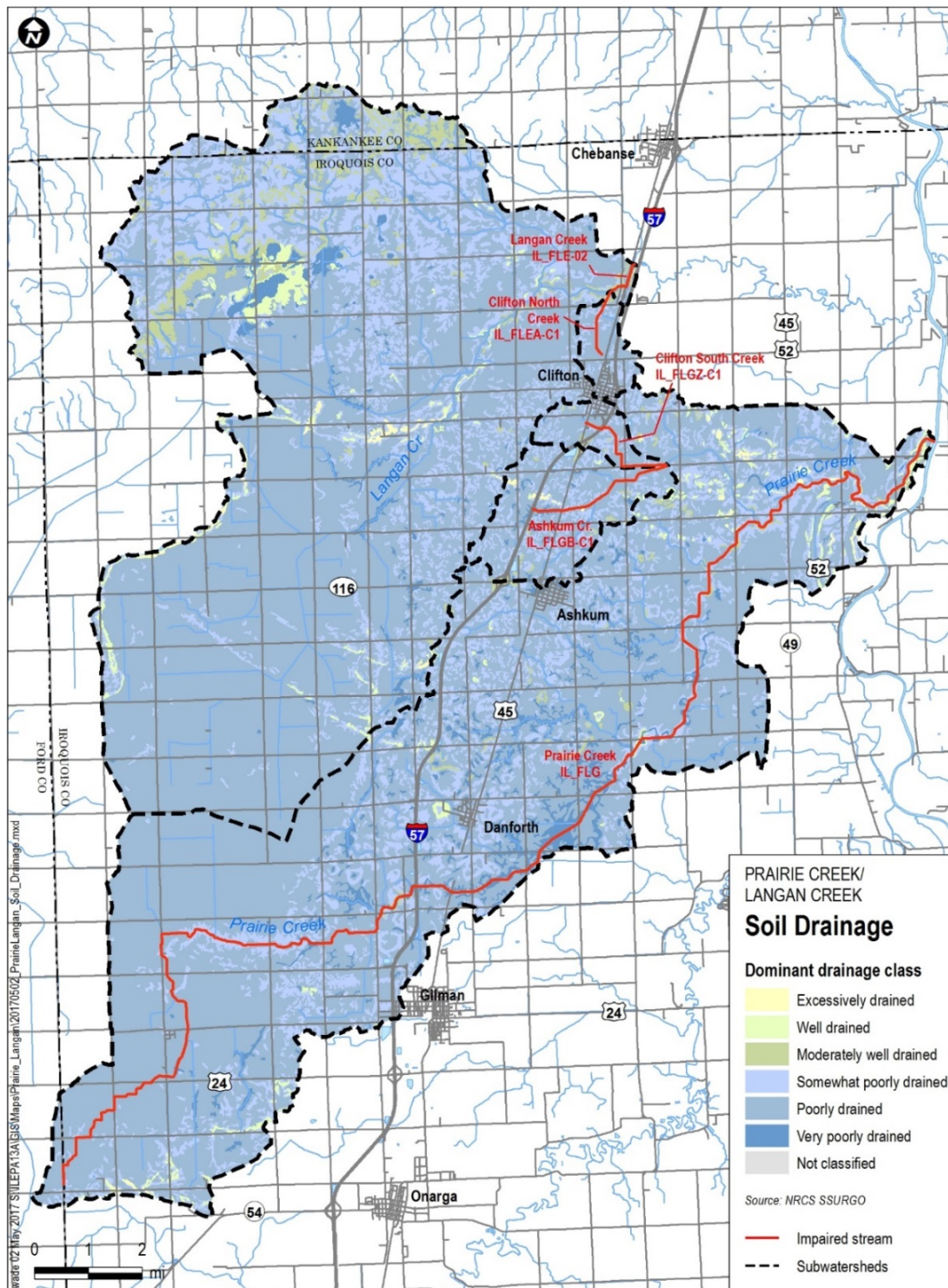


Figure 2-11. Soil Drainage Classification in the Prairie Creek/Langan Creek Watershed



Groundwater in the Prairie Creek/Langan Creek watershed is very shallow (Figure 2-12), with 75% of the watershed having an annual minimum water table depth of 15 cm (~6 in.) or less. Furthermore, 75% of the soils in the watershed are classified as hydric (Figure 2-13). These conditions suggest that much of the Prairie Creek/Langan Creek watershed was covered by wetlands in the past.

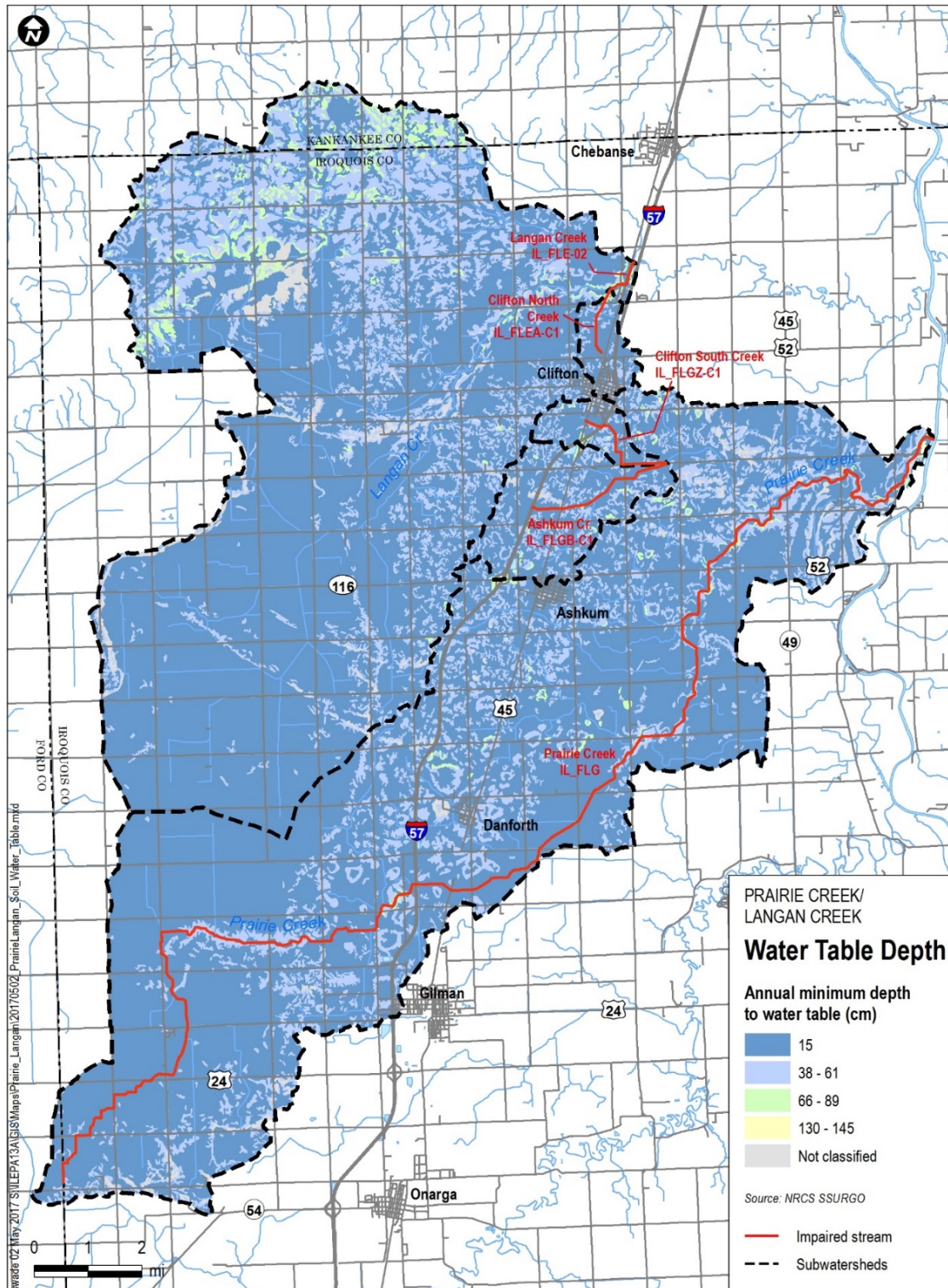


Figure 2-12. Depth to Groundwater in the Prairie Creek/Langan Creek Watershed



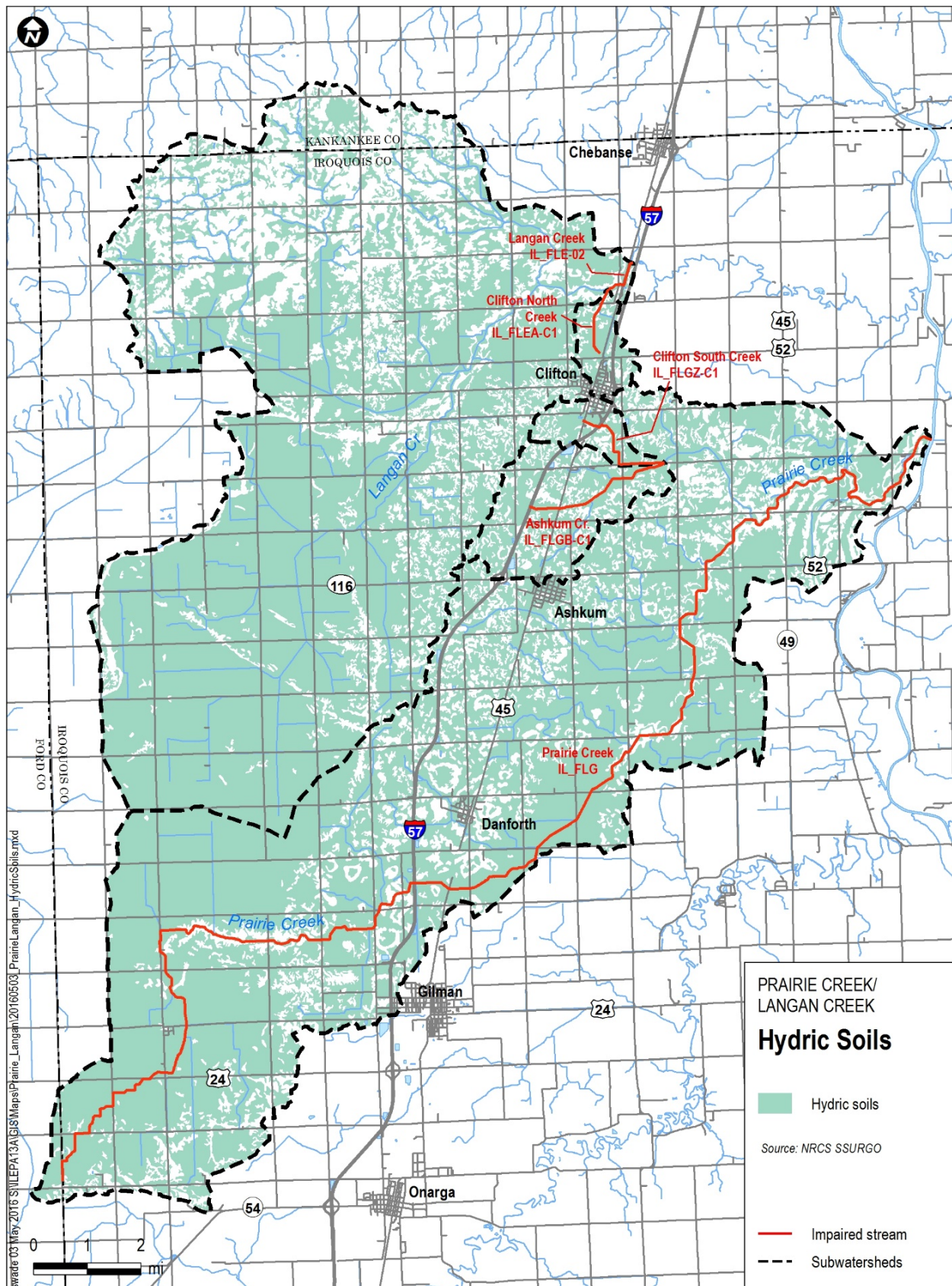


Figure 2-13. Hydric Soils in the Prairie Creek/Langan Creek Watershed



The NRCS classifies the agricultural quality of soils and 71% of the Prairie Creek/Langan Creek watershed is classified as “prime farmland if drained”. Another 23% is classified as “prime farmland” (Figure 2-14).

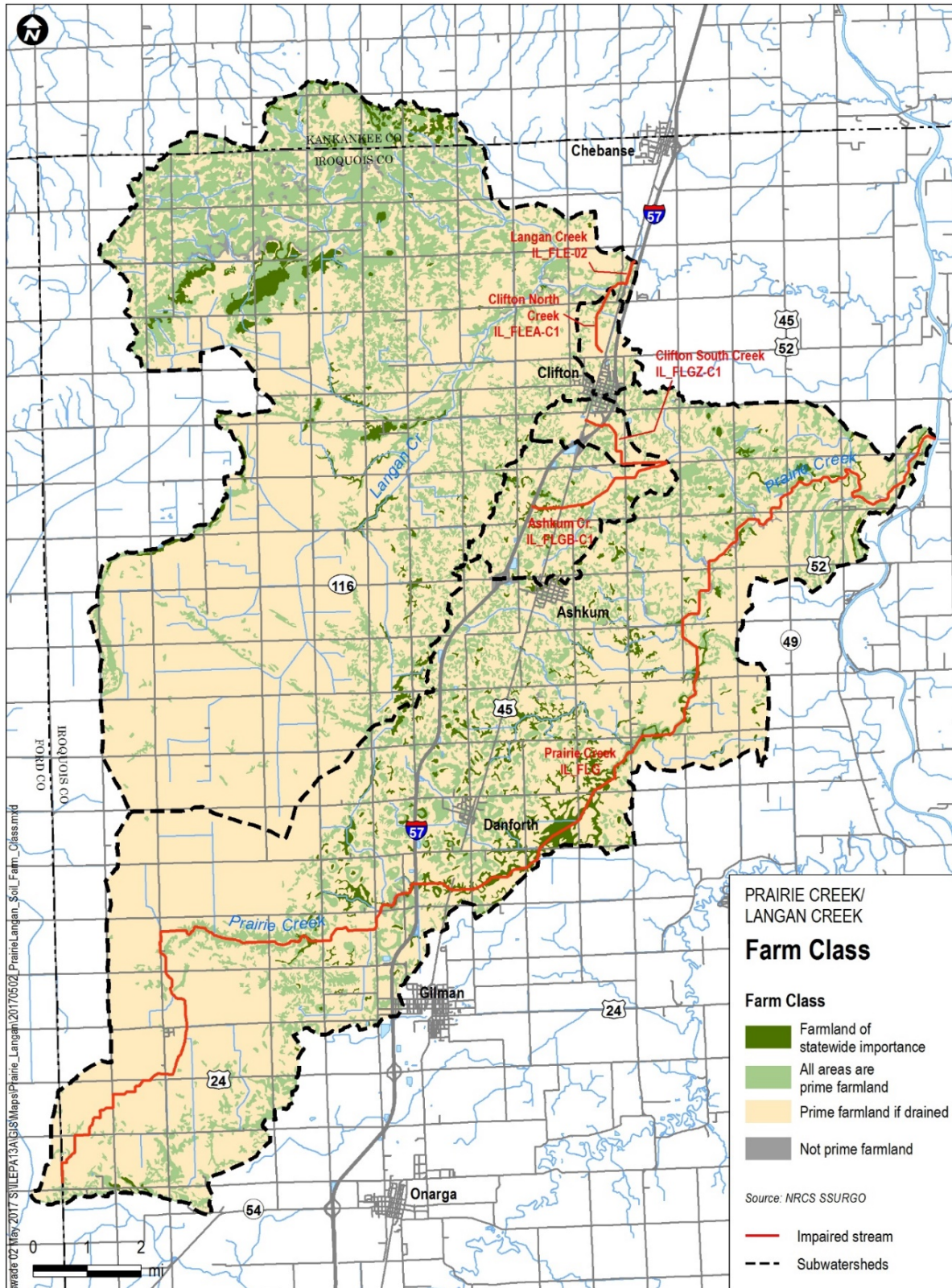


Figure 2-14. Farmland Quality in the Prairie Creek/Langan Creek Watershed



Fifty-one percent of soil in the Prairie Creek/Langan Creek watershed is classified as moderately erodible and almost 49% is classified as low erodibility (Figure 2-15). Less than 1% of the soil is classified as highly erodible.

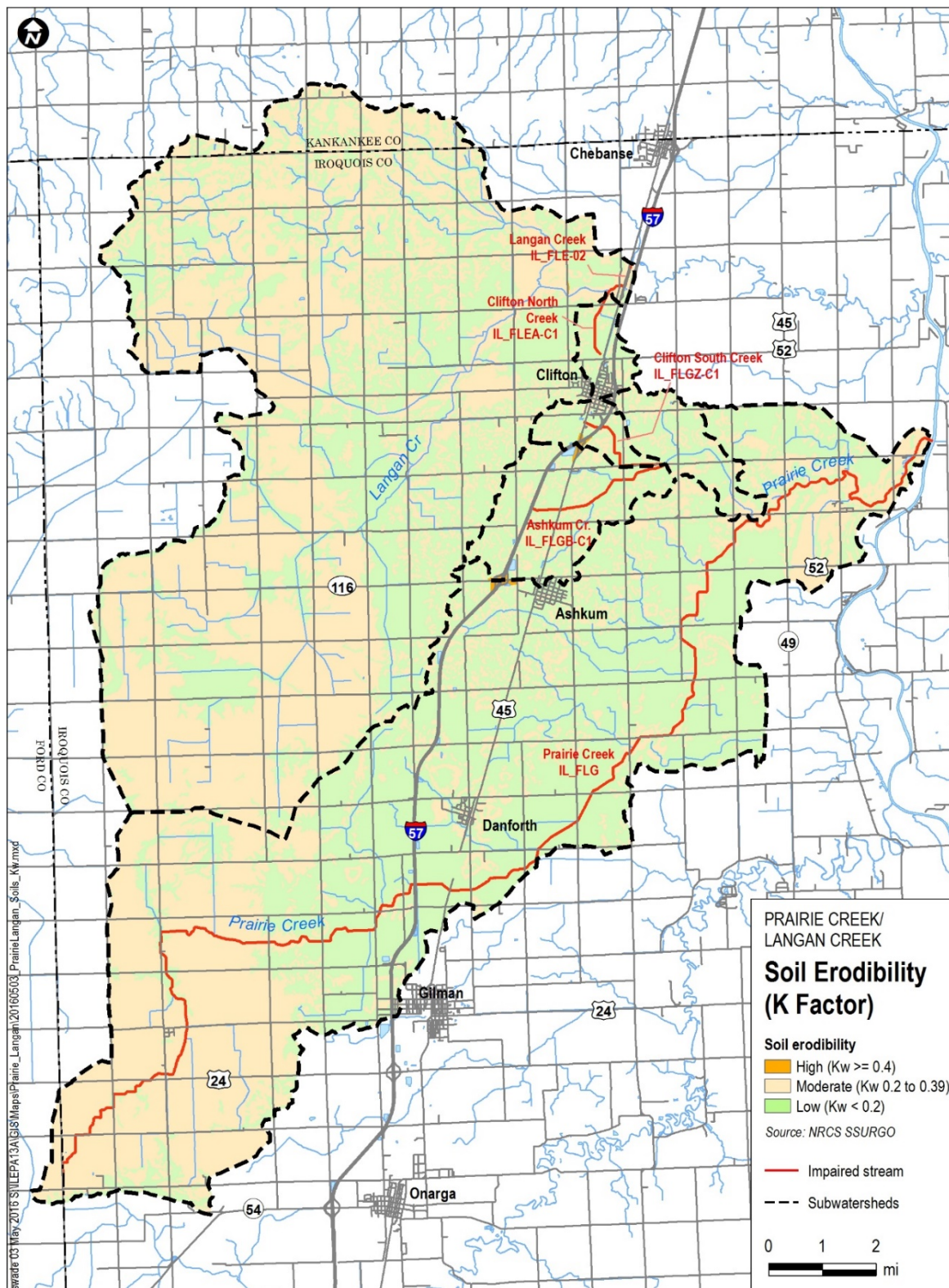


Figure 2-15. Soil Erodibility in the Prairie Creek/Langan Creek Watershed



2.2.5 Demographics and Urbanization

Population statistics and projections are available on a county basis and the majority of this watershed is located in Iroquois County. According to the United States Census Bureau, the population of Iroquois County was 28,334 as of July 1, 2016, which is the most recent data available². This number is down from 29,718 as of April 1, 2010, a decrease of 4.7%. The average population density of Iroquois County is approximately 25 people per square mile.

Urbanization in the watershed is centered in the towns of Clifton, Ashkum and Danforth. The land cover data indicates that the watershed is approximately 7% urbanized, but none of it is considered heavily developed. Any urban areas in this region are considered low intensity development. The watershed population is estimated to be roughly 7,100 people.

Table 2-1. Estimated Population³ of Major Towns in the Prairie Creek/Langan Creek Watershed

Town	2015 Estimated Population
Clifton	1,410
Ashkum	737
Danforth	578

2.2.6 Land Cover

Using the 2011 Cropland Data Layer (CDL) for Illinois from the NRCS, it is apparent that the Prairie Creek/Langan Creek watershed is predominantly agricultural with approximately 90% of the land being cultivated crops (Figure 2-16). Roughly 7% of the land area is developed and the remainder is grassland. Of the cultivated crops, corn is the most predominant, accounting for around 55% of the total cultivated crop land. Soybeans account for around 43% and the remainder is made up of various less common crops, with winter wheat accounting for the largest portion. Land cover is mapped in Figure 2-17.

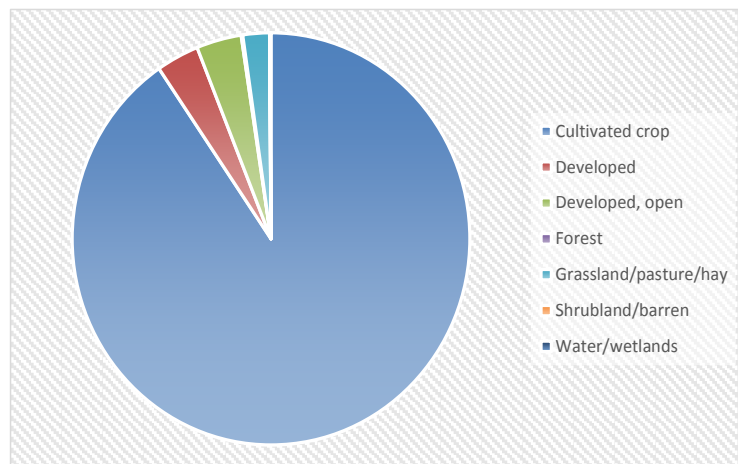


Figure 2-16. Prairie Creek/Langan Creek Watershed Land Cover Distribution

² <https://www.census.gov/quickfacts/table/HCN010212/17075>, accessed 5/4/17.

³ Estimated 2015 populations obtained from Wikipedia on 5/4/17.

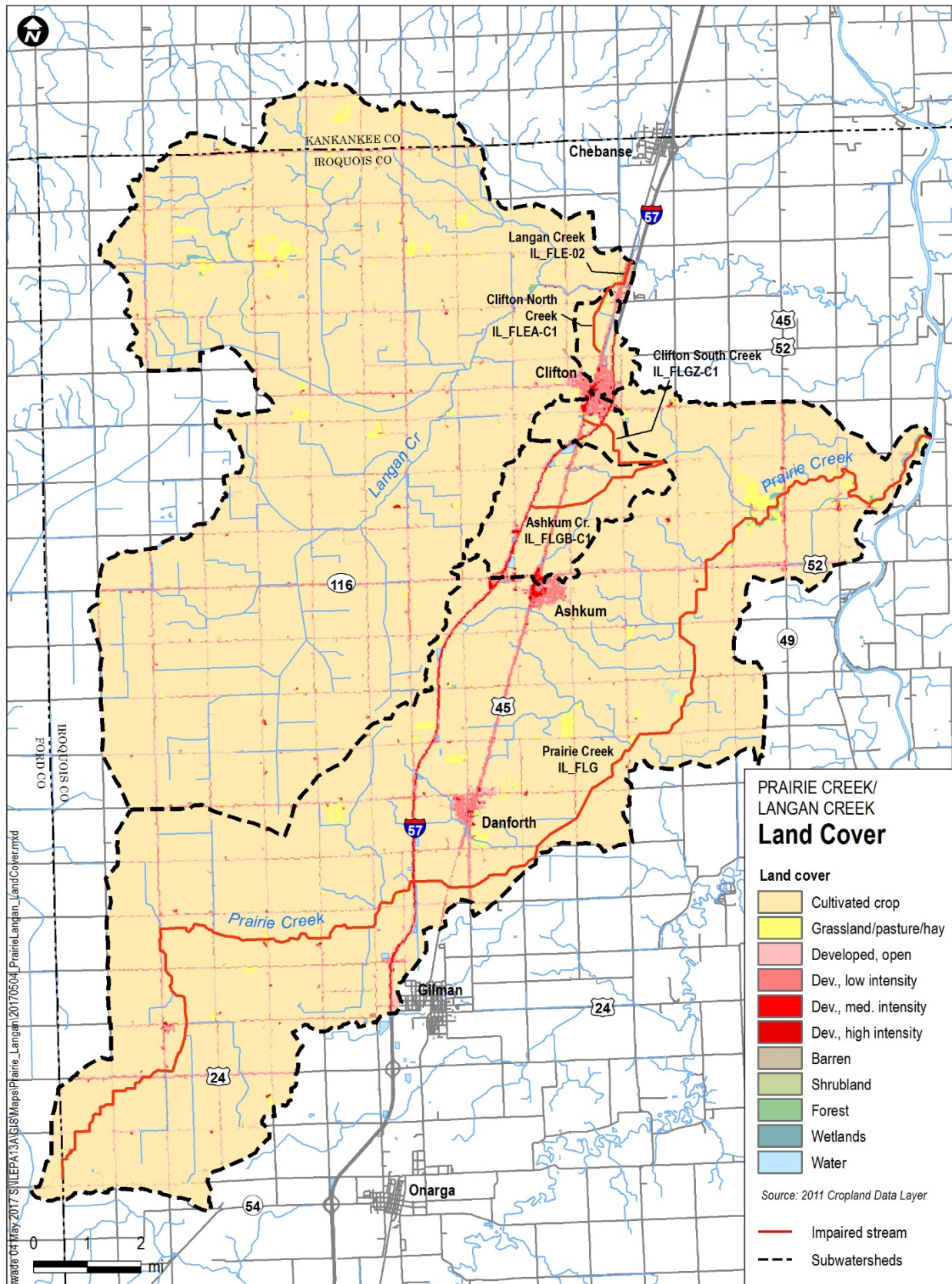


Figure 2-17. Land Cover in the Prairie Creek/Langan Creek Watershed



2.3 Additional Information Gathering

In addition to the desktop characterization described above, supplemental watershed inventory information was collected through a watershed tour and interviews with public officials. Additional information was obtained during a public meeting. These activities are described below.

2.3.1 Watershed Tour

A tour of the Prairie Creek/Langan Creek watershed was conducted in June 2013. This tour focused on the parts of the watershed containing impaired waters. The objectives of the watershed tour were:

- To verify observations made during the desktop analysis.
- To observe conditions at, and immediately upstream of, Illinois EPA water quality sampling locations.
- To identify concerns or potential causes of water quality impairment not previously identified

Most stream observations were made from bridge crossings or within a short hike of bridge crossings. A windshield survey of developed areas (towns) was conducted, but given the dominance of row crops in the watershed, this contributed little information.

It should be noted that the decision was made not to conduct a stream walk/inventory for this watershed characterization effort because stream erosion is not considered a significant source of phosphorus loading in this watershed, based on several lines of evidence including:

- Soils – Soils in the Prairie Creek/Langan Creek watershed are dominated by fine-grained silty clay loams, silty clays and silt loams, with low to moderate erodibility factors. In fact, less than 1% of soils in the watershed are classified as highly erodible.
- Topography – The watershed has very little topographic relief, with an average area-weighted surface slope of 0.71%, which is extremely flat. Flat topography tends to reduce erosion.
- Stream gradient – Stream gradients in the Prairie Creek/Langan Creek watershed are also very flat. The average gradient of Prairie Creek is 0.18% and the average gradient of Langan Creek is 0.1%.
- Prevalence of other sources – Given that land use the Prairie Creek/Langan Creek watershed is dominated by agriculture and drain tiling of agricultural fields is common, the most prevalent source of phosphorus loading is likely agricultural stormwater, conveyed to stream via drain tiles.

The absence of bank erosion in the watershed was corroborated during the watershed tour, when it was observed that nearly all stream channels observed during the tour had well-vegetated banks and did not exhibit signs of erosion.

One significant observation made during the watershed tour was the prevalence of drain tiles, which were observed as pipes protruding from streambanks, in many cases several feet above water level. Active drainage was observed in some of these drain tiles. The prevalence of drain tiles in the watershed was suspected from the topography and soil characteristics of the watershed, but this visual confirmation was significant.

Attached algae were observed at many sites, verifying earlier observations by Illinois EPA, and aquatic plants were observed growing at one site. Some streams had narrow buffers along them that were wooded, but many others had only grassy buffers, if any.



2.3.2 Interviews with Local Officials

In addition to the extensive desktop watershed study and the watershed tour, the following local officials were contacted for information on a range of relevant subjects:

- Thad Eshleman, NRCS Soils and Water Conservation District - tillage practices, erosion, pollutant sources, livestock counts and extent of cover cropping.
- Stephanie Rhoades, Iroquois Health Department - wildcat sewers in Iroquois Co.
- Trevor Sample, IL EPA Project Manager for Prairie/Langan Creek Watersheds - private sewage systems, wildcat sewers and pollutant sources.
- Terry Eilman, Director of Iroquois/Ford public health environmental sector - private sewage systems in Prairie/Langan watersheds.

These interviews did not reveal new information, but confirmed information previously developed, as well as the understanding of pollutant sources.

2.3.3 Public Input

A public meeting was conducted at the Clifton Community Building in Clifton, Illinois, on April 24, 2014 to present the findings of the watershed characterization and gather any additional information available from the public. The meeting was advertised in the Clifton Advocate and public notices were mailed directly to 15 entities or organizations in the watershed. Approximately ten people attended the meeting, in addition to the meeting organizers. A background presentation was made on the watershed characterization, covering the following topics:

- The TMDL process and water quality goals;
- Target water quality issues in the Prairie Creek/Langan Creek watershed; and
- Suspected sources of pollutants.

Questions were invited and input was requested at the meeting. The public in attendance was in overall agreement with the findings of the watershed characterization.



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3 Identification of Causes of Impairment and Pollutant Sources

As stated previously, the purpose of this watershed implementation plan is to address excess phosphorus loading to five waterbody segments in the Prairie Creek/Langan Creek watershed that IEPA has assessed as impaired due to elevated total phosphorus concentrations. It is believed that this excess phosphorus has caused or contributed to excessive algal growth and exaggerated diurnal dissolved oxygen variation. Load reduction strategies have been developed for these five stream segments (Figure 3-1) and additional detail is found in the Stage 3 report for the Prairie Creek/Langan Creek watershed.

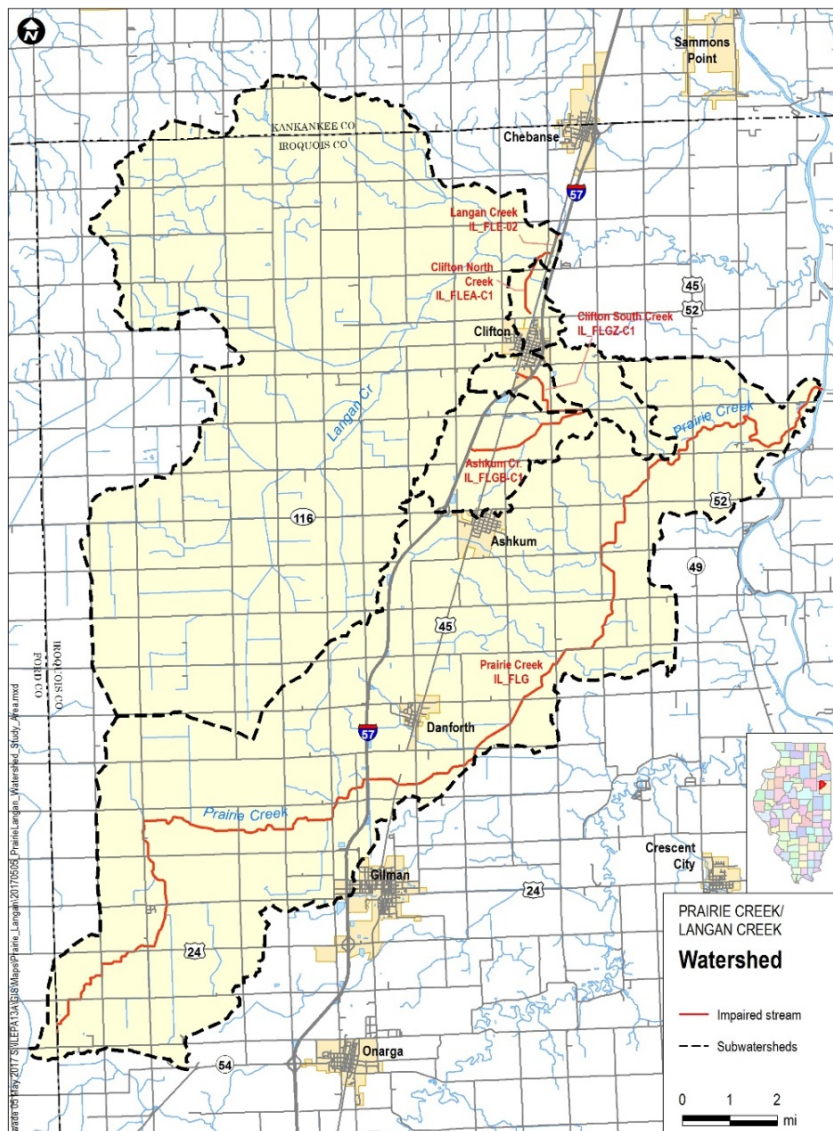


Figure 3-1. Study area map



3.1 Identification of Potential Pollutant Sources

Past experience shows that there are several potential sources of excessive phosphorus loading in agricultural watersheds:

- Agricultural runoff and tile drainage
- Livestock operations (runoff and livestock in stream)
- Point sources (municipal wastewater treatment and private wastewater systems)
- Legacy sediment sources
- Stream erosion

Each of these potential sources is evaluated below.

3.2 Assessment of Potential Pollutant Sources

Pollutant sources were evaluated using the watershed characterization information presented in Section 2, available monitoring data, L-THIA watershed modeling, GIS analysis of watershed characteristics, a site visit and calls to local agencies.

3.2.1 Agricultural Runoff and Tile Drainage

Experience in predominantly agricultural watersheds in the Midwest shows that runoff from croplands (both surface runoff and tile drainage) and livestock operations are often a major contributor of phosphorus to surface waters. In-stream sampling data, watershed modeling and the prevalence of agricultural cropland indicate that agricultural runoff is the major source of phosphorus in the Prairie Creek/Langan Creek watershed.

- ***In-Stream Sampling Data*** - IEPA sampling in 2014-2015 shows that phosphorus concentrations are elevated during higher flow conditions compared to low flow conditions, indicating that runoff is a source of phosphorus (Table 3-1).

Table 3-1. Average 2014-2015 Total Phosphorus Concentrations (mg/l) During Different Flow Conditions.

Flow condition	Average TP (mg/l) at station FLG-02 (upstream)	Average TP (mg/l) at station FLG-01 (downstream)
Low flow	0.252	0.065
High flow	0.618	
Unknown	0.245	

**Multiple concentrations recorded on the same day were averaged, before being averaged with measurements recorded on other dates.*

- ***Watershed Model Load Calculations*** – Long-term average phosphorus loading was estimated for the Prairie Creek/Langan Creek watershed using the Long Term Hydrologic Impact Analysis (L-THIA) model supported by Purdue University⁴. The L-THIA results show that nonpoint source runoff of phosphorus from cultivated cropland is estimated to comprise 96% of the phosphorus load from surface runoff watershed-wide (Table 3-2). Note that these model results do not include loading from tile drainage.

⁴ The L-THIA model is accessible at <https://engineering.purdue.edu/~lthia/>.



Table 3-2. Phosphorus Load Estimate by Source (Surface runoff only)

Source Area	Relative phosphorus load contribution
Cultivated cropland (surface runoff)	96%
Private sewage disposal systems	1%
Surface runoff from developed & non-cropland areas	3%

- ***Spatial Estimate of Tile Drainage*** – Tile drains are likely an important pathway for phosphorus, based on the prevalence of tile drains in the watershed and available data that show roughly 50% of the total phosphorus is in dissolved form. Nearly every farm in the region uses tile drains due to the relatively impervious soils in the region (Iroquois County NRCS). Areas likely to have tile drains are flat areas (<2% slope) with poorly drained (hydrologic soils group D) soils. A GIS analysis of these conditions in the Prairie Creek/Langan Creek watershed was performed to identify where tile drainage would most likely be found. This analysis corroborated the input from the Iroquois County NRCS that the majority of the watershed is likely to have tile drains (Figure 3-2). This finding was confirmed visually during the watershed tour. Areas likely to have tile drains are also likely to be less suitable for septic systems. Development that is not serviced by sewage treatment plants (including more concentrated development in Danforth and Ashkum) is likely to be served by on-site systems.



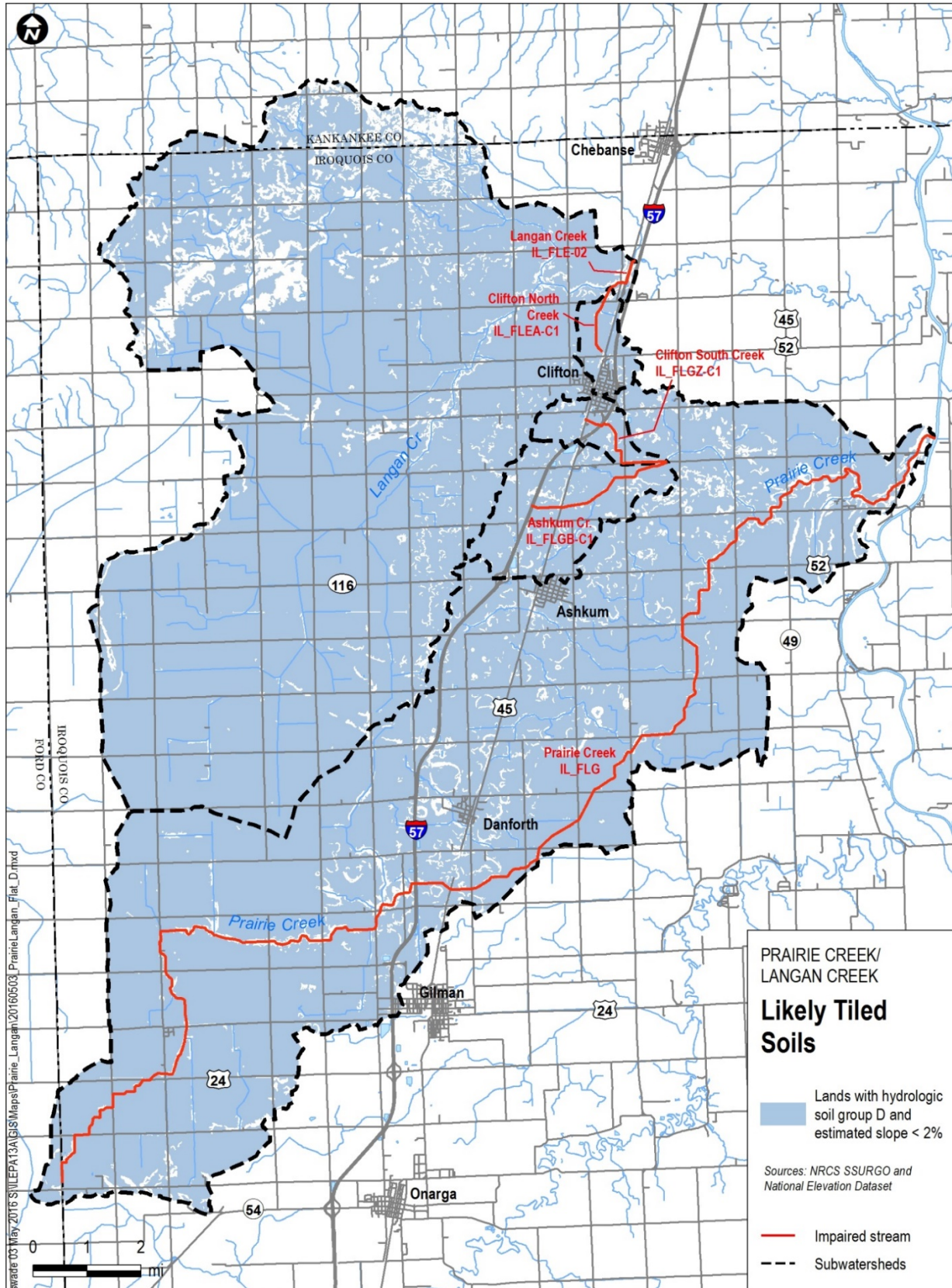


Figure 3-2. GIS Estimate of Likely Tile-Drained Land, Based on Topography and Soils



3.2.2 Livestock operations

Livestock can contribute to phosphorus loads via waste runoff. If the animals are not fenced away from waterways, they may be a direct source to the streams. Several observations of livestock farms were made during the watershed tour. According to the most recent (2012) census of agriculture (NASS, 2014), cattle farms are the most common type of livestock farm in Iroquois County, but there are more than twice as many hogs than cattle suggesting hogs are more concentrated. For load calculations, the number of animals in the Prairie Creek/Langan Creek watershed was approximated by downscaling the countywide numbers to the area of the watershed in Iroquois County. These numbers were then reviewed, and revised by the Iroquois County SWCD based on local knowledge (Table 3-3). These results indicate that livestock may generate significant phosphorus loading (141,715 lbs/yr), although the fraction that runs off into the streams is unknown. Poultry, sheep, equine and goat farms are less common in the Prairie Creek/Langan Creek watershed and there are no NPDES-permitted CAFOs in this watershed.

