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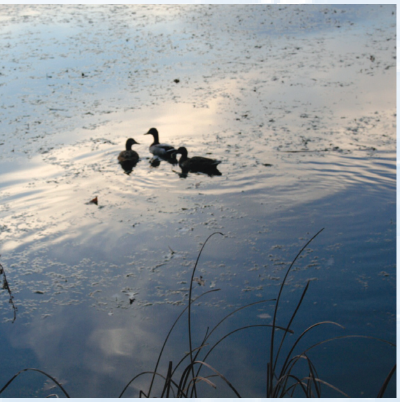
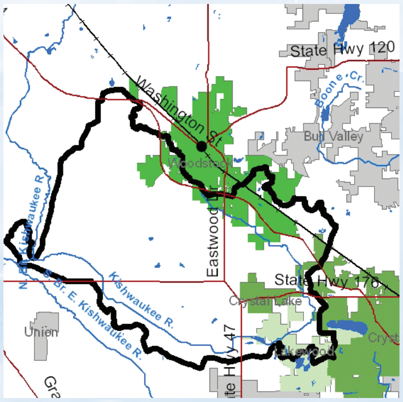
Upper Kishwaukee River Watershed Plan

Technical Report





November 2008

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The planning process was coordinated by KREP and CMAP. Contributors to the plan include Jesse Elam, Kristin Heery, Lori Heringa, and Tim Loftus of CMAP and Ders Anderson of Openlands/KREP. Nathan Hill of KREP provided GIS consultation and map analysis. Hey and Associates, Inc. provided assistance with urban best management practices and ecosystem restoration recommendations. The authors gratefully acknowledge the many contributors to this planning process and especially thank the staff of the Village of Lakewood, City of Crystal Lake, City of Woodstock, McHenry County Department of Planning and Development, McHenry County Conservation District, McHenry County Soil and Water Conservation District, Natural Resources Conservation Service, McHenry County Health Department, and members of the Kishwaukee River Ecosystem Partnership.

Finally, the authors wish to acknowledge the work and stewardship role of the Kishwaukee River Ecosystem Partnership. Prior to this planning process, KREP developed initial watershed plans for each of the 42 subwatersheds of the Kishwaukee River Basin. The KREP-developed watershed plan for the Upper Kishwaukee River was a valuable component to the award-winning Section 319 grant application. KREP’s reputation, reconnaissance of watershed resources, and knowledge of the river basin proved useful throughout the planning process.

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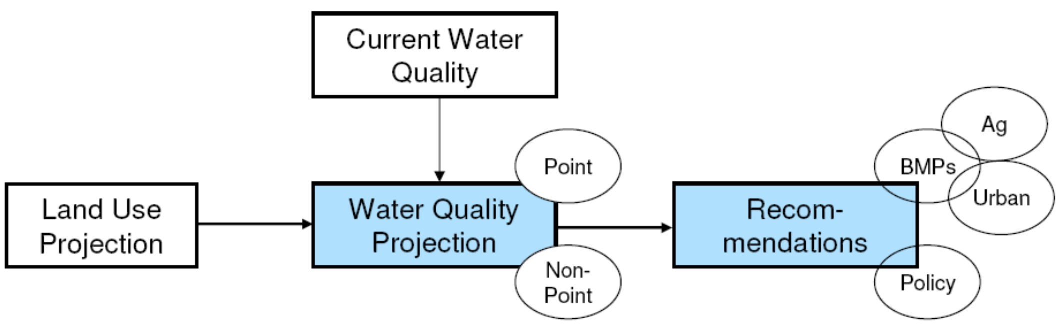
1. INTRODUCTION

1.1 Purpose

This plan has two main goals: first, to restore a healthy aquatic community in the Upper Kishwaukee River, and second to ensure the river remains a vital resource to the neighborhoods surrounding it. While impaired,[1] the stream is in fair condition. It has not been badly degraded by urbanization, agriculture, or wastewater treatment plant discharges, but it has been affected. Projections in this plan suggest some conditions will worsen without restorative actions. Since the Upper Kishwaukee is considered impaired, the first objective is to develop a strategy to address the existing impairment. The second objective is to project conditions given expected land use change and loading from wastewater treatment plants and to offer recommendations to control the effects of that change. These recommendations include new policies as well as physical projects, such as ecosystem restoration or stormwater best management practices. A conceptual model of the process is shown in Figure 1-1.

Figure 1-1. Conceptual model of planning process in the Upper Kishwaukee watershed



1.2 Regional Context