Table 3-3. Estimated Livestock and Poultry in the Prairie/Langan Watershed

Census Item	# of Farms	# of Animals
Cattle, incl calves - inventory	25	2,500
Hogs - inventory	7	7,858
Sheep, incl lambs - inventory	3	77
All goats	3	82
Equine	9	56
Poultry totals - hatched, measured in head	7	Not available

3.2.3 Point Source Discharges

There are five permitted dischargers in the Prairie Creek/Langan Creek watershed (Figure 3-3), none of which have permit limits or monitoring requirements for phosphorus (Table 3-4). Two of the facilities are water treatment plants (Danforth and Ashkum) which discharge filter backwash; filter backwash is not a significant contributor of phosphorus and loads from these two facilities are expected to be negligible, if not zero. Prairieview Lutheran Home and Merkle Knipprath Nursing Home are small sewage treatment facilities that are expected to have the potential to contribute phosphorus, but no effluent phosphorus data are available for either of these sources. However, the potential phosphorus contribution from these facilities is expected to be small, because the average flow for both is 0.01 MGD. The Clifton Sewage Treatment Plant (STP), which discharges to Clifton North Creek, has a higher average flow and no phosphorus monitoring or effluent limits.



Table 3-4. NPDES Discharges in the Target Watershed

NPDES ID	Facility Name	Type	Description	Permit Expiration	Subwatershed
ILG640084	Danforth WTP	Municipal	Iron filter backwash	04/30/2017	Prairie Creek / IL_FLG
ILG551007	Merkle-Knipprath Nursing Home	Private	STP outfall	06/30/2018	Ashkum Creek / IL_FLGB-C4
IL0037397	Prairieview Lutheran Home	Private	STP outfall	8/31/2018	Prairie Creek / IL_FLG
ILG640117	Ashkum WTP	Municipal	Iron filter backwash	04/30/2017	Prairie Creek / IL_FLG
IL0049573	Clifton STP	Municipal	STP outfall	01/31/2020	Clifton North Creek / IL_FLEA-C1

Because total phosphorus effluent monitoring data from the Clifton STP do not exist, the contribution from this facility to water quality is unknown. However, inspection of available in-stream phosphorus data from the Prairie Creek/Langan Creek watershed shows that phosphorus concentrations in Clifton North Creek downstream of the Clifton STP are the highest observed anywhere in the watershed (Figure 3-4).

Onsite sewage treatment systems vary greatly in the watershed. In regions outside of sewage treatment plant service areas, septic tanks, modified cisterns, aerobic treatment units, and sometimes unpermitted surface discharges are used (personal communication, Ford/Iroquois Public Health Department). Because the soils experience slow percolation, they are generally unfavorable for onsite sewage treatment. Based on a GIS analysis, there are approximately 600 homes that may be served by a private sewage disposal system in the Prairie/Langan watershed. While these systems may contribute some phosphorus to streams, the load is not believed to be significant compared to other sources.



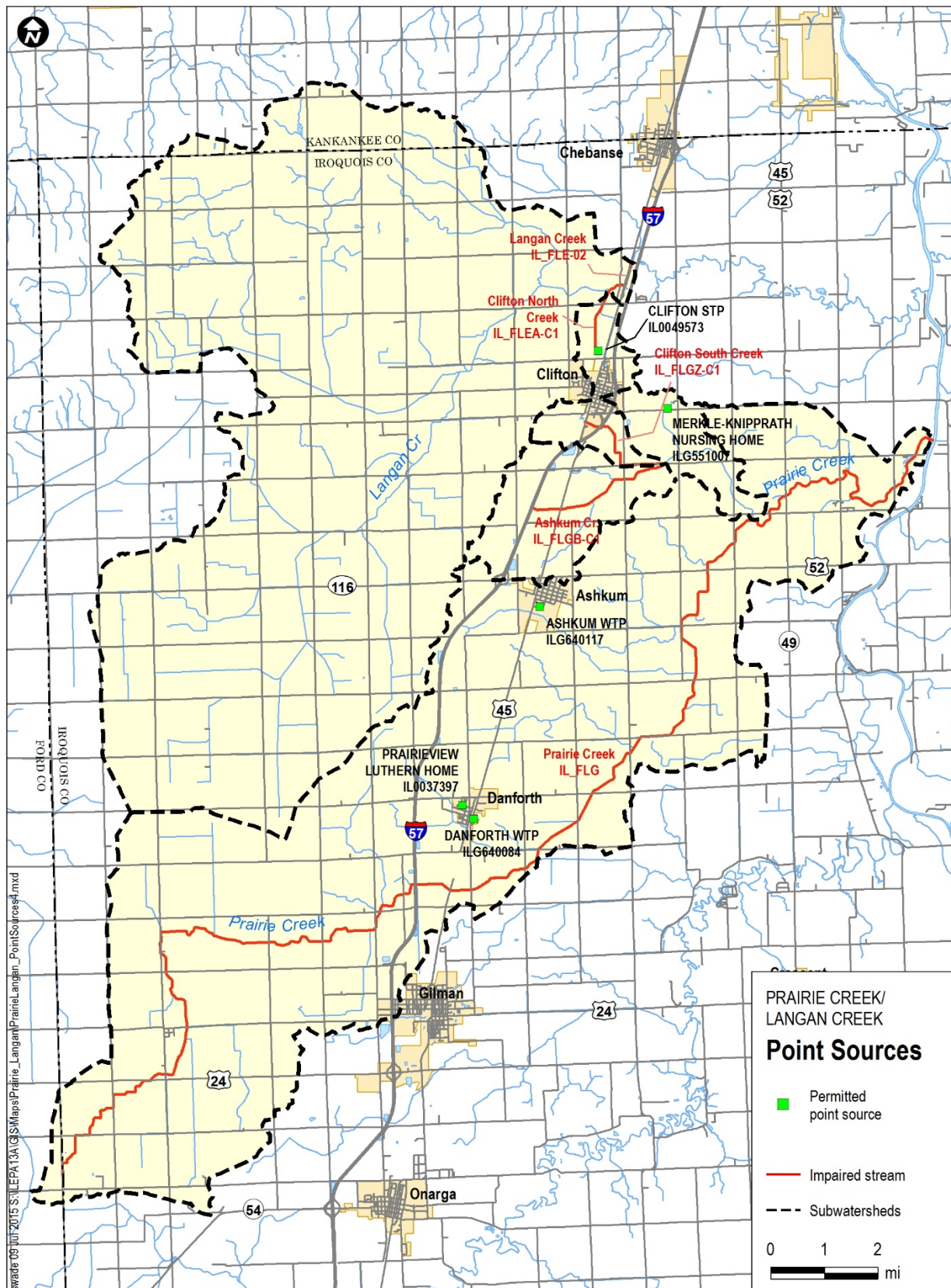


Figure 3-3. Permitted NPDES Dischargers in the Prairie Creek/Langan Creek Watershed.

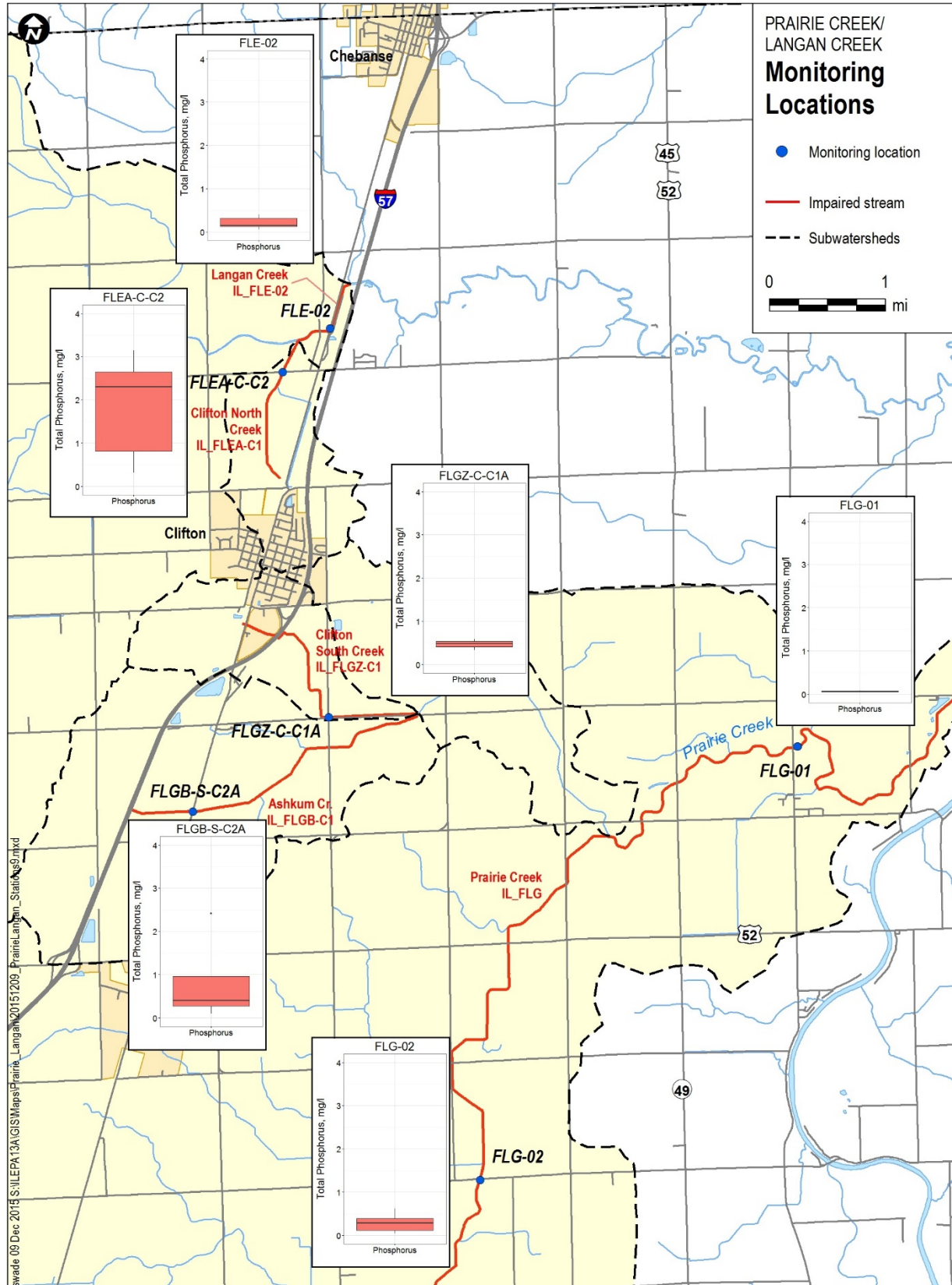


Figure 3-4. Monitoring stations in the Prairie/Langan Creek area with boxplots of available TP concentrations (2014-2015).



3.2.4 Legacy Sediments

Historical phosphorus loads to streams may accumulate in bottom sediments, and the resulting unusually high sediment phosphorus can subsequently be introduced into water over time. These areas are known as legacy sediment sources. Although no sediment data are available for the Prairie Creek/Langan Creek watershed, water quality may provide some clues as to the presence of legacy sediments. For example, significantly higher low-flow phosphorus concentrations at the Clifton North Creek sampling location (FLEA-C-C2) and Ashkum Creek sampling location (FLBG-S-C2A) may reflect legacy phosphorus loads in the sediment. Each of these is described below:

- **Clifton North Creek** – In the 1994 IEPA Facility-Related Stream Survey Report for Clifton North, an appendix to the Stage 1 report, the biologist noted that Clifton North Creek was found to have wildcat sewer discharges, substantial black sludge deposits, and very poor environmental conditions. Total phosphorus varied between 1.4 and 5.8 mg/L. Although the Clifton WWTP is now treating sewage for residents of this village, the high concentrations in this creek may reflect legacy phosphorus effects.
- **Ashkum Creek** – High phosphorus concentrations at station FLGB-S-C2A, north of the village of Ashkum, IL, may reflect legacy phosphorus loads from the Swissland Packing Company (NPDES #IL0065358) which has been closed.

Legacy phosphorus loads from the sediments in Clifton North Creek could be confirmed with sediment sampling and remediation can be pursued by dredging out the sediments. Effluent phosphorus from the Clifton STP (IL0049573) could also be sampled to rule out this facility as a contributing source. Legacy phosphorus loads from the sediments Ashkum Creek could be confirmed with sediment sampling and remediation can be pursued by dredging out the sediments.

3.2.5 Stream Erosion

Streambank erosion can sometimes contribute both sediment and sediment-attached phosphorus directly to waterways. Conditions that lead to significant streambank erosion include high gradient streams, erodible soils, steep topography and increased watershed imperviousness (leading to more “flashy” hydrography). None of these conditions exist in the Prairie Creek/Langan Creek watershed. As discussed in Section 2, streams are mostly very low gradient and the watershed is extremely flat. Nearly half the soils are classified as “low erodibility” and land use is predominantly agricultural.

During the watershed tour, most streambanks were observed to be well-vegetated with no evidence of significant bank erosion (Figure 3-5). In some cases, minor streambank erosion was observed close to bridges and is likely cause by concentrated road runoff. However, these areas were of limited extent and stream erosion is not believed to be a major contributor to water quality impairments in the Prairie Creek/Langan Creek watershed.





Figure 3-5. Examples of well vegetated, stable streambanks in the Prairie Creek/Langan Creek Watershed.

3.3 Summary of Priority Sources of Phosphorus

Based on the watershed characterization and evaluation of potential sources of phosphorus in the Prairie Creek/Langan Creek watershed, the following conclusions regarding priority sources of phosphorus are supported:

- All indications are that the primary source of phosphorus loading to streams in the watershed is agricultural runoff from cropland and livestock areas and that much of this runoff enters streams through drain tiles. This source is diffuse throughout the watershed, without specific “hot spots”, and affects all listed impaired water bodies.
- In Clifton North Creek (IL-FLEA-C1) and Ashkum Creek (IL-FLGB-C1), it is possible that legacy sediments are contributing phosphorus to the streams.
- Stream erosion is not a significant contributor of phosphorus in the Prairie Creek/Langan Creek watershed.

The controls described in subsequent sections of this implementation plan are therefore focused on reducing phosphorus from agricultural runoff, targeting the largest phosphorus source.

4 Recommended Management Measures

Recommended non-point source control measures to reduce phosphorus loading in the Prairie Creek/Langan Creek watershed are discussed in this section.

4.1 Phosphorus Load Reduction Targets

The Prairie Creek/Langan Creek Stage 3 Report (LimnoTech, 2017) presents the total phosphorus LRSs for five streams in the Prairie Creek/Langan Creek watershed. The percent reduction in phosphorus load for each segment ranges from 26% to 94% (Table 4-1). For purposes of this implementation plan, a watershed model was developed to calculate current phosphorus loads from different land uses, as well as livestock and septic systems. The resulting phosphorus loads were calculated for the entire Prairie Creek/Langan Creek watershed, and parse out phosphorus loads by source. These results were used in conjunction with LRS percent reductions to determine the actual loads that can be reduced by controls targeted at different sources. Table 4-1 presents the current average annual phosphorus load by subwatershed, the percent load reduction needed for each subwatershed and the targeted total phosphorus load reduction to be attained in each subwatershed.

Table 4-1. Total Phosphorus Load Reduction Targets by Subwatershed

Stream (Segment)	Current Average Annual Phosphorus Load (lbs/yr)	Target LRS Percent Reduction	Target Average Annual Phosphorus Load to be Reduced
Langan Creek (IL_FLE-02)	164,360	50%	82,180
Clifton N. Creek (IL_FLEA-C1)	3,009	94%	2,828
Prairie Creek (IL_FLG)	163,540	26%	42,521
Ashkum Creek (IL_FLGB-C1)	11,614	87%	10,104
Clifton S. Creek (IL_FLGZ-C1)	3,258	78%	2,541

Based on watershed modeling, non-point source phosphorus loading in the Prairie Creek/Langan Creek watershed are predominantly (97%) from agricultural land, divided between cropland and livestock operations.

Table 4-2. Total Modeled Phosphorus Loads by Source

Land Use	Annual Average Phosphorus Load (lbs)	% of Total
Non-cropland	6,144	<2%
Cropland generalized agriculture	195,095	56%
Private sewage	2,827	<1%
Livestock	141,715	41%
OVERALL	345,781	100%

* Numbers may not sum to 100% due to rounding



The non-point source control measures potentially applicable in the Prairie Creek/Langan Creek watershed, based on the non-point sources of phosphorus identified in the Section 3 of this report, are described in the following section.

4.2 Potential Management Measures

Several potential management measure exist for controlling non-point source runoff from agricultural land and the most commonly used measures in Illinois are the following:

- Conservation Tillage
- Conservation Buffers
- Cover Crops
- Treatment Wetlands
- Nutrient Management Plans
- Water and Sediment Control Basins
- Livestock Management Controls

Each of these is briefly described below.

4.2.1 Conservation Tillage

The objective of conservation tillage is to provide profitable crop production while minimizing soil erosion (Simmons and Nafziger, undated). This reduction in erosion also reduces the amount of phosphorus and TSS lost from the land and delivered to the streams. The NRCS has replaced the term conservation tillage with the term crop residue management, or the year-round management of residue to maintain the level of cover needed for adequate control of erosion. This often requires more than 30% residue cover after planting (Simmons and Nafziger, undated). Conservation tillage/crop residue management systems are recognized as a cost-effective means of significantly reducing soil erosion and maintaining productivity.

According to the NRCS, corn accounts for around 55% of the crop production in the Prairie Creek/Langan Creek watershed and soybeans account for around 43%. The remainder is made up of various less common crops such as winter wheat. Based on Illinois Department of Agriculture Soil Conservation Transect Survey Report results for 2015, approximately 30% of corn is conventionally tilled. Almost all of the soybeans have some form of conservation tillage. Conventional tillage has a higher soil loss rate than other forms of conservation tillage (Table 4-3), for both corn and soybeans. Based on the figures shown in Table 4-3, approximately 32% of cropland in corn is not currently managed using conservation tillage.

Table 4-3. Illinois Soil Conservation Transect Survey Reports for Iroquois County Corn and Soybeans (2015)

	Corn tillage		Soybean tillage	
	Percent of transects (225 total)	Average soil loss (tons/acre)	Percent of transects (219 total)	Average soil loss (tons/acre)
No Till	6.2%	0.2	39.3%	0.1
Mulch Till	30.2%	0.5	53.9%	0.3
Reduced Till	32%	1.5	6.4%	0.9
Conventional Till	31.6%	3.1	0.5%	1.7

Source: <https://www.agr.state.il.us/illinois-soil-conservation-transect-survey-reports>



The implementation of additional conservation tillage measures for corn and soybeans is expected to result in reduced phosphorus loss. In systems where surface soil test phosphorus values are within recommended ranges, researchers have found that total phosphorus export from no-till fields may be reduced up to 67% when compared to conventional tillage due to the reduction in sediment load and associated phosphorus (DeLaune & Sij, 2012). The Illinois Nutrient Loss Reduction Strategy estimates phosphorus loss is decreased by 50% if reduced tillage is applied to soils which were experiencing soil losses greater than “T”, the tolerable soil loss (IDOA and IEPA, 2015). However, fields which are losing soil in excess of “T” tend to be more sloped than the flat soils found in the study watersheds. In general, conservation tillage and no-till practices are moderate to highly effective at reducing particulate phosphorus, but exhibit low or even negative effectiveness in reducing dissolved phosphorus (NRCS, 2006). A range of estimates are available for assessing the costs of moving to a no-till system. The Illinois Nutrient Loss Reduction Strategy assigns savings of \$17/acre when moving from conventional to reduced tillage (IDOA and IEPA, 2015). The Iroquois County SWCD estimates the cost of no till and strip till to be \$33.33/acre, but do not provide costs for mulch-till. Overall, the total cost per acre for machinery and labor decreases as the amount of tillage decreases and farm size increases (Simmons and Nafziger, undated).

4.2.2 Conservation Buffers

Conservation buffers are areas or strips of land maintained in permanent vegetation to help control pollutants, generally by slowing the rate of runoff, while filtering sediment and nutrients. Additional benefits may include the creation of wildlife habitat, improved aesthetics, and potential economic benefits from marketing specialty forest crops (Trees Forever, 2005). This category of controls includes buffer strips, field borders, filter strips, vegetative barriers, riparian buffers, etc. The Iroquois County SWCD estimates the cost of critical area planting to be \$350/acre. The total cost of buffers presented in the Illinois Nutrient Loss Reduction Strategy (IDOA and IEPA, 2015), taking costs related to lost income potential, planting and maintenance is \$294/acre, possibly reflecting geographic variability in farmland value.

Based on the NHD high-resolution flowlines (streams), there are roughly 223 miles of streams in the Prairie/Langan watershed. A GIS analysis was conducted to identify stream lengths that already have some sort of buffer, and found that 22.4 miles of streams are already buffered by vegetation (grass, shrubs, trees, wetlands), indicating 201 miles of streams (90% of the stream miles in the watershed) could benefit from this control.

According to the NRCS Conservation Practice Standard for filter strips (NRCS, NHCP, 2016), the minimum flow length through the filter strip will be 20 feet for suspended solids and associated contaminants in runoff, and 30 feet for dissolved contaminants and pathogens in runoff. Calculations assume the filter strips are 30 feet wide on either side of the streams that are not already buffered. This practice standard states the drainage area immediately above the filter strips will have a slope of one percent or greater. Average slopes in each subwatershed range from 0.7 to 1.2%, indicating filter strips may be more appropriate in some areas than others, and that field investigations could be conducted to identify the most suitable locations.

Filter strips and similar vegetative control methods can be very effective in reducing nutrient transport. According to the Illinois Nutrient Loss Reduction Strategy (IDOA and IEPA, 2015), the total phosphorus reduction per acre for buffers on cropland ranges from 25 to 50%, with a median removal rate of 37.5%.

The Conservation Practices Cost-Share Program (CPP), part of the Illinois Partners for Conservation Fund, provides cost sharing for conservation practices including field borders and filter strips⁵. The

⁵ <http://www.agr.state.il.us/C2000>



Department of Agriculture distributes funding for the cost-share program to Illinois' Soil and Water Conservation Districts (SWCDs), which prioritize and select projects. The Illinois Buffer Partnership offers cost sharing for installation of streamside buffer plantings at selected sites. An additional program that may be of interest is the Visual Investments to Enhance Watersheds (VIEW), which involves a landscape design consultant in the assessment and design of targeted BMPs within a watershed. Sponsored by Trees Forever⁶, VIEW guides a committee of local stakeholders through a watershed landscape planning process. Additional funding for conservation buffers may be available through other sources such as the Conservation Reserve Program.

4.2.3 Cover Crops

Cover crops are grasses, legumes, rye or forbs that are planted seasonally to cover soil when it would usually be bare (Miller et al., 2012; IDOA and IEPA, 2015). While these crops are not usually sold or utilized agronomically, they have other benefits which make them useful to producers. Cover crops are planted for a variety of purposes including erosion reduction from wind and water, increasing soil organic matter and capturing, recycling, or redistributing excess soil nutrients. Cover crops can benefit water quality through three pathways – by increasing the soil's ability to infiltrate rainfall, by scavenging and taking up nutrients, and by intercepting raindrop impact in order to reduce soil crusting and erosion (Miller et al., 2012).

Cover crops effectively reduce both nitrate-nitrogen and total phosphorus losses while also improving soil tilth and other important properties (IDOA and IEPA, 2015). The Iroquois County SWCD estimates the cost of cover crops to be \$66.66/acre. The Illinois Nutrient Loss Reduction Strategy indicates cover crops can reduce total phosphorus by 30% per acre (IDOA and IEPA, 2015). According to IDOA and IEPA, 2015, cover crops may introduce additional management challenges, particularly in adverse years. Establishing cover crops may be difficult in years with dry summers and falls. Cover crop planting and termination operations may also introduce logistical issues on farms.). Landowners and producers in the watershed are encouraged to work with their local agronomist, certified crop advisor, or seed retailer to determine the type of cover crops that would best suit their soil types and cropping operations.

4.2.4 Treatment Wetlands

Soils in the Prairie Creek/Langan Creek watershed are poorly drained and, as previously discussed, drainage has likely been enhanced using tile drains in much of the watershed. The exact areas with tile drains is unknown, but a GIS analysis indicates almost the entire watershed is likely to have poorly drained soils with low slopes (<2%), indicating tile drains are likely prevalent. Site visit observations confirm the prevalence of tile drains in the watershed.

Treatment wetlands have been shown to be effective at reducing phosphorus from tile drain flow, if they are properly sited and sized. A pilot study on an experimental farm indicates that treatment wetlands that intercepted tile drains removed approximately 47-57 percent of the total phosphorus from water (IDOA and IEPA, 2015).

According to IDOA and IEPA (2015), the reduction practice is the construction of 5 acres of wetland for every 100 acres of production, and costs are \$60.63/acre/yr if a wetland is assumed to provide treatment for 20 years, the farmland taken out of production is charged against the remaining cropland, and \$3 per acre yearly maintenance cost. Using the reported total costs (IDOA & IEPA, 2015), inclusive of the per acre purchase price, and dividing the total out over 20 years produces annual costs of \$683/acre. Of note, this practice represents a large decrease in income-generating potential if the acreage taken out of cropland was agronomically productive ground.

⁶ http://www.treesforever.org/Illinois_Buffer_Partnership



4.2.5 Nutrient Management Plans

Nutrient management plans are designed to minimize nutrient losses from agricultural lands and improve nutrient use efficiency of the crop, and therefore minimize the amount of phosphorus transported to waterbodies. Because agriculture is the most common land use in the watershed (roughly 90%), controls focused on reducing phosphorus loads from these areas are expected to help reduce phosphorus loads delivered to the streams. The focus of a nutrient management plan is to increase the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface and ground waters (USEPA, 2003).

Nutrient management is defined as managing the amount, source, placement, form, and timing of plant nutrients and soil amendments (NRCS Illinois, 2002). The 4R Concept for nutrient stewardship summarizes this as the Right fertilizer source at the Right rate, at the Right time and in the Right place <http://www.nutrientstewardship.com/4rs/>. The NRCS Practice Standard for nutrient management notes that this practice applies on all lands where plant nutrients and soil amendments are applied. Additional details regarding nutrient management are provided in the NRCS Illinois Practice Standard (NRCS Illinois, 2013 and chapter 8 of the Illinois Agronomy Handbook (Fernandez and Hoeft, undated), and two example practices are described below.

- Site-specific or variable-rate nutrient application: “This application method uses several remote sensing technologies, yield monitors, global positioning systems, geographical information systems, and variable-rate technology (VRT). These technologies can improve the efficacy of fertilization and promote more environmentally sound placement of fertilizer compared to single-rate applications derived from the conventional practice of collecting a composite soil sample to represent a large area of the field. Research has shown that this technology often reduces the amount of fertilizer applied over an entire field. However, one of the drawbacks of this placement method is the expense associated with these technologies. Also, VRT can only be as accurate as the soil test information used to guide the application rate” (Fernandez and Hoeft, undated).
- Deep fertilizer placement: “With this system any combination of N, P, and K can be injected at a depth of 4 to 8 inches. The knife spacing varies, but generally it is 15 to 18 inches apart for close-grown crops such as wheat and 30 inches for row crops. (Fernandez and Hoeft, undated). This practice may be beneficial (as long as the subsurface band application does not create a channel for water and soil movement) in areas where the potential for surface water runoff is high.

The Illinois Agronomy Handbook (Fernandez and Hoeft, undated) gives a broad overview of phosphorus recommendations in Chapter 8. For producers in Iroquois County, it is important to keep in mind that they are in a region of “low” available subsoil phosphorus. This means it is recommended that soil test values be built up to 50 pounds per acre (measured by Bray P_i) to ensure corn and soybean crop yields will not be restricted by phosphorus availability (Fernandez and Hoeft, undated). Soils testing between 50 and 70 pounds per acre should have fertilizer applied only in the amount of expected removal of the current crop while soils showing greater than 70 pounds per acre of phosphorus will experience no agronomic advantage in additional application (Fernandez and Hoeft, undated).

Nutrient management is generally effective, but for phosphorus, most fertilizer is applied to the surface of the soil where it is subject to transport (NRCS, 2006). Tillage will incorporate this surface-applied fertilizer; however a no-till system will leave the phosphorus on the surface. In an extensively cropped watershed, the loss of even a small fraction of the fertilizer-applied phosphorus can have a significant impact on water quality. It is recommended that nutrient management plans be developed and implemented based on soil testing conducted at least every four years and applied to all cropland acres in the watershed.



According to the Iroquois County SWCD, the cost of developing (\$4/acre) and implementing (\$12/acre) a nutrient management plan totals \$16/acre. This cost may be offset in part by savings associated with using less fertilizer. For example, a study in Iowa showed that improved nutrient management on cornfields led to a savings of about \$5/acre (EPA, 2003).

Phosphorus rate reduction resulting from implementation of nutrient management plans was estimated to reduce TP export by 7%. This estimate was provided by the Illinois Nutrient Loss Reduction Strategy (IDOA and IEPA, 2015).

4.2.6 Water and Sediment Control Basins

A water and sediment control basin (WASCOB) is an earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet (NRCS, 2008). This practice may be applied to reduce watercourse and gully erosion, to trap sediment or reduce and manage onsite and downstream runoff. These structures must include an adequate outlet which will allow the runoff to be conveyed downstream to a point where it cannot cause erosion or damage. Since runoff water is restricted and released slowly, sedimentation can occur. This not only reduces transported sediment, but also the transport of sediment-bound phosphorus into the waterways. Modeling results indicate this practice can reduce sediment-P by 74-80% (Miller et al., 2012).

The Iroquois County SWCD has identified 1,500 feet of Langan Creek suitable for water and sediment control basins at a cost of \$5,000. If implemented, this control has the potential to remove 74-80% of incoming, sediment-bound phosphorus. The location of this control is not available and the contributing area and associated load could not be calculated.

4.2.7 Livestock Management Controls

BMPs to prevent livestock pollution include activities on the grounds to manage manure and reduce runoff and the proper siting, construction and management of lagoons, settling basins and holding ponds, to reduce groundwater and surface water impacts. Land application of manure can be environmentally beneficial, and a few examples of land application BMPs to reduce nutrient runoff include: development of a manure management plan, scheduling application times that are compatible with crop rotations, having sufficient land available to land apply, locating land application sites away from valleys, and applying manure on fields that are not highly erodible. Many more examples can be found on line⁷. In addition to manure management and runoff reduction from livestock areas, the appropriate management of pasture or grazing-based livestock production can minimize nutrient losses by eliminating uncontrolled livestock access to streams, providing shade and water sources away from streams, and maintaining healthy grass stands that reduce runoff (IDOA and IEPA, 2015).

4.3 Management Measures Already in Place or Planned

Information about existing and planned management measures to control non-point source runoff from agricultural land in the Prairie Creek/Langan Creek watershed was obtained from the NRCS and the Iroquois County SWCD. It is important to note that these agencies prefer not to share the location of planned and implemented management measures on a property-scale, therefore they can only be identified at the subwatershed or watershed scale. Identified in-place and planned management measures for the Prairie Creek/Langan Creek watershed are as follows:

⁷ <http://www.epa.illinois.gov/topics/pollution-prevention/fact-sheets/bmp-pork/index> and <http://web.extension.illinois.edu/sfmm/beef.cfm>



- According to the Illinois Department of Agriculture, approximately 68% of croplands used for corn and soybean production in the Prairie Creek/Langan Creek watershed are managed using some form of conservation tillage.
- The Iroquois County SWCD has identified 1,500 feet of Langan Creek suitable for water and sediment control basins.
- As described above, approximately 10% of streams in the watershed currently have buffers.

A summary of site-specific practices that could be implemented in the watershed was identified by the SWCD by HUC (Table 4-4). The exact location of these practices within each HUC was not provided.

Table 4-4. Site-Specific Practices by HUC, Identified by Iroquois County SWCD

HUC	Practice	Cost estimate	Acres	Feet
71200020902	Grassed Waterway	\$21,729	3.8	
71200020902	Rock chute structure	\$13,000	0.2	
71200020901	Grassed Waterway	\$10,800	1.9	
71200021202	Grassed Waterway	\$12,800	2.2	
71200021202	Grassed Waterway	\$6,650	1.1	
71200021202	Water and Sediment Control Basins (WASCOBS)	\$5,000		1500
71200020902	Grassed Waterway	\$26,800	4.6	
71200021202	Grassed Waterway	\$4,680	0.8	
71200021201	Grassed Waterway w/Drop Pipe Structure	\$11,402	1.5	
71200021202	Aluminum toewall structure	\$12,900	0.2	

4.4 Recommended Management Measures by Subwatershed

Based on the preceding information, recommended non-point source management measures to reduce phosphorus loading in the Prairie Creek/Langan Creek watershed are discussed in the following sections, by subwatershed.

4.4.1 Langan Creek (IL_FLE-02)

The Langan Creek subwatershed covers approximately 52,751 acres and has an average annual phosphorus load reduction target of 50% (82,180 lbs/yr). Land use in the Langan Creek subwatershed is mostly (48,450 acres or 92%) agricultural land (Figure 4-1).



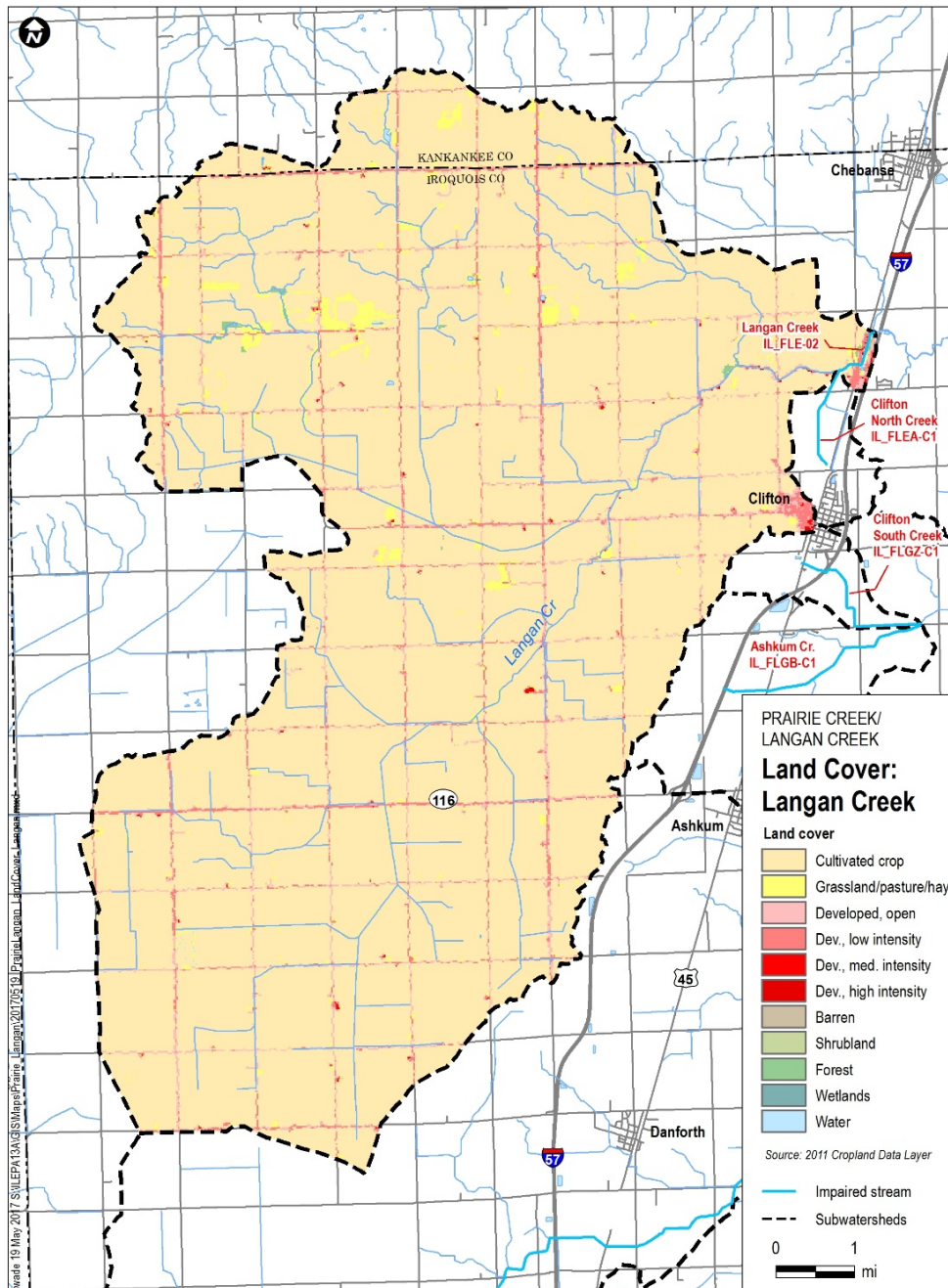


Figure 4-1. Land Cover in the Langan Creek Subwatershed.

The non-point source phosphorus load reduction target for the Langan Creek subwatershed is 50%, which is somewhat higher than the statewide target of 40% set forth in the Illinois Nutrient Loss Reduction Strategy. This load reduction target will require aggressive implementation of management measures, including the following:

- **Conservation Tillage** – Because conservation tillage is already a common practice, relatively easy to implement, does not affect the quantity of productive land and has a relatively high typical phosphorus removal rate (67%), it is the primary recommended measure. If conservation tillage

can be implemented on the 32% of agricultural land that is currently not managed using conservation tillage, approximately 21% of the phosphorus load can be controlled.

- **Conservation Buffers** – Based on the spatial analysis described above, only about 10% of streams in the Langan Creek subwatershed are currently buffered. Assuming that conservation buffers control runoff from land within an eighth of a mile of the stream, each mile of buffer can control runoff from 80 acres of land. Adding conservation buffers on half of the currently unbuffered stream would add buffers to 52 miles of stream, controlling about 17% of agricultural land. With a buffer width of 30 feet on each side of the stream, this would take 218 acres of land out of production for buffers. At a median removal effectiveness of 37.5%, this would reduce phosphorus loading in the Langan Creek subwatershed by about an additional 6%.
- **Cover Crops** – The quantity of land in the Langan subwatershed managed using cover crops is assumed to be 5% based on input from the Iroquois County SWCD. If cover crops are added to the management of the remaining 95% of agricultural land, with an estimated phosphorus reduction rate of 30%, phosphorus load from these lands can be reduced another 28%.
- **Nutrient Management Plans** – As described in Section 4.2.5, nutrient management plans are estimated to be 7% effective at phosphorus reduction. If implemented everywhere in the Langan Creek subwatershed, they would reduce total phosphorus loading by 7%.

Combined, the management measures described above would provide a total load reduction of 62% (101,903 lbs/yr), slightly more than the target 50%. Because the management measures would not all work independently, as some would function in series, the levels of implementation exceeding target removal are appropriate. Based on the discussion above, the recommend management measures for the Langan subwatershed are summarized in Table 4-5.

Table 4-5. Recommended Management Measures for the Langan Creek Subwatershed

Management Measure	Percent of P Load Controlled
Conservation Tillage	21%
Conservation Buffers	6%
Cover Crops	28%
Nutrient Management Plans	7%

4.4.2 Clifton N. Creek (IL_FLEA-C1)

The Clifton North Creek subwatershed covers approximately 966 acres and has an average annual phosphorus load reduction target of 90% (3,216 lbs/yr). Land use in the Clifton North Creek subwatershed is mostly (672 acres or 70%) agricultural land (Figure 4-2).



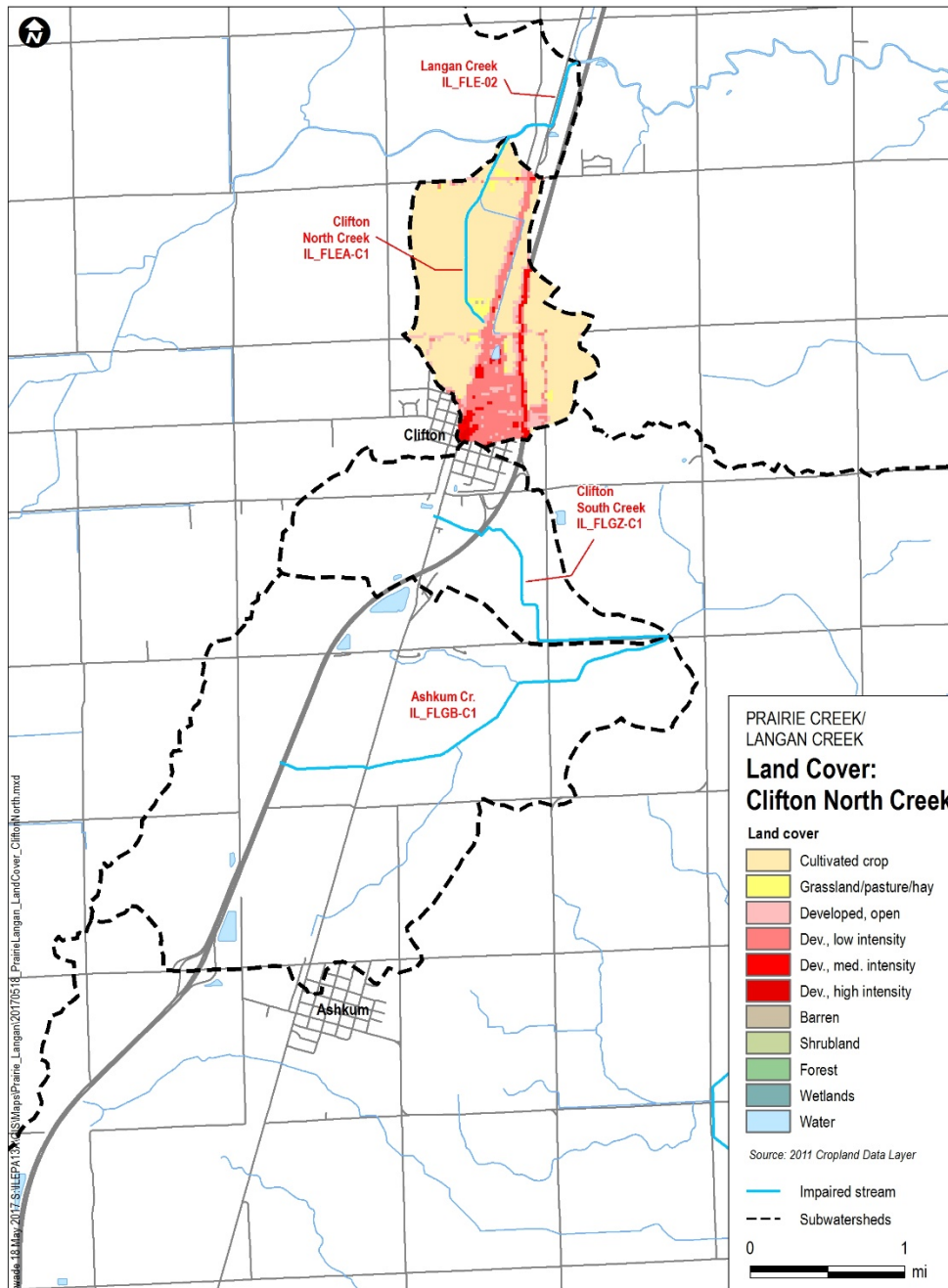


Figure 4-2. Land Cover in the Clifton North Creek Subwatershed.

The non-point source phosphorus load reduction target for the Clifton North Creek subwatershed is 94%, which is more than double the statewide target set forth in the Illinois Nutrient Loss Reduction Strategy. Such an extremely high load reduction target will require extensive implementation of management measures. Given this aggressively high target, the recommended non-point source management measures in the Clifton North Creek subwatershed include the following:

- **Conservation Tillage** – Because conservation tillage is already a common practice, relatively easy to implement, does not affect the quantity of productive land and has a relatively high typical phosphorus removal rate (67%), it is the primary recommended measure. If conservation tillage



can be implemented on the 32% of agricultural land that is currently not managed using conservation tillage, approximately 21% of the phosphorus load can be controlled.

- **Conservation Buffers** – Based on the spatial analysis described above, only about 8% of streams in the Clifton North Creek subwatershed are currently buffered. Assuming that conservation buffers control runoff from land within an eighth of a mile of the stream, each mile of buffer can control runoff from 80 acres of land. Adding conservation buffers on all of the currently unbuffered stream would add buffers to 2.3 miles of stream, controlling about 54% of agricultural land. With a buffer width of 30 feet on each side of the stream, this would take 16.7 acres of land out of production for buffers. At a median removal effectiveness of 37.5%, this would reduce phosphorus loading in the Clifton North Creek subwatershed by about 20%.
- **Cover Crops** – The quantity of land in the Clifton North subwatershed managed using cover crops is assumed to be 5%, based on input from the Iroquois Count SWCD. If cover crops are added to the management of the remaining 95% of agricultural land, with an estimated phosphorus reduction rate of 30%, phosphorus load from these lands can be reduced another 28%.
- **Nutrient Management Plans** – As described in Section 4.2.5, nutrient management plans are estimated to be 7% effective at phosphorus reduction. If implemented everywhere in the Clifton North Creek subwatershed, they would reduce total phosphorus loading by 7%.
- **Treatment Wetlands** – If the four common management measures described above are implemented in the Clifton North Creek subwatershed, at the aggressive levels of implementation described, their combined, estimated phosphorus load reduction will be 76%, which would fall short of the 94% target by 18%. This remaining load would have to be controlled by other means and of the measures described here, the most effective would be treatment wetlands, which are estimated to have a median phosphorus removal effectiveness of 52%. To achieve the additional 18% phosphorus reduction, treatment wetlands will be needed for treat of runoff from 35% of agricultural land in the subwatershed.

Based on the discussion above, the recommend management measures for the Clifton North Creek subwatershed are summarized in Table 4-6. If fully implemented, these measures would result in a 94% phosphorus load reduction (2,828 lbs/yr).

Table 4-6. Recommended Management Measures for the Clifton North Creek Subwatershed

Management Measure	Percent of P Load Controlled
Conservation Tillage	21%
Conservation Buffers	20%
Cover Crops	28%
Nutrient Management Plans	7%
Treatment Wetlands	18%

4.4.3 Prairie Creek (IL_FLG)

The Prairie Creek subwatershed covers approximately 52,751 acres and has an average annual phosphorus load reduction target of 26% (42,521 lbs/yr). Land use in the Prairie Creek subwatershed is mostly (47,268 acres or 90%) agricultural land (Figure 4-3).



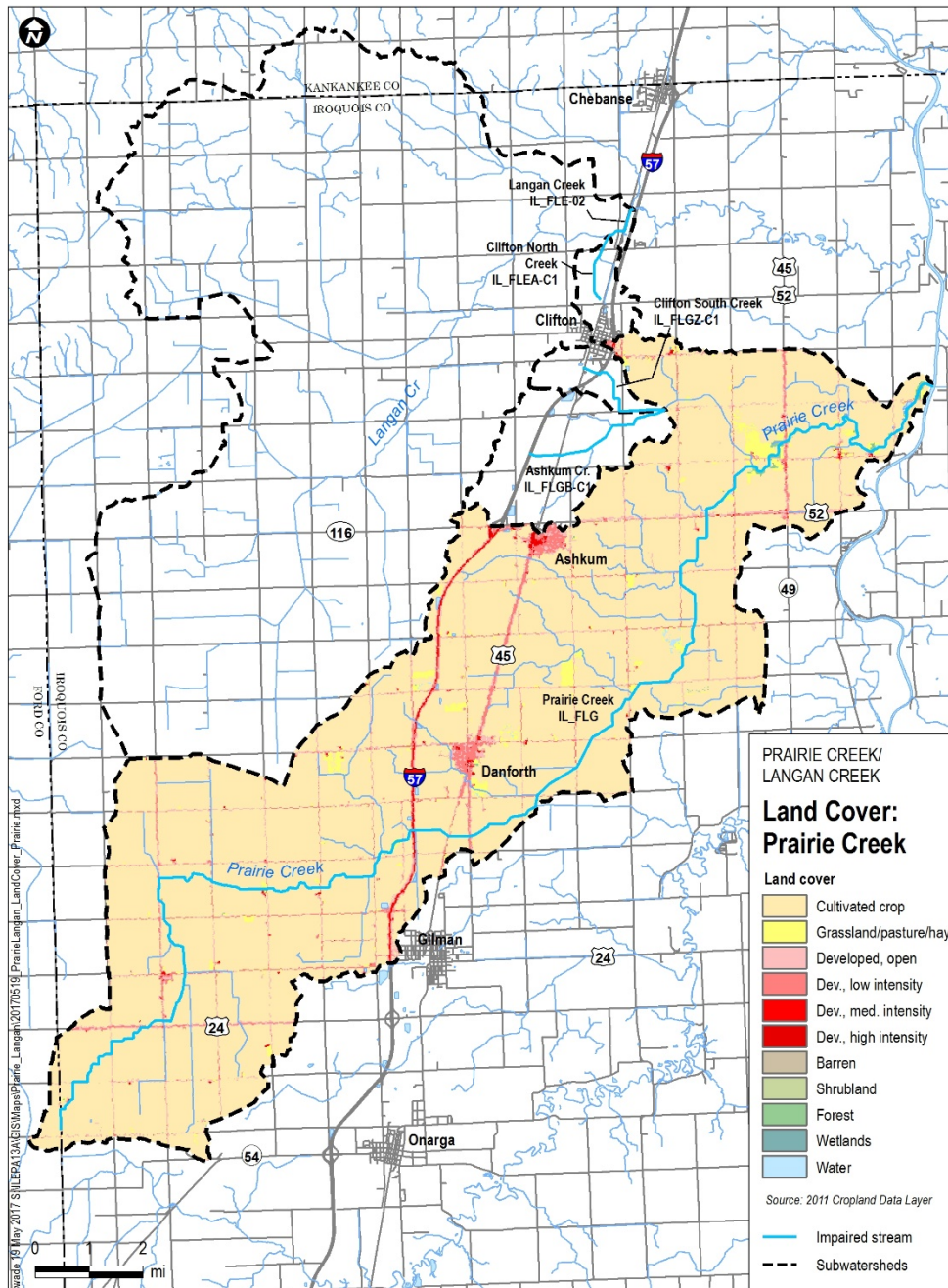


Figure 4-3. Land Cover in the Prairie Creek Subwatershed.

The non-point source phosphorus load reduction target for the Prairie Creek subwatershed is 26%, which is significantly less than the statewide target of 40% set forth in the Illinois Nutrient Loss Reduction Strategy. This load reduction target will require aggressive implementation of management measures, including the following:

- **Conservation Tillage** – Because conservation tillage is already a common practice, relatively easy to implement, does not affect the quantity of productive land and has a relatively high typical phosphorus removal rate (67%), it is the primary recommended measure. If conservation tillage

can be implemented on the 32% of agricultural land that is currently not managed using conservation tillage, approximately 21% of the phosphorus load can be controlled.

- **Conservation Buffers** – Based on the spatial analysis described above, only about 10% of streams in the Prairie Creek subwatershed are currently buffered. Assuming that conservation buffers control runoff from land within an eighth of a mile of the stream, each mile of buffer can control runoff from 80 acres of land. Adding conservation buffers on half of the currently unbuffered stream would add buffers to 44 miles of stream, controlling about 15% of agricultural land. With a buffer width of 30 feet on each side of the stream, this would take 320 acres of land out of production for buffers. At a median removal effectiveness of 37.5%, this would reduce phosphorus loading in the Prairie Creek subwatershed by approximately 6%.

Combined, the management measures described above would provide a total load reduction of 27% (44,156 lbs/yr), which slightly exceeds the target 26%. Because the management measures would not all work independently, as some would function in series, the levels of implementation exceeding target removal are appropriate. Based on the discussion above, the recommend management measures for the Prairie Creek subwatershed are summarized in Table 4-7.

Table 4-7. Recommended Management Measures for the Prairie Creek Subwatershed.

Management Measure	Percent of P Load Controlled
Conservation Tillage	21%
Conservation Buffers	6%

4.4.4 Ashkum Creek (IL_FLGB-C1)

The Ashkum Creek subwatershed covers approximately 3,728 acres and has an average annual phosphorus load reduction target of 87% (10,104 lbs/yr). Land use in the Ashkum Creek subwatershed is mostly (3,210 acres or 86%) agricultural land (Figure 4-4).



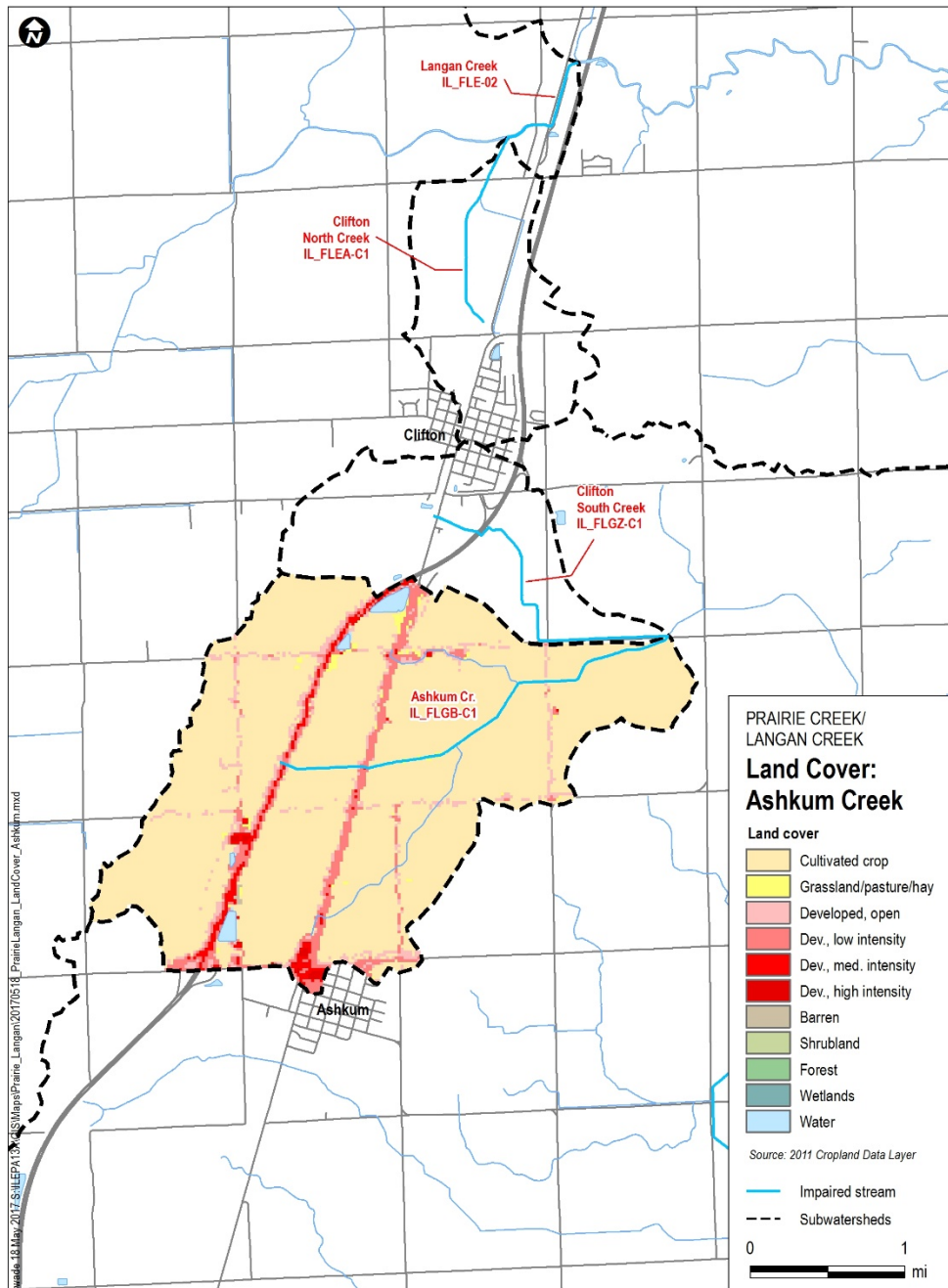


Figure 4-4. Land Cover in the Ashkum Creek Subwatershed.

The non-point source phosphorus load reduction target for the Ashkum Creek subwatershed is 87%, which is more than twice the statewide target of 40% set forth in the Illinois Nutrient Loss Reduction Strategy. This load reduction target will require aggressive implementation of management measures, including the following:

- **Conservation Tillage** – Because conservation tillage is already a common practice, relatively easy to implement, does not affect the quantity of productive land and has a relatively high typical phosphorus removal rate (67%), it is the primary recommended measure. If conservation tillage

can be implemented on the 32% of agricultural land that is currently not managed using conservation tillage, approximately 21% of the phosphorus load can be controlled.

- **Conservation Buffers** – Based on the spatial analysis described above, only about 4% of streams in the Ashkum Creek subwatershed are currently buffered. Assuming that conservation buffers control runoff from land within an eighth of a mile of the stream, each mile of buffer can control runoff from 80 acres of land. Adding conservation buffers on all of the currently unbuffered stream would add buffers to 5.4 miles of stream, controlling about 27% of agricultural land. With a buffer width of 30 feet on each side of the stream, this would take 39 acres of land out of production for buffers. At a median removal effectiveness of 37.5%, this would reduce phosphorus loading in the Ashkum Creek subwatershed by approximately 10%.
- **Cover Crops** – The quantity of land in the Ashkum Creek subwatershed managed using cover crops is assumed to be 5% based on input from the Iroquois SWCD. If cover crops are added to the management of the remaining 95% of agricultural land, with an estimated phosphorus reduction rate of 30%, phosphorus load from these lands can be reduced another 28%.
- **Nutrient Management Plans** – As described in Section 4.2.5, nutrient management plans are estimated to be 7% effective at phosphorus reduction. If implemented everywhere in the Ashkum Creek subwatershed, they would reduce total phosphorus loading by 7%.
- **Treatment Wetlands** – If the four common management measures described above are implemented in the Ashkum Creek subwatershed, at the aggressive levels of implementation described, their combined, estimated phosphorus load reduction will be 66%, which would fall short of the 87% target by 21%. This remaining load would have to be controlled by other means and of the measures described here, the most effective would be treatment wetlands, which are estimated to have a median phosphorus removal effectiveness of 52%. To achieve the additional 21% phosphorus reduction, treatment wetlands will be needed for treat of runoff from 40% of agricultural land in the subwatershed.

Based on the discussion above, the recommend management measures for the Ashkum Creek subwatershed are summarized in Table 4-8. If fully implemented, these measures would results in an 87% phosphorus load reduction (10,104 lbs/yr).

Table 4-8. Recommended Management Measures for the Ashkum Creek Subwatershed.

Management Measure	Percent of P Load Controlled
Conservation Tillage	21%
Conservation Buffers	20%
Cover Crops	28%
Nutrient Management Plans	7%
Treatment Wetlands	21%

4.4.5 Clifton S. Creek (IL_FLGZ-C1)

The Clifton South Creek subwatershed covers approximately 1,045 acres and has an average annual phosphorus load reduction target of 78% (2,541 lbs/yr). Land use in the Clifton South Creek subwatershed is mostly (811 acres or 78%) agricultural land (Figure 4-5).



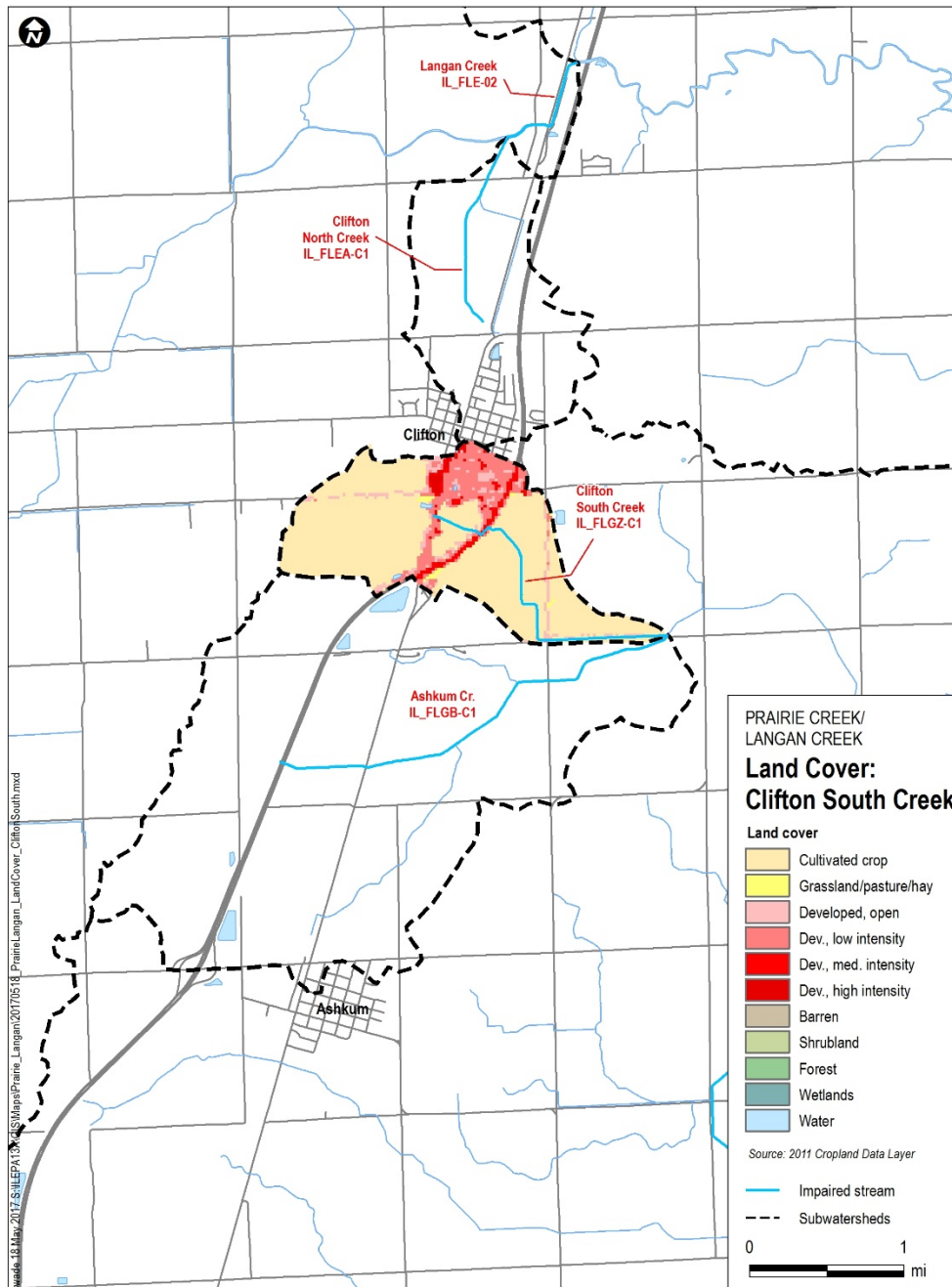


Figure 4-5. Land Cover in the Prairie Creek Subwatershed.

The non-point source phosphorus load reduction target for the Clifton South Creek subwatershed is 78%, which is nearly twice the statewide target of 40% set forth in the Illinois Nutrient Loss Reduction Strategy. This load reduction target will require aggressive implementation of management measures, including the following:

- **Conservation Tillage** – Because conservation tillage is already a common practice, relatively easy to implement, does not affect the quantity of productive land and has a relatively high typical phosphorus removal rate (67%), it is the primary recommended measure. If conservation tillage

can be implemented on the 32% of agricultural land that is currently not managed using conservation tillage, approximately 21% of the phosphorus load can be controlled.

- **Conservation Buffers** – Based on the spatial analysis described above, only about 3% of streams in the Clifton South Creek subwatershed are currently buffered. Assuming that conservation buffers control runoff from land within an eighth of a mile of the stream, each mile of buffer can control runoff from 80 acres of land. Adding conservation buffers on all of the currently unbuffered stream would add buffers to 2.1 miles of stream, controlling about 42% of agricultural land. With a buffer width of 30 feet on each side of the stream, this would take 15 acres of land out of production for buffers. At a median removal effectiveness of 37.5%, this would reduce phosphorus loading in the Clifton South Creek subwatershed by approximately 16%.
- **Cover Crops** – The quantity of land in the Clifton South subwatershed managed using cover crops is not known, but is assumed to be 5% based on input from the Iroquois County SWCD. If cover crops are added to the management of the remaining 95% of agricultural land, with an estimated phosphorus reduction rate of 30%, phosphorus load from these lands can be reduced another 28%.
- **Nutrient Management Plans** – As described in Section 4.2.5, nutrient management plans are estimated to be 7% effective at phosphorus reduction. If implemented everywhere in the Clifton South Creek subwatershed, they would reduce total phosphorus loading by 7%.
- **Treatment Wetlands** – If the four common management measures described above are implemented in the Clifton South Creek subwatershed, at the aggressive levels of implementation described, their combined, estimated phosphorus load reduction will be 72%, which would fall short of the 78% target by 6%. This remaining load would have to be controlled by other means and of the measures described here, the most effective would be treatment wetlands, which are estimated to have a median phosphorus removal effectiveness of 52%. To achieve the additional 6% phosphorus reduction, treatment wetlands will be needed for treat of runoff from 11.5% of agricultural land in the subwatershed.

Based on the discussion above, the recommend management measures for the Clifton South Creek subwatershed are summarized in Table 4-9. If fully implemented, these measures would results in a 78% phosphorus load reduction (2,541 lbs/yr).

Table 4-9. Recommended Management Measures for the Clifton South Creek Subwatershed.

Management Measure	Percent of P Load Controlled
Conservation Tillage	21%
Conservation Buffers	16%
Cover Crops	28%
Nutrient Management Plans	7%
Treatment Wetlands	6%

4.5 Summary of Recommended Non-Point Source Management Measures

Based on the preceding discussion, extensive implementation of non-point source management measures are needed to achieve the target phosphorus load reductions for the Prairie Creek/Langan Creek watershed. These management measures are summarized by subwatershed in Table 4-10, along with quantities required for each management measure.



Table 4-10. Summary of Management Measures Recommended for the Prairie Creek/Langan Creek Watershed to Achieve Phosphorus Load Reduction Targets.

Subwatershed	Management Measures				
	Conservation Tillage (acres)	Conservation Buffer (stream miles)	Cover Crops (acres)	Nutrient Management Plans (acres)	Constructed Wetlands ⁸ (acres)
Langan Creek	15,504	52	46,027	48,450	-
Clifton North Creek	215	2.3	638	672	10
Prairie Creek	15,126	44	-	-	-
Ashkum Creek	1,027	5.4	3,050	3,210	65
Clifton South Creek	259	2.1	770	811	5

4.6 Estimated Cost of Recommended Management Measures

The overall capital cost of implementing the recommended non-point source management measures in the Prairie Creek/Langan Creek watershed were estimated on a unit cost basis. Unit costs for on-field or edge-of-field measures were obtained from the Iroquois County SWCD, where available, and are used in this plan. Unit costs for constructed wetlands were obtained from the Illinois Nutrient Loss Reduction Strategy:

- **Conservation Tillage** – The estimated cost of no till and strip till is \$33.33/acre, but the Iroquois County SWCD could not provide costs for mulch-till. The unit cost of \$33.33/acre is used in this plan.
- **Conservation Buffers** – The estimated cost of critical area planting from the Iroquois County SWCD is \$350/acre. The total cost of buffers presented in the Illinois Nutrient Loss Reduction Strategy (IDOA and IEPA, 2015), taking costs related to lost income potential, planting and maintenance is \$294/acre, possibly reflecting geographic variability in farmland value. For purposes of this plan, the higher value of \$350/acre is used.
- **Cover Crops** – The estimated the cost of cover crops to be \$66.66/acre.
- **Nutrient Management Plans** – According to the Iroquois County SWCD, the cost of developing (\$4/acre) and implementing (\$12/acre) a nutrient management plan totals \$16/acre.
- **Constructed Wetlands** – According to 2015 Illinois Nutrient Loss Reduction Strategy, constructed wetlands cost \$60.63/acre/yr. If a wetland is assumed to provide treatment for 20 years, the farmland taken out of production is charged against the remaining cropland, and \$3 per acre yearly maintenance cost. Using the reported total costs, inclusive of the per acre purchase price, and dividing the total out over 20 years produces annual costs of \$683/acre.

Using these unit costs, the total cost for implementation of recommended management measures can be estimated, as summarized in Table 4-11.

⁸ It is assumed that 5 acres of constructed wetland will be required for every 100 acres of agricultural land from which runoff/tile drainage is captured. Wetland areas rounded up to the nearest acre.



Table 4-11. Estimated Cost of Management Measures Recommended for the Prairie Creek/Langan Creek Watershed to Achieve Phosphorus Load Reduction Targets (assumes 20 years of implementation).

Control	Unit Cost (per acre)	Prairie Creek & Tributaries			Langan Creek & Tributaries	
		Ashkum Creek (IL_FLGB-C1)	Clifton South (IL_FLGZ-C1)	Prairie Creek (IL_FLG)	Clifton North Creek (IL_FLEA-C1)	Langan Creek (IL_FLE-02)
Nutrient Management Plans	\$16/acre /year	\$1,027,200	\$259,520	-	\$215,040	\$15,504,000
Conservation Tillage	\$33.33/acre /year	\$684,600	\$172,640	\$10,083,000	\$143,320	\$10,334,960
Conservation Buffers	\$350/acre	\$8,018	\$3,118	\$65,333	\$3,415	\$77,212
Cover Crops	\$66.66/acre /year	\$4,066,260	\$1,026,564	-	\$850,582	\$61,363,196
Treatment wetlands	\$683/acre	\$44,395	\$3,415	-	\$6,830	-
Total per Subwatershed		\$5,830,473	\$1,465,257	\$10,148,333	\$1,219,187	\$87,279,368

Based on these subwatershed estimates, the total estimated cost for implementing recommended management measures in the Prairie Creek/Langan Creek watershed is \$105,942,618 over 20 years.

4.7 Prioritization of Management Measures by Subwatershed

The available in-stream phosphorus data clearly show that total phosphorus concentrations in Clifton North Creek are significantly higher than concentrations observed elsewhere. Because of this, it is recommended that early action focus on the Clifton North Creek subwatershed. Conversely, Prairie Creek had the lowest median phosphorus concentration; therefore it is recommended that Prairie Creek be given the lowest priority. These priorities are reflected in the implementation schedule outlined in Section 6.

4.8 Potential Funding Sources

One of the most important aspects of implementing nonpoint source controls is obtaining adequate funding to implement voluntary or incentive-based programs. Table 4-12 presents potential funding sources for the recommended controls. This is not an exhaustive source of funding opportunities, but is intended to facilitate the pursuit of funding from applicable sources. Other programs and funding sources may also be available beyond those identified herein. Additional information regarding potential funding sources is provided below.



Table 4-12. Potential Funding Sources for Recommended Controls

Control	Applicable, potential funding sources
Conservation Buffers	Funded under EQIP as field border (386), riparian herbaceous cover (390), or riparian forest buffer (391). Also funded under the Conservation Practices Cost-Share Program.
Conservation Tillage	Funded under EQIP as residue and tillage management, no-till (329). Also funded under the Conservation Practices Cost-Share Program, with some restrictions.
Cover Crops	Funded under EQIP as cover crop (340). Both cover and green manure crops are also funded under the Conservation Practices Cost-Share Program, with some restrictions.
Livestock Management Controls	Funded under EQIP as fence (382) and access control (472).
Nutrient Management Plans	Funded under EQIP as comprehensive nutrient management plan (102), nutrient management plan - written (104), and nutrient management (590). Both nutrient management planning and implementation are also funded under the Conservation Practices Cost-Share Program.
Treatment wetlands	Funded under EQIP as constructed wetland (656) and wetland restoration (657). Wetland reserve easements are also available to help protect, restore, and enhance wetlands through the Agricultural Conservation Easement Program.
Water & Sediment Control Basins	Funded under EQIP as sediment basin (350) and water and sediment control basin (638). This practice is also funded under the Conservation Practices Cost-Share Program.

4.8.1 Federal Programs

Clean Water Act Section 319 grants⁹ to address nonpoint source pollution. Section 319(h) of the Clean Water Act provides Federal funding for states and tribal agencies for the implementation of approved nonpoint source (NPS) management programs. These funds are received and administered by the Illinois EPA. Funding under these grants are used in Illinois to finance projects that demonstrate cost-effective solutions to NPS problems. Projects must address water quality issues relating directly to NPS pollution. Of the total project cost, up to 60% can be awarded through the fund. Grantees must provide at least 40% of the costs as an in-kind match or cash. Funds can be used to develop watershed-based plans and for the implementation of watershed-based plans, including the development of information and education programs, and for the installation of best management practices. This is a reimbursement program. Applications are due each year by close of business on August 1st to the Illinois EPA.

⁹ <http://www.epa.state.il.us/water/financial-assistance/non-point.html>



Conservation Reserve Program¹⁰ administered by the Farm Service Agency. The Conservation Reserve Program (CRP) provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, conservation planning and practice implementation.

Agricultural Conservation Easement Program¹¹ - NRCS's Agricultural Conservation Easement Program (ACEP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance agricultural land and wetlands on their property. The NRCS provides technical and financial support to help landowners with their restoration efforts. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

Environmental Quality Incentive Program¹² sponsored by NRCS - The Environmental Quality Incentives Program (EQIP) provides a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical assistance to eligible participants to install or implement structural and management practices on eligible agricultural land. Contracts may last for up to 10 years. Special payment schedules are in place for socially disadvantaged, beginning and limited resource farmers, Indian tribes, and veterans.

Application is a competitive process and EQIP applicants compete for funds by 'funding pool', a process that allows similar applicants to be grouped together for consideration. Payments are set by practice and are provided to the participants after the implementation of activities identified in their EQIP plan of operations. Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive. As part of the changes contained within the 2014 Farm Bill, the former Wildlife Habitat Incentive Program (WHIP), which provided both technical assistance and cost-share payments to help establish and improve fish and wildlife habitat, was folded in the EQIP program. Additional changes include un-waivable payment limits of \$450,000.

Conservation Stewardship Program (CSP)¹³ - This program assists agricultural producers with the maintenance and continued improvement of their in-place conservation systems. In addition, the program can provide assistance in the adoption of additional conservation practices which address priority resource concerns. These resource concerns can be water quality/quantity, habitat quality, soil quality, air quality, and energy conservation. Two payment types are offered, both on five-year contracts: a supplemental payment for adopting resource-conserving crop rotations, and annual payments for the adoption or installation of new conservation activities or maintenance of existing practices.

4.8.2 State Programs

Partners for Conservation Fund¹⁴ is a program designed to take a broad-based, long-term ecosystem approach to conserving, restoring, and managing Illinois' natural lands, soils, and water resources while providing additional high-quality opportunities for outdoor recreation. New programs under this fund must meet two key criteria:

¹⁰ <http://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/index>

¹¹ <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/easements/acep>

¹² general information at <http://www.nrcs.usda.gov/PROGRAMS/EQIP/>; Illinois information and materials at <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/il/programs/financial/eqip/>

¹³ <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/>

¹⁴ <http://www.agr.state.il.us/C2000>



1. They must be voluntary, and based on incentives rather than government regulation.
2. They must be broad-based, locally-organized efforts, incorporating the interests and participation of local communities, and of private, public and corporate landowners.

The Sustainable Agriculture Grant Program administered through this fund is seeking proposals from parties wishing to complete on-farm research or demonstrations, outreach and education, or university research in the area of agricultural sustainability. Up to \$20,000 of support is available per grant.

Conservation Practices Cost-Share Program. Another component of Partners for Conservation Fund, the Conservation Practices Program (CPP) focuses on conservation practices, such as terraces, filter strips and grass waterways that are aimed at reducing soil loss on Illinois cropland to tolerable levels. IDOA distributes funding for the cost-share program to Illinois' SWCDs, which prioritize and select projects. Construction costs are divided between the state and landowners.

Illinois Conservation Reserve Enhancement Program (CREP)¹⁵. As an outgrowth of the Conservation Reserve Program, CREP pays the owners of environmentally sensitive land an annual rental rate in exchange for ceasing production and implementing conservation practices. In Illinois, the focus is placed on the Illinois and Kaskaskia River Watersheds. Contracts are typically between 10 and 15 years and all participation is voluntary. CREP is different from CRP in that CREP focuses on the partnership between state and/or tribal agencies and the federal government. As of 2015, there are 126,805 acres enrolled in the Federal CREP program in Illinois. Over 90,100 acres are protected by CREP easements executed by the State (Illinois CREP, 2015). This program is administered by the Farm Service Agency and landowners wishing to participate must be located in a state with a CREP agreement with the federal government.

Water Quality Management Planning Grants¹⁶. Grants are available to regional public comprehensive planning organizations and other entities to carry out water quality management planning activities that protect water quality in Illinois. Projects must address water quality issues.

Grant funds can be used to determine the nature, extent, and causes of point and nonpoint source water pollution; develop water quality management plans; develop technical and administrative guidance tools for water pollution control; develop preliminary designs for best management practices (BMPs) to address water quality problems; implement administrative water pollution controls; and educate the public about the impact and importance of water pollution control.

Illinois EPA receives these funds through Section 604b of the Clean Water Act and administers the program within Illinois. The project period is two years unless otherwise approved. This is a reimbursement program.

¹⁵ <http://www.dnr.illinois.gov/conservation/CREP/Pages/default.aspx>

¹⁶ <http://epa.illinois.gov/topics/water-quality/watershed-management/wqmp/grants/index>



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5 Public Engagement, Education and Information

It has been determined that phosphorus is predominantly from non-point sources in the Prairie Creek/Langan Creek watershed, specifically agricultural land used for crop cultivation and livestock management. Overall, these land use activities are distributed across 90% of the watershed and large-scale implementation of management measures will be needed to achieve target phosphorus load reductions. Because sources are ubiquitous in the watershed, identification of specific areas is infeasible. Furthermore, because of the non-point source nature of phosphorus loading in the watershed, implementation of recommended management measures will be completely voluntary.

Given these facts, achieving the phosphorus load reduction targets in the watershed will require organized and sustained efforts in public engagement, education and information. Such efforts will create a culture of stewardship and a broad understanding of the need for phosphorus control.

5.1 Watershed Group Formation

Currently, there is no local, citizen-centered group active in the Prairie Creek/Langan Creek watershed advocating for environmental and water resource health. The establishment of such a watershed group, comprised of local individuals with interest in improving water quality, and supported by local agencies, will be an essential first step in implementing the making improvements towards the phosphorus load reduction goals for the watershed. Functions of a citizen-driven watershed group are numerous, including:

- Provide a forum for like-minded citizens to discuss issues, actions and priorities for the watershed;
- Be a source of watershed information for the public;
- Organize meetings and watershed events;
- Create vehicles for distributing watershed information such as newsletters, blogs, e-mailings and a web site; and
- Solicit donations and obtain grant funding from government agencies and foundations.

This watershed group will likely need to complete the following tasks to help it accomplish its goals:

- Choose a meaningful name for their new group and develop a logo.
- Hold organizational meetings to generate volunteer interest.
- Organize and conduct public meetings to present this implementation plan and get public input.
- Develop a web page and social media outlets which are appropriate for their target audience. These should allow the group to provide updates, post callouts for volunteer events, gather and display data, and present progress.
- Create 1-2 page fact sheets or brochures which can be distributed at public meetings and events. This educational material should educate landowners and community members on their opportunities to implement best management practices and the influence these practices may



have on their local water quality. It is ideal to have promotional material which is targeted to residential landowners (perhaps including information on septics) and agricultural landowners.

- Identify local events where their outreach can have an effective impact on the watershed community. This might be a local festival, a school science fair, a library event, or anywhere where people from the community gather and there is an opportunity to set up a booth or hand out flyers.

There are many online resources which members can review as they begin forming their watershed group, although it is recommended that interested parties begin by contacting Illinois EPA to identify staff or other available resources that may be available to facilitate formation of a watershed group. In addition, Illinois EPA¹⁷ has resources for resident-led watershed management activities and information and provides an example for performance-based environmental management (the Hewitt Creek Model). Loudoun Watershed Watch¹⁸ provides a PDF guide which discusses concerns such as what to do at the first meeting, how to form an organizational structure, and how to identify needs. The Blue Ridge Watershed Coalition in West Virginia has posted a useful document¹⁹ detailing how they formed. The group will want to think carefully about how to cultivate the membership to be sure that all relevant members of the community can be represented. It can be important to have members from many different sectors: agribusiness operators, recreation groups, rural non-farm and farm residents, urban/suburban residents, environmental interests, elected officials, and farmers (both those who own the land they farm and who rent).

5.2 Public Education and Outreach

Group activities should include public education and outreach to inform watershed residents of the problems with in the watershed, and to solicit input on controls that stakeholders are willing to implement. Because the controls are voluntary, stakeholder involvement and buy-in are critical for success. A variety of stakeholders should be included, such as landowners and farmers in the watershed, as well as representatives from federal, state and local environmental and planning organizations. Individuals familiar with the watershed can provide local insight and knowledge. These include, but are not limited to staff from the NRCS, SWCD, and local health department. Once the core membership has been formed, the watershed group will be well positioned to plan further outreach to the general public. Outreach to educate stakeholders on the problems and sources, and the recommended control practices is a high priority. To promote buy-in, the group should be prepared to offer insight into what any member of the community may do to advance watershed health. This could include developing strategic plans for unique watershed users – both by geography and by topic.

In addition to the implementation of controls specific to agricultural cropland that have already been discussed, another recommendation might be to develop a specific outreach plan for rural septic owners. Septic systems are not expected to contribute substantially to the phosphorus loads, and control of this source has not been discussed in length previously. This discussion provides detail on steps that could be taken to address issues arising from private sewerages in the study area, if there is interest:

- Include at least one representative of the Iroquois County Health Department in the watershed group.
- Seek grants or other funding opportunities to assist the Health Department with record keeping:
 - Digitization of existing permits and records.

¹⁷ <http://www.epa.illinois.gov/topics/water-quality/watershed-management/watershed-based-planning/index>

¹⁸ http://www.loudounwatershedwatch.org/pdf/Citizens_Guide.pdf

¹⁹ <http://www.blueridgewatershed.org/documents.php>



- Coordination of existing permits and records, which are by last name, to a property parcel or tax ID.
- Utilization of GIS personnel to assist with incorporating these data into a spatial framework.
- Identify and monitor 'wildcat' sewers. These systems may consist solely of a tank and a tile which run to a nearby water-body with no intervening treatment. Per a conversation with the Iroquois Health Department, these may be in place in rural areas and incorporated areas such as Danforth and Ashkum. Activities could include:
 - Taking GPS coordinates at or near outfalls or tile outlets of wildcat sewers.
 - Monitoring phosphorus concentrations in effluent from outfalls or tile outlets of wildcat sewers if publically accessible or with landowner's permission.
 - Consider adding in-stream sampling locations both upstream and downstream from suspected wildcat sewers. For example, sampling could be completed at the culvert on E 2200 North Road and the bridge on S Central St. to account for the in-stream effects of on-site septics in Danforth.
- Promote septic maintenance by producing and distributing materials which highlight best practices for septic system owners. One example could be contrasting the cost of pumping a septic tank (~\$250) every 3 years and the costs associated with installing a new system should the current one fail (\$8,000 to \$10,000).
- Consider the costs and staff effort associated with implementing a time-of-transfer or tax-linked septic maintenance plan. These plans would require residents to either prove their home has a working system before they are allowed to sell it or produce proof of septic maintenance with their annual tax payments. Either of these programs would likely require additional funding to the appropriate county office.

As the county works to improve private septic maintenance and upkeep, the group can note that these activities will not only decrease the phosphorus loading to the local waterways, but will also serve to decrease contamination from E. coli, nitrogen, and any potentially dangerous pathogens which may be present in human waste.



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6 Implementation

As mentioned in the prior section, the first scheduled task should be to convene a watershed group. Once this watershed group has convened, they can begin necessary public education and outreach. The first year of implementation should be devoted to organizing this group and beginning the public outreach and education aspects of implementation, as described in Table 6-1.

Table 6-1. Year 1 Start-Up Schedule

Year	Action	Notes	Milestones/Measures of Success
1	Organize watershed group	Recommended members include individuals including producers, and representatives from IEPA, Iroquois County Health Department, SWCD, ag retailers, and other interested stakeholders.	Establishment of a watershed group within 1 year of TMDL approval.
1	Designate watershed coordinator/committee	Can be an individual or group of individuals	Identification of watershed coordinator/committee on web site with names and contact information
1	Develop logo and statement of purpose; initiate web site & other social media accounts (Twitter, Facebook)	Can be simple at first, initial purpose is to raise awareness, serve as an information outlet	Web site & social media accounts active
1	Prepare handout/flyer describing purpose of watershed group	Simple 1-2 page flyer	Print copies available at meetings; PDF on web site
1	Conduct informational presentations; booth at community events	Target existing groups that hold regular meetings, school groups, etc.	At least 6 presentations/booth events
1	Identify priority actions for years 2-5	These should be actions that can be funded by available grants, government programs, etc.	
1	Conduct first annual public watershed meeting	Advertise ahead of time, get the word out	Meeting conducted towards end of year 1

After organizing the watershed group and beginning public outreach, setting up a monitoring program to measure and track water quality improvement should be started. It may be possible that sampling can be conducted by volunteers to reduce costs and local entities may be willing to donate laboratory analytical services. Prior to monitoring, it is recommended that a Quality Assurance Project Plan (QAPP) be developed. If external funding for monitoring is required, the watershed group will need to identify funding sources. Once funding is secured and the monitoring points identified, the watershed group will



conduct the sampling. The frequency of sampling and number of sampling locations will depend on available resources. The group should plan to interface with IEPA and Illinois State Water Survey about any and all sampling events within the Prairie Creek/Langan Creek watershed to help them assess phosphorus reductions and any concurrent improvements in dissolved oxygen concentrations. Planning should be completed by the end of year 1, so implementation of the monitoring program can be started in year 2 to provide information on baseline stream water quality conditions. The schedule for watershed monitoring activities is shown in Table 6-2.

Table 6-2. Watershed Monitoring Schedule

Year	Action	Notes	Milestones/Measures of Success
1	Plan sampling; line up laboratory analysis services	Sampling should include total and dissolved phosphorus concentrations; plan should include sampling locations map	Written plan
1	Prepare QAPP; present sampling plan; seek volunteers	The QAPP should describe the who, what, when, where and why of sampling. The sampling plan should be presented at the first annual public watershed meeting	Written QAPP See Section 7
2	Prepare sampling schedule	Based on volunteer availability and availability of laboratory resources, plan sampling schedule	Sampling schedule posted to web site
2	Seek supplemental funding	If needed, apply for grants to support sampling program	Grant(s) for supplemental funding
2	Conduct sampling	Collect samples as planned	Completion of sampling event(s) by local watershed group
2	Evaluate results; review program; determine need for changes	Identify successes, problems, challenges from initial sampling; revise plan accordingly	Revised sampling plan
3-10	Implement sampling program	Review program every year and identify new resources, areas for improvement. Results should be evaluated for trends over time, as well as compared to target phosphorus concentration to determine whether goals have been attained.	

Implementation of the recommended measures described in Section 4 should begin in year 2, after establishment of the watershed group and start-up of the public information and engagement program. As described in Section 4.7, Clifton North Creek should be prioritized because water quality data collected there show the highest median phosphorus concentrations anywhere in the Prairie Creek/Langan Creek watershed. Langan Creek, Clifton South Creek and Ashkum Creek have intermediate priority and Prairie Creek has the lowest priority for implementation. These priorities should be reviewed and adjusted as new monitoring data are generated. The planned schedule for implementation of management measures is presented in Table 6-3.



Table 6-3. Management Measure Implementation Schedule, Years 2-5²⁰

Year	Management Measure Action	Milestones/Measures of Success
2	Prepare nutrient management plans for 672 acres in the Clifton North Creek subwatershed	Acres covered by new nutrient management plans
2	Identify candidate sites for constructed wetlands (20 acres) and conservation buffers in Clifton North Creek subwatershed	Viable site identified, suitable for grant application
3	Prepare nutrient management plans for 811 acres in the Clifton South Creek subwatershed	Acres covered by new nutrient management plans
3	Prepare grant applications for constructed wetlands projects in Clifton North Creek subwatershed	Grant applications submitted
3-4	Establish cover crop practices on 336 acres in the Clifton North Creek subwatershed	Acres of cover crop practices started
3-4	Establish conservation buffers for 2.3 miles of streams in the Clifton North Creek subwatershed	Stream miles with new conservation buffers
4	Prepare nutrient management plans for 3,210 acres in the Ashkum Creek subwatershed	Acres covered by new nutrient management plans
4	Identify candidate sites for constructed wetlands (15 acres) and conservation buffers in Clifton South Creek subwatershed	Viable site identified, suitable for grant application
4-5	Begin construction of wetlands in the Clifton North Creek subwatershed	Acres of new constructed wetlands
4-5	Establish conservation tillage practices on 215 acres in the Clifton North Creek subwatershed	Acres of conservation tillage established
5	Prepare grant applications for constructed wetlands projects in Clifton South Creek subwatershed	Grant applications submitted
5	Conduct 5-year review of implementation plan and prepare updated plan	Completion of updated implementation plan, based on 5-year review

In year five, the Prairie Creek/Langan Creek watershed group will conduct a five-year review of the implementation plan to assess the need for modifications. Public input will be obtained through public meetings, social media feedback and internet-based polling of residents. Based on this review and assessment, the plan may be updated to reflect realities of funding availability, implementation rate of management measures in the first five years, findings of annual monitoring and changing priorities. The implementation schedule for year 6 through year 10 presented in Table 6-4 may be adjusted significantly based on the five-year assessment.

²⁰ Implementation of management measures dependent on funding availability and landowner cooperation. Schedule may be adjusted annually.



Table 6-4. Management Measure Implementation Schedule, Years 6-10²¹

Year	Management Measure Action	Milestones/Measures of Success
6	Prepare nutrient management plans for 12,000 acres in the Langan Creek subwatershed	Acres covered by new nutrient management plans
6-7	Begin construction of wetlands in the Clifton South Creek subwatershed	Acres of new constructed wetlands
6	Identify candidate sites for constructed wetlands (104 acres) and conservation buffers in Ashkum Creek subwatershed	Viable site identified, suitable for grant application
6-7	Establish conservation buffers for 2.1 miles of streams in the Clifton South Creek subwatershed	Stream miles with new conservation buffers
7-8	Prepare grant applications for constructed wetlands projects in Ashkum Creek subwatershed	Grant applications submitted
7-10	Establish conservation tillage practices on 259 acres in the Clifton South Creek subwatershed	Acres of conservation tillage established
7-10	Establish cover crop practices on 406 acres in the Clifton South Creek subwatershed	Acres of cover crop practices started
7-10	Establish conservation tillage practices on 1,027 acres in the Ashkum Creek subwatershed	Acres of conservation tillage established
7-10	Establish cover crop practices on 1,605 acres in the Ashkum Creek subwatershed	Acres of cover crop practices started
8-10	Prepare nutrient management plans for the Langan Creek subwatershed	Acres covered by new nutrient management plans
8-10	Establish conservation buffers for 5.4 miles of streams in the Ashkum Creek subwatershed	Stream miles with new conservation buffers
9-10	Begin construction of wetlands in the Clifton Ashkum subwatershed	Acres of new constructed wetlands
10	Conduct 10-year review of implementation plan and prepare updated plan	Completion of updated implementation plan, based on 10-year review

Under this schedule, by the end of year ten, all management measures will have been implemented or begun in the Clifton North Creek, Clifton South Creek and Ashkum Creek subwatersheds. In addition, establishment of management measures in the Langan Creek subwatershed will have been started (in the form of nutrient management plans. Ten years of monitoring data will be available to support water quality assessment of streams in the watershed and to assess the effectiveness of management measures. In year ten, the Prairie Creek/Langan Creek watershed group will again conduct a review of the implementation plan to assess the need for modifications and plan activities for years 10-20. Because of the great uncertainty regarding funding availability, landowner cooperation, implementation rate of management measures in the first ten years, outcomes of annual monitoring and changing priorities, a detailed schedule for years 10 through 20 is not included here.

²¹ Implementation of management measures dependent on funding availability and landowner cooperation. Schedule may be adjusted annually.



As outlined above, there are several interim milestones that should be evaluated to assess progress as the implementation plan moves forward. With the exception of the watershed group's establishment, all measureable milestones should be finalized by the group. Achievement of these milestones will assure the watershed group that they are making progress in their role. However, additional criteria should be developed which will specifically document the group's progress at improving water quality. These criteria should be decided by the watershed group after formation, but should include the following elements:

- A defined plan for documenting and tracking phosphorus concentrations over time.
- A mechanism for tracking implementation of phosphorus controls in each watershed, or documenting interest in or commitments to implementing controls for future follow-up.
- A mechanism for including the following concepts in their tracking of water quality:
 - Annual fluctuations in precipitation and/or temperature
 - Appreciable quantities of land use change
 - The addition or removal of any point source facilities
 - The patterns displayed by the dominant crops in the watershed (was there a drought which impacted the crops ability to accumulate biomass, did the planting occur early or late, etc.)
 - The season and 7-day prior conditions during which the samples were taken
- The target concentrations

The watershed group should acknowledge that it may be difficult to determine progress at an early stage of implementation. As enumerated above, any number of factors may alter the in-stream concentrations on a year to year basis. It may be necessary to plan for a multi-year effort which will allow the longer term collection of data and determination of a long term concentration average.



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7 Monitoring

Illinois EPA conducts a variety of lake and stream monitoring programs, including: a statewide Ambient Water Quality Monitoring Network; an Intensive Basin Survey Program that covers all major watersheds on a five-year rotation basis; and a Facility-Related Stream Survey Program. Illinois EPA does not sample any of the Prairie Creek/Langan Creek watershed streams under their Ambient Water Quality Monitoring program²² and the most recent Facility-Related Stream Surveys completed in this watershed were in 1994.

However, Illinois EPA recently sampled a number of stations (Figure 7-1) on the impaired streams as part of the 2015 Intensive Basin Survey. This watershed will likely be sampled again in 2020, as part of IEPA's five-year rotating schedule. Monitoring by Illinois EPA at 5-year intervals at the stations shown in Figure 7-1 will provide information on the change in phosphorus concentrations over time, reflecting improvements following implementation of management measures.

Once formed, the watershed group should encourage IEPA to monitor this watershed under their Ambient Water Quality Monitoring Network program, as part of the Kankakee River Basin monitoring to help assess progress in reducing phosphorus loads. Additionally, Illinois EPA should be encouraged to monitor Clifton North Creek in the vicinity of the Clifton STP, under the Facility-Related Stream Survey Program. Additional monitoring is also recommended to supplement data collected by Illinois EPA. There are two recommended aspects of this supplemental sampling:

1. A minimum of monthly sampling at the stations shown in Figure 7-1 in years when Illinois EPA does not conduct sampling at those stations. Both low and high flow conditions should be targeted over the course of the year.
2. A minimum of monthly sampling at the new stations, as shown in Figure 7-1. Both low and high flow conditions should be targeted over the course of the year.

Annual sampling will provide more frequent data which will help identify temporal trends, as well as patterns related to weather. In addition, more frequent data will allow better discernment of the impacts of management measures as they are implemented.

Additional sampling locations will create a richer data set to assess water quality in streams and may provide a means to better observe the effects of management measures by providing upstream/downstream sampling pairs. All water quality should include sampling for dissolved and total phosphorus concentrations. Where possible, flow measurement should be conducted as a component of watershed monitoring.

Water quality monitoring should include a component of sampling during or immediately after rain events, preferably in the spring when higher runoff volumes are likely.

²² <http://www.epa.state.il.us/water/water-quality/monitoring-strategy/monitoring-strategy-2015-2020.pdf>



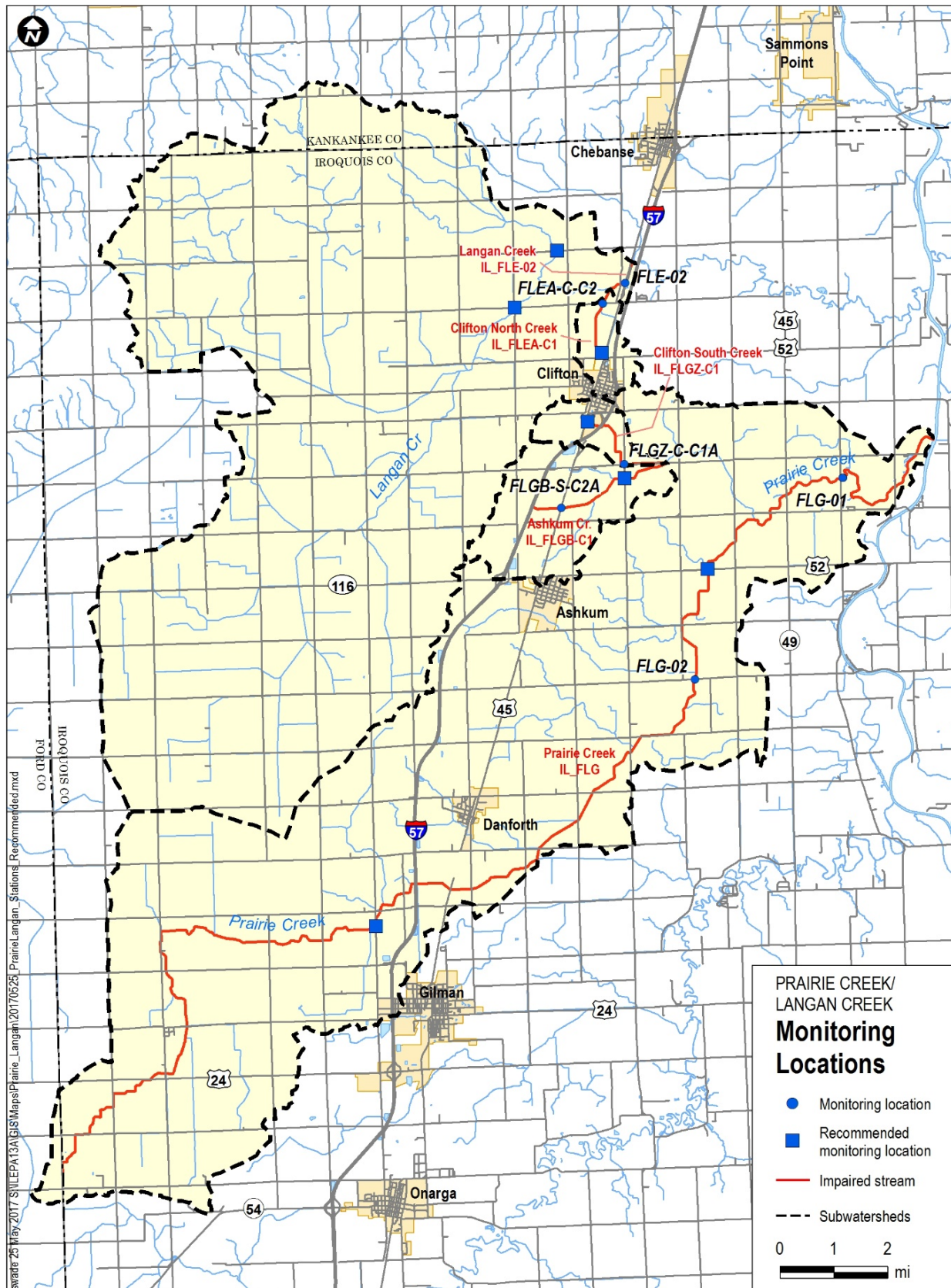


Figure 7-1. Illinois EPA Monitoring Locations



References

- DeLaune, P. B., & Sij, J. W., 2012. Impact of tillage on runoff in long term no-till wheat systems. *Soil and Tillage Research*, 124, 32-35.
- Fernandez, F. G. and R. G. Hoef, undated. *Illinois Agronomy Handbook*. Chapter 8 Managing Soil pH and Crop Nutrients. Accessed online at:
<http://extension.cropsciences.illinois.edu/handbook/pdfs/chapter08.pdf>
- Illinois Conservation Reserve Enhancement Program (Illinois CREP), 2015. 2015 Annual Report. Retrieved from
http://www.dnr.illinois.gov/conservation/CREP/Documents/CREP_annualReport2015.pdf
- Illinois Department of Agriculture (IDOA) and Illinois Environmental Protection Agency (IEPA), 2015, Illinois Nutrient Loss Reduction Strategy, Available online at
<http://www.epa.illinois.gov/topics/water-quality/watershed-management/excess-nutrients/nutrient-loss-reduction-strategy/index>
- Miller, T. P., J. R. Peterson, C. F. Lenhart, and Y. Nomura. 2012. *The Agricultural BMP Handbook for Minnesota*. Minnesota Department of Agriculture.
- Natural Resources Conservation Service (NRCS), 2008. *Natural Resources Conservation Service Conservation Practice Standard: Water and Sediment Control Basin (No.) Code 638*. September 2008.
- NRCS Illinois, 2013. *Natural Resources Conservation Service Conservation Practice Standard: Nutrient Management (Ac.) Code 590*. January 2002.
- Smith, D.R., K.W. King, L. Johnson, W. Francesconi, P. Richards, D. Baker and A. N. Sharpley. 2014. *Surface Runoff and Tile Drainage Transport of Phosphorus in the Midwestern United States*. DOI: 10.2134/jeq2014.04.0176.
- Simmons, F. W., and E.D. Nafziger, undated. *Illinois Agronomy Handbook*, Chapter 10. Soil Management and Tillage. Available online at: <http://extension.cropsciences.illinois.edu/handbook/>
- United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS), 1996. *Engineering Field Handbook: Chapter 16 Streambank and Shoreline Protection*. Retrieved from <http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba>
- United States Environmental Protection Agency (USEPA), 2013. *A Meta-Analysis of Phosphorus Attenuation in Best Management Practices (BMP) and Low Impact Development (LID) Practices in Urban and Agricultural Areas*. EPA600/R-13/208 September 2013. Available online at: <https://archive.epa.gov/ada/web/pdf/p100jdot.pdf>
- USEPA, 2008. *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. EPA 841-B-08-002. Office of Water, Washington, DC.
- USEPA, 2003. *National Management Measures to Control Nonpoint Source Pollution from Agriculture*. EPA 841-B-03-004. Office of Water, Washington, DC. Available at <http://www.epa.gov/owow/nps/agmm/index.html>
- USEPA, 2000. *Nutrient Criteria Technical Guidance Manual, Rivers and Streams*. Office of Water. EPA-822-B-00-002.



USEPA, 1991. *Guidance for Water Quality-based Decisions: The TMDL Process*. EPA 440/4-91-001.
Office of Water, Washington, DC.





Stage 3 Report

Prairie Creek/Langan Creek Watershed

Prepared for:
Illinois EPA

May 19, 2017

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Prairie Creek/Langan Creek Watershed Load Reduction Strategy

Stage 3 Report

**Prepared for:
Illinois EPA**

May 19, 2017

**Prepared by:
LimnoTech**

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Attachments

Attachment 1. IEPA 2014 assessment and Stage 2 monitoring data

Attachment 2: IEPA Watershed Management Load Reduction Strategy

Attachment 3: QUAL2E inputs and outputs



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Executive Summary

Section 303(d) of the 1972 Clean Water Act requires States to define impaired waters and identify them on a list, which is called the 303(d) list. The final 2014 Integrated Water Quality Report and Section 303(d) List - 2014 (IEPA, 2014) is available on the web at: <http://www.epa.state.il.us/water/tmdl/303d-list.html>. This work began before the 2014 report was available, and therefore focuses on assessments based on the 2012 303(d) list, modified to reflect IEPA's recent sampling that resulted in the removal of several impairment causes. Section 303(d) of the Clean Water Act and USEPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and instream conditions. This allowable loading represents the maximum quantity of the pollutant that the waterbody can receive without exceeding water quality standards. The TMDL also takes into account a margin of safety, which reflects scientific uncertainty, as well as the effects of seasonal variation. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (USEPA, 1991).

Load Reduction Strategies (LRSs) are being completed for causes that do not have numeric standards. LRSs for causes of impairment with target criteria will consist of loading capacity and the percent reduction needed to meet the target criteria.

Five waterbodies in the Prairie/Langan watershed are listed on the 2012 Illinois Section 303(d) List of Impaired Waters (IEPA, 2012) as not meeting their designated uses, and additional sampling in 2014 and 2015 confirmed the impairments described in this Stage 3 report and supported the modeling presented in this report. This document presents LRSs for Prairie Creek, Langan Creek, Clifton South Creek, Clifton North Creek and Ashkum Creek. The report is organized as follows:

- Problem Identification
- Stage 2 Sampling
- Development of Numeric Targets
- Development of Water Quality Models
- LRS Development



Illinois EPA conducts TMDLs and LRSs following a three-stage process. Stage 1 includes watershed characterization, data analysis and model selection. Stage 2 involves data collection, and is conducted if necessary. Stage 3 includes model calibration and application, and TMDL/LRS and implementation plan development. Prairie/Langan Stage 1 work began in September, 2013. A public meeting to present the Stage 1 findings and the draft Stage 1 report was held in April 2014. The final Stage 1 report was completed in May, 2014. One key conclusion of Stage 1 was that many of the streams were last sampled in 1994, and the available data might not reflect current conditions in the Prairie/Langan waterbodies. Stage 2 sampling was therefore conducted in 2014 and 2015 by Illinois EPA and the Illinois State Water Survey. These data were reviewed by IEPA, who delisted many parameters, based on improved instream conditions that were observed. Table ES-1 presents a summary of the waterbody listing changes that have occurred as a result of the Stage 2 sampling. Additional details are provided in Section 2.

Table ES-1. Summary of Impairment Cause Changes Resulting from IEPA Stage 2 Sampling

Waterbody/Segment Name	Causes Removed as a Result of Stage 2 Sampling
Langan Cr / IL_FLE-02	Ammonia (Total), Boron, Dissolved oxygen
Clifton N / IL_FLEA-C1	Ammonia (Total), Boron, Copper; Dissolved oxygen; Sedimentation/Siltation
Prairie Cr / IL_FLG	None
Ashkum Cr / IL_FLGB-C1	Ammonia (Total), Boron, Dissolved oxygen
Ashkum Cr / IL_FLGB-C4	Boron, Sedimentation/Siltation
Clifton South Cr / IL_FLGZ-C1	Ammonia (Total), Boron, Dissolved oxygen; Sedimentation/Siltation

The impaired waterbodies that are the focus of this Stage 3 report are shown in Table ES-2.

Table ES-2. Impaired Waterbody Summary

Waterbody/Segment Name	Impaired Designated Use	Size (mile)	Impairment Cause
Langan Cr / IL_FLE-02	Aquatic Life	0.78	Phosphorus (Total)
Clifton N / IL_FLEA-C1	Aquatic Life	1.31	Phosphorus (Total)
Prairie Cr / IL_FLG	Aquatic Life	29.72	Phosphorus (Total)*
Ashkum Cr / IL_FLGB-C1	Aquatic Life	2.84	Phosphorus (Total)
Clifton South Cr / IL_FLGZ-C1	Aquatic Life	2.18	Phosphorus (Total)

* Phosphorus was determined to be the primary cause of the Prairie Creek dissolved oxygen impairment, due to its role in causing excess aquatic plant growth and resultant excessive diurnal variability.



1

Problem Identification

The impaired waterbodies addressed in this Stage 3 report are listed below (Table 1-1), with the parameters (causes) they are listed for, and the impairment status of each designated use. Based on Stage 2 sampling completed in 2014, IEPA has determined that the condition of the Prairie/Langan waterbodies has improved and many of the impairments previously discussed in the Stage 1 report no longer exist. The waterbodies and impairments presented in Table 1-1 were identified subsequent to IEPA's stage 2 sampling. Furthermore, the 2014 IEPA sampling identified Ashkum Creek (IL_FLGB-C4) as being fully supporting of the aquatic life use. Findings from the 2014 IEPA sampling and the data are found in Attachment 1. Load Reduction Strategies (LRSs) are being developed for pollutants that do not have numerical water quality standards, in this case total phosphorus in streams.

Table 1-1. Impaired Waterbody Summary

Waterbody/Segment Name	Impaired Designated Use	Size (mile)	Impairment Cause	TMDL or LRS?
Langan Cr / IL_FLE-02	Aquatic Life	0.78	Phosphorus (Total)	LRS
Clifton N / IL_FLEA-C1	Aquatic Life	1.31	Phosphorus (Total)	LRS
Prairie Cr / IL_FLG	Aquatic Life	29.72	Phosphorus (Total)*	LRS
Ashkum Cr / IL_FLGB-C1	Aquatic Life	2.84	Phosphorus (Total)	LRS
Clifton South Cr / IL_FLGZ-C1	Aquatic Life	2.18	Phosphorus (Total)	LRS

* Phosphorus was determined to be the primary cause of the dissolved oxygen impairment, due to its role in causing excess aquatic plant growth and resultant excessive diurnal variability. As such, a total phosphorus LRS has been developed to meet in-stream phosphorus targets judged to be protective of the dissolved oxygen standard.



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2

Stage 2 Sampling

As described in the Stage 1 report, most of the waterbodies in the Prairie/Langan watershed were identified as impaired based on sampling conducted in 1994. Those data are over 20 years old and do not reflect current conditions in the watershed. IEPA conducted additional sampling in this watershed in 2014 and 2015 (Attachment 1), and based on a review of the newer data, the designated use support and impairment causes have changed from the Stage 1 descriptions (Table 2-1).

Table 2-1. Impairment Cause Changes Based on Stage 2 Sampling

Waterbody/Segment Name	Previous Impairment Cause	Causes Removed as a Result of Stage 2 Sampling
Langan Cr / IL_FLE-02	Ammonia (Total), Boron, Dissolved oxygen, Phosphorus (Total)	Ammonia (Total), Boron, Dissolved oxygen
Clifton N / IL_FLEA-C1	Ammonia (Total), Boron, Copper; Dissolved oxygen; Phosphorus (Total), Sedimentation/Siltation	Ammonia (Total), Boron, Copper; Dissolved oxygen; Sedimentation/Siltation
Prairie Cr / IL_FLG	Dissolved oxygen	
Ashkum Cr / IL_FLGB-C1	Ammonia (Total), Boron, Dissolved oxygen; Phosphorus (Total)	Ammonia (Total), Boron, Dissolved oxygen
Ashkum Cr / IL_FLGB-C4	Boron, Sedimentation/Siltation;	Boron, Sedimentation/Siltation
Clifton South Cr / IL_FLGZ-C1	Ammonia (Total), Boron, Dissolved oxygen; Phosphorus (Total); Sedimentation/Siltation	Ammonia (Total), Boron, Dissolved oxygen; Sedimentation/Siltation

Table 2-2 presents the 2014 and 2015 data that IEPA used to determine some of the previously-identified impairment causes are no longer of concern.



Table 2-2. Summary of Data Supporting Impairment Cause Change

Waterbody/ Segment Name	Impairment Cause Removed	Station	Criteria	Min	Max	Notes
Langan Cr / IL_FLE-02	Ammonia (Total)	FLE-02	15 mg/L	ND	0.84	15 mg/l is more stringent than criteria calculated based on pH
	Boron	FLE-02	40,100 ug/L Average of 4 samples over at least 4 days not to exceed 7,600 ug/L	54	135	Acute criteria Chronic criteria
	Dissolved oxygen	FLE-02	5 mg/L March-July 4 mg/L other months	5.69	9.61	
Clifton N / IL_FLEA-C1	Ammonia (Total)	FLEA-C-C2	15 mg/L	0.13	0.74	15 mg/l is more stringent than criteria calculated based on pH
	Boron	FLEA-C-C2	40,100 ug/L Average of 4 samples over at least 4 days not to exceed 7,600 ug/L	94.9	920	Acute criteria Chronic criteria
	Copper	FLEA-C-C2	39.97 ug/L	3.06	19.5	Data are total copper. Criteria are dissolved copper, and are calculated based on hardness. Most stringent value for this station is presented.
	Dissolved oxygen	FLEA-C-C2	5 mg/L March-July 4 mg/L other months	4.93	9.69	
	Sedimentation/ Siltation	FLEA-C-C2	N/A	9	101	TSS data (mg/L) presented. No numeric criteria for sedimentation/siltation
Ashkum Cr / IL_FLGB-C1	Ammonia (Total)	FLGB-S-C2A	15 mg/L	0.43	11.2	15 mg/l is more stringent than criteria calculated based on pH
	Boron	FLGB-S-C2A	40,100 ug/L Average of 4 samples over at least 4 days not to exceed 7,600 ug/L	54.1	99.4	Acute criteria Chronic criteria
	Dissolved oxygen	FLGB-S-C2A	5 mg/L March-July 4 mg/L other months	5.2	10.16	



Waterbody/ Segment Name	Impairment Cause Removed	Station	Criteria	Min	Max	Notes
Ashkum Cr / IL_FLGB-C4	Boron	FLGB-S-C5	40,100 ug/L Average of 4 samples over at least 4 days not to exceed 7,600 ug/L	57	99	Acute criteria Chronic criteria
	Sedimentation/ Siltation	FLGB-S-C5	N/A	19	74	TSS data (mg/L) presented. No numeric criteria for sedimentation/siltation
Clifton South Cr / IL_FLGZ- C1	Ammonia (Total)	FLGZ-C-C1A	15 mg/L	0.09	0.41	15 mg/l is more stringent than criteria calculated based on pH
	Boron	FLGZ-C-C1A	40,100 ug/L Average of 4 samples over at least 4 days not to exceed 7,600 ug/L	59.4	146	Acute criteria Chronic criteria
	Dissolved oxygen	FLGZ-C-C1A	5 mg/L March-July 4 mg/L other months	5.0	6.8	
	Sedimentation/ Siltation	FLGZ-C-C1A	N/A	34	59	TSS data (mg/L) presented. No numeric criteria for sedimentation/siltation

Figure 2-1 shows a map of the watershed, and includes waterways, roads, NPDES-permitted dischargers, and other key features. Figure 2-2 shows the locations sampled in 2014 and/or 2015 by IEPA and ISWS, which serve as the basis for this Stage 3 report.



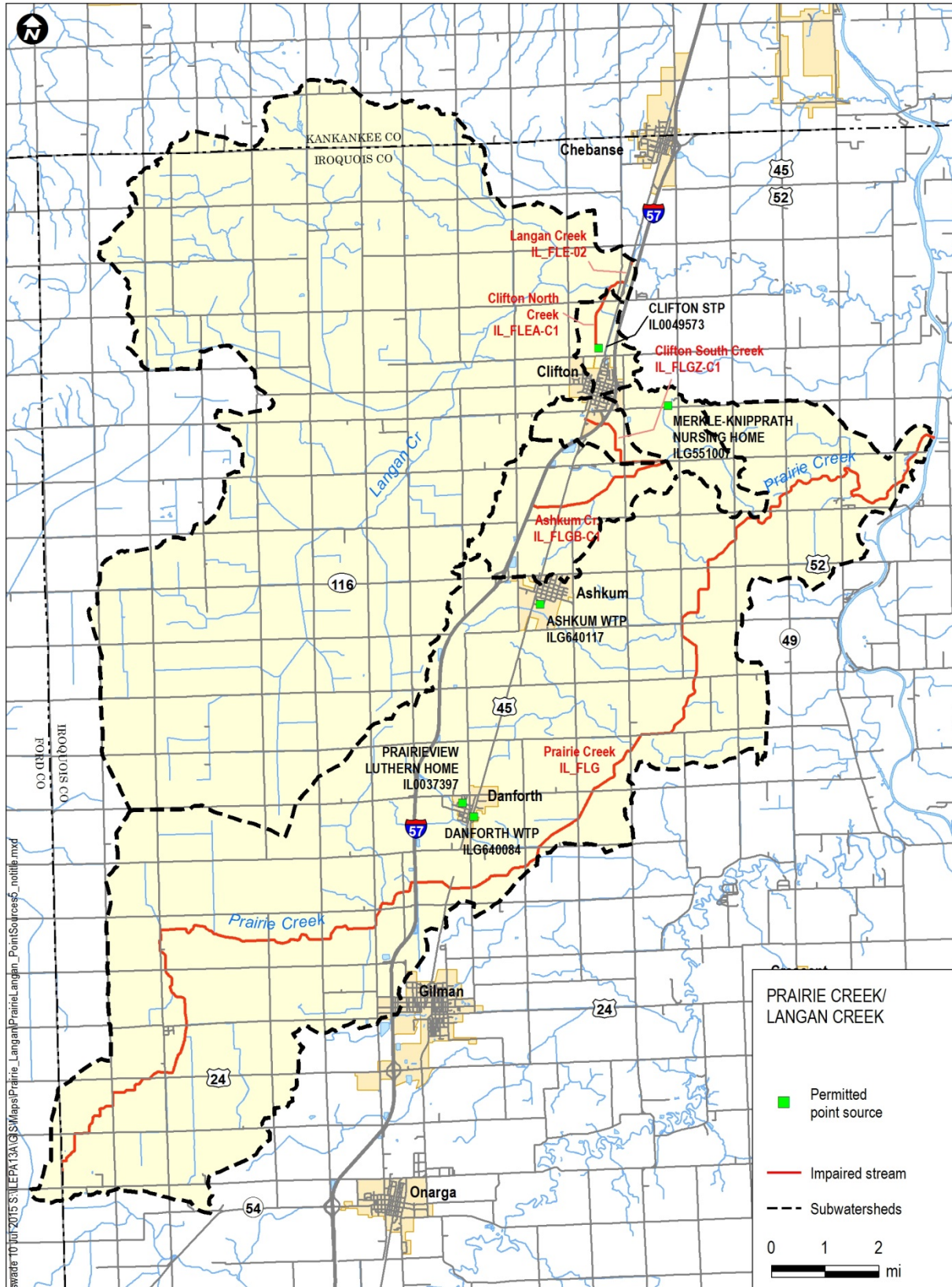


Figure 2-1. Base Map of the Prairie Creek/Langan Creek Watershed



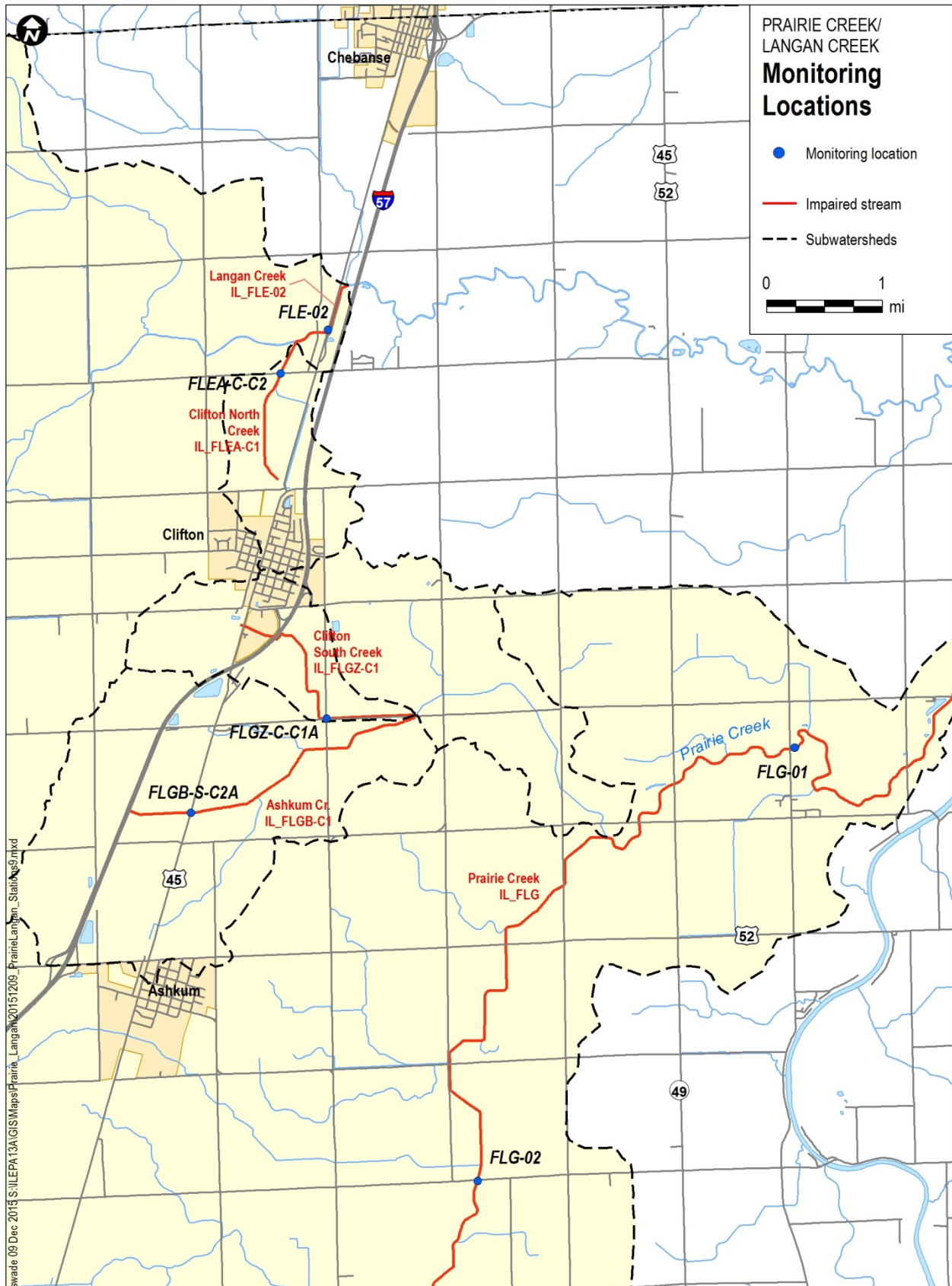


Figure 2-2. Sampling Locations for Impaired Segments



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3

Development of LRS Targets

Designated use, use support and water quality criteria for waterbodies in the Prairie/Langan watershed have been previously described in the Stage 1 Report. This section describes the development of numeric LRS targets.

3.1 Target Development

The LRS target is a numeric endpoint specified to represent the level of acceptable water quality that is to be achieved by implementing the LRS. Where possible, the water quality criterion for the pollutant of concern is used as the numeric endpoint.

For the Prairie Creek dissolved oxygen impairment, the target is set at the water quality criterion for daily minimum dissolved oxygen of 5.0 mg/L recognizing that this is the more conservative of the seasonal minimal dissolved oxygen criteria (recall that between August and February, the minimum equals 3.5 mg/L). The QUAL2E model used to calculate the LRS predicts a daily average dissolved oxygen concentration and does not directly predict daily minimum values. QUAL2E results can be translated into a form comparable to a daily minimum, by subtracting the observed difference between daily average and daily minimum dissolved oxygen from the model output. Based upon data analysis described in Section 4, a maximum diurnal variation of 7.8 mg/l was used to ensure that the 5.0 mg/l water quality standard is met. Phosphorus was determined to be the primary cause of the dissolved oxygen impairment, due to its role in causing excess aquatic plant growth and resultant excessive diurnal variability. As such, the LRS was developed to meet in-stream phosphorus targets judged to be protective of the dissolved oxygen standard.

When appropriate numeric standards do not exist, surrogate parameters must be selected to represent protection of the designated use. For all streams in the Prairie Creek/Langan Creek watershed, IEPA has developed a LRS target of 0.104 mg/l TP. For LRS development, this target is used for: Langan Creek (IL_FLE-02), Clifton North Creek (IL_FLEA-C1), Ashkum Creek (IL_FLGB-C1) and Clifton South Creek (IL_FLGZ-C1). As described in Attachment 2, these targets are based on an average of validated, Agency assessment data (1999-2013) for Langan Creek, segment IL_FLE-01, which meets full support use in the project watershed.



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4

Development of Water Quality Models

Water quality models are used to define the relationship between pollutant loading and the resulting water quality. This section describes both the dissolved oxygen and total phosphorus modeling. The dissolved oxygen assessment for Prairie Creek is based on the QUAL2E model in conjunction with analysis of continuous dissolved oxygen measurements and is described in the following sections.

- Model selection
- Modeling approach
- Model inputs
- Model calibration
- Model sensitivity analysis

The remainder of this section describes the total phosphorus modeling to support the TP LRS for all impaired streams in this watershed. Note that the Prairie Creek modeling is described in two parts: 1) QUAL2E dissolved oxygen modeling; and 2) total phosphorus modeling.

4.1 QUAL2E Model for Dissolved Oxygen in Prairie Creek

The QUAL2E water quality model was used to define the relationship between external oxygen-demanding loads and the resulting concentrations of dissolved oxygen in Prairie Creek, in order to determine the extent to which these oxygen-demanding loads contributed to the dissolved oxygen impairment.

QUAL2E is a one-dimensional stream water quality model applicable to dendritic, well-mixed streams. It assumes that the major pollutant transport mechanisms, advection and dispersion, are significant only along the main direction of flow. The model allows for multiple waste discharges, water withdrawals, tributary flows, and incremental inflows and outflows.

4.1.1 Model Selection

A discussion of the model selection process for the Prairie Creek watershed is provided in the Stage 1 report.

The QUAL2E model (Brown and Barnwell, 1987) was selected to address dissolved oxygen impairments in Prairie Creek. QUAL2E is the most commonly used water quality model for addressing low flow conditions. An empirical approach was selected for determining watershed loads, with more detailed analysis of specific sources to be conducted during the implementation phase.

4.1.2 Modeling Approach

The approach selected for the dissolved oxygen assessment consists of using data collected during 2015 dry weather surveys to define the current water quality of the river, and using the QUAL2E model to define the extent to which oxygen-demanding loads contribute to the dissolved oxygen impairment. Load reductions will be determined subsequent to the QUAL2E modeling. This is the recommended approach presented in the Stage 1 report. The dominant land use in the watershed is agriculture and there are four



permitted NPDES discharges in the Prairie Creek watershed. These are: Danforth WTP, Prairieview Lutheran Home, Village of Ashkum WTP, and Merkle Knipprath Nursing Home (See Stage 1 Report, Section 2.8).

4.1.3 QUAL2E Model Inputs

This section gives an overview of the model inputs required for QUAL2E application, and how they were derived. The following categories of inputs are required for QUAL2E:

- Model options (title data)
- Model segmentation
- Hydraulic characteristics
- Reach kinetic coefficients
- Initial conditions
- Incremental inflow conditions
- Headwater characteristics
- Point source flows and loads

4.1.3.a Model Options

This portion of the model input parameters defines the specific water quality constituents to be simulated. QUAL2E was set up to simulate biochemical oxygen demand, the nitrogen series and dissolved oxygen.

4.1.3.b Model Segmentation

The QUAL2E model divides the river being simulated into discrete segments (called “reaches”) that are considered to have constant channel geometry and hydraulic characteristics. Reaches are further divided into “computational elements”, which define the interval at which results are provided. The Prairie Creek QUAL2E model consists of five reaches, which are comprised of a varying number of computational elements. Computational elements have a fixed length of 0.2 miles. Reaches are defined with respect to water quality monitoring stations and tributaries. Model segmentation is presented below in Table 4-1 and Figure 4-1.

Table 4-1. QUAL2E Segmentation

Reach	River miles	Number of computational elements	Other features
1	14.5 – 10.5	20	Danforth WTP; Prairieview Lutheran Home
2	10.5 – 9.7	4	
3	9.7 – 6.5	16	Village of Ashkum WTP
4	6.5 – 3.5	15	Merkle Knipprath Nursing Home
5	3.5 – 0.1	17	



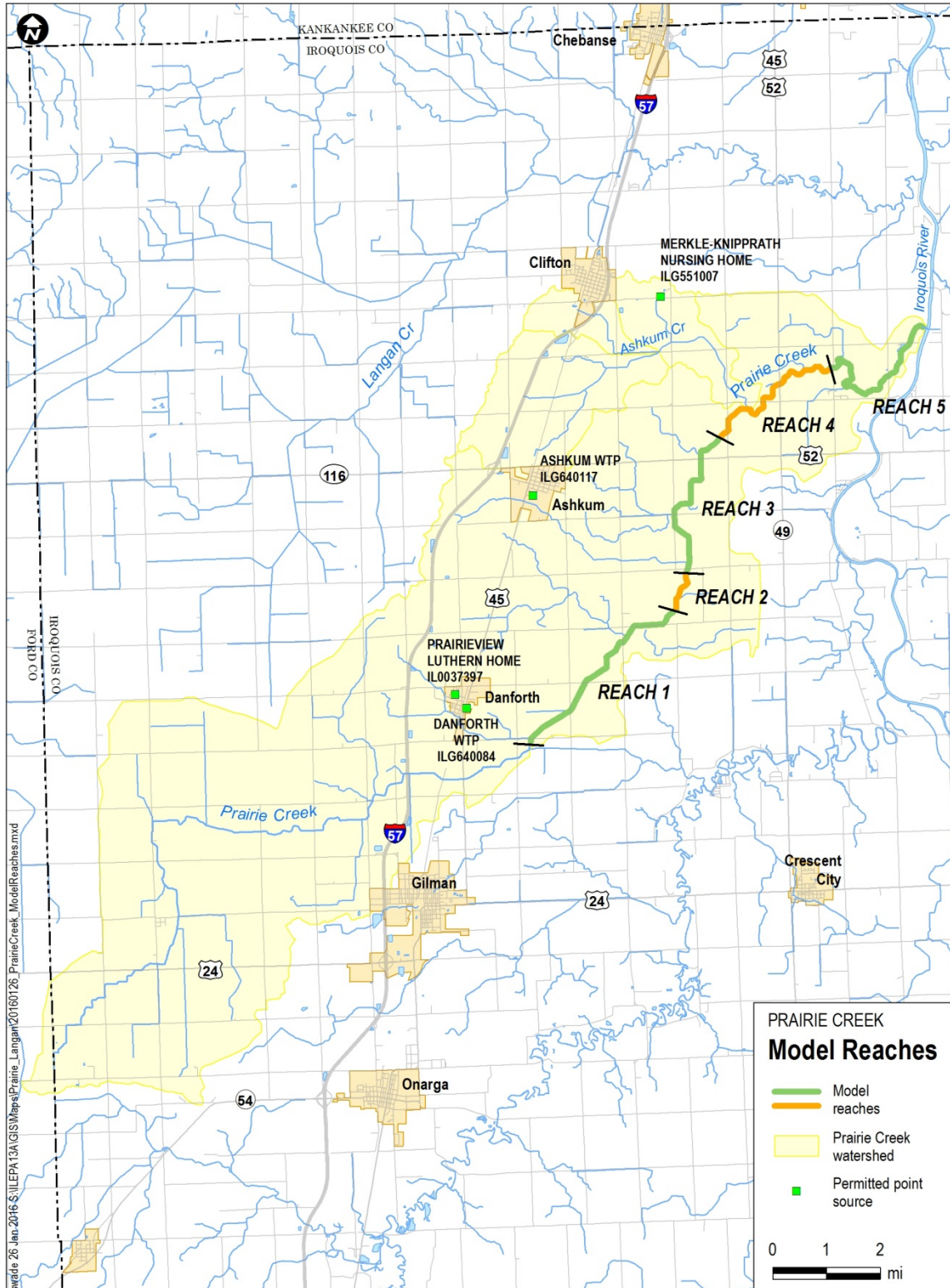


Figure 4-1. Prairie Creek QUAL2E Segmentation



4.1.3.c Hydraulic characteristics

A functional representation was used to describe the hydraulic characteristics of the system. For each reach, velocity and depth were specified, based on measurements taken during the September 2015 field surveys.

4.1.3.d Reach Kinetic Coefficients

Kinetic coefficients were set at typical values in the absence of specific data. The decay rate for ammonia, which was also assumed to be constant over all reaches, was decreased to a low value of 0.01 d^{-1} to match observed concentrations.

4.1.3.e Initial Conditions

Initial model conditions were based on field observations taken during 2015. Specifically, site-specific information on creek flow, velocity, and concentrations ammonia were used to specify initial conditions.

4.1.3.f Incremental Inflow Conditions

Incremental inflows were calculated from the measured flows. Observed increases in flows were added to each reach incrementally (flows were increasing from upstream to downstream). Based on field measurements flow was increasing in the reach immediately below reach four (RM 6.5 – 3.5). Incremental flow was added to reach five (RM 3.5 – 0.1). Other flows came from the headwater and point sources.

4.1.3.g Headwater Characteristics

Headwater characteristics were based on the flow/water quality measurements collected at the more upstream field station (FLG-02). There were no water quality measurements in the headwaters of the watershed.

4.1.3.h Point Source Flows and Loads

The model considers four point sources, including three tributaries which receive effluent from the four permitted dischargers in the watershed. All of these discharges are assumed to contribute small loads (based on discharge monitoring report (DMR) data and some assumptions where data were not available). See Table 4-2 for details of when data were used, and when assumptions were made.

The tributaries were considered to have concentrations at typical background levels (Table 4-2), and were added in with the incremental flow adjustment, and with the headwater flow.



Table 4-2. Concentrations of QUAL2e model inputs.

Model input point	Flow (cfs)	Temp. (Deg C)	DO (mg/L)	BOD (mg/L)	Ammonia (mg/L)	Source
Headwater	0.20	20	7.5	1	0.14	Data collected at FLG-02
Danforth WTP and Prairieview Lutheran Home	0.02	21	6.3	4	0.10	Available water quality for Prairieview: were used to characterize both dischargers. Flows based on monitoring data
Ashkum WTP	0.28	21	6.3	1	0.11	Flows were measured. Water quality concentrations were assumed, due to lack of data.
Merkle-Knipprath Nursing Home	0.02	21	6.3	4	0.10	BOD and flow from data. Other concentrations assumed based on Prairieview effluent data.
Incremental flow at RM3.5	2.01	23	9.6	3.2	0.10	Assumed

4.1.4 QUAL2E Calibration

QUAL2E model calibration consisted of:

- Applying the model with all inputs specified as above
- Comparing model results to observed dissolved oxygen and ammonia data
- Adjusting model coefficients to provide the best comparison between model predictions and observed dissolved oxygen data.

The QUAL2E dissolved oxygen calibration for Prairie Creek (IL_FLG) is discussed below. The model was initially applied with the model inputs as specified above. Observed data for the survey conducted September 3-17, 2015 were used for calibration purposes.

QUAL2E was calibrated to match the observed diurnal averages of dissolved oxygen concentrations measured at two locations (FLG-02 and FLG-01) on the mainstem of the creek. Model results initially under-predicted ammonia data. The mismatch between model and data was minimized during the calibration process by decreasing the ammonia decay rate to align model to data for ammonia and adjusting the point source and headwater ammonia concentrations (where no data was available).

The resulting dissolved oxygen and ammonia predictions compared well to the measured concentrations, as shown in Figure 4-2 and 4-3. The QUAL2E model output files from the calibration run are included in Attachment 3.



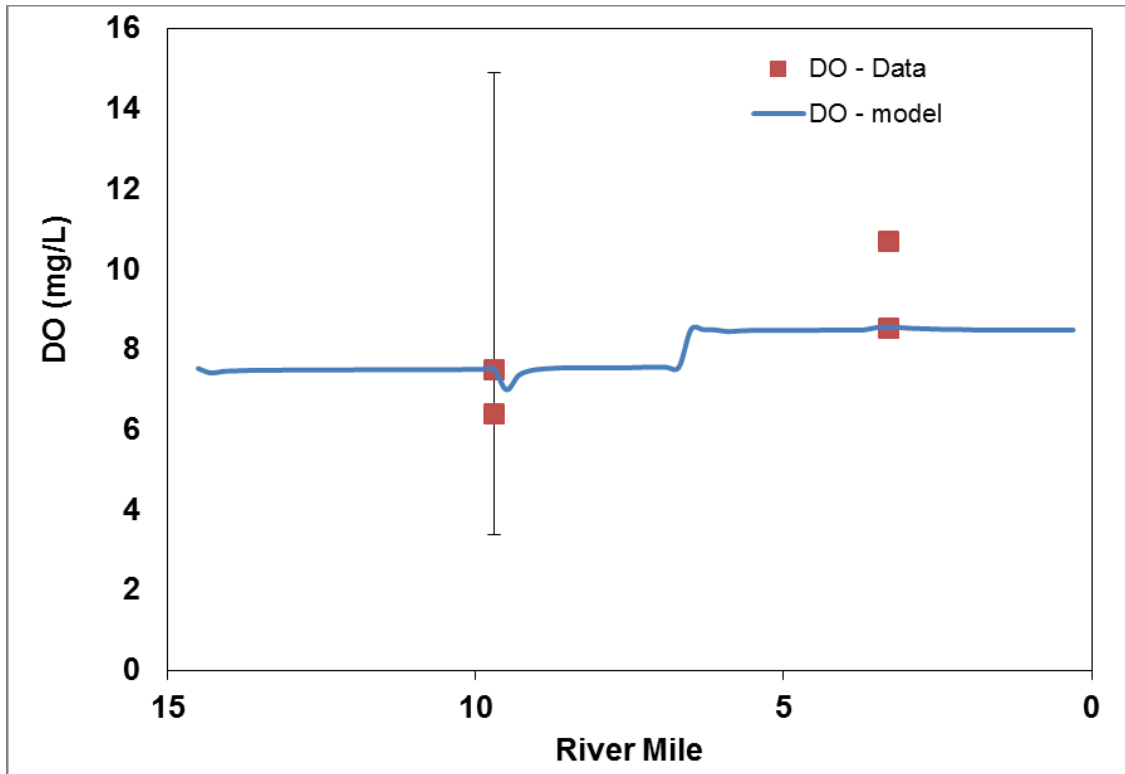


Figure 4-2. QUAL2E DO Calibration Prairie Creek. Error Bars represent the diurnal swing at FLG-02 (the minimum and maximum concentration). This is from data collected by ISWS.

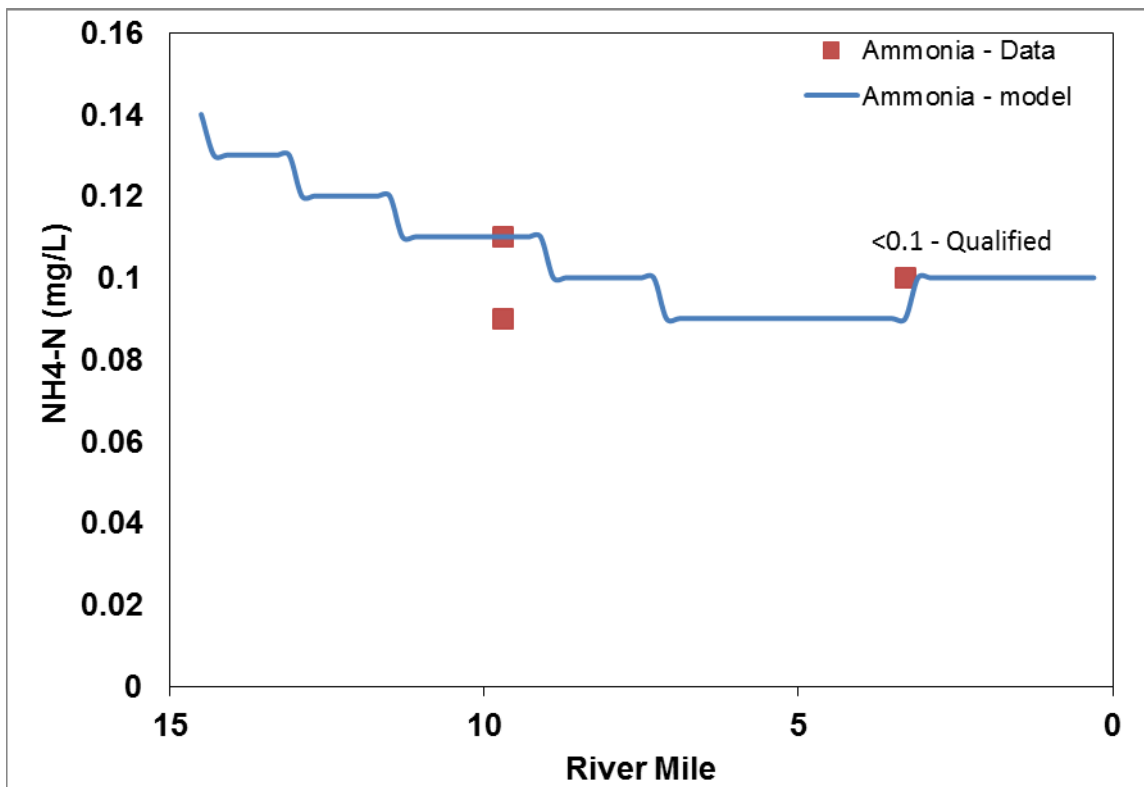


Figure 4-3. QUAL2E Ammonia Calibration Prairie Creek



4.1.5 QUAL2E Sensitivity Analysis

Subsequent to calibrating the QUAL2E model, a sensitivity analysis was conducted to examine the effect of oxygen-demanding substances from point sources on instream dissolved oxygen concentrations. The significance of oxygen-demanding substances was assessed first by performing a QUAL2E sensitivity analysis that set the BOD and ammonia concentrations for each point source to zero, and examined the effect on predicted dissolved oxygen. This sensitivity analysis showed a very minor change (i.e. < 0.2 mg/l) in Prairie Creek dissolved oxygen concentrations in response to elimination of point source oxygen-demanding loads, indicating these sources are an insignificant contributor to the impairment.

In order to further assess the causes of dissolved oxygen violations in Prairie Creek, continuous dissolved oxygen measurements collected during low flow conditions were examined. Figure 4-4 presents continuous dissolved oxygen concentrations at FLG-02 during a period of low flow. As shown in this figure, dissolved oxygen concentrations vary significantly over the course of the day, with differences between daily minima and maxima sometimes exceeding 10 mg/l. This level of diurnal variability is much larger than normal, and is highly correlated to excessive nutrient concentration and the impairment of aquatic life. Heiskary and Markus (2003) concluded that variation in dissolved oxygen concentrations caused by aquatic plant productivity was an important causal pathway between increasing nutrients and decreasing biological quality.

Sediment oxygen demand (SOD) and reduced reaeration due to decreased base stream flow are commonly found to be the cause of dissolved oxygen impairment in Illinois streams. SOD measurements were not available, but SOD was ruled out as a primary contributor to dissolved oxygen violations. This is because SOD reduces the daily average dissolved oxygen levels and the observed data indicate that primary problem is excessive diurnal swings depressing the daily minimum dissolved oxygen. This does not mean that improvements in SOD or reaeration will not benefit the system (because increases in average dissolved oxygen will also increase the daily minimum), only that these factors are not the dominant cause of the impairment.

Phosphorus was determined to be the primary cause of the dissolved oxygen impairment, due to its role in causing excess aquatic plant growth and resultant excessive diurnal variability. As such, the LRS will be developed to meet in-stream phosphorus targets judged to be protective of the dissolved oxygen standard.



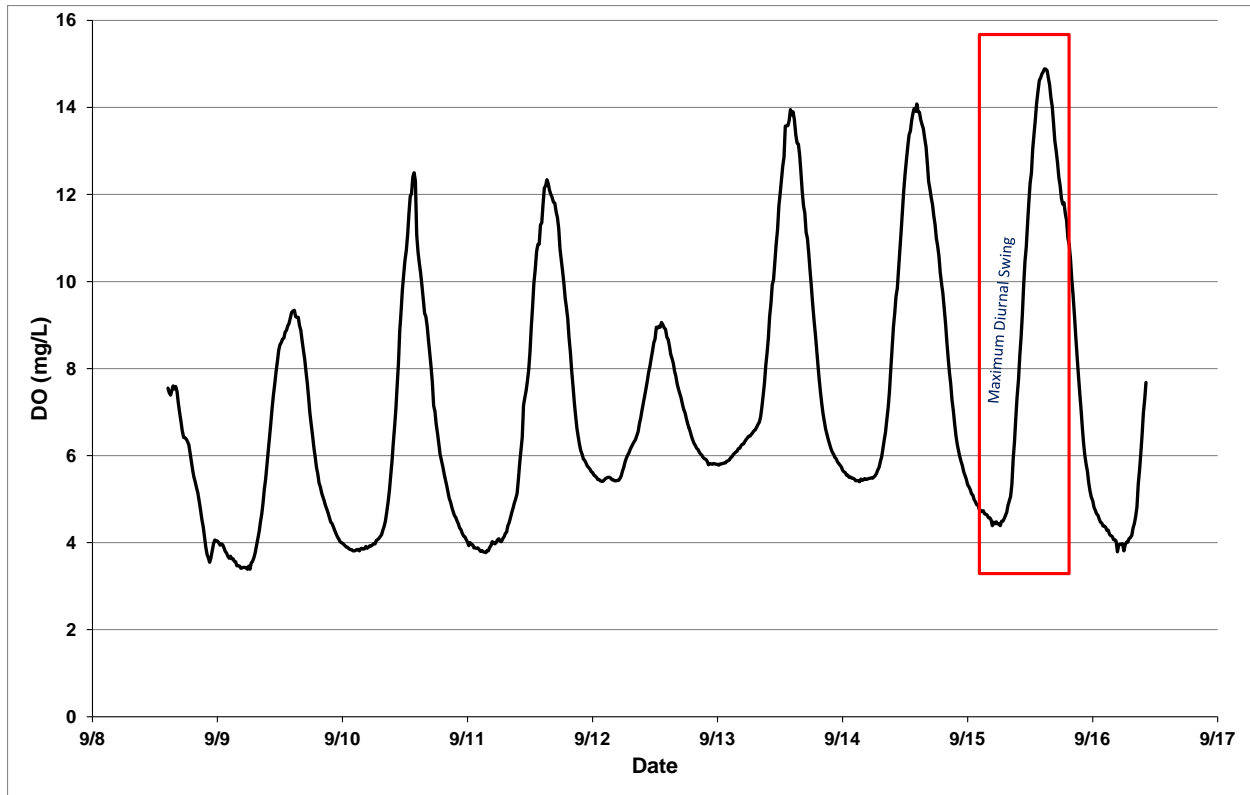


Figure 4-4. Continuous Dissolved Oxygen Concentrations at FLG-02 in September 2015. The maximum diurnal swing in this period highlighted in a red box.

4.2 Total Phosphorus Model for Load Reduction Strategy

This section describes the model selection and modeling approach for the total phosphorus load reduction strategy for four streams identified by IEPA as being impaired due to elevated phosphorus concentrations, as well as the total phosphorus load reduction strategy for the Prairie Creek dissolved oxygen impairment which is also due to elevated phosphorus concentrations.

4.2.1 Model Selection

The total phosphorus load reduction strategy is based on a simple dilution model using instream phosphorus data collected in 2014 by IEPA. The model assumes that instream phosphorus concentrations are directly proportional to the phosphorus loading rate, such that a given percentage reduction in phosphorus load results in an identical reduction in instream phosphorus concentration. The Prairie Creek LRS is based on this same model.

4.2.2 Modeling Approach

To support LRS development, total phosphorus measurements collected in the four streams (Langan Creek/IL_FLE-02, Clifton North/IL_FLEA-C1, Ashkum Creek/IL_FLGB-C1; and Clifton South Creek/IL_FLGZ-C1) were compared to the target total phosphorus concentration of 0.104 mg/L (Section 4.1) to determine the percent reduction needed for the LRS for each impaired waterbody segment. To support Prairie Creek LRS development, total phosphorus measurements collected in Prairie Creek/IL_FLG, were compared to the phosphorus target for Prairie Creek which is discussed in Section 5.1.



5

LRS Development

This section presents the development of the Prairie Creek (IL_FLG) total phosphorus load reduction strategy to address the dissolved oxygen impairment. It also presents the total phosphorus load reduction strategy for four other streams impaired due to total phosphorus. IEPA requires each LRS to identify the load capacity, and the percentage reduction needed. These are presented below.

5.1 LRS Percent Reduction

This section describes the methods used to calculate the percent reduction for the total phosphorus LRSs for five stream segments.

5.1.1 Prairie Creek

Phosphorus is the pollutant of concern for Prairie Creek, due to its influence on algal growth and resulting diurnal dissolved oxygen swings. Over an approximately 8-day period in September 2015, dissolved oxygen was observed to vary from 3.39 mg/l to 14.89 mg/l at station FLG-02, illustrating a maximum diurnal swing of 10.5 mg/l over this period. Measured phosphorus concentrations in Prairie Creek ranged from 0.046 to 0.618 mg/l during 2014 and 2015 sampling, and these concentrations are sufficiently elevated that they are not limiting algal growth.

The objective of the model simulation was to define the extent that phosphorus loads would need to be reduced in order for Prairie Creek to comply with the dissolved oxygen target. To conduct this determination, the magnitude of the diurnal dissolved oxygen variation was assumed to be directly proportional to the phosphorus concentration. This assumption was made because the correlation between phosphorus concentration, aquatic plant productivity, and resulting diurnal variation is well established, and insufficient site-specific data exist on the nature and density (e.g. Heiskary and Markus, 2003; Miltner, 2010; USEPA, 2000) of aquatic plants present in Prairie Creek to develop a model that supports anything other than a direct proportional relationship.

The first step in calculating the loading capacity was to determine the reduction in phosphorus load that would result in Prairie Creek attaining the daily minimum dissolved oxygen standard of 5.0 mg/l. The required reduction was calculated as:

$$\% \text{ reduction} = 100 - 100 \times (\text{diurnal necessary to attain WQS}) / (\text{existing diurnal})$$

Given a maximum diurnal swing of 10.5 mg/l (Figure 5-4) observed during the 2015 continuous DO monitoring and a maximum allowable DO swing of 7.8 mg/l, it was determined that a 26% phosphorus load reduction is required for Prairie Creek to attain 5.0 mg/l dissolved oxygen.

5.1.2 Four Streams

The percent reduction was calculated by comparing 2014 measured total phosphorus concentrations (Attachment 1) to the LRS target concentration. Table 5-1 presents the percent reduction for each of the four streams.



Table 5-1. Total Phosphorus Concentration and Percent Reduction

Stream (Segment)	Monitoring Station	Target (mg/L)	Average 2014 Concentration (mg/L)	Percent Reduction
Langan Creek (IL_FLE-02)	FLE-02	0.104	0.21	50%
Clifton N. Creek (IL_FLEA-C1)	FLEA-C-C2	0.104	1.86	94%
Ashkum Creek (IL_FLGB-C1)	FLGB-S-C2A	0.104	0.83	87%
Clifton S. Creek (IL_FLGZ-C1)	FLGZ-C-C1A	0.104	0.47	78%

5.2 Current Load and Load Capacity

The current annual phosphorus loads for each of the five impaired stream segments were calculated using a simple watershed model, L-THIA, as well as estimates of livestock and septic loads.

The L-THIA tool is accessible online¹ allows the user to select a watershed and then provides feedback on the load contribution by source area through the use of land cover, soils, and 30 years of daily precipitation from a nearby gage. By applying the Curve Number method and estimated event mean concentrations, L-THIA calculates total phosphorus loads for surface runoff. Livestock loads were calculated by downscaling the countywide livestock numbers to the area of the watershed in Iroquois County and consider the nutrient content of manure (<http://pubs.usgs.gov/sir/2006/5012/>). Septic loads were based on a GIS-analysis to identify the number of homes outside of sewer areas, an average effluent phosphorus concentration and per capita flow volume.

Total phosphorus loads by stream segment subwatershed are presented in Table 5-2 and source-specific loads are presented in a separate implementation plan.

The load capacity for each stream segment was calculated based on the current load and the necessary percent reduction. Table 5-2 presents the results of this calculation for each stream segment, along with the average annual phosphorus load reduction needed to meet the load capacity.

Table 5-2. LRS Summary

Stream (Segment)	Current Average Annual Phosphorus Load (lbs/yr)	Target LRS Percent Reduction	Load capacity (lbs/yr)	Target Average Annual Phosphorus Load Reduction (lbs/yr)
Langan Creek (IL_FLE-02)	164,360	50%	93,456	82,180
Clifton N. Creek (IL_FLEA-C1)	3,009	94%	205	2,828
Prairie Creek (IL_FLG)	163,540	26%	137,625	42,521
Ashkum Creek (IL_FLGB-C1)	11,614	87%	1,717	10,104
Clifton S. Creek (IL_FLGZ-C1)	3,258	78%	815	2,541

¹ <https://engineering.purdue.edu/~lthia/>



References

- Brown, L. C. and T. O. Barnwell, Jr., 1987. The enhanced stream water quality models QUAL2E and QUAL2E-UNCAS: Documentation and User Manual. Tufts University and US EPA, Athens, Georgia.
- Heiskary S. and H Markus. 2003. Establishing relationships among instream nutrient concentrations, phytoplankton and periphyton abundance and composition, fish and macroinvertebrate indices, and biochemical oxygen demand in Minnesota USA rivers. Minnesota Pollution Control Agency, Environmental Outcomes Division, St. Paul, MN.
- Illinois Environmental Protection Agency (IEPA), 2015. Illinois EPA Watershed Management Load Reduction Strategy. Filename: Load Reduction Handout_03-25-2015_AH_BW.docx IEPA, 2014. *Illinois Integrated Water Quality Report and Section 303(d) List, 2014. Clean Water Act Sections 303(d), 305(b) and 314*. Water Resource Assessment Information and List of Impaired Waters Volume I: Surface Water. March 24, 2014. Illinois Environmental Protection Agency, Bureau of Water. Springfield, Illinois. Accessed online on 11/06/15 at: <http://www.epa.illinois.gov/topics/water-quality/watershed-management/tmdls/303d-list/>
- IEPA, 2012. *Illinois Integrated Water Quality Report and Section 303(D) List, 2012*. Clean Water Act Sections 303(d), 305(b) and 314 Water Resource Assessment Information and List of Impaired Waters Volume I: Surface Water. Bureau of Water, Division of Water Pollution Control. Springfield, Illinois.
- Miltner, R. J. 2010. A Method and Rationale for Deriving Nutrient Criteria for Small Rivers and Streams in Ohio. Environmental Management. DOI 10.1007/s00267-010-9439-9.
- Smith, D.R., K.W. King, L. Johnson, W. Francesconi, P. Richards, D. Baker and A. N. Sharpley. 2014. Surface Runoff and Tile Drainage Transport of Phosphorus in the Midwestern United States. DOI: 10.2134/jeq2014.04.0176.
- USEPA, 2000. Nutrient Criteria Technical Guidance Manual, Rivers and Streams. Office of Water. EPA-822-B-00-002.
- USEPA, 1991. *Guidance for Water Quality-based Decisions: The TMDL Process*. EPA 440/4-91-001. Office of Water, Washington, DC.



Attachment 1:
2014 IEPA Assessment
Stage 2 Monitoring Data
2014 IEPA Total phosphorus data
2015 IEPA Prairie Creek data
2015 ISWS Prairie Creek continuous data



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ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

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BRUCE RAUNER, GOVERNOR LISA BONNETT, DIRECTOR

217/782-3362

July 6, 2015

LimnoTech
Attn: Ms. Penelope Moskus
501 Avis Drive
Ann Arbor, MI 48108

Re: Prairie-Langan Creek TMDL Watershed Stage Two Monitoring

Penelope,

The Prairie-Langan Creek Watershed Stage One TMDL report contained recommendations for additional monitoring on most of the streams in the watershed targeted for TMDL and Load Reduction Strategy (LRS) development. Data for many of the original assessments and subsequent 303(d) listings were based on data collected in 1994. The Agency conducted Stage Two monitoring monthly from May-September of 2014. On September 23 and 24, 2014, the Agency's Surface Water Section staff in the Des Plaines regional office conducted Facility Related Stream Surveys (FRSS) for the following streams:

- Clifton North Creek FLEA-C1
- Ashkum Creek FLGB-C1
- Ashkum Creek FLGB-C4

FRSS could not be conducted for Clifton South Creek FLGZ-C1 due to no flow being present when the other surveys were conducted. FRSS was not conducted in 2014 for Prairie Creek FLG since data was collected during the 2010 Intensive Basin Survey. FRSS was also not conducted in 2014 for Langan Creek FLE-02. The assessment for FLE-02 was extrapolated from the upstream Clifton North Creek segment FLEA-C1. The water quality data collected during Stage Two monitoring for FLG and FLE-02 was used for updating cause of impairment.

A short summary of each assessment is listed below:

IL_FLEA-C1

Not supporting – fair. Causes: changes in stream depth and velocity patterns, phosphorus. Station FLEA-C-C2: MBI = 6.7. QHEI = 56; recovering channelization, riparian width very narrow, bank erosion – none. Impounded upstream of bridge. Dam like concrete pad underneath bridge - water drops about 2 feet on downstream side of bridge. Pool/slow run upstream, riffle/run downstream. New Village of Clifton waste water treatment plant upstream. No General Use water quality standard exceedances (six samples).

IL_FLE-02

Not supporting – fair. Cause: phosphorus

Station FLE-02: no General Use water quality standard exceedances (five samples). New wastewater treatment plant replaced wildcat sewer system that discharged into Clifton North Creek tributary to Langan Creek. Poor water quality from the wildcat sewer system and a large debris jam just downstream of the confluence of Langan Creek and Clifton North Creek in 1994 caused the previous poor conditions in this segment.

IL_FLGB-C1

Not supporting - fair. Cause: Alteration in stream-side or littoral vegetative covers, phosphorus.

Station FLGB-S-C2A: MBI = 7.8. QHEI = 31; channelization - recent or no recovery; no riparian width; land use - row crops; bottom substrate sand, silt, fine gravel. Recent replacement of culvert and road resurfaced. No General Use water quality standard exceedances (four samples). Note: ammonia nitrogen 11.2 mg/L, total Kjeldahl nitrogen 9.91 mg/L on 9/23/14. This is a QC issue because TKN should be higher than ammonia since it includes both ammonia and organic nitrogen. The field pH for this sample was 7.7, resulting in an acute ammonia nitrogen standard of 14.7 mg/L.

IL_FLGZ-C1

Not supporting – fair. Causes: phosphorus, sedimentation/siltation

Three water quality samples at station FLGZ-C-C1A in May, June and July - no General Use Water Quality Standards exceedances. No samples in August and September due to no flow. Clifton South wildcat sewer system, which was the source of impairment in 1994, has since been replaced with a new Village of Clifton waste water treatment plant that discharges into Clifton North Creek (FLEA).

IL_FLGB-C4

Full Use

Station FLGB-S-C4: MBI = 5.4. QHEI = 52, recovering channelization; no riparian width, gravel substrate, row crops. No General Use water quality standard exceedances (one sample); station FLGB-S-C5 - no General Use water quality standard exceedances (five samples).

IL_FLG

Not supporting – fair (unchanged from previous assessment 2012, based on 2010 Intensive Basin Survey). One General Use water quality standard exceedance (dissolved oxygen) per four readings at station FLG-02, source unknown; no chemical exceedances (five samples).

Therefore, based on the Stage Two monitoring results, Stage Three shall be conducted for the following water body segments and associated parameters. See Table 1 below.

Table 1.

Waterbody Name	AUID	Pollutant	Type
Langan Creek	FLE-02	total phosphorus	Load Reduction Strategy
Clifton South Creek	FLGZ-C1	total phosphorus	Load Reduction Strategy
Clifton North Creek	FLEA-C1	total phosphorus	Load Reduction Strategy
Ashkum Creek	FLGB-C1	total phosphorus	Load Reduction Strategy
Prairie Creek	FLG	dissolved oxygen	Total Maximum Daily Load

The water quality data collected during Stage Two and FRSSs will be sent to you in a separate email. Information contained in this letter and the associated water quality data should be included in the Stage Three TMDL Report to document the work conducted and updated assessment information. Should you have any questions, please contact me at the number listed above.

Sincerely,



Trevor Sample

Stage 2 Monitoring Data



2014 IEPA Total Phosphorus Data

These data have not yet been reviewed by the Illinois EPA Surface Water Section for their utility for Clean Water Act assessment and reporting.

These data are subject to change pending such review.

ReportedBy	SampleGroup	LabSampleID	StationCode	CollectionDate	CollectionTime	ReceiptDate	ReceiptTime	PrepDate	PrepTime	AnalysisDate	AnalysisTime	SampleMedium	MethodCode	Analyte	SampleFract	Result_M	Result_Uni	Qu	MethodD	Metho	Report	Repor	ReportDate
IllinoisEPA_DivisionOfLaboratori	SE40577	SE40577-01	FLE-02	5/13/2014	10:40	5/13/2014	15:30	5/15/2014	10:15	5/16/2014	12:43	Water	365.3	Phosphorus	Total	0.402	mg/l		0.0034	mg/l	0.005	mg/l	12/11/2014
IllinoisEPA_DivisionOfLaboratori	SF40559	SF40559-01	FLE-02	6/11/2014	10:32	6/11/2014	15:00	6/13/2014	9:45	6/16/2014	14:11	Water	365.1	Phosphorus	Total	0.318	mg/l		0.0034	mg/l	0.005	mg/l	12/19/2014
IllinoisEPA_DivisionOfLaboratori	SG41858	SG41858-01	FLE-02	7/31/2014	11:05	7/31/2014	16:05	8/5/2014	11:07	8/6/2014	11:37	Water	365.1	Phosphorus	Total	0.149	mg/l		0.0034	mg/l	0.005	mg/l	1/30/2015
IllinoisEPA_DivisionOfLaboratori	SH41939	SH41939-01	FLE-02	8/27/2014	11:06	8/27/2014	16:05	9/2/2014	11:30	9/4/2014	10:13	Water	365.1	Phosphorus	Total	0.126	mg/l		0.0034	mg/l	0.005	mg/l	2/10/2015
IllinoisEPA_DivisionOfLaboratori	SI41230	SI41230-01	FLE-02	9/24/2014	11:42:00	9/24/2014	16:05:00	9/26/2014	10:11:00	9/29/2014	14:27:17	Water	365.1	Phosphorus	Total	0.053	mg/l		0.0034	mg/l	0.005	mg/l	3/13/2015
IllinoisEPA_DivisionOfLaboratori	SE40579	SE40579-01	FLEA-C-C2	5/13/2014	10:25	5/13/2014	15:30	5/15/2014	10:15	5/16/2014	12:45	Water	365.3	Phosphorus	Total	0.318	mg/l		0.0034	mg/l	0.005	mg/l	12/11/2014
IllinoisEPA_DivisionOfLaboratori	SF40560	SF40560-01	FLEA-C-C2	6/11/2014	10:15	6/11/2014	15:00	6/13/2014	9:45	6/16/2014	14:12	Water	365.1	Phosphorus	Total	0.329	mg/l		0.0034	mg/l	0.005	mg/l	12/19/2014
IllinoisEPA_DivisionOfLaboratori	SG41857	SG41857-01	FLEA-C-C2	7/31/2014	10:45	7/31/2014	16:05	8/5/2014	11:07	8/6/2014	12:00	Water	365.1	Phosphorus	Total	3.14	mg/l		0.0034	mg/l	0.005	mg/l	1/30/2015
IllinoisEPA_DivisionOfLaboratori	SH41938	SH41938-01	FLEA-C-C2	8/27/2014	10:51	8/27/2014	16:05	9/2/2014	11:30	9/4/2014	10:13	Water	365.1	Phosphorus	Total	2.76	mg/l	J3	0.0034	mg/l	0.005	mg/l	2/10/2015
IllinoisEPA_DivisionOfLaboratori	SI41231	SI41231-01	FLEA-C-C2	9/24/2014	11:23:00	9/24/2014	16:05:00	9/26/2014	10:11:00	9/29/2014	14:55:14	Water	365.1	Phosphorus	Total	2.28	mg/l		0.0034	mg/l	0.005	mg/l	3/13/2015
IllinoisEPA_DivisionOfLaboratori	SI41321	SI41321-01	FLEA-C-C2	9/24/2014	12:30:00	9/26/2014	9:30:00	9/29/2014	11:09:00	9/30/2014	16:32:53	Water	365.1	Phosphorus	Total	2.31	mg/l		0.0034	mg/l	0.005	mg/l	3/13/2015
IllinoisEPA_DivisionOfLaboratori	SE40573	SE40573-01	FLGB-S-C2A	5/13/2014	12:20	5/13/2014	15:30	5/15/2014	10:15	5/16/2014	12:42	Water	365.3	Phosphorus	Total	0.473	mg/l		0.0034	mg/l	0.005	mg/l	12/11/2014
IllinoisEPA_DivisionOfLaboratori	SF40558	SF40558-01	FLGB-S-C2A	6/11/2014	11:55	6/11/2014	15:00	6/13/2014	9:45	6/16/2014	14:11	Water	365.1	Phosphorus	Total	0.331	mg/l		0.0034	mg/l	0.005	mg/l	12/19/2014
IllinoisEPA_DivisionOfLaboratori	SG41854	SG41854-01	FLGB-S-C2A	7/31/2014	12:30	7/31/2014	16:05	8/5/2014	11:07	8/6/2014	11:34	Water	365.1	Phosphorus	Total	0.1	mg/l		0.0034	mg/l	0.005	mg/l	1/30/2015
IllinoisEPA_DivisionOfLaboratori	SI41322	SI41322-01	FLGB-S-C2A	9/23/2014	13:00	9/26/2014	9:30	9/29/2014	11:09	9/30/2014	16:34	Water	365.1	Phosphorus	Total	2.41	mg/l		0.0034	mg/l	0.005	mg/l	2/19/2015
IllinoisEPA_DivisionOfLaboratori	SE40578	SE40578-01	FLGZ-C-C1A	5/13/2014	11:05	5/13/2014	15:30	5/15/2014	10:15	5/16/2014	12:44	Water	365.3	Phosphorus	Total	0.589	mg/l		0.0034	mg/l	0.005	mg/l	12/11/2014
IllinoisEPA_DivisionOfLaboratori	SF40556	SF40556-01	FLGZ-C-C1A	6/11/2014	10:50	6/11/2014	15:00	6/13/2014	9:43	6/16/2014	15:12	Water	365.1	Phosphorus	Total	0.342	mg/l		0.0034	mg/l	0.005	mg/l	12/19/2014
IllinoisEPA_DivisionOfLaboratori	SG41856	SG41856-01	FLGZ-C-C1A	7/31/2014	11:30	7/31/2014	16:05	8/5/2014	11:07	8/6/2014	11:35	Water	365.1	Phosphorus	Total	0.484	mg/l		0.0034	mg/l	0.005	mg/l	1/30/2015

2015 IEPA Prairie Creek Data

Station	Parameter	Total or Dissolved	Date	Time	Result	Qualifier	Units	Reporting Limit	MDL	Notes
FLG-01	Temp_Water		9/17/2015	17:20	25.62		deg, C			78.116 deg F
FLG-01	Temp_Water		9/17/2015	9:55	19.99		deg, C			67.982 deg F
FLG-02	Temp_Water		9/16/2015	11:30	19.89		deg, C			67.802 deg F
FLG-01	Dissolved oxygen		9/17/2015	17:20	10.7		mg/L			
FLG-01	Dissolved oxygen		9/17/2015	9:55	8.51		mg/L			
FLG-02	Dissolved oxygen		9/16/2015	11:30	7.49		mg/L			
FLG-02	NH4-N	TOTAL	9/8/2015	13:32	0.09	J	mg/L	0.1	0.03	
FLG-02	TKN	TOTAL	9/8/2015	13:32	1.48		mg/L	0.5	0.16	
FLG-01	NH4-N	TOTAL	9/17/2015	9:55		ND	mg/L	0.1	0.03	
FLG-01	TKN	TOTAL	9/17/2015	9:55	0.64		mg/L	0.5	0.16	
FLG-02	NH4-N	TOTAL	9/16/2015	11:30	0.11		mg/L	0.1	0.03	
FLG-02	TKN	TOTAL	9/16/2015	11:30	0.96		mg/L	0.5	0.16	
FLG-02	Chlorophyll-A (corr)	TOTAL	9/16/2015	11:30	11.6		ug/L	0.5		
FLG-02	Chlorophyll-A (unco)	TOTAL	9/16/2015	11:30	17.5		ug/L	0.5		
FLG-01	Chlorophyll-A (corr)	TOTAL	9/17/2015	9:55	4.45		ug/L	0.5		
FLG-01	Chlorophyll-A (unco)	TOTAL	9/17/2015	9:55	5.71		ug/L	0.5		
FLG-01	Discharge		9/17/2015	8:49	2.53		cfs			
FLG-01	Mean Depth		9/17/2015	8:49	0.419		ft			
FLG-01	Total Width		9/17/2015	8:49	21		ft			
FLG-02	Discharge		9/16/2015	9:45	0.2246		cfs			
FLG-02	Mean Depth		9/16/2015	9:45	0.839		ft			
FLG-02	Total Width		9/16/2015	9:45	21.1		ft			
FLG-02	Discharge		9/8/2015	13:33	-0.2717		cfs			
FLG-02	Mean Depth		9/8/2015	13:33	0.855		ft			
FLG-02	Total Width		9/8/2015	13:33	20.197		ft			
FLG-01	Mean Velocity - calculated by RSL		9/17/2015		0.28809		ft/sec			
FLG-02	Mean Velocity - calculated by RSL		9/16/2015		0.012687		ft/sec			
FLG-02	Organic N calculated by RSL		9/16/2015		0.85		mg/L			
FLG-02	Phosphorus as P All Forms		9/8/2015	13:32	0.371		mg/L	0.005	0.0034	
FLG-01	Phosphorus as P All Forms		9/17/2015	9:55	0.088		mg/L	0.005	0.0034	
FLG-02	Phosphorus as P All Forms		9/16/2015	11:30	0.196		mg/L	0.005	0.0034	

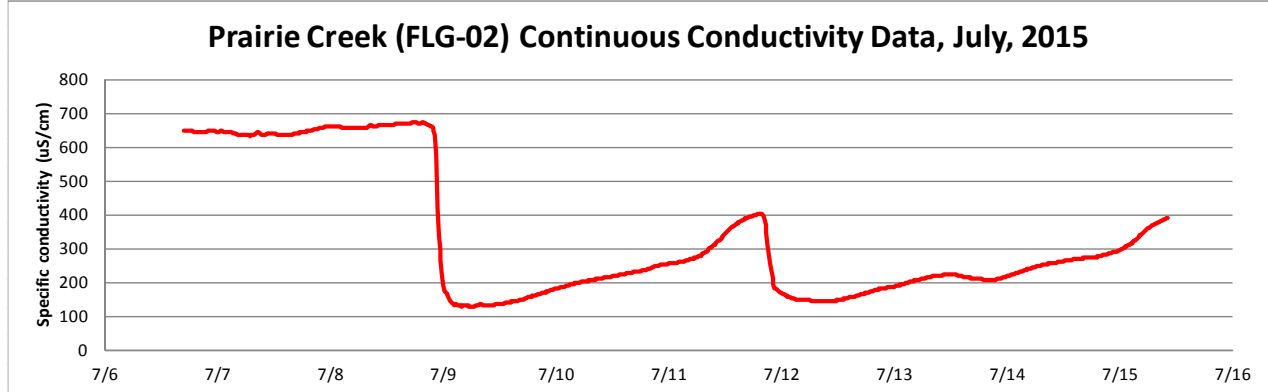
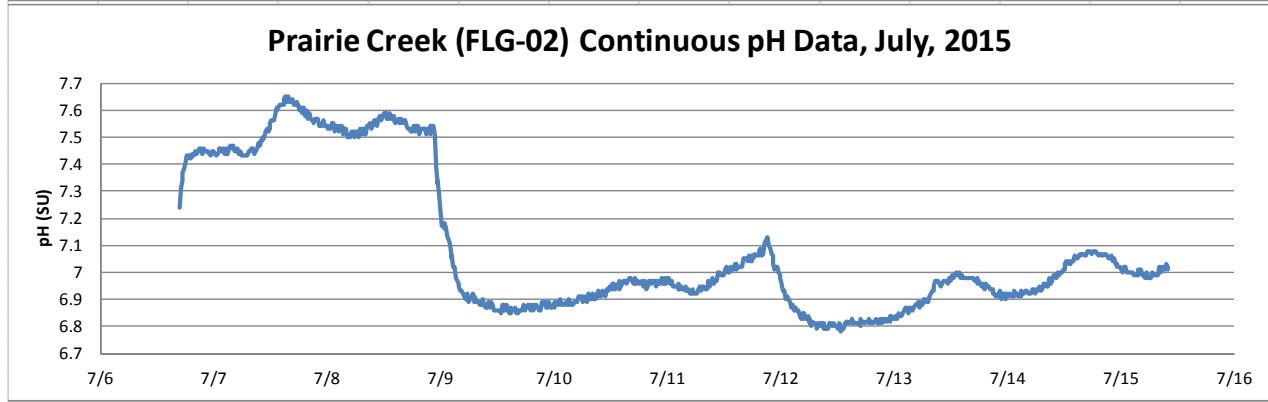
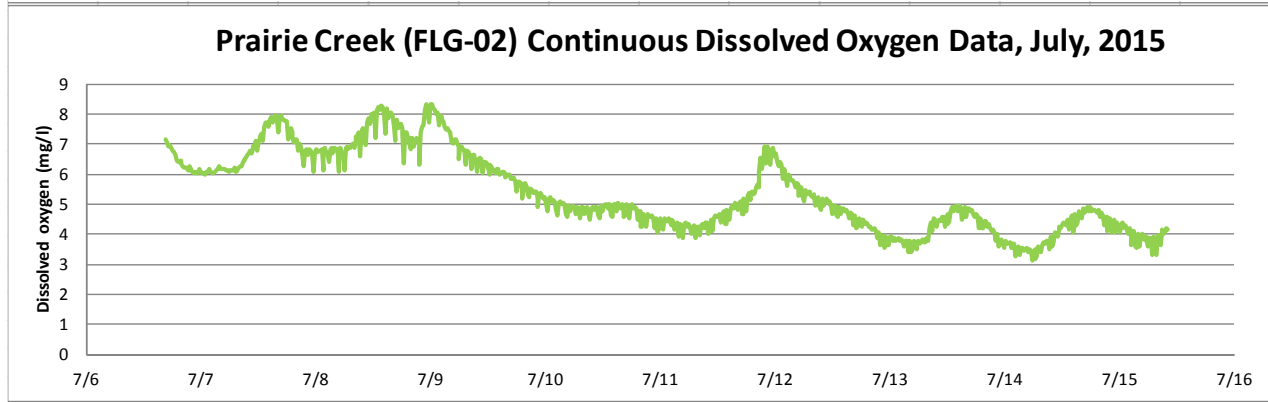
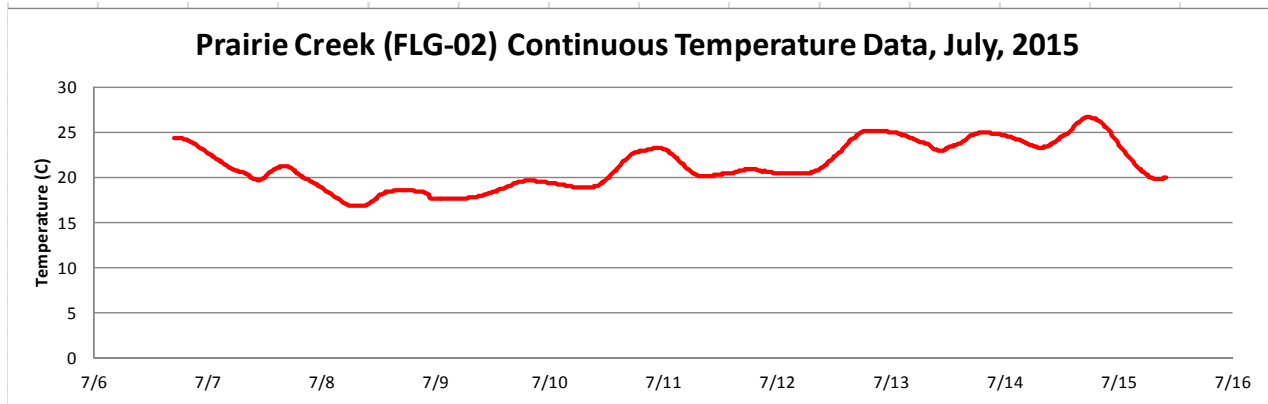


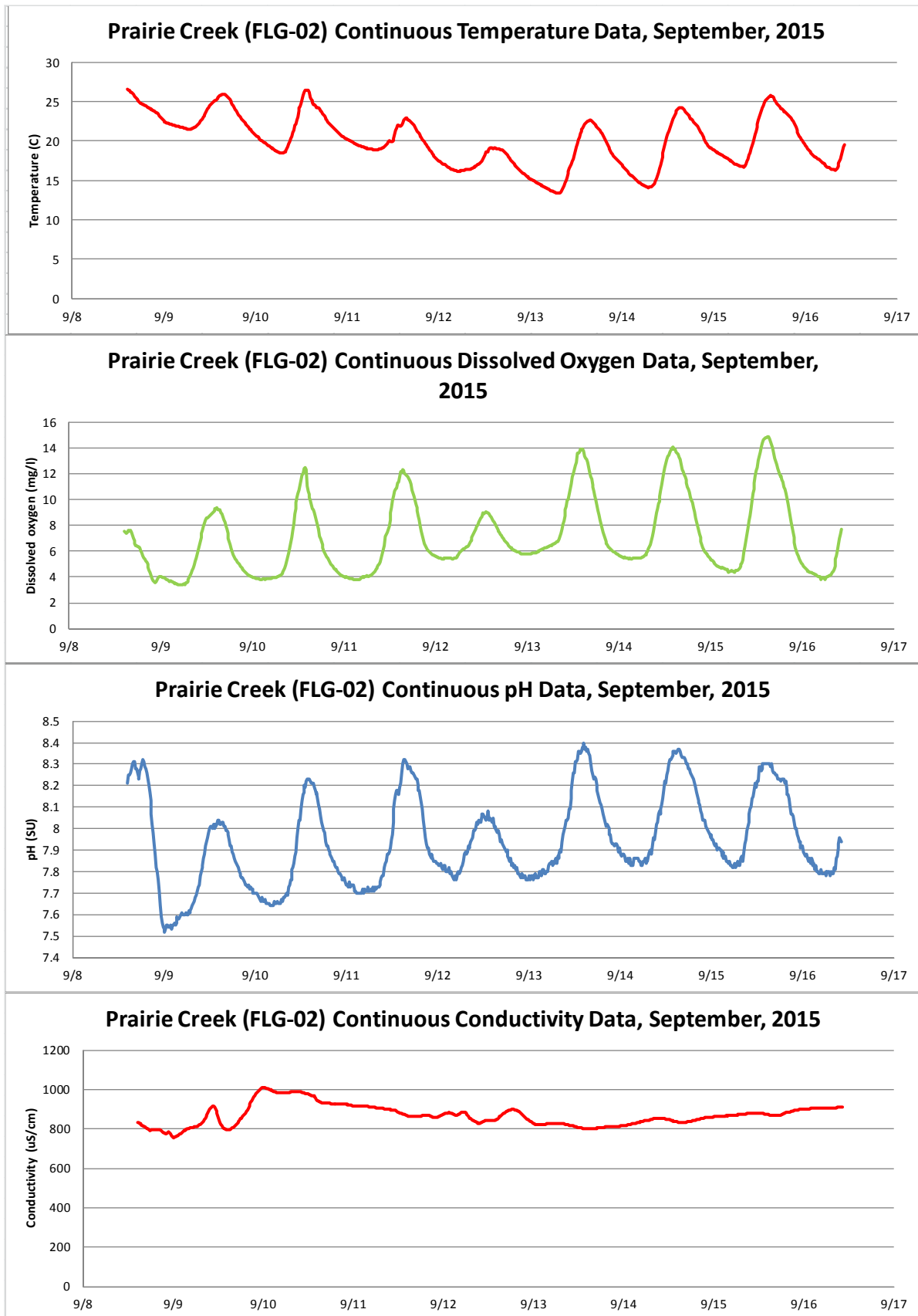
2015 ISWS Prairie Creek continuous data



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Attachment 2:

IEPA Watershed Management Load Reduction Strategy



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Load Reduction Strategy

As part of the TMDL development process the Agency started to include Load Reduction Strategies (LRS) in TMDL watershed projects in 2012 for those pollutants that do not currently have a numeric water quality standards. Developing an LRS involves determining the loading capacity and load reduction necessary that is needed in order for the water body to meet “**Full Use Support**” for its designated uses. The load capacity is not divided into WLA, LA, or MOS, these are represented by one number as a target concentration for load reduction within each unique watershed. This LRS here is only for two parameters (Total Phosphorus and Total Suspended Solids); all other parameters such as Sedimentation/Siltation and Turbidity will be addressed separately. The Load Reduction Strategy provides guidance (with no regulatory requirements) for voluntary nonpoint source reduction efforts by implementing agricultural and urban stormwater best management practices (BMPs).

To arrive at these results, three tasks were performed: **Identification**, **Analysis**, and **Application**.

Identification:

1. For each TMDL watershed, the US Geological Survey ten-digit Hydrologic Unit Code, or HUC-10 was identified.
2. Within each HUC-10, each and every stream segment or lake was identified.
3. Each stream segment or lake was checked against the Illinois EPA Assessment Data Base (or ADB) to determine those segments and lakes that are in full support for aquatic life.
4. For each HUC-10 basin, full-support stream segments and lakes were grouped to show where each unique watershed is at its best in providing a healthy environment for aquatic plants and animals. A statewide “one size fits all” approach was purposefully avoided to allow the distinct nature of each watershed to become apparent.

Analysis:

1. For each stream segment or lake that fully supports designated uses, the water quality data from 1999 through 2013 was compiled. This includes data from the Illinois EPA’s Surface Water Section’s ambient monitoring, intensive basin surveys, and special studies. The pollutants (or parameters) for which data compiled data are Total Phosphorus (TP) and Total Suspended Solids (TSS), those pollutants requiring an LRS be developed.
2. This data underwent a last quality control check and carefully discriminated against any data that did not pass all the rigorous quality assurance checks. Only the data that passed all checks was used to calculate the targets in this strategy.
3. Mathematical operations were kept to a minimum in order to establish targets which are as accurate and relevant as possible. For each stream segment (or lake), the raw average of all available data from 1999 through 2013 was calculated for TP and TSS, respectively.

Application:

1. For each stream segment or lake, an average concentration for TP and/or TSS over the entire time period was calculated.
2. Within each unique watershed, these long-term results for TP and TSS for all the fully supporting segments and streams in the watershed were averaged together. This allows these healthy waters to most accurately represent the level of aquatic life support the watershed is capable of providing.
3. The average concentrations for the aquatic-life-supporting water bodies were then assigned as targets for all water bodies of the same type in the watershed, e.g. stream targets for streams, lake targets for lakes. The rationale for assigning this composite average is that within a given watershed, all streams for example share similar geology, soil type, land use, agricultural practices, and topography. The same holds true for lakes.

Finally, the average of these long-term concentrations can be the target concentrations for impaired stream segments or lakes requiring an LRS be developed.

The targets for each watershed are presented below:

Pecatonica Watershed-Wide Load Reduction Targets

USGS HUC-10 Basins Addressed: 0709000311, 0709000312, 0709000313, 0709000314, 0709000315, 0709000316, 0709000408, and 0709000215.

The following stream segments are full use support in the Pecatonica watershed:

- Pecatonica River PW-07
- Pecatonica River PW-02
- Waddams Creek PWQ-04
- Raccoon Creek PWA-01
- Sugar Creek PWB-03
- Sumner Creek PWH-02
- Rock Run PWI-01
- Richland Creek PWP-06
- Cedar Creek PWPA-01
- Otter Creek PWBA-02

The averages of data for each fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Pecatonica River PW-07	0.19 mg/l	93 mg/l
Pecatonica River PW-02	0.206 mg/l	66 mg/l
Waddams Creek PWQ-04	0.4 mg/l	14 mg/l
Raccoon Creek PWA-01	0.091 mg/l	20 mg/l
Sugar Creek PWB-03	0.16 mg/l	63 mg/l
Sumner Creek PWH-02	0.036 mg/l	13.5 mg/l
Rock Run PWI-01	0.074 mg/l	18 mg/l
Richland Creek PWP-06	0.17 mg/l	53 mg/l
Cedar Creek PWPA-01	0.062 mg/l	22 mg/l
Otter Creek PWBA-02	0.165 mg/l	35 mg/l
Raw Average	0.156 mg/l	40 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.156 milligrams/liter

Total Suspended Solids: 40 milligrams/liter

Lake Le-Aqua-Na (RPA) (Cause of TSS listed) has this target:

The Total Suspended Solids: 17 milligrams/liter {analysis of 1999 – 2013 data}

Galena Sinsinawa Watershed-Wide Load Reduction Targets

USGS HUC-10 Basins Addressed: 0706000502 and 0706000503.

The following stream segments are full use support in the Galena Sinsinawa watershed:

- Little Menominee River MT-01
- Menominee River MU-01
- East Fork Galena River MQB-01

The averages of data for each fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Little Menominee River MT-01	0.157 mg/l	{no data}
Menominee River MU-01	0.158 mg/l	34.2 mg/l
East Fork Galena River MQB-01	0.101 mg/l	14.1 mg/l
Raw Average	0.138 mg/l	24.1 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.138 milligrams/liter

Total Suspended Solids: 24.1 milligrams/liter

Little Vermillion Watershed-Wide Load Reduction Targets

USGS HUC-10 Basin Addressed: 0713000103

The following stream segments are full use support in the Little Vermillion watershed:

- Little Vermillion River DR-04
- Tomahawk Creek DRA

The averages of data for each fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Little Vermillion River DR-04	0.454 mg/l	21.6 mg/l
Tomahawk Creek DRA	0.124 mg/l	29.1 mg/l
Raw Average	0.289 mg/l	25.3 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.289 milligrams/liter

Total Suspended Solids: 25.3 milligrams/liter

Middle Sangamon Watershed-Wide Load Reduction Targets

USGS HUC-10 Basins Addressed: 0713000605, 0713000606, 0713000607, and 0713000608.

The following stream segments are full use support in the Middle Sangamon watershed:

- Sangamon River E-05
- Sangamon River E-06
- Sangamon River E-09
- Sangamon River E-16
- Stevens Creek ES-13

The averages of data for each fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Sangamon River E-05	1.801 mg/l	33.2 mg/l
Sangamon River E-06	0.173 mg/l	20.1 mg/l
Sangamon River E-09	0.222 mg/l	25.4 mg/l
Sangamon River E-16	1.412 mg/l	44.0 mg/l
Stevens Creek ES-13	0.091 mg/l	11.9 mg/l
Raw Average	0.739 mg/l	26.9 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.739 milligrams/liter

Total Suspended Solids: 26.9 milligrams/liter

Prairie Langan Watershed-Wide Load Reduction Targets

USGS HUC-10 Basins Addressed: 0712000209 and 0712000212.

The following stream segment meets full use support in the Prairie Langan watershed:

- Langan Creek FLE-01

The averages of data for this fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Langan Creek FLE-01	0.104 mg/l	16.2 mg/l

Based on an average of validated, real-world data for this stream over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.104 milligrams/liter

Total Suspended Solids: 16.2 milligrams/liter

Lake Springfield and Sugar Creek Watershed Load Reduction Targets

USGS HUC-10 Basin Addressed: 0713000707

The following water body in this watershed supports aquatic life, while not being Full Use Support:

- Lake Springfield REF

The load reduction target is as follows:

Total Suspended Solids: 19 milligrams/liter {analysis of 1999 – 2013 data}

Streams in This Watershed: There are no stream segments in this watershed that meet full use support. Illinois EPA took the approach to use the load reduction target analysis from Middle Sangamon Watershed, since these two watersheds are nearly identical in their land use, agricultural practices, topography, and soil geology. Given this similarity and proximity, the load reduction targets for streams in the Middle Sangamon watershed are assigned to streams in the Lake Springfield and Sugar Creek watershed. These targets are as follows:

Total Phosphorus: 0.739 milligrams/liter

Total Suspended Solids: 26.9 milligrams/liter

Rend Lake Watershed Load Reduction Targets

USGS HUC-10 Basins Addressed: 0714010601, 0714010602, and 0714010603.

The following stream segments are in full use support in the Rend Lake watershed:

- Rayse Creek NK-01
- Rayse Creek NK-02

The averages of data for each fully supporting stream are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Rayse Creek NK-01	0.207 mg/l	53.4mg/l
Rayse Creek NK-02	0.112 mg/l	17.1 mg/l
Raw Average	0.159 mg/l	35.2 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.159 milligrams/liter

Total Suspended Solids: 35.2 milligrams/liter

In addition to the streams, Rend Lake (RNB) supports aquatic life, while not being Full Use Support.

The load reduction target for Rend Lake is as follows:

Total Suspended Solids: 13 milligrams/liter {analysis of 1999 – 2013 data}

Upper Big Muddy Load Reduction Targets

USGS HUC-10 Basins Addressed: 0714010604, 0714010605, and 0715010607.

The following stream segments are full use support in the Upper Big Muddy watershed:

- Ewing Creek NHB-01
- Middle Fork, Upper Big Muddy River NH-26

The averages of data for each fully supporting stream segment are as follows:

Stream Name	Total Phosphorus	Total Suspended Solids
Ewing Creek NHB-01	0.04 mg/l	8.5 mg/l
Mid. Fk. Upper Big Muddy R. NH-26	0.395 mg/l	56 mg/l
Raw Average	0.217 mg/l	32.2 mg/l

Based on an average of validated, real-world data for these streams over a period from 1999 to 2013, the load reduction targets for all streams in this watershed are as follows:

Total Phosphorus: 0.217 milligrams/liter

Total Suspended Solids: 32.2 milligrams/liter

The following lakes in this watershed support aquatic life, while not being Full Use Support:

- West Frankfort Old Lake (RNP)
- West Frankfort New Lake (RNQ)
- Johnston City Reservoir (RNZE)

For all lakes in the watershed, the load reduction targets are as follows:

Total Suspended Solids: 23 milligrams/liter {analysis of 1999 – 2013 data}

Horseshoe Lake in Alexander County Watershed Load Reduction Targets

USGS HUC-10 Basin Addressed: 0714010803

In this watershed, the Cache River through segment IX-08 is full use support. A review of the available validated data from 1999 through 2013 shows the following concentrations:

- **Total Phosphorus:** 0.141 milligrams/liter
- **Total Suspended Solids:** 58.4 milligrams/liter

These concentrations should then be the load reduction targets for all streams in this watershed.

In addition to the streams, Horseshoe Lake (RIA) supports aquatic life, while not being Full Use Support.

For Horseshoe Lake and all other lakes in this watershed, the load reduction targets are:

- **Total Suspended Solids:** 31 milligrams/liter {analysis of 1999 – 2013 data}

Attachment 3:
QUAL2E Model Files
Calibration input
Calibration output
Sensitivity input
Sensitivity output



PrairieLangan_calib_9.INP

TITLE01 Prairie Creek DO TMDL TLEPA13A
TITLE02 Calibration run, Nov. 25, 2015
TITLE03 NO CONSERVATIVE MINERAL I
TITLE04 NO CONSERVATIVE MINERAL II
TITLE05 NO CONSERVATIVE MINERAL III
TITLE06 YES TEMPERATURE
TITLE07 YES 5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08 NO ALGAE AS CHL-A IN UG/L
TITLE09 NO PHOSPHORUS CYCLE AS P IN MG/L
TITLE10 (ORGANIC-P; DISSOLVED-P)
TITLE11 YES NITROGEN CYCLE AS N IN MG/L
TITLE12 (ORGANIC-N; AMMONIA-N; NITRITE-N; NITRATE-N)
TITLE13 YES DISSOLVED OXYGEN IN MG/L
TITLE14 NO FECAL COLIFORM IN NO./100 ML
TITLE15 NO ARBITRARY NON-CONSERVATIVE

ENDTITLE
LIST DATA INPUT
NOWRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
NO TRAPEZOIDAL CHANNELS
NO PRINT LCD/SOLAR DATA
NO PLOT DO AND BOD

FIXED DNSTM CONC (YES=1)= 0 5D-ULT BOD CONV K COEF = 0.230
INPUT METRIC = 0 OUTPUT METRIC = 0
NUMBER OF REACHES = 5 NUMBER OF JUNCTIONS = 0
NUM OF HEADWATERS = 1 NUMBER OF POINT LOADS = 3
TIME STEP (HOURS) = 1 LNTH. COMP. ELEMENT (MI) = 0.2
MAXIMUM ROUTE TIME (HRS) = 60 TIME INC. FOR RPT2 (HRS) = 1.0
LATITUDE OF BASIN (DEG) = 38.5 LONGITUDE OF BASIN (DEG) = 89.00
STANDARD MERIDIAN (DEG) = 0 DAY OF YEAR START TIME = 243
EVAP. COEF., (AE) = 0.00068 EVAP. COEF., (BE) = 0.00027
ELEV. OF BASIN (ELEV) = 520 DUST ATTENUATION COEF. = 0.06

ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)= 3.43 O UPTAKE BY NO2 OXID(MG O/MG N)= 1.14
O PROD BY ALGAE (MG O/MG A) = 1.8 O UPTAKE BY ALGAE (MG O/MG A) = 1.90
N CONTENT OF ALGAE (MG N/MG A) = 0.09 P CONTENT OF ALGAE (MG P/MG A) = 0.014
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.0 ALGAE RESPIRATION RATE (1/DAY)= 0.105
N HALF SATURATION CONST (MG/L) = 0.03 P HALF SATURATION CONST (MG/L)= 0.005
LIN ALG SHADE CO (1/H-UGCHA/L) = 0.003 NLIN SHADE (1/H-(UGCHA/L)**2/3)= 0.000
LIGHT FUNCTION OPTION (LFNOPT) = 2.0 LIGHT SATURATION COEF (INT/MIN)= 0.66
DAILY AVERAGING OPTION (LAVOPT)= 3.0 LIGHT AVERAGING FACTOR (INT) = 0.9
NUMBER OF DAYLIGHT HOURS (DLH) = 13.3 TOTAL DAILY SOLAR RADTN (INT) = 1500.
ALG GROWTH CALC OPTION(LGROPT)= 2.0 ALGAL PREF FOR NH3-N (PREFN) = 0.1
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.45 NITRIFICATION INHIBITION COEF = 0.6

ENDATA1A
SOD RATE 1.0

ENDATA1B
STREAM REACH 1. RCH= Hdwtr, To RM 10.5 FROM 14.5 TO 10.5
STREAM REACH 2. RCH= RM 10.5 to 9.7 FROM 10.5 TO 9.7
STREAM REACH 3. RCH= RM 9.7 to 6.5 FROM 9.7 TO 6.5
STREAM REACH 4. RCH= RM 6.5 to 3.5 FROM 6.5 TO 3.5
STREAM REACH 5. RCH= RM 3.5 to 0.1 FROM 3.5 TO 0.1

ENDATA2
ENDATA3
FLAG FIELD RCH= 1. 20 1. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 2. 4 2. 2. 2. 2.
FLAG FIELD RCH= 3. 16 2. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 4. 15 2. 2. 2. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 5. 17 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 5.

ENDATA4
HYDRAULI CS RCH= 1. 100.0 0.013 0.00 0.84 0.000 0.020
HYDRAULI CS RCH= 2. 100.0 0.013 0.00 0.84 0.000 0.020

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HYDRAULICS RCH=	3.	100.0	0.013	0.00	0.84	0.000	0.020			
HYDRAULICS RCH=	4.	100.0	0.288	0.00	0.42	0.000	0.020			
HYDRAULICS RCH=	5.	100.0	0.288	0.00	0.42	0.000	0.020			
ENDATA5										
TEMP/LCD	1.	627.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	2.	624.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	3.	617.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	4.	614.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	5.	609.00	0.06	0.40	62.0	53.0	29.23	5.4		
ENDATA5A										
REACT COEF RCH=	1.	0.050	0.00	0.0500	3.	.35	0.0000	0.0000		
REACT COEF RCH=	2.	0.050	0.00	0.0500	3.	.35	0.0000	0.0000		
REACT COEF RCH=	3.	0.050	0.00	0.0500	3.	.20	0.0000	0.0000		
REACT COEF RCH=	4.	0.050	0.00	0.0500	3.	.33	0.0000	0.0000		
REACT COEF RCH=	5.	0.050	0.00	0.0500	3.	.07	0.0000	0.0000		
ENDATA6										
N AND P COEF RCH=	1.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	2.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	3.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	4.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	5.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
ENDATA6A										
ALGAE/OTHER RCH=	1.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	2.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	3.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	4.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	5.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ENDATA6B										
INITIAL COND-1 RCH=	1.	70.70	1.40	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	2.	70.70	1.65	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	3.	71.78	1.85	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	4.	73.58	0.50	3.20	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	5.	78.80	3.50	3.20	0.00	0.00	0.00	0.000	0.0	
ENDATA7										
INITIAL COND-2 RCH=	1.									
INITIAL COND-2 RCH=	2.									
INITIAL COND-2 RCH=	3.									
INITIAL COND-2 RCH=	4.									
INITIAL COND-2 RCH=	5.									
ENDATA7A										
INCR INFLOW-1 RCH=	1.	0.000	70.70	6.0	1.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	2.	0.000	70.70	6.0	1.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	3.	0.000	71.78	6.0	5.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	4.	0.000	73.58	6.0	10.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	5.	1.810	73.00	9.6	3.2	0.0	0.0	0.0	0.0	
ENDATA8										
INCR INFLOW-2 RCH=	1.	0.00	0.00	0.20	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	2.	0.00	0.00	0.30	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	3.	0.00	0.00	0.51	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	4.	0.00	0.00	0.07	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	5.	0.00	0.64	0.10	0.00	0.00	0.00	0.00		
ENDATA8A										
ENDATA9										
HDWTR-NFK HDW=	1.		PrairieCK	0.201	67.80	7.50	1.00	0.0	0.0	
ENDATA10										
HEADWTR-2 HDW=	1.	0.00	0.0	11.60	0.85	0.14	0.00	0.00	0.00	
ENDATA10A										
POINTLD-1 PTL=	1.	DafdLHom	0.00	0.023	70.00	6.3	4.0	0.0	0.0	
POINTLD-1 PTL=	2.	ASHKUM	0.00	0.285	70.00	6.3	1.0	0.0	0.0	
POINTLD-1 PTL=	3.	NURSEHOME	0.00	0.019	70.00	6.3	4.0	0.0	0.0	
ENDATA11										
POINTLD-2 PTL=	1.	0.00	0.0	0.00	0.00	0.10	0.00	0.00	0.0	
POINTLD-2 PTL=	2.	0.00	0.0	0.00	0.00	0.11	0.00	0.00	0.0	

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POINTLD-2 PTL= 3. 0.00 0.0 0.00 0.00 0.10 0.00 0.00 0.00 0.0
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A

FF

* * * QUAL-2E STREAM QUALITY ROUTING MODEL * * *

Version 3.22 -- May 1996

\$\$\$ (PROBLEM TITLES) \$\$\$

CARD TYPE	QUAL-2E PROGRAM TITLES
TITLE01	Prairie Creek DO TMDL ILEPA13A
TITLE02	Calibration run, Nov. 25, 2015
TITLE03 NO	CONSERVATIVE MINERAL I
TITLE04 NO	CONSERVATIVE MINERAL II
TITLE05 NO	CONSERVATIVE MINERAL III
TITLE06 YES	TEMPERATURE
TITLE07 YES	5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08 NO	ALGAE AS CHL-A IN UG/L
TITLE09 NO	PHOSPHORUS CYCLE AS P IN MG/L
TITLE10	(ORGANIC-P; DISSOLVED-P)
TITLE11 YES	NITROGEN CYCLE AS N IN MG/L
TITLE12	(ORGANIC-N; AMMONIA-N; NITRITE-N; NITRATE-N)
TITLE13 YES	DISSOLVED OXYGEN IN MG/L
TITLE14 NO	FECAL COLIFORM IN NO./100 ML
TITLE15 NO	ARBITRARY NON-CONSERVATIVE
ENDTITLE	

\$\$\$ DATA TYPE 1 (CONTROL DATA) \$\$\$

CARD TYPE		CARD TYPE	
LIST DATA INPUT	0.00000		0.00000
NOWRITE OPTIONAL SUMMARY	0.00000		0.00000
NO FLOW AUGMENTATION	0.00000		0.00000
STEADY STATE	0.00000		0.00000
NO TRAPEZOIDAL CHANNELS	0.00000		0.00000
NO PRINT LCD/SOLAR DATA	0.00000		0.00000
NO PLOT DO AND BOD	0.00000		0.00000
FIXED DNSTM CONC (YES=1)=	0.00000	D-ULT BOD CONV K COEF =	0.23000
INPUT METRIC =	0.00000	UTPUT METRIC =	0.00000
NUMBER OF REACHES =	5.00000	UMBER OF JUNCTIONS =	0.00000
NUM OF HEADWATERS =	1.00000	UMBER OF POINT LOADS =	3.00000
TIME STEP (HOURS) =	1.00000	NTH. COMP. ELEMENT (MI)=	0.20000
MAXIMUM ROUTE TIME (HRS)=	60.00000	IME INC. FOR RPT2 (HRS)=	1.00000
LATITUDE OF BASIN (DEG) =	38.50000	ONGITUDE OF BASIN (DEG)=	89.00000
STANDARD MERIDIAN (DEG) =	0.00000	AY OF YEAR START TIME =	243.00000
EVAP. COEF., (AE) =	0.00068	VAP. COEF., (BE) =	0.00027
ELEV. OF BASIN (ELEV) =	520.00000	UST ATTENUATION COEF. =	0.06000
ENDATA1	0.00000		0.00000

\$\$\$ DATA TYPE 1A (ALGAE PRODUCTION AND NITROGEN OXIDATION CONSTANTS) \$\$\$

CARD TYPE		CARD TYPE	
O UPTAKE BY NH3 OXID(MG O/MG N)=	3.4300	O UPTAKE BY NO2 OXID(MG O/MG	
N)=	1.1400		
O PROD BY ALGAE (MG O/MG A) =	1.8000	O UPTAKE BY ALGAE (MG O/MG A)	
=	1.9000		
N CONTENT OF ALGAE (MG N/MG A) =	0.0900	P CONTENT OF ALGAE (MG P/MG A)	
=	0.0140		

```

ALG MAX SPEC GROWTH RATE(1/DAY)= 2.0000 ALGAE RESPIRATION RATE
(1/DAY)= 0.1050
N HALF SATURATION CONST (MG/L) = 0.0300 P HALF SATURATION CONST
(MG/L)= 0.0050
LIN ALG SHADE CO (1/FT-UGCHA/L)= 0.0030 NLIN
SHADE(1/FT-(UGCHA/L)**2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 2.0000 LIGHT SAT'N COEF (BTU/FT2-MIN)
= 0.6600
DAILY AVERAGING OPTION (LAVOPT)= 3.0000 LIGHT AVERAGING FACTOR (INT)
= 0.9000
NUMBER OF DAYLIGHT HOURS (DLH) = 13.3000 TOTAL DAILY SOLR RAD (BTU/FT-2)=
1500.0000
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000 ALGAL PREF FOR NH3-N (PREFN)
= 0.1000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500 NITRIFICATION INHIBITION COEF
= 0.6000
ENDATA1A
0.0000 0.0000

```

\$\$\$ DATA TYPE 1B (TEMPERATURE CORRECTION CONSTANTS FOR RATE COEFFICIENTS) \$\$\$

CARD TYPE	RATE CODE	THETA VALUE	
THETA(1)	BOD DECA	1.047	DFLT
THETA(2)	BOD SETT	1.024	DFLT
THETA(3)	OXY TRAN	1.024	DFLT
THETA(4)	SOD RATE	1.000	USER
THETA(5)	ORGN DEC	1.047	DFLT
THETA(6)	ORGN SET	1.024	DFLT
THETA(7)	NH3 DECA	1.083	DFLT
THETA(8)	NH3 SRCE	1.074	DFLT
THETA(9)	NO2 DECA	1.047	DFLT
THETA(10)	PORG DEC	1.047	DFLT
THETA(11)	PORG SET	1.024	DFLT
THETA(12)	DISP SRC	1.074	DFLT
THETA(13)	ALG GROW	1.047	DFLT
THETA(14)	ALG RESP	1.047	DFLT
THETA(15)	ALG SETT	1.024	DFLT
THETA(16)	COLI DEC	1.047	DFLT
THETA(17)	ANC DECA	1.000	DFLT
THETA(18)	ANC SETT	1.024	DFLT
THETA(19)	ANC SRCE	1.000	DFLT

ENDATA1B

\$\$\$ DATA TYPE 2 (REACH IDENTIFICATION) \$\$\$

CARD TYPE	REACH ORDER AND IDENT	R. MI/KM		R. MI/KM
STREAM REACH	1.0 RCH= Hdwtr, To RM 1	FR 14.5	TO	10.5
STREAM REACH	2.0 RCH= RM 10.5 to 9.7	FR 10.5	TO	9.7
STREAM REACH	3.0 RCH= RM 9.7 to 6.5	FR 9.7	TO	6.5
STREAM REACH	4.0 RCH= RM 6.5 to 3.5	FR 6.5	TO	3.5
STREAM REACH	5.0 RCH= RM 3.5 to 0.1	FR 3.5	TO	0.1
ENDATA2	0.0	0.0		0.0

\$\$\$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) \$\$\$

CARD TYPE	REACH	AVAIL	HDWS	TARGET	ORDER	OF	AVAIL	SOURCES
ENDATA3	0.	0.	0.0	0.	0.	0.	0.	0.

\$\$\$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) \$\$\$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL	FLAGS
FLAG FIELD	1.	20.	1.6.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.	
FLAG FIELD	2.	4.	2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	
FLAG FIELD	3.	16.	2.6.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.0.0.0.	
FLAG FIELD	4.	15.	2.2.2.6.2.2.2.2.2.2.2.2.2.2.2.2.0.0.0.0.	
FLAG FIELD	5.	17.	2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.5.0.0.0.	
ENDATA4	0.	0.	0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.	

\$\$\$ DATA TYPE 5 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH) \$\$\$

CARD TYPE	REACH	COEF-DSPN	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	2.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	3.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	4.	100.00	0.288	0.000	0.420	0.000	0.020
HYDRAULICS	5.	100.00	0.288	0.000	0.420	0.000	0.020
ENDATA5	0.	0.00	0.000	0.000	0.000	0.000	0.000

\$\$\$ DATA TYPE 5A (STEADY STATE TEMPERATURE AND CLIMATOLOGY DATA) \$\$\$

CARD TYPE	REACH	SOLAR RAD	DUST	CLOUD	DRY BULB	WET BULB
ATM	REACH	ELEVATION	COEF	COVER	TEMP	TEMP
	PRESSURE	WIND	ATTENUATION			
TEMP/LCD	1.	627.00	0.06	0.40	62.00	53.00
29.23	5.40	1.00				
TEMP/LCD	2.	624.00	0.06	0.40	62.00	53.00
29.23	5.40	1.00				
TEMP/LCD	3.	617.00	0.06	0.40	62.00	53.00
29.23	5.40	1.00				
TEMP/LCD	4.	614.00	0.06	0.40	62.00	53.00
29.23	5.40	1.00				
TEMP/LCD	5.	609.00	0.06	0.40	62.00	53.00
29.23	5.40	1.00				
ENDATA5A	0.	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00				

\$\$\$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) \$\$\$

CARD TYPE	REACH	K1	K3	SOD	K2OPT	K2	COEQK2
OR	EXPQK2			RATE			TSIV COEF
				OR	SLOPE		FOR OPT
FOR OPT 8							
REACT COEF	1.	0.05	0.00	0.050	3.	0.35	
0.000	0.00000						

REACT COEF	2.	0.05	0.00	0.050	3.	0.35
0.000	0.00000					
REACT COEF	3.	0.05	0.00	0.050	3.	0.20
0.000	0.00000					
REACT COEF	4.	0.05	0.00	0.050	3.	0.33
0.000	0.00000					
REACT COEF	5.	0.05	0.00	0.050	3.	0.07
0.000	0.00000					
ENDATA6	0.	0.00	0.00	0.000	0.	0.00
0.000	0.00000					

\$\$\$ DATA TYPE 6A (NITROGEN AND PHOSPHORUS CONSTANTS) \$\$\$

CARD TYPE	REACH	CKNH2	SETNH2	CKNH3	SNH3	CKNO2
CKPORG SETPORG	SPO4					
N AND P COEF	1.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	2.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	3.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	4.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	5.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
ENDATA6A	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00	0.00					

\$\$\$ DATA TYPE 6B (ALGAE/OTHER COEFFICIENTS) \$\$\$

CARD TYPE	REACH	ALPHAO	ALGSET	EXCOEF	CK5	CKANC
SETANC SRCANC						
					CKCOLI	
ALGAE/OTHER	1.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	2.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	3.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	4.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	5.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ENDATA6B	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						

\$\$\$ DATA TYPE 7 (INITIAL CONDITIONS) \$\$\$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-1	CM-2
CM-3 ANC	COLI					
INITIAL COND-1	1.	70.70	1.40	1.00	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	2.	70.70	1.65	1.00	0.00	0.00
0.00 0.00	0.00					

INITIAL COND-1	3.	71.78	1.85	1.00	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	4.	73.58	0.50	3.20	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	5.	78.80	3.50	3.20	0.00	0.00
0.00 0.00	0.00					
ENDATA7	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00	0.00					

\$\$\$ DATA TYPE 7A (INITIAL CONDITIONS FOR CHOROPHYLL A, NITROGEN, AND PHOSPHORUS) \$\$\$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P DIS-P						
INITIAL COND-2	1.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	2.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	3.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	4.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	5.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
ENDATA7A	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						

\$\$\$ DATA TYPE 8 (INCREMENTAL INFLOW CONDITIONS) \$\$\$

CARD TYPE	REACH	FLOW	TEMP	D.O.	BOD	CM-1
CM-2 CM-3	ANC	COLI				
INCR INFLOW-1	1.	0.000	70.70	6.00	1.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	2.	0.000	70.70	6.00	1.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	3.	0.000	71.78	6.00	5.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	4.	0.000	73.58	6.00	10.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	5.	1.810	73.00	9.60	3.20	0.00
0.00 0.00	0.00	0.00				
ENDATA8	0.	0.000	0.00	0.00	0.00	0.00
0.00 0.00	0.00	0.00				

\$\$\$ DATA TYPE 8A (INCREMENTAL INFLOW CONDITIONS FOR CHLOROPHYLL A, NITROGEN, AND PHOSPHORUS) \$\$\$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P DIS-P						
INCR INFLOW-2	1.	0.00	0.00	0.20	0.00	0.00
0.00 0.00						
INCR INFLOW-2	2.	0.00	0.00	0.30	0.00	0.00
0.00 0.00						
INCR INFLOW-2	3.	0.00	0.00	0.51	0.00	0.00
0.00 0.00						

INCR	INFLOW-2	4.	0.00	0.00	0.07	0.00	0.00
0.00	0.00						
INCR	INFLOW-2	5.	0.00	0.64	0.10	0.00	0.00
0.00	0.00						
ENDATA8A		0.	0.00	0.00	0.00	0.00	0.00
0.00	0.00						

\$\$\$ DATA TYPE 9 (STREAM JUNCTIONS) \$\$\$

CARD TYPE	JUNCTION ORDER AND IDENT	UPSTRM	JUNCTION	TRIB
ENDATA9	0.	0.	0.	0.

\$\$\$ DATA TYPE 10 (HEADWATER SOURCES) \$\$\$

CARD TYPE	HDWTR	NAME	FLOW	TEMP	D.O.	BOD
CM-1	CM-2	CM-3				
	ORDER					
HDWTR-NFK	1.	PrairieCK	0.20	67.80	7.50	1.00
0.00	0.00	0.00				
ENDATA10	0.		0.00	0.00	0.00	0.00
0.00	0.00	0.00				

\$\$\$ DATA TYPE 10A (HEADWATER CONDITIONS FOR CHLOROPHYLL, NITROGEN, PHOSPHORUS, COLIFORM AND SELECTED NON-CONSERVATIVE CONSTITUENT) \$\$\$

CARD TYPE	HDWTR	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P	DIS-P							
	ORDER							
HEADWTR-2	1.	0.00	0.00E+00	11.60	0.85	0.14	0.00	0.00
0.00	0.00							
ENDATA10A	0.	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00
0.00	0.00							

\$\$\$ DATA TYPE 11 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) \$\$\$

CARD TYPE	POINT LOAD	NAME	EFF	FLOW	TEMP	D.O.	BOD
CM-1	CM-2	CM-3					
	ORDER						
POINTLD-1	1.	DafdLHom	0.00	0.02	70.00	6.30	4.00
0.00	0.00	0.00					
POINTLD-1	2.	ASHKUM	0.00	0.28	70.00	6.30	1.00
0.00	0.00	0.00					
POINTLD-1	3.	NURSEHOME	0.00	0.02	70.00	6.30	4.00
0.00	0.00	0.00					
ENDATA11	0.		0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00					

\$\$\$ DATA TYPE 11A (POINT SOURCE CHARACTERISTICS - CHLOROPHYLL A, NITROGEN, PHOSPHORUS, COLIFORMS AND SELECTED NON-CONSERVATIVE CONSTITUENT) \$\$\$

CARD TYPE	POINT LOAD	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P	DIS-P							

```

ORDER
POINTLD-2      1.      0.00 0.00E+00      0.00      0.00      0.10      0.00      0.00
0.00      0.00
POINTLD-2      2.      0.00 0.00E+00      0.00      0.00      0.11      0.00      0.00
0.00      0.00
POINTLD-2      3.      0.00 0.00E+00      0.00      0.00      0.10      0.00      0.00
0.00      0.00
ENDATA11A      0.      0.00 0.00E+00      0.00      0.00      0.00      0.00      0.00
0.00      0.00
    
```

\$\$\$ DATA TYPE 12 (DAM CHARACTERISTICS) \$\$\$

```

DAM      RCH      ELE      ADAM      BDAM      FDAM      HDAM
ENDATA12      0.      0.      0.      0.00      0.00      0.00      0.00
    
```

\$\$\$ DATA TYPE 13 (DOWNSTREAM BOUNDARY CONDITIONS-1) \$\$\$

```

CARD TYPE      TEMP      D.O.      BOD      CM-1      CM-2
CM-3      ANC      COLI
ENDATA13      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED
    
```

\$\$\$ DATA TYPE 13A (DOWNSTREAM BOUNDARY CONDITIONS-2) \$\$\$

```

CARD TYPE      CHL-A      ORG-N      NH3-N      NO2-N      NH3-N
ORG-P      DIS-P
ENDATA13A      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED
    
```



STEADY STATE TEMPERATURE SIMULATION; CONVERGENCE SUMMARY:

```

NUMBER OF
ITERATION      NONCONVERGENT
ELEMENTS
1              18
2              0
    
```

SUMMARY OF VALUES FOR STEADY STATE TEMPERATURE CALCULATIONS (SUBROUTINE HEATER):

```

DAILY NET SOLAR RADIATION =      2111.997 BTU/FT-2      ( 573.133 LANGLEYS)
NUMBER OF DAYLIGHT HOURS =      12.9
    
```

HOURLY VALUES OF SOLAR RADIATION (BTU/FT-2)

```

1      0.00      9      0.00      17      252.77
2      0.00      10     0.00      18      270.56
3      0.00      11     0.00      19      269.60
    
```

4	0.00	12	1.07	20	249.99
5	0.00	13	47.76	21	213.52
6	0.00	14	110.61	22	163.47
7	0.00	15	169.01	23	104.39
8	0.00	16	217.88	24	41.35

STEADY STATE ALGAE/NUTRIENT/DISSOLVED OXYGEN SIMULATION; CONVERGENCE SUMMARY:

VARIABLE	ITERATION	NUMBER OF NONCONVERGENT ELEMENTS
NITRIFICATION INHIBITION	1	72
NITRIFICATION INHIBITION	2	72
NITRIFICATION INHIBITION	3	72
NITRIFICATION INHIBITION	4	72
NITRIFICATION INHIBITION	5	55
NITRIFICATION INHIBITION	6	35
NITRIFICATION INHIBITION	7	0
NITRIFICATION INHIBITION	8	0

STREAM QUALITY
SIMULATION
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QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22 -- May 1996

OUTPUT


***** STEADY STATE SIMULATION *****

** HYDRAULICS SUMMARY **

ELE	RCH	ELE	BEGIN	END	POINT	INCR					
TRVL					BOTTOM	X-SECT	DSPRSN				
ORD	NUM	NUM	LOC	LOC	FLOW	SRCE	FLOW	VEL	TIME	DEPTH	WIDTH
VOLUME			AREA	AREA	COEF						
			MILE	MILE	CFS	CFS	CFS	FPS	DAY	FT	FT
			K-FT-3	K-FT-2	FT-2	FT-2	FT-2/S				
1	1	1	14.50	14.30	0.20	0.00	0.00	0.013	0.940	0.840	18.407
16.33			21.21	15.46	0.09						
2	1	2	14.30	14.10	0.22	0.02	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
3	1	3	14.10	13.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
4	1	4	13.90	13.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
5	1	5	13.70	13.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
6	1	6	13.50	13.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
7	1	7	13.30	13.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513

18.20			23.44	17.23	0.09							
8	1	8	13.10	12.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
9	1	9	12.90	12.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
10	1	10	12.70	12.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
11	1	11	12.50	12.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
12	1	12	12.30	12.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
13	1	13	12.10	11.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
14	1	14	11.90	11.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
15	1	15	11.70	11.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
16	1	16	11.50	11.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
17	1	17	11.30	11.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
18	1	18	11.10	10.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
19	1	19	10.90	10.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
20	1	20	10.70	10.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
21	2	1	10.50	10.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
22	2	2	10.30	10.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
23	2	3	10.10	9.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
24	2	4	9.90	9.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
25	3	1	9.70	9.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513	
18.20			23.44	17.23	0.09							
26	3	2	9.50	9.30	0.51	0.28	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
27	3	3	9.30	9.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
28	3	4	9.10	8.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
29	3	5	8.90	8.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
30	3	6	8.70	8.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
31	3	7	8.50	8.30	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00	39.15	0.09							
32	3	8	8.30	8.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612	

41.35			51.00		39.15		0.09					
33	3	9	8.10	7.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
34	3	10	7.90	7.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
35	3	11	7.70	7.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
36	3	12	7.50	7.30	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
37	3	13	7.30	7.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
38	3	14	7.10	6.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
39	3	15	6.90	6.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
40	3	16	6.70	6.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					



 STREAM QUALITY

 SIMULATION

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 QUAL-2E STREAM QUALITY ROUTING MODEL

 Version 3.22 -- May 1996

OUTPUT

***** STEADY STATE SIMULATION *****

** HYDRAULICS SUMMARY **

ELE	RCH	ELE	BEGIN	END	POINT	INCR						
TRVL					BOTTOM	X-SECT	DSPRSN					
ORD	NUM	NUM	LOC	LOC	FLOW	SRCE	FLOW	VEL	TIME	DEPTH	WIDTH	
VOLUME			AREA	AREA	COEF							
			MILE	MILE	CFS	CFS	CFS	FPS	DAY	FT	FT	
			K-FT-3	K-FT-2	FT-2	FT-2	FT-2/S					
41	4	1	6.50	6.30	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
42	4	2	6.30	6.10	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
43	4	3	6.10	5.90	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
44	4	4	5.90	5.70	0.53	0.02	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
45	4	5	5.70	5.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
46	4	6	5.50	5.30	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
47	4	7	5.30	5.10	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
48	4	8	5.10	4.90	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
49	4	9	4.90	4.70	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							

50	4	10	4.70	4.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
51	4	11	4.50	4.30	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
52	4	12	4.30	4.10	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
53	4	13	4.10	3.90	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
54	4	14	3.90	3.70	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
55	4	15	3.70	3.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
56	5	1	3.50	3.30	0.63	0.00	0.11	0.288	0.042	0.420	5.245
2.33			6.43	2.20	1.07						
57	5	2	3.30	3.10	0.74	0.00	0.11	0.288	0.042	0.420	6.126
2.72			7.36	2.57	1.07						
58	5	3	3.10	2.90	0.85	0.00	0.11	0.288	0.042	0.420	7.006
3.11			8.29	2.94	1.07						
59	5	4	2.90	2.70	0.95	0.00	0.11	0.288	0.042	0.420	7.886
3.50			9.21	3.31	1.07						
60	5	5	2.70	2.50	1.06	0.00	0.11	0.288	0.042	0.420	8.766
3.89			10.14	3.68	1.07						
61	5	6	2.50	2.30	1.17	0.00	0.11	0.288	0.042	0.420	9.646
4.28			11.07	4.05	1.07						
62	5	7	2.30	2.10	1.27	0.00	0.11	0.288	0.042	0.420	10.527
4.67			12.00	4.42	1.07						
63	5	8	2.10	1.90	1.38	0.00	0.11	0.288	0.042	0.420	11.407
5.06			12.93	4.79	1.07						
64	5	9	1.90	1.70	1.49	0.00	0.11	0.288	0.042	0.420	12.287
5.45			13.86	5.16	1.07						
65	5	10	1.70	1.50	1.59	0.00	0.11	0.288	0.042	0.420	13.167
5.84			14.79	5.53	1.07						
66	5	11	1.50	1.30	1.70	0.00	0.11	0.288	0.042	0.420	14.047
6.23			15.72	5.90	1.07						
67	5	12	1.30	1.10	1.81	0.00	0.11	0.288	0.042	0.420	14.928
6.62			16.65	6.27	1.07						
68	5	13	1.10	0.90	1.91	0.00	0.11	0.288	0.042	0.420	15.808
7.01			17.58	6.64	1.07						
69	5	14	0.90	0.70	2.02	0.00	0.11	0.288	0.042	0.420	16.688
7.40			18.51	7.01	1.07						
70	5	15	0.70	0.50	2.13	0.00	0.11	0.288	0.042	0.420	17.568
7.79			19.44	7.38	1.07						
71	5	16	0.50	0.30	2.23	0.00	0.11	0.288	0.042	0.420	18.448
8.18			20.37	7.75	1.07						
72	5	17	0.30	0.10	2.34	0.00	0.11	0.288	0.042	0.420	19.329
8.57			21.30	8.12	1.07						

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** REACTION COEFFICIENT SUMMARY **

RCH	ELE	DO	K2	OXYGN	BOD	BOD	SOD	ORGN	ORGN	NH3	NH3	NO2	ORGP
ORGP	DISP	COLI		ANC	ANC	ANC							
NUM	NUM	SAT	OPT	REAIR	DECAY	SETT	RATE	DECAY	SETT	DECAY	SRCE	DECAY	DECAY
SETT	SRCE	DECAY	DECAY	DECAY	SETT	SRCE							
		MG/L		1/DAY	1/DAY	1/DAY	G/F2D	1/DAY	1/DAY	1/DAY	MG/F2D	1/DAY	1/DAY
		MG/F2D	1/DAY	1/DAY	1/DAY	MG/F2D							1/DAY
1	1	8.74	3	1.96	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.05	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	2	8.69	3	1.97	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.08	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	5	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	6	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	7	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	8	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	9	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	10	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	11	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	12	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	13	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	14	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	15	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	16	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	17	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	18	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	19	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	20	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

2	1	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	2	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	1	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	2	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.08	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	5	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	6	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	7	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	8	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	9	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	10	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	11	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	12	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	13	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	14	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	15	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	16	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 4

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** REACTION COEFFICIENT SUMMARY **

RCH	ELE	DO	K2	OXYGN	BOD	BOD	SOD	ORGN	ORGN	NH3	NH3	NO2	ORGP
ORGP	DISP	COLI		ANC	ANC	ANC							
NUM	NUM	SAT	OPT	REAIR	DECAY	SETT	RATE	DECAY	SETT	DECAY	SRCE	DECAY	DECAY
SETT	SRCE	DECAY	DECAY	SETT	SRCE								
	MG/L		1/DAY	1/DAY	1/DAY	G/F2D	1/DAY	1/DAY	1/DAY	MG/F2D	1/DAY	1/DAY	1/DAY
	MG/F2D	1/DAY	1/DAY	1/DAY	MG/F2D								
4	1	8.67	3	14.15	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	2	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	3	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	4	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	5	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	6	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	7	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	8	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	9	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	10	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	11	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	12	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	13	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	14	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	15	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	1	8.63	3	26.46	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.13	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	2	8.61	3	26.54	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	3	8.60	3	26.58	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	4	8.59	3	26.61	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	5	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	6	8.59	3	26.63	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	7	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

5	8	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	9	8.59	3	26.61	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	10	8.59	3	26.60	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	11	8.59	3	26.60	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	12	8.60	3	26.59	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	13	8.60	3	26.58	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	14	8.60	3	26.57	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	15	8.60	3	26.56	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	16	8.61	3	26.55	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	17	8.61	3	26.54	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						



STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 5

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** WATER QUALITY VARIABLES **

RCH	ELE	CM-1	CM-2	ANC								
NUM	NUM	TEMP	DO	BOD	ORGN	NH3N	NO2N	NO3N	SUM-N			
ORGP	DIS-P	SUM-P	COLI	CHLA	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L		
		DEG-F			MG/L	MG/L	MG/L	MG/L	MG/L	MG/L		
		MG/L	MG/L	MG/L #/100ML		UG/L						
1	1	69.45	0.00	0.00	0.00	7.52	0.96	0.85	0.14	0.00	0.00	0.99
0.00	0.00	0.00.00E+00	0.00	0.00								
1	2	70.01	0.00	0.00	0.00	7.41	1.21	0.76	0.13	0.00	0.00	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	3	70.18	0.00	0.00	0.00	7.45	1.15	0.76	0.13	0.00	0.00	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	4	70.24	0.00	0.00	0.00	7.46	1.10	0.76	0.13	0.00	0.00	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	5	70.26	0.00	0.00	0.00	7.47	1.05	0.76	0.13	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	6	70.26	0.00	0.00	0.00	7.47	1.00	0.76	0.13	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	7	70.26	0.00	0.00	0.00	7.47	0.95	0.76	0.13	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	8	70.26	0.00	0.00	0.00	7.48	0.90	0.76	0.13	0.00	0.01	0.90

0.00	0.00	0.00.00E+00	0.00	0.00								
1	9	70.26	0.00	0.00	0.00	7.48	0.86	0.76	0.12	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	10	70.26	0.00	0.00	0.00	7.48	0.82	0.76	0.12	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	11	70.26	0.00	0.00	0.00	7.48	0.78	0.76	0.12	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	12	70.26	0.00	0.00	0.00	7.48	0.74	0.76	0.12	0.00	0.01	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	13	70.26	0.00	0.00	0.00	7.48	0.71	0.76	0.12	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	14	70.26	0.00	0.00	0.00	7.49	0.68	0.76	0.12	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	15	70.26	0.00	0.00	0.00	7.49	0.64	0.76	0.12	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	16	70.26	0.00	0.00	0.00	7.49	0.61	0.76	0.12	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	17	70.26	0.00	0.00	0.00	7.49	0.58	0.76	0.11	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	18	70.26	0.00	0.00	0.00	7.49	0.56	0.76	0.11	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	19	70.26	0.00	0.00	0.00	7.49	0.53	0.76	0.11	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
1	20	70.26	0.00	0.00	0.00	7.49	0.50	0.76	0.11	0.00	0.02	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
2	1	70.26	0.00	0.00	0.00	7.49	0.48	0.76	0.11	0.00	0.03	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
2	2	70.26	0.00	0.00	0.00	7.49	0.46	0.76	0.11	0.00	0.03	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
2	3	70.26	0.00	0.00	0.00	7.50	0.44	0.76	0.11	0.00	0.03	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
2	4	70.26	0.00	0.00	0.00	7.50	0.42	0.76	0.11	0.00	0.03	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
3	1	70.26	0.00	0.00	0.00	7.50	0.40	0.76	0.11	0.00	0.03	0.90
0.00	0.00	0.00.00E+00	0.00	0.00								
3	2	70.20	0.00	0.00	0.00	6.99	0.71	0.34	0.11	0.00	0.01	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	3	70.24	0.00	0.00	0.00	7.35	0.67	0.34	0.11	0.00	0.01	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	4	70.25	0.00	0.00	0.00	7.47	0.64	0.34	0.11	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	5	70.26	0.00	0.00	0.00	7.51	0.61	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	6	70.26	0.00	0.00	0.00	7.53	0.58	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	7	70.26	0.00	0.00	0.00	7.54	0.56	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	8	70.26	0.00	0.00	0.00	7.54	0.53	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	9	70.26	0.00	0.00	0.00	7.54	0.50	0.34	0.10	0.00	0.02	0.46

0.00	0.00	0.00.00E+00	0.00	0.00								
3	10	70.26	0.00	0.00	0.00	7.54	0.48	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	11	70.26	0.00	0.00	0.00	7.54	0.46	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	12	70.26	0.00	0.00	0.00	7.54	0.44	0.34	0.10	0.00	0.02	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	13	70.26	0.00	0.00	0.00	7.55	0.41	0.34	0.10	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	14	70.26	0.00	0.00	0.00	7.55	0.40	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	15	70.26	0.00	0.00	0.00	7.55	0.38	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
3	16	70.26	0.00	0.00	0.00	7.55	0.36	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								



STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 6

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** WATER QUALITY VARIABLES **

RCH	ELE		CM-1	CM-2								ANC
NUM	NUM	TEMP			DO	BOD	ORGN	NH3N	NO2N	NO3N	SUM-N	
ORGP	DIS-P	SUM-P	COLI	CHLA								
		DEG-F			MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
		MG/L	MG/L	MG/L #/100ML		UG/L						
4	1	70.26	0.00	0.00	0.00	8.50	0.35	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
4	2	70.26	0.00	0.00	0.00	8.49	0.35	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
4	3	70.26	0.00	0.00	0.00	8.48	0.35	0.34	0.09	0.00	0.03	0.46
0.00	0.00	0.00.00E+00	0.00	0.00								
4	4	70.25	0.00	0.00	0.00	8.44	0.48	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	5	70.25	0.00	0.00	0.00	8.46	0.48	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	6	70.25	0.00	0.00	0.00	8.47	0.48	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	7	70.25	0.00	0.00	0.00	8.47	0.48	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	8	70.25	0.00	0.00	0.00	8.47	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	9	70.25	0.00	0.00	0.00	8.47	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								
4	10	70.25	0.00	0.00	0.00	8.47	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00.00E+00	0.00	0.00								

4	11	70.25	0.00	0.00	0.00	8.47	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	12	70.25	0.00	0.00	0.00	8.48	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	13	70.26	0.00	0.00	0.00	8.48	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	14	70.26	0.00	0.00	0.00	8.48	0.47	0.32	0.09	0.00	0.03	0.44
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	15	70.26	0.00	0.00	0.00	8.48	0.47	0.32	0.09	0.00	0.03	0.45
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	1	70.65	0.00	0.00	0.00	8.54	0.92	0.38	0.09	0.00	0.02	0.49
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	2	70.87	0.00	0.00	0.00	8.55	1.25	0.42	0.09	0.00	0.02	0.53
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	3	71.00	0.00	0.00	0.00	8.54	1.49	0.44	0.09	0.00	0.02	0.56
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	4	71.07	0.00	0.00	0.00	8.52	1.68	0.47	0.10	0.00	0.02	0.58
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	5	71.11	0.00	0.00	0.00	8.51	1.83	0.48	0.10	0.00	0.01	0.59
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	6	71.12	0.00	0.00	0.00	8.50	1.95	0.50	0.10	0.00	0.01	0.61
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	7	71.12	0.00	0.00	0.00	8.49	2.05	0.51	0.10	0.00	0.01	0.62
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	8	71.10	0.00	0.00	0.00	8.49	2.13	0.52	0.10	0.00	0.01	0.63
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	9	71.08	0.00	0.00	0.00	8.48	2.20	0.53	0.10	0.00	0.01	0.64
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	10	71.06	0.00	0.00	0.00	8.48	2.26	0.54	0.10	0.00	0.01	0.64
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	11	71.03	0.00	0.00	0.00	8.48	2.32	0.54	0.10	0.00	0.01	0.65
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	12	71.01	0.00	0.00	0.00	8.48	2.36	0.55	0.10	0.00	0.01	0.65
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	13	70.98	0.00	0.00	0.00	8.48	2.41	0.55	0.10	0.00	0.01	0.66
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	14	70.96	0.00	0.00	0.00	8.48	2.44	0.56	0.10	0.00	0.01	0.66
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	15	70.93	0.00	0.00	0.00	8.48	2.47	0.56	0.10	0.00	0.01	0.67
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	16	70.90	0.00	0.00	0.00	8.48	2.50	0.57	0.10	0.00	0.01	0.67
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	17	70.88	0.00	0.00	0.00	8.48	2.53	0.57	0.10	0.00	0.01	0.67
0.00	0.00	0.00	0.00E+00	0.00	0.00							

STREAM QUALITY

SIMULATION

PAGE NUMBER 7

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

OUTPUT

***** STEADY STATE SIMULATION *****

** DISSOLVED OXYGEN DATA **

ELE ORD OXYGN	RCH NUM	ELE NUM	COMPONENTS OF DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)								
			TEMP	DO SAT	DO DO	DO DEF	DAM INPUT	NIT INHIB	F-FNCTN		
			DEG-F	MG/L	MG/L	MG/L	MG/L	FACT	INPUT	REAIR	C-BOD
			SOD	P-R	NH3-N	NO2-N					
1	1	1	69.45	8.74	7.52	1.22	0.00	0.99	7.98	2.40	-0.05
-2.10			0.00	-0.01	0.00						
2	1	2	70.01	8.69	7.41	1.28	0.00	0.99	0.69	2.52	-0.06
-2.10			0.00	0.00	0.00						
3	1	3	70.18	8.67	7.45	1.22	0.00	0.99	0.00	2.41	-0.06
-2.10			0.00	0.00	0.00						
4	1	4	70.24	8.67	7.46	1.20	0.00	0.99	0.00	2.38	-0.06
-2.10			0.00	0.00	0.00						
5	1	5	70.26	8.67	7.47	1.20	0.00	0.99	0.00	2.37	-0.06
-2.10			0.00	0.00	0.00						
6	1	6	70.26	8.67	7.47	1.19	0.00	0.99	0.00	2.36	-0.05
-2.10			0.00	0.00	0.00						
7	1	7	70.26	8.67	7.47	1.19	0.00	0.99	0.00	2.36	-0.05
-2.10			0.00	0.00	0.00						
8	1	8	70.26	8.67	7.48	1.19	0.00	0.99	0.00	2.35	-0.05
-2.10			0.00	0.00	0.00						
9	1	9	70.26	8.67	7.48	1.19	0.00	0.99	0.00	2.35	-0.05
-2.10			0.00	0.00	0.00						
10	1	10	70.26	8.67	7.48	1.19	0.00	0.99	0.00	2.35	-0.04
-2.10			0.00	0.00	0.00						
11	1	11	70.26	8.67	7.48	1.19	0.00	0.99	0.00	2.34	-0.04
-2.10			0.00	0.00	0.00						
12	1	12	70.26	8.67	7.48	1.18	0.00	0.99	0.00	2.34	-0.04
-2.10			0.00	0.00	0.00						
13	1	13	70.26	8.67	7.48	1.18	0.00	0.99	0.00	2.34	-0.04
-2.10			0.00	0.00	0.00						
14	1	14	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.34	-0.04
-2.10			0.00	0.00	0.00						
15	1	15	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
-2.10			0.00	0.00	0.00						
16	1	16	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
-2.10			0.00	0.00	0.00						
17	1	17	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
-2.10			0.00	0.00	0.00						
18	1	18	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
-2.10			0.00	0.00	0.00						
19	1	19	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
-2.10			0.00	0.00	0.00						
20	1	20	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
-2.10			0.00	0.00	0.00						

21	2	1	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
-2.10		0.00	0.00	0.00							
22	2	2	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.02
-2.10		0.00	0.00	0.00							
23	2	3	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.32	-0.02
-2.10		0.00	0.00	0.00							
24	2	4	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
-2.10		0.00	0.00	0.00							
25	3	1	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
-2.10		0.00	0.00	0.00							
26	3	2	70.20	8.67	6.99	1.68	0.00	0.98	3.75	3.32	-0.04
-2.10		0.00	0.00	0.00							
27	3	3	70.24	8.67	7.35	1.32	0.00	0.99	0.00	2.62	-0.04
-2.10		0.00	0.00	0.00							
28	3	4	70.25	8.67	7.47	1.20	0.00	0.99	0.00	2.37	-0.03
-2.10		0.00	0.00	0.00							
29	3	5	70.26	8.67	7.51	1.15	0.00	0.99	0.00	2.28	-0.03
-2.10		0.00	0.00	0.00							
30	3	6	70.26	8.67	7.53	1.14	0.00	0.99	0.00	2.25	-0.03
-2.10		0.00	0.00	0.00							
31	3	7	70.26	8.67	7.54	1.13	0.00	0.99	0.00	2.23	-0.03
-2.10		0.00	0.00	0.00							
32	3	8	70.26	8.67	7.54	1.13	0.00	0.99	0.00	2.23	-0.03
-2.10		0.00	0.00	0.00							
33	3	9	70.26	8.67	7.54	1.13	0.00	0.99	0.00	2.22	-0.03
-2.10		0.00	0.00	0.00							
34	3	10	70.26	8.67	7.54	1.12	0.00	0.99	0.00	2.22	-0.03
-2.10		0.00	0.00	0.00							
35	3	11	70.26	8.67	7.54	1.12	0.00	0.99	0.00	2.22	-0.02
-2.10		0.00	0.00	0.00							
36	3	12	70.26	8.67	7.54	1.12	0.00	0.99	0.00	2.22	-0.02
-2.10		0.00	0.00	0.00							
37	3	13	70.26	8.67	7.55	1.12	0.00	0.99	0.00	2.22	-0.02
-2.10		0.00	0.00	0.00							
38	3	14	70.26	8.67	7.55	1.12	0.00	0.99	0.00	2.22	-0.02
-2.10		0.00	0.00	0.00							
39	3	15	70.26	8.67	7.55	1.12	0.00	0.99	0.00	2.21	-0.02
-2.10		0.00	0.00	0.00							
40	3	16	70.26	8.67	7.55	1.12	0.00	0.99	0.00	2.21	-0.02
-2.10		0.00	0.00	0.00							

STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 8

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** DISSOLVED OXYGEN DATA **

										COMPONENTS OF DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)		
ELE	RCH	ELE	DO		DO	DAM	NIT					
ORD	NUM	NUM	TEMP	SAT	DO	DEF	INPUT	INHIB	F-FNCTN			
OXYGN			NET									
			DEG-F	MG/L	MG/L	MG/L	MG/L	FACT	INPUT	REAIR	C-BOD	
			SOD	P-R	NH3-N	NO2-N						
41	4	1	70.26	8.67	8.50	0.17	0.00	0.99	0.00	2.40	-0.02	
-4.20			0.00	0.00	0.00							
42	4	2	70.26	8.67	8.49	0.18	0.00	0.99	0.00	4.79	-0.02	
-4.20			0.00	0.00	0.00							
43	4	3	70.26	8.67	8.48	0.19	0.00	0.99	0.00	4.94	-0.02	
-4.20			0.00	0.00	0.00							
44	4	4	70.25	8.67	8.44	0.23	0.00	0.99	5.34	6.04	-0.03	
-4.20			0.00	0.00	0.00							
45	4	5	70.25	8.67	8.46	0.21	0.00	0.99	0.00	5.52	-0.03	
-4.20			0.00	0.00	0.00							
46	4	6	70.25	8.67	8.47	0.20	0.00	0.99	0.00	5.28	-0.03	
-4.20			0.00	0.00	0.00							
47	4	7	70.25	8.67	8.47	0.20	0.00	0.99	0.00	5.16	-0.03	
-4.20			0.00	0.00	0.00							
48	4	8	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.11	-0.03	
-4.20			0.00	0.00	0.00							
49	4	9	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.08	-0.03	
-4.20			0.00	0.00	0.00							
50	4	10	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.07	-0.02	
-4.20			0.00	0.00	0.00							
51	4	11	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.06	-0.02	
-4.20			0.00	0.00	0.00							
52	4	12	70.25	8.67	8.48	0.19	0.00	0.99	0.00	5.06	-0.02	
-4.20			0.00	0.00	0.00							
53	4	13	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.06	-0.02	
-4.20			0.00	0.00	0.00							
54	4	14	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.06	-0.02	
-4.20			0.00	0.00	0.00							
55	4	15	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.05	-0.02	
-4.20			0.00	0.00	0.00							
56	5	1	70.65	8.63	8.54	0.09	0.00	0.99	37.96	2.31	-0.05	
-4.20			0.00	0.00	0.00							
57	5	2	70.87	8.61	8.55	0.06	0.00	0.99	32.51	1.58	-0.07	
-4.20			0.00	0.00	0.00							
58	5	3	71.00	8.60	8.54	0.06	0.00	0.99	28.42	1.55	-0.08	
-4.20			0.00	0.00	0.00							
59	5	4	71.07	8.59	8.52	0.07	0.00	0.99	25.25	1.76	-0.09	
-4.20			0.00	0.00	0.00							
60	5	5	71.11	8.59	8.51	0.08	0.00	0.99	22.71	2.01	-0.10	
-4.20			0.00	0.00	0.00							
61	5	6	71.12	8.59	8.50	0.08	0.00	0.99	20.64	2.25	-0.11	
-4.20			0.00	0.00	0.00							
62	5	7	71.12	8.59	8.49	0.09	0.00	0.99	18.92	2.46	-0.11	
-4.20			0.00	0.00	0.00							

63	5	8	71.10	8.59	8.49	0.10	0.00	0.99	17.46	2.64	-0.12
-4.20		0.00	0.00	0.00							
64	5	9	71.08	8.59	8.48	0.11	0.00	0.99	16.21	2.80	-0.12
-4.20		0.00	0.00	0.00							
65	5	10	71.06	8.59	8.48	0.11	0.00	0.99	15.12	2.93	-0.12
-4.20		0.00	0.00	0.00							
66	5	11	71.03	8.59	8.48	0.11	0.00	0.99	14.17	3.04	-0.13
-4.20		0.00	0.00	0.00							
67	5	12	71.01	8.60	8.48	0.12	0.00	0.99	13.34	3.14	-0.13
-4.20		0.00	0.00	0.00							
68	5	13	70.98	8.60	8.48	0.12	0.00	0.99	12.60	3.22	-0.13
-4.20		0.00	0.00	0.00							
69	5	14	70.96	8.60	8.48	0.12	0.00	0.99	11.93	3.29	-0.13
-4.20		0.00	0.00	0.00							
70	5	15	70.93	8.60	8.48	0.13	0.00	0.99	11.33	3.36	-0.13
-4.20		0.00	0.00	0.00							
71	5	16	70.90	8.61	8.48	0.13	0.00	0.99	10.79	3.42	-0.13
-4.20		0.00	0.00	0.00							
72	5	17	70.88	8.61	8.48	0.13	0.00	0.99	10.30	3.47	-0.14
-4.20		0.00	0.00	0.00							

PrairieLangan_sensiti_vity_10.INP

TITLE01 Prairie Creek DO TMDL ILEPA13A
TITLE02 Sensitivity Analysis, December 3, 2015
TITLE03 NO CONSERVATIVE MINERAL I
TITLE04 NO CONSERVATIVE MINERAL II
TITLE05 NO CONSERVATIVE MINERAL III
TITLE06 YES TEMPERATURE
TITLE07 YES 5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08 NO ALGAE AS CHL-A IN UG/L
TITLE09 NO PHOSPHORUS CYCLE AS P IN MG/L
TITLE10 (ORGANIC-P; DISSOLVED-P)
TITLE11 YES NITROGEN CYCLE AS N IN MG/L
TITLE12 (ORGANIC-N; AMMONIA-N; NITRITE-N;' NITRATE-N)
TITLE13 YES DISSOLVED OXYGEN IN MG/L
TITLE14 NO FECAL COLIFORM IN NO./100 ML
TITLE15 NO ARBITRARY NON-CONSERVATIVE

ENDTITLE

LIST DATA INPUT

NOWRITE OPTIONAL SUMMARY

NO FLOW AUGMENTATION

STEADY STATE

NO TRAPEZOIDAL CHANNELS

NO PRINT LCD/SOLAR DATA

NO PLOT DO AND BOD

FIXED DNSTM CONC (YES=1)= 0 5D-ULT BOD CONV K COEF = 0.230
INPUT METRIC = 0 OUTPUT METRIC = 0
NUMBER OF REACHES = 5 NUMBER OF JUNCTIONS = 0
NUM OF HEADWATERS = 1 NUMBER OF POINT LOADS = 3
TIME STEP (HOURS) = 1 LNTH. COMP. ELEMENT (MI)= 0.2
MAXIMUM ROUTE TIME (HRS)= 60 TIME INC. FOR RPT2 (HRS)= 1.0
LATITUDE OF BASIN (DEG) = 38.5 LONGITUDE OF BASIN (DEG)= 89.00
STANDARD MERIDIAN (DEG) = 0 DAY OF YEAR START TIME = 243
EVAP. COEF., (AE) = 0.00068 EVAP. COEF., (BE) = 0.00027
ELEV. OF BASIN (ELEV) = 520 DUST ATTENUATION COEF. = 0.06

ENDATA1

O UPTAKE BY NH3 OXID(MG O/MG N)= 3.43 O UPTAKE BY NO2 OXID(MG O/MG N)= 1.14
O PROD BY ALGAE (MG O/MG A) = 1.8 O UPTAKE BY ALGAE (MG O/MG A) = 1.90
N CONTENT OF ALGAE (MG N/MG A) = 0.09 P CONTENT OF ALGAE (MG P/MG A) = 0.014
ALG MAX SPEC GROWTH RATE(1/DAY)= 2.0 ALGAE RESPIRATION RATE (1/DAY)= 0.105
N HALF SATURATION CONST (MG/L) = 0.03 P HALF SATURATION CONST (MG/L)= 0.005
LIN ALG SHADE CO (1/H-UGCHA/L) = 0.003 NLIN SHADE (1/H-(UGCHA/L)**2/3)= 0.000
LIGHT FUNCTION OPTION (LFNOPT) = 2.0 LIGHT SATURATION COEF (INT/MIN)= 0.66
DAILY AVERAGING OPTION (LAVOPT)= 3.0 LIGHT AVERAGING FACTOR (INT) = 0.9
NUMBER OF DAYLIGHT HOURS (DLH) = 13.3 TOTAL DAILY SOLAR RADTN (INT) = 1500.
ALG GROWTH CALC OPTION(LGROPT)= 2.0 ALGAL PREF FOR NH3-N (PREFN) = 0.1
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.45 NITRIFICATION INHIBITION COEF = 0.6

ENDATA1A

SOD RATE 1.0

ENDATA1B

STREAM REACH 1. RCH= Hdwtr, To RM 10.5 FROM 14.5 TO 10.5
STREAM REACH 2. RCH= RM 10.5 to 9.7 FROM 10.5 TO 9.7
STREAM REACH 3. RCH= RM 9.7 to 6.5 FROM 9.7 TO 6.5
STREAM REACH 4. RCH= RM 6.5 to 3.5 FROM 6.5 TO 3.5
STREAM REACH 5. RCH= RM 3.5 to 0.1 FROM 3.5 TO 0.1

ENDATA2

ENDATA3

FLAG FIELD RCH= 1. 20 1. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 2. 4 2. 2. 2. 2.
FLAG FIELD RCH= 3. 16 2. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 4. 15 2. 2. 2. 6. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2.
FLAG FIELD RCH= 5. 17 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 2. 5.

ENDATA4

HYDRAULI CS RCH= 1. 100.0 0.013 0.00 0.84 0.000 0.020
HYDRAULI CS RCH= 2. 100.0 0.013 0.00 0.84 0.000 0.020

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HYDRAULICS RCH=	3.	100.0	0.013	0.00	0.84	0.000	0.020			
HYDRAULICS RCH=	4.	100.0	0.288	0.00	0.42	0.000	0.020			
HYDRAULICS RCH=	5.	100.0	0.288	0.00	0.42	0.000	0.020			
ENDATA5										
TEMP/LCD	1.	627.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	2.	624.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	3.	617.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	4.	614.00	0.06	0.40	62.0	53.0	29.23	5.4		
TEMP/LCD	5.	609.00	0.06	0.40	62.0	53.0	29.23	5.4		
ENDATA5A										
REACT COEF RCH=	1.	0.050	0.00	0.0500	3.	.35	0.0000	0.0000		
REACT COEF RCH=	2.	0.050	0.00	0.0500	3.	.35	0.0000	0.0000		
REACT COEF RCH=	3.	0.050	0.00	0.0500	3.	.20	0.0000	0.0000		
REACT COEF RCH=	4.	0.050	0.00	0.0500	3.	.33	0.0000	0.0000		
REACT COEF RCH=	5.	0.050	0.00	0.0500	3.	.07	0.0000	0.0000		
ENDATA6										
N AND P COEF RCH=	1.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	2.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	3.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	4.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
N AND P COEF RCH=	5.	0.00	0.00	0.01	0.00	2.00	0.00	0.00	0.00	
ENDATA6A										
ALGAE/OTHER RCH=	1.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	2.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	3.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	4.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ALGAE/OTHER RCH=	5.	50.0	1.0	0.01	0.00	0.00	0.00	0.00		
ENDATA6B										
INITIAL COND-1 RCH=	1.	70.70	1.40	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	2.	70.70	1.65	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	3.	71.78	1.85	1.00	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	4.	73.58	0.50	3.20	0.00	0.00	0.00	0.000	0.0	
INITIAL COND-1 RCH=	5.	78.80	3.50	3.20	0.00	0.00	0.00	0.000	0.0	
ENDATA7										
INITIAL COND-2 RCH=	1.									
INITIAL COND-2 RCH=	2.									
INITIAL COND-2 RCH=	3.									
INITIAL COND-2 RCH=	4.									
INITIAL COND-2 RCH=	5.									
ENDATA7A										
INCR INFLOW-1 RCH=	1.	0.000	70.70	6.0	1.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	2.	0.000	70.70	6.0	1.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	3.	0.000	71.78	6.0	5.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	4.	0.000	73.58	6.0	10.0	0.0	0.0	0.0	0.0	
INCR INFLOW-1 RCH=	5.	1.810	73.00	9.6	3.2	0.0	0.0	0.0	0.0	
ENDATA8										
INCR INFLOW-2 RCH=	1.	0.00	0.00	0.20	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	2.	0.00	0.00	0.30	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	3.	0.00	0.00	0.51	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	4.	0.00	0.00	0.07	0.00	0.00	0.00	0.00		
INCR INFLOW-2 RCH=	5.	0.00	0.64	0.10	0.00	0.00	0.00	0.00		
ENDATA8A										
ENDATA9										
HDWTR-NFK HDW=	1.		PrairieCK	0.201	67.80	7.50	1.00	0.0	0.0	
ENDATA10										
HEADWTR-2 HDW=	1.	0.00	0.0	11.60	0.85	0.14	0.00	0.00	0.00	
ENDATA10A										
POINTLD-1 PTL=	1.	DafdlHom	0.00	0.023	70.00	6.3	0.0	0.0	0.0	
POINTLD-1 PTL=	2.	ASHKUM	0.00	0.285	70.00	6.3	0.0	0.0	0.0	
POINTLD-1 PTL=	3.	NURSEHOME	0.00	0.019	70.00	6.3	0.0	0.0	0.0	
ENDATA11										
POINTLD-2 PTL=	1.	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.0	
POINTLD-2 PTL=	2.	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.0	

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POINTLD-2 PTL= 3. 0.00 0.0 0.00 0.00 0.00 0.00 0.00 0.00 0.0
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A

FF

* * * QUAL-2E STREAM QUALITY ROUTING MODEL * * *

Version 3.22 -- May 1996

\$\$\$ (PROBLEM TITLES) \$\$\$

CARD TYPE	QUAL-2E PROGRAM TITLES
TITLE01	Prairie Creek DO TMDL ILEPA13A
TITLE02	Sensitivity Analyis, December 3, 2015
TITLE03 NO	CONSERVATIVE MINERAL I
TITLE04 NO	CONSERVATIVE MINERAL II
TITLE05 NO	CONSERVATIVE MINERAL III
TITLE06 YES	TEMPERATURE
TITLE07 YES	5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08 NO	ALGAE AS CHL-A IN UG/L
TITLE09 NO	PHOSPHORUS CYCLE AS P IN MG/L
TITLE10	(ORGANIC-P; DISSOLVED-P)
TITLE11 YES	NITROGEN CYCLE AS N IN MG/L
TITLE12	(ORGANIC-N; AMMONIA-N; NITRITE-N; NITRATE-N)
TITLE13 YES	DISSOLVED OXYGEN IN MG/L
TITLE14 NO	FECAL COLIFORM IN NO./100 ML
TITLE15 NO	ARBITRARY NON-CONSERVATIVE
ENDTITLE	

\$\$\$ DATA TYPE 1 (CONTROL DATA) \$\$\$

CARD TYPE		CARD TYPE	
LIST DATA INPUT	0.00000		0.00000
NOWRITE OPTIONAL SUMMARY	0.00000		0.00000
NO FLOW AUGMENTATION	0.00000		0.00000
STEADY STATE	0.00000		0.00000
NO TRAPEZOIDAL CHANNELS	0.00000		0.00000
NO PRINT LCD/SOLAR DATA	0.00000		0.00000
NO PLOT DO AND BOD	0.00000		0.00000
FIXED DNSTM CONC (YES=1)=	0.00000	D-ULT BOD CONV K COEF =	0.23000
INPUT METRIC =	0.00000	UTPUT METRIC =	0.00000
NUMBER OF REACHES =	5.00000	UMBER OF JUNCTIONS =	0.00000
NUM OF HEADWATERS =	1.00000	UMBER OF POINT LOADS =	3.00000
TIME STEP (HOURS) =	1.00000	NTH. COMP. ELEMENT (MI)=	0.20000
MAXIMUM ROUTE TIME (HRS)=	60.00000	IME INC. FOR RPT2 (HRS)=	1.00000
LATITUDE OF BASIN (DEG) =	38.50000	ONGITUDE OF BASIN (DEG)=	89.00000
STANDARD MERIDIAN (DEG) =	0.00000	AY OF YEAR START TIME =	243.00000
EVAP. COEF., (AE) =	0.00068	VAP. COEF., (BE) =	0.00027
ELEV. OF BASIN (ELEV) =	520.00000	UST ATTENUATION COEF. =	0.06000
ENDATA1	0.00000		0.00000

\$\$\$ DATA TYPE 1A (ALGAE PRODUCTION AND NITROGEN OXIDATION CONSTANTS) \$\$\$

CARD TYPE		CARD TYPE	
O UPTAKE BY NH3 OXID(MG O/MG N)=	3.4300	O UPTAKE BY NO2 OXID(MG O/MG N)=	1.1400
O PROD BY ALGAE (MG O/MG A) =	1.8000	O UPTAKE BY ALGAE (MG O/MG A)	= 1.9000
N CONTENT OF ALGAE (MG N/MG A) =	0.0900	P CONTENT OF ALGAE (MG P/MG A)	= 0.0140


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ALG MAX SPEC GROWTH RATE(1/DAY)= 2.0000 ALGAE RESPIRATION RATE
(1/DAY)= 0.1050
N HALF SATURATION CONST (MG/L) = 0.0300 P HALF SATURATION CONST
(MG/L)= 0.0050
LIN ALG SHADE CO (1/FT-UGCHA/L)= 0.0030 NLIN
SHADE(1/FT-(UGCHA/L)**2/3)= 0.0000
LIGHT FUNCTION OPTION (LFNOPT) = 2.0000 LIGHT SAT'N COEF (BTU/FT2-MIN)
= 0.6600
DAILY AVERAGING OPTION (LAVOPT)= 3.0000 LIGHT AVERAGING FACTOR (INT)
= 0.9000
NUMBER OF DAYLIGHT HOURS (DLH) = 13.3000 TOTAL DAILY SOLR RAD (BTU/FT-2)=
1500.0000
ALGY GROWTH CALC OPTION(LGROPT)= 2.0000 ALGAL PREF FOR NH3-N (PREFN)
= 0.1000
ALG/TEMP SOLR RAD FACTOR(TFACT)= 0.4500 NITRIFICATION INHIBITION COEF
= 0.6000
ENDATA1A
0.0000 0.0000

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\$\$\$ DATA TYPE 1B (TEMPERATURE CORRECTION CONSTANTS FOR RATE COEFFICIENTS) \$\$\$

CARD TYPE	RATE CODE	THETA VALUE	
THETA(1)	BOD DECA	1.047	DFLT
THETA(2)	BOD SETT	1.024	DFLT
THETA(3)	OXY TRAN	1.024	DFLT
THETA(4)	SOD RATE	1.000	USER
THETA(5)	ORGN DEC	1.047	DFLT
THETA(6)	ORGN SET	1.024	DFLT
THETA(7)	NH3 DECA	1.083	DFLT
THETA(8)	NH3 SRCE	1.074	DFLT
THETA(9)	NO2 DECA	1.047	DFLT
THETA(10)	PORG DEC	1.047	DFLT
THETA(11)	PORG SET	1.024	DFLT
THETA(12)	DISP SRC	1.074	DFLT
THETA(13)	ALG GROW	1.047	DFLT
THETA(14)	ALG RESP	1.047	DFLT
THETA(15)	ALG SETT	1.024	DFLT
THETA(16)	COLI DEC	1.047	DFLT
THETA(17)	ANC DECA	1.000	DFLT
THETA(18)	ANC SETT	1.024	DFLT
THETA(19)	ANC SRCE	1.000	DFLT

ENDATA1B

\$\$\$ DATA TYPE 2 (REACH IDENTIFICATION) \$\$\$

CARD TYPE	REACH ORDER AND IDENT	R. MI/KM		R. MI/KM
STREAM REACH	1.0 RCH= Hdwtr, To RM 1	FR 14.5	TO	10.5
STREAM REACH	2.0 RCH= RM 10.5 to 9.7	FR 10.5	TO	9.7
STREAM REACH	3.0 RCH= RM 9.7 to 6.5	FR 9.7	TO	6.5
STREAM REACH	4.0 RCH= RM 6.5 to 3.5	FR 6.5	TO	3.5
STREAM REACH	5.0 RCH= RM 3.5 to 0.1	FR 3.5	TO	0.1
ENDATA2	0.0	0.0		0.0

\$\$\$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) \$\$\$

CARD TYPE	REACH	AVAIL	HDWS	TARGET	ORDER	OF	AVAIL	SOURCES
ENDATA3	0.	0.	0.0	0.	0.	0.	0.	0.

\$\$\$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) \$\$\$

CARD TYPE	REACH	ELEMENTS/REACH	COMPUTATIONAL	FLAGS
FLAG FIELD	1.	20.	1.6	2.
FLAG FIELD	2.	4.	2.2	2.2.2.2.0.
FLAG FIELD	3.	16.	2.6	2.0.0.0.0.0.
FLAG FIELD	4.	15.	2.2	2.2.6.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.0.0.0.0.
FLAG FIELD	5.	17.	2.2	2.5.0.0.0.0.
ENDATA4	0.	0.	0.0	0.

\$\$\$ DATA TYPE 5 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH) \$\$\$

CARD TYPE	REACH	COEF-DSPN	COEFQV	EXPOQV	COEFQH	EXPOQH	CMANN
HYDRAULICS	1.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	2.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	3.	100.00	0.013	0.000	0.840	0.000	0.020
HYDRAULICS	4.	100.00	0.288	0.000	0.420	0.000	0.020
HYDRAULICS	5.	100.00	0.288	0.000	0.420	0.000	0.020
ENDATA5	0.	0.00	0.000	0.000	0.000	0.000	0.000

\$\$\$ DATA TYPE 5A (STEADY STATE TEMPERATURE AND CLIMATOLOGY DATA) \$\$\$

CARD TYPE	REACH	ELEVATION	WIND	DUST	CLOUD	DRY BULB	WET BULB
ATM		SOLAR RAD					
	REACH	ELEVATION	WIND	COEF	COVER	TEMP	TEMP
	PRESSURE		ATTENUATION				
TEMP/LCD	1.	627.00	1.00	0.06	0.40	62.00	53.00
29.23	5.40						
TEMP/LCD	2.	624.00	1.00	0.06	0.40	62.00	53.00
29.23	5.40						
TEMP/LCD	3.	617.00	1.00	0.06	0.40	62.00	53.00
29.23	5.40						
TEMP/LCD	4.	614.00	1.00	0.06	0.40	62.00	53.00
29.23	5.40						
TEMP/LCD	5.	609.00	1.00	0.06	0.40	62.00	53.00
29.23	5.40						
ENDATA5A	0.	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00					

\$\$\$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND REAERATION) \$\$\$

CARD TYPE	REACH	K1	K3	SOD	K2OPT	K2	COEQK2
OR EXPQK2							
				RATE			TSIV COEF
				OR SLOPE			FOR OPT

8 FOR OPT 8
 REACT COEF 1. 0.05 0.00 0.050 3. 0.35
 0.000 0.00000

REACT COEF	2.	0.05	0.00	0.050	3.	0.35
0.000	0.00000					
REACT COEF	3.	0.05	0.00	0.050	3.	0.20
0.000	0.00000					
REACT COEF	4.	0.05	0.00	0.050	3.	0.33
0.000	0.00000					
REACT COEF	5.	0.05	0.00	0.050	3.	0.07
0.000	0.00000					
ENDATA6	0.	0.00	0.00	0.000	0.	0.00
0.000	0.00000					

\$\$\$ DATA TYPE 6A (NITROGEN AND PHOSPHORUS CONSTANTS) \$\$\$

CARD TYPE	REACH	CKNH2	SETNH2	CKNH3	SNH3	CKNO2
CKPORG SETPORG	SPO4					
N AND P COEF	1.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	2.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	3.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	4.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
N AND P COEF	5.	0.00	0.00	0.01	0.00	2.00
0.00 0.00	0.00					
ENDATA6A	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00	0.00					

\$\$\$ DATA TYPE 6B (ALGAE/OTHER COEFFICIENTS) \$\$\$

CARD TYPE	REACH	ALPHAO	ALGSET	EXCOEF	CK5	CKANC
SETANC SRCANC						
					CKCOLI	
ALGAE/OTHER	1.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	2.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	3.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	4.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ALGAE/OTHER	5.	50.00	1.00	0.01	0.00	0.00
0.00 0.00						
ENDATA6B	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						

\$\$\$ DATA TYPE 7 (INITIAL CONDITIONS) \$\$\$

CARD TYPE	REACH	TEMP	D.O.	BOD	CM-1	CM-2
CM-3 ANC	COLI					
INITIAL COND-1	1.	70.70	1.40	1.00	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	2.	70.70	1.65	1.00	0.00	0.00
0.00 0.00	0.00					

INITIAL COND-1	3.	71.78	1.85	1.00	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	4.	73.58	0.50	3.20	0.00	0.00
0.00 0.00	0.00					
INITIAL COND-1	5.	78.80	3.50	3.20	0.00	0.00
0.00 0.00	0.00					
ENDATA7	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00	0.00					

\$\$\$ DATA TYPE 7A (INITIAL CONDITIONS FOR CHOROPHYLL A, NITROGEN, AND PHOSPHORUS) \$\$\$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P DIS-P						
INITIAL COND-2	1.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	2.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	3.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	4.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
INITIAL COND-2	5.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						
ENDATA7A	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						

\$\$\$ DATA TYPE 8 (INCREMENTAL INFLOW CONDITIONS) \$\$\$

CARD TYPE	REACH	FLOW	TEMP	D.O.	BOD	CM-1
CM-2 CM-3	ANC	COLI				
INCR INFLOW-1	1.	0.000	70.70	6.00	1.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	2.	0.000	70.70	6.00	1.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	3.	0.000	71.78	6.00	5.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	4.	0.000	73.58	6.00	10.00	0.00
0.00 0.00	0.00	0.00				
INCR INFLOW-1	5.	1.810	73.00	9.60	3.20	0.00
0.00 0.00	0.00	0.00				
ENDATA8	0.	0.000	0.00	0.00	0.00	0.00
0.00 0.00	0.00	0.00				

\$\$\$ DATA TYPE 8A (INCREMENTAL INFLOW CONDITIONS FOR CHLOROPHYLL A, NITROGEN, AND PHOSPHORUS) \$\$\$

CARD TYPE	REACH	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P DIS-P						
INCR INFLOW-2	1.	0.00	0.00	0.20	0.00	0.00
0.00 0.00						
INCR INFLOW-2	2.	0.00	0.00	0.30	0.00	0.00
0.00 0.00						
INCR INFLOW-2	3.	0.00	0.00	0.51	0.00	0.00
0.00 0.00						

INCR INFLOW-2	4.	0.00	0.00	0.07	0.00	0.00
0.00 0.00						
INCR INFLOW-2	5.	0.00	0.64	0.10	0.00	0.00
0.00 0.00						
ENDATA8A	0.	0.00	0.00	0.00	0.00	0.00
0.00 0.00						

\$\$\$ DATA TYPE 9 (STREAM JUNCTIONS) \$\$\$

CARD TYPE	JUNCTION ORDER AND IDENT	UPSTRM	JUNCTION	TRIB
ENDATA9	0.	0.	0.	0.

\$\$\$ DATA TYPE 10 (HEADWATER SOURCES) \$\$\$

CARD TYPE	HDWTR	NAME	FLOW	TEMP	D.O.	BOD
CM-1	CM-2	CM-3				
	ORDER					
HDWTR-NFK	1.	PrairieCK	0.20	67.80	7.50	1.00
0.00	0.00	0.00				
ENDATA10	0.		0.00	0.00	0.00	0.00
0.00	0.00	0.00				

\$\$\$ DATA TYPE 10A (HEADWATER CONDITIONS FOR CHLOROPHYLL, NITROGEN, PHOSPHORUS, COLIFORM AND SELECTED NON-CONSERVATIVE CONSTITUENT) \$\$\$

CARD TYPE	HDWTR	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P	DIS-P							
	ORDER							
HEADWTR-2	1.	0.00	0.00E+00	11.60	0.85	0.14	0.00	0.00
0.00	0.00							
ENDATA10A	0.	0.00	0.00E+00	0.00	0.00	0.00	0.00	0.00
0.00	0.00							

\$\$\$ DATA TYPE 11 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) \$\$\$

CARD TYPE	POINT LOAD	NAME	EFF	FLOW	TEMP	D.O.	BOD
CM-1	CM-2	CM-3					
	ORDER						
POINTLD-1	1.	DafdLHom	0.00	0.02	70.00	6.30	0.00
0.00	0.00	0.00					
POINTLD-1	2.	ASHKUM	0.00	0.28	70.00	6.30	0.00
0.00	0.00	0.00					
POINTLD-1	3.	NURSEHOME	0.00	0.02	70.00	6.30	0.00
0.00	0.00	0.00					
ENDATA11	0.		0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00					

\$\$\$ DATA TYPE 11A (POINT SOURCE CHARACTERISTICS - CHLOROPHYLL A, NITROGEN, PHOSPHORUS, COLIFORMS AND SELECTED NON-CONSERVATIVE CONSTITUENT) \$\$\$

CARD TYPE	POINT LOAD	ANC	COLI	CHL-A	ORG-N	NH3-N	NO2-N	NO3-N
ORG-P	DIS-P							

```

ORDER
POINTLD-2      1.      0.00 0.00E+00      0.00      0.00      0.00      0.00      0.00
0.00      0.00
POINTLD-2      2.      0.00 0.00E+00      0.00      0.00      0.00      0.00      0.00
0.00      0.00
POINTLD-2      3.      0.00 0.00E+00      0.00      0.00      0.00      0.00      0.00
0.00      0.00
ENDATA11A      0.      0.00 0.00E+00      0.00      0.00      0.00      0.00      0.00
0.00      0.00
    
```

\$\$\$ DATA TYPE 12 (DAM CHARACTERISTICS) \$\$\$

```

DAM      RCH      ELE      ADAM      BDAM      FDAM      HDAM
ENDATA12      0.      0.      0.      0.00      0.00      0.00      0.00
    
```

\$\$\$ DATA TYPE 13 (DOWNSTREAM BOUNDARY CONDITIONS-1) \$\$\$

```

CARD TYPE      TEMP      D.O.      BOD      CM-1      CM-2
CM-3      ANC      COLI
ENDATA13      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED
    
```

\$\$\$ DATA TYPE 13A (DOWNSTREAM BOUNDARY CONDITIONS-2) \$\$\$

```

CARD TYPE      CHL-A      ORG-N      NH3-N      NO2-N      NH3-N
ORG-P      DIS-P
ENDATA13A      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE UNCONSTRAINED
    
```



STEADY STATE TEMPERATURE SIMULATION; CONVERGENCE SUMMARY:

```

NUMBER OF
ITERATION      NONCONVERGENT
ELEMENTS
1              18
2              0
    
```

SUMMARY OF VALUES FOR STEADY STATE TEMPERATURE CALCULATIONS (SUBROUTINE HEATER):

```

DAILY NET SOLAR RADIATION =      2111.997 BTU/FT-2      ( 573.133 LANGLEYS)
NUMBER OF DAYLIGHT HOURS =      12.9
    
```

HOURLY VALUES OF SOLAR RADIATION (BTU/FT-2)

```

1      0.00      9      0.00      17      252.77
2      0.00      10     0.00      18      270.56
3      0.00      11     0.00      19      269.60
    
```

4	0.00	12	1.07	20	249.99
5	0.00	13	47.76	21	213.52
6	0.00	14	110.61	22	163.47
7	0.00	15	169.01	23	104.39
8	0.00	16	217.88	24	41.35

STEADY STATE ALGAE/NUTRIENT/DISSOLVED OXYGEN SIMULATION; CONVERGENCE SUMMARY:

VARIABLE	ITERATION	NUMBER OF NONCONVERGENT ELEMENTS
NITRIFICATION INHIBITION	1	72
NITRIFICATION INHIBITION	2	72
NITRIFICATION INHIBITION	3	72
NITRIFICATION INHIBITION	4	72
NITRIFICATION INHIBITION	5	55
NITRIFICATION INHIBITION	6	35
NITRIFICATION INHIBITION	7	0
NITRIFICATION INHIBITION	8	0

STREAM QUALITY

SIMULATION

OUTPUT

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QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** HYDRAULICS SUMMARY **

ELE	RCH	ELE	BEGIN	END	POINT	INCR					
TRVL					BOTTOM	X-SECT	DSPRSN				
ORD	NUM	NUM	LOC	LOC	FLOW	SRCE	FLOW	VEL	TIME	DEPTH	WIDTH
VOLUME			AREA	AREA	COEF						
			MILE	MILE	CFS	CFS	CFS	FPS	DAY	FT	FT
			K-FT-3	K-FT-2	FT-2	FT-2	FT-2/S				
1	1	1	14.50	14.30	0.20	0.00	0.00	0.013	0.940	0.840	18.407
16.33			21.21	15.46	0.09						
2	1	2	14.30	14.10	0.22	0.02	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
3	1	3	14.10	13.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
4	1	4	13.90	13.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
5	1	5	13.70	13.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
6	1	6	13.50	13.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
7	1	7	13.30	13.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513

18.20			23.44	17.23	0.09						
8	1	8	13.10	12.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
9	1	9	12.90	12.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
10	1	10	12.70	12.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
11	1	11	12.50	12.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
12	1	12	12.30	12.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
13	1	13	12.10	11.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
14	1	14	11.90	11.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
15	1	15	11.70	11.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
16	1	16	11.50	11.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
17	1	17	11.30	11.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
18	1	18	11.10	10.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
19	1	19	10.90	10.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
20	1	20	10.70	10.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
21	2	1	10.50	10.30	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
22	2	2	10.30	10.10	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
23	2	3	10.10	9.90	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
24	2	4	9.90	9.70	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
25	3	1	9.70	9.50	0.22	0.00	0.00	0.013	0.940	0.840	20.513
18.20			23.44	17.23	0.09						
26	3	2	9.50	9.30	0.51	0.28	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
27	3	3	9.30	9.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
28	3	4	9.10	8.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
29	3	5	8.90	8.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
30	3	6	8.70	8.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
31	3	7	8.50	8.30	0.51	0.00	0.00	0.013	0.940	0.840	46.612
41.35			51.00	39.15	0.09						
32	3	8	8.30	8.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612

41.35			51.00		39.15		0.09					
33	3	9	8.10	7.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
34	3	10	7.90	7.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
35	3	11	7.70	7.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
36	3	12	7.50	7.30	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
37	3	13	7.30	7.10	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
38	3	14	7.10	6.90	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
39	3	15	6.90	6.70	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					
40	3	16	6.70	6.50	0.51	0.00	0.00	0.013	0.940	0.840	46.612	
41.35			51.00		39.15		0.09					



STREAM QUALITY

SIMULATION

OUTPUT

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QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** HYDRAULICS SUMMARY **

ELE	RCH	ELE	BEGIN	END	POINT	INCR						
TRVL					BOTTOM		X-SECT	DSPRSN				
ORD	NUM	NUM	LOC	LOC	FLOW	SRCE	FLOW	VEL	TIME	DEPTH	WIDTH	
VOLUME			AREA	AREA	COEF							
			MILE	MILE	CFS	CFS	CFS	FPS	DAY	FT	FT	
			K-FT-3	K-FT-2		FT-2	FT-2/S					
41	4	1	6.50	6.30	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
42	4	2	6.30	6.10	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
43	4	3	6.10	5.90	0.51	0.00	0.00	0.288	0.042	0.420	4.208	
1.87			5.33	1.77	1.07							
44	4	4	5.90	5.70	0.53	0.02	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
45	4	5	5.70	5.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
46	4	6	5.50	5.30	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
47	4	7	5.30	5.10	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
48	4	8	5.10	4.90	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							
49	4	9	4.90	4.70	0.53	0.00	0.00	0.288	0.042	0.420	4.365	
1.94			5.50	1.83	1.07							

50	4	10	4.70	4.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
51	4	11	4.50	4.30	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
52	4	12	4.30	4.10	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
53	4	13	4.10	3.90	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
54	4	14	3.90	3.70	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
55	4	15	3.70	3.50	0.53	0.00	0.00	0.288	0.042	0.420	4.365
1.94			5.50	1.83	1.07						
56	5	1	3.50	3.30	0.63	0.00	0.11	0.288	0.042	0.420	5.245
2.33			6.43	2.20	1.07						
57	5	2	3.30	3.10	0.74	0.00	0.11	0.288	0.042	0.420	6.126
2.72			7.36	2.57	1.07						
58	5	3	3.10	2.90	0.85	0.00	0.11	0.288	0.042	0.420	7.006
3.11			8.29	2.94	1.07						
59	5	4	2.90	2.70	0.95	0.00	0.11	0.288	0.042	0.420	7.886
3.50			9.21	3.31	1.07						
60	5	5	2.70	2.50	1.06	0.00	0.11	0.288	0.042	0.420	8.766
3.89			10.14	3.68	1.07						
61	5	6	2.50	2.30	1.17	0.00	0.11	0.288	0.042	0.420	9.646
4.28			11.07	4.05	1.07						
62	5	7	2.30	2.10	1.27	0.00	0.11	0.288	0.042	0.420	10.527
4.67			12.00	4.42	1.07						
63	5	8	2.10	1.90	1.38	0.00	0.11	0.288	0.042	0.420	11.407
5.06			12.93	4.79	1.07						
64	5	9	1.90	1.70	1.49	0.00	0.11	0.288	0.042	0.420	12.287
5.45			13.86	5.16	1.07						
65	5	10	1.70	1.50	1.59	0.00	0.11	0.288	0.042	0.420	13.167
5.84			14.79	5.53	1.07						
66	5	11	1.50	1.30	1.70	0.00	0.11	0.288	0.042	0.420	14.047
6.23			15.72	5.90	1.07						
67	5	12	1.30	1.10	1.81	0.00	0.11	0.288	0.042	0.420	14.928
6.62			16.65	6.27	1.07						
68	5	13	1.10	0.90	1.91	0.00	0.11	0.288	0.042	0.420	15.808
7.01			17.58	6.64	1.07						
69	5	14	0.90	0.70	2.02	0.00	0.11	0.288	0.042	0.420	16.688
7.40			18.51	7.01	1.07						
70	5	15	0.70	0.50	2.13	0.00	0.11	0.288	0.042	0.420	17.568
7.79			19.44	7.38	1.07						
71	5	16	0.50	0.30	2.23	0.00	0.11	0.288	0.042	0.420	18.448
8.18			20.37	7.75	1.07						
72	5	17	0.30	0.10	2.34	0.00	0.11	0.288	0.042	0.420	19.329
8.57			21.30	8.12	1.07						

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** REACTION COEFFICIENT SUMMARY **

RCH	ELE	DO	K2	OXYGN	BOD	BOD	SOD	ORGN	ORGN	NH3	NH3	NO2	ORGP
ORGP	DISP	COLI		ANC	ANC	ANC							
NUM	NUM	SAT	OPT	REAIR	DECAY	SETT	RATE	DECAY	SETT	DECAY	SRCE	DECAY	DECAY
SETT	SRCE	DECAY	DECAY	SETT	SRCE								
		MG/L		1/DAY	1/DAY	1/DAY	G/F2D	1/DAY	1/DAY	1/DAY	MG/F2D	1/DAY	1/DAY
		MG/F2D	1/DAY	1/DAY	1/DAY	MG/F2D							1/DAY
1	1	8.74	3	1.96	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.05	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	2	8.69	3	1.97	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.08	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	5	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	6	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	7	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	8	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	9	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	10	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	11	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	12	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	13	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	14	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	15	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	16	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	17	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	18	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	19	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
1	20	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

2	1	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	2	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
2	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	1	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	2	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.08	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	3	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	4	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.09	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	5	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	6	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	7	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	8	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	9	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	10	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	11	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	12	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	13	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	14	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	15	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
3	16	8.67	3	1.98	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 4

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** REACTION COEFFICIENT SUMMARY **

RCH	ELE	DO	K2	OXYGN	BOD	BOD	SOD	ORGN	ORGN	NH3	NH3	NO2	ORGP
ORGP	DISP	COLI		ANC	ANC	ANC							
NUM	NUM	SAT	OPT	REAIR	DECAY	SETT	RATE	DECAY	SETT	DECAY	SRCE	DECAY	DECAY
SETT	SRCE	DECAY	DECAY	SETT	SRCE								
	MG/L		1/DAY	1/DAY	1/DAY	G/F2D	1/DAY	1/DAY	1/DAY	MG/F2D	1/DAY	1/DAY	1/DAY
	MG/F2D	1/DAY	1/DAY	1/DAY	MG/F2D								
4	1	8.67	3	14.15	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	2	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	3	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	4	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.10	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	5	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	6	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	7	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	8	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	9	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	10	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	11	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	12	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	13	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	14	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
4	15	8.67	3	26.32	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.11	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	1	8.63	3	26.46	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.13	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	2	8.61	3	26.54	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	3	8.60	3	26.58	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	4	8.59	3	26.61	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	5	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	6	8.59	3	26.63	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							
5	7	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00							

5	8	8.59	3	26.62	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	9	8.59	3	26.61	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	10	8.59	3	26.60	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	11	8.59	3	26.60	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	12	8.60	3	26.59	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.15	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	13	8.60	3	26.58	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	14	8.60	3	26.57	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	15	8.60	3	26.56	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	16	8.61	3	26.55	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
5	17	8.61	3	26.54	0.05	0.00	0.05	0.00	0.00	0.01	0.00	2.14	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						



STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 5

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** WATER QUALITY VARIABLES **

RCH	ELE		CM-1	CM-2									
NUM	NUM	TEMP				DO	BOD	ORGN	NH3N	NO2N	NO3N	ANC	
ORGP	DIS-P	SUM-P	COLI	CHLA		MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	SUM-N
		DEG-F					UG/L						
		MG/L	MG/L	MG/L	#/100ML								
1	1	69.45	0.00	0.00	0.00	7.52	0.95	0.85	0.14	0.00	0.00	0.99	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	2	70.01	0.00	0.00	0.00	7.42	0.82	0.76	0.12	0.00	0.00	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	3	70.18	0.00	0.00	0.00	7.47	0.78	0.76	0.12	0.00	0.00	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	4	70.24	0.00	0.00	0.00	7.48	0.74	0.76	0.12	0.00	0.00	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	5	70.26	0.00	0.00	0.00	7.48	0.71	0.76	0.12	0.00	0.01	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	6	70.26	0.00	0.00	0.00	7.49	0.67	0.76	0.12	0.00	0.01	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	7	70.26	0.00	0.00	0.00	7.49	0.64	0.76	0.12	0.00	0.01	0.89	
0.00	0.00	0.00	0.00E+00	0.00	0.00								
1	8	70.26	0.00	0.00	0.00	7.49	0.61	0.76	0.12	0.00	0.01	0.89	

0.00	0.00	0.00.00E+00	0.00	0.00								
1	9	70.26	0.00	0.00	0.00	7.49	0.58	0.76	0.11	0.00	0.01	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	10	70.26	0.00	0.00	0.00	7.49	0.55	0.76	0.11	0.00	0.01	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	11	70.26	0.00	0.00	0.00	7.49	0.53	0.76	0.11	0.00	0.01	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	12	70.26	0.00	0.00	0.00	7.49	0.50	0.76	0.11	0.00	0.01	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	13	70.26	0.00	0.00	0.00	7.49	0.48	0.76	0.11	0.00	0.01	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	14	70.26	0.00	0.00	0.00	7.49	0.46	0.76	0.11	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	15	70.26	0.00	0.00	0.00	7.50	0.43	0.76	0.11	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	16	70.26	0.00	0.00	0.00	7.50	0.41	0.76	0.11	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	17	70.26	0.00	0.00	0.00	7.50	0.39	0.76	0.11	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	18	70.26	0.00	0.00	0.00	7.50	0.38	0.76	0.10	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	19	70.26	0.00	0.00	0.00	7.50	0.36	0.76	0.10	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
1	20	70.26	0.00	0.00	0.00	7.50	0.34	0.76	0.10	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
2	1	70.26	0.00	0.00	0.00	7.50	0.32	0.76	0.10	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
2	2	70.26	0.00	0.00	0.00	7.50	0.31	0.76	0.10	0.00	0.02	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
2	3	70.26	0.00	0.00	0.00	7.50	0.29	0.76	0.10	0.00	0.03	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
2	4	70.26	0.00	0.00	0.00	7.50	0.28	0.76	0.10	0.00	0.03	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
3	1	70.26	0.00	0.00	0.00	7.50	0.27	0.76	0.10	0.00	0.03	0.89
0.00	0.00	0.00.00E+00	0.00	0.00								
3	2	70.20	0.00	0.00	0.00	7.01	0.11	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	3	70.24	0.00	0.00	0.00	7.37	0.11	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	4	70.25	0.00	0.00	0.00	7.49	0.10	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	5	70.26	0.00	0.00	0.00	7.54	0.10	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	6	70.26	0.00	0.00	0.00	7.55	0.09	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	7	70.26	0.00	0.00	0.00	7.56	0.09	0.34	0.04	0.00	0.01	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	8	70.26	0.00	0.00	0.00	7.56	0.09	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	9	70.26	0.00	0.00	0.00	7.56	0.08	0.34	0.04	0.00	0.02	0.39

0.00	0.00	0.00.00E+00	0.00	0.00								
3	10	70.26	0.00	0.00	0.00	7.56	0.08	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	11	70.26	0.00	0.00	0.00	7.56	0.07	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	12	70.26	0.00	0.00	0.00	7.56	0.07	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	13	70.26	0.00	0.00	0.00	7.56	0.07	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	14	70.26	0.00	0.00	0.00	7.56	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	15	70.26	0.00	0.00	0.00	7.56	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
3	16	70.26	0.00	0.00	0.00	7.56	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								



STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 6

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** WATER QUALITY VARIABLES **

RCH	ELE		CM-1	CM-2								ANC
NUM	NUM	TEMP			DO	BOD	ORGN	NH3N	NO2N	NO3N	SUM-N	
ORGP	DIS-P	SUM-P	COLI	CHLA								
		DEG-F			MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
		MG/L	MG/L	MG/L #/100ML		UG/L						
4	1	70.26	0.00	0.00	0.00	8.50	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
4	2	70.26	0.00	0.00	0.00	8.49	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
4	3	70.26	0.00	0.00	0.00	8.48	0.06	0.34	0.04	0.00	0.02	0.39
0.00	0.00	0.00.00E+00	0.00	0.00								
4	4	70.25	0.00	0.00	0.00	8.44	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	5	70.25	0.00	0.00	0.00	8.46	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	6	70.25	0.00	0.00	0.00	8.47	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	7	70.25	0.00	0.00	0.00	8.47	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	8	70.25	0.00	0.00	0.00	8.47	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	9	70.25	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								
4	10	70.25	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00.00E+00	0.00	0.00								

4	11	70.25	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	12	70.25	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	13	70.26	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	14	70.26	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00	0.00E+00	0.00	0.00							
4	15	70.26	0.00	0.00	0.00	8.48	0.05	0.32	0.04	0.00	0.02	0.38
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	1	70.65	0.00	0.00	0.00	8.54	0.58	0.38	0.05	0.00	0.02	0.44
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	2	70.87	0.00	0.00	0.00	8.55	0.95	0.42	0.05	0.00	0.01	0.48
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	3	71.00	0.00	0.00	0.00	8.54	1.23	0.44	0.06	0.00	0.01	0.51
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	4	71.07	0.00	0.00	0.00	8.53	1.45	0.47	0.06	0.00	0.01	0.54
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	5	71.11	0.00	0.00	0.00	8.51	1.62	0.48	0.07	0.00	0.01	0.56
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	6	71.12	0.00	0.00	0.00	8.50	1.76	0.50	0.07	0.00	0.01	0.58
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	7	71.12	0.00	0.00	0.00	8.49	1.88	0.51	0.07	0.00	0.01	0.59
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	8	71.10	0.00	0.00	0.00	8.49	1.98	0.52	0.08	0.00	0.01	0.60
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	9	71.08	0.00	0.00	0.00	8.49	2.06	0.53	0.08	0.00	0.01	0.61
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	10	71.06	0.00	0.00	0.00	8.48	2.13	0.54	0.08	0.00	0.01	0.62
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	11	71.03	0.00	0.00	0.00	8.48	2.19	0.54	0.08	0.00	0.01	0.63
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	12	71.01	0.00	0.00	0.00	8.48	2.25	0.55	0.08	0.00	0.01	0.63
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	13	70.98	0.00	0.00	0.00	8.48	2.29	0.55	0.08	0.00	0.01	0.64
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	14	70.96	0.00	0.00	0.00	8.48	2.34	0.56	0.08	0.00	0.00	0.65
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	15	70.93	0.00	0.00	0.00	8.48	2.38	0.56	0.08	0.00	0.00	0.65
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	16	70.90	0.00	0.00	0.00	8.48	2.41	0.57	0.08	0.00	0.00	0.65
0.00	0.00	0.00	0.00E+00	0.00	0.00							
5	17	70.88	0.00	0.00	0.00	8.48	2.44	0.57	0.08	0.00	0.00	0.66
0.00	0.00	0.00	0.00E+00	0.00	0.00							

STREAM QUALITY

SIMULATION

PAGE NUMBER 7

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

OUTPUT

***** STEADY STATE SIMULATION *****

** DISSOLVED OXYGEN DATA **

ELE ORD	RCH NUM	ELE NUM	COMPONENTS OF DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)								
			TEMP	DO			DAM	NIT	F-FNCTN		
				SAT	DO	DEF	INPUT	INHIB	INPUT	REAIR	C-BOD
			DEG-F	NET			MG/L	MG/L	FACT		
SOD	P-R	NH3-N	NO2-N	MG/L	MG/L						
1	1	1	69.45	8.74	7.52	1.22	0.00	0.99	7.98	2.40	-0.05
			-2.10	0.00	-0.01	0.00					
2	1	2	70.01	8.69	7.42	1.27	0.00	0.99	0.69	2.50	-0.04
			-2.10	0.00	0.00	0.00					
3	1	3	70.18	8.67	7.47	1.21	0.00	0.99	0.00	2.39	-0.04
			-2.10	0.00	0.00	0.00					
4	1	4	70.24	8.67	7.48	1.19	0.00	0.99	0.00	2.35	-0.04
			-2.10	0.00	0.00	0.00					
5	1	5	70.26	8.67	7.48	1.18	0.00	0.99	0.00	2.34	-0.04
			-2.10	0.00	0.00	0.00					
6	1	6	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.34	-0.04
			-2.10	0.00	0.00	0.00					
7	1	7	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
			-2.10	0.00	0.00	0.00					
8	1	8	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
			-2.10	0.00	0.00	0.00					
9	1	9	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
			-2.10	0.00	0.00	0.00					
10	1	10	70.26	8.67	7.49	1.18	0.00	0.99	0.00	2.33	-0.03
			-2.10	0.00	0.00	0.00					
11	1	11	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
			-2.10	0.00	0.00	0.00					
12	1	12	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
			-2.10	0.00	0.00	0.00					
13	1	13	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.03
			-2.10	0.00	0.00	0.00					
14	1	14	70.26	8.67	7.49	1.17	0.00	0.99	0.00	2.32	-0.02
			-2.10	0.00	0.00	0.00					
15	1	15	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.32	-0.02
			-2.10	0.00	0.00	0.00					
16	1	16	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
			-2.10	0.00	0.00	0.00					
17	1	17	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
			-2.10	0.00	0.00	0.00					
18	1	18	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
			-2.10	0.00	0.00	0.00					
19	1	19	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
			-2.10	0.00	0.00	0.00					
20	1	20	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
			-2.10	0.00	0.00	0.00					

21	2	1	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
-2.10		0.00	0.00	0.00							
22	2	2	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.31	-0.02
-2.10		0.00	0.00	0.00							
23	2	3	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.30	-0.02
-2.10		0.00	0.00	0.00							
24	2	4	70.26	8.67	7.50	1.16	0.00	0.99	0.00	2.30	-0.01
-2.10		0.00	0.00	0.00							
25	3	1	70.26	8.67	7.50	1.17	0.00	0.99	0.00	2.30	-0.01
-2.10		0.00	0.00	0.00							
26	3	2	70.20	8.67	7.01	1.67	0.00	0.99	3.75	3.29	-0.01
-2.10		0.00	0.00	0.00							
27	3	3	70.24	8.67	7.37	1.30	0.00	0.99	0.00	2.57	-0.01
-2.10		0.00	0.00	0.00							
28	3	4	70.25	8.67	7.49	1.18	0.00	0.99	0.00	2.32	-0.01
-2.10		0.00	0.00	0.00							
29	3	5	70.26	8.67	7.54	1.13	0.00	0.99	0.00	2.24	-0.01
-2.10		0.00	0.00	0.00							
30	3	6	70.26	8.67	7.55	1.12	0.00	0.99	0.00	2.21	0.00
-2.10		0.00	0.00	0.00							
31	3	7	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
32	3	8	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
33	3	9	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
34	3	10	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
35	3	11	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
36	3	12	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
37	3	13	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
38	3	14	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
39	3	15	70.26	8.67	7.56	1.11	0.00	0.99	0.00	2.19	0.00
-2.10		0.00	0.00	0.00							
40	3	16	70.26	8.67	7.56	1.10	0.00	0.99	0.00	2.18	0.00
-2.10		0.00	0.00	0.00							

STREAM QUALITY

SIMULATION

OUTPUT

PAGE NUMBER 8

QUAL-2E STREAM QUALITY ROUTING MODEL

Version 3.22 -- May 1996

***** STEADY STATE SIMULATION *****

** DISSOLVED OXYGEN DATA **

										COMPONENTS OF DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)		
ELE	RCH	ELE	DO		DO	DAM	NIT	F-FNCTN				
ORD	NUM	NUM	TEMP	SAT	DO	DEF	INPUT	INHIB				
OXYGN			NET									
			DEG-F	MG/L	MG/L	MG/L	MG/L	FACT	INPUT	REAIR	C-BOD	
			SOD	P-R	NH3-N	NO2-N						
41	4	1	70.26	8.67	8.50	0.17	0.00	0.99	0.00	2.36	0.00	
-4.20			0.00	0.00	0.00							
42	4	2	70.26	8.67	8.49	0.18	0.00	0.99	0.00	4.74	0.00	
-4.20			0.00	0.00	0.00							
43	4	3	70.26	8.67	8.48	0.19	0.00	0.99	0.00	4.90	0.00	
-4.20			0.00	0.00	0.00							
44	4	4	70.25	8.67	8.44	0.23	0.00	0.99	5.34	6.01	0.00	
-4.20			0.00	0.00	0.00							
45	4	5	70.25	8.67	8.46	0.21	0.00	0.99	0.00	5.49	0.00	
-4.20			0.00	0.00	0.00							
46	4	6	70.25	8.67	8.47	0.20	0.00	0.99	0.00	5.24	0.00	
-4.20			0.00	0.00	0.00							
47	4	7	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.12	0.00	
-4.20			0.00	0.00	0.00							
48	4	8	70.25	8.67	8.47	0.19	0.00	0.99	0.00	5.07	0.00	
-4.20			0.00	0.00	0.00							
49	4	9	70.25	8.67	8.48	0.19	0.00	0.99	0.00	5.04	0.00	
-4.20			0.00	0.00	0.00							
50	4	10	70.25	8.67	8.48	0.19	0.00	0.99	0.00	5.03	0.00	
-4.20			0.00	0.00	0.00							
51	4	11	70.25	8.67	8.48	0.19	0.00	0.99	0.00	5.03	0.00	
-4.20			0.00	0.00	0.00							
52	4	12	70.25	8.67	8.48	0.19	0.00	0.99	0.00	5.02	0.00	
-4.20			0.00	0.00	0.00							
53	4	13	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.02	0.00	
-4.20			0.00	0.00	0.00							
54	4	14	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.02	0.00	
-4.20			0.00	0.00	0.00							
55	4	15	70.26	8.67	8.48	0.19	0.00	0.99	0.00	5.02	0.00	
-4.20			0.00	0.00	0.00							
56	5	1	70.65	8.63	8.54	0.09	0.00	0.99	37.96	2.28	-0.03	
-4.20			0.00	0.00	0.00							
57	5	2	70.87	8.61	8.55	0.06	0.00	0.99	32.51	1.55	-0.05	
-4.20			0.00	0.00	0.00							
58	5	3	71.00	8.60	8.54	0.06	0.00	0.99	28.42	1.53	-0.07	
-4.20			0.00	0.00	0.00							
59	5	4	71.07	8.59	8.53	0.07	0.00	0.99	25.25	1.74	-0.08	
-4.20			0.00	0.00	0.00							
60	5	5	71.11	8.59	8.51	0.07	0.00	0.99	22.71	1.99	-0.09	
-4.20			0.00	0.00	0.00							
61	5	6	71.12	8.59	8.50	0.08	0.00	0.99	20.64	2.23	-0.10	
-4.20			0.00	0.00	0.00							
62	5	7	71.12	8.59	8.49	0.09	0.00	0.99	18.92	2.45	-0.10	
-4.20			0.00	0.00	0.00							

63	5	8	71.10	8.59	8.49	0.10	0.00	0.99	17.46	2.63	-0.11
-4.20		0.00	0.00	0.00							
64	5	9	71.08	8.59	8.49	0.10	0.00	0.99	16.21	2.78	-0.11
-4.20		0.00	0.00	0.00							
65	5	10	71.06	8.59	8.48	0.11	0.00	0.99	15.12	2.92	-0.12
-4.20		0.00	0.00	0.00							
66	5	11	71.03	8.59	8.48	0.11	0.00	0.99	14.17	3.03	-0.12
-4.20		0.00	0.00	0.00							
67	5	12	71.01	8.60	8.48	0.12	0.00	0.99	13.34	3.13	-0.12
-4.20		0.00	0.00	0.00							
68	5	13	70.98	8.60	8.48	0.12	0.00	0.99	12.60	3.21	-0.12
-4.20		0.00	0.00	0.00							
69	5	14	70.96	8.60	8.48	0.12	0.00	0.99	11.93	3.29	-0.13
-4.20		0.00	0.00	0.00							
70	5	15	70.93	8.60	8.48	0.13	0.00	0.99	11.33	3.35	-0.13
-4.20		0.00	0.00	0.00							
71	5	16	70.90	8.61	8.48	0.13	0.00	0.99	10.79	3.41	-0.13
-4.20		0.00	0.00	0.00							
72	5	17	70.88	8.61	8.48	0.13	0.00	0.99	10.30	3.46	-0.13
-4.20		0.00	0.00	0.00							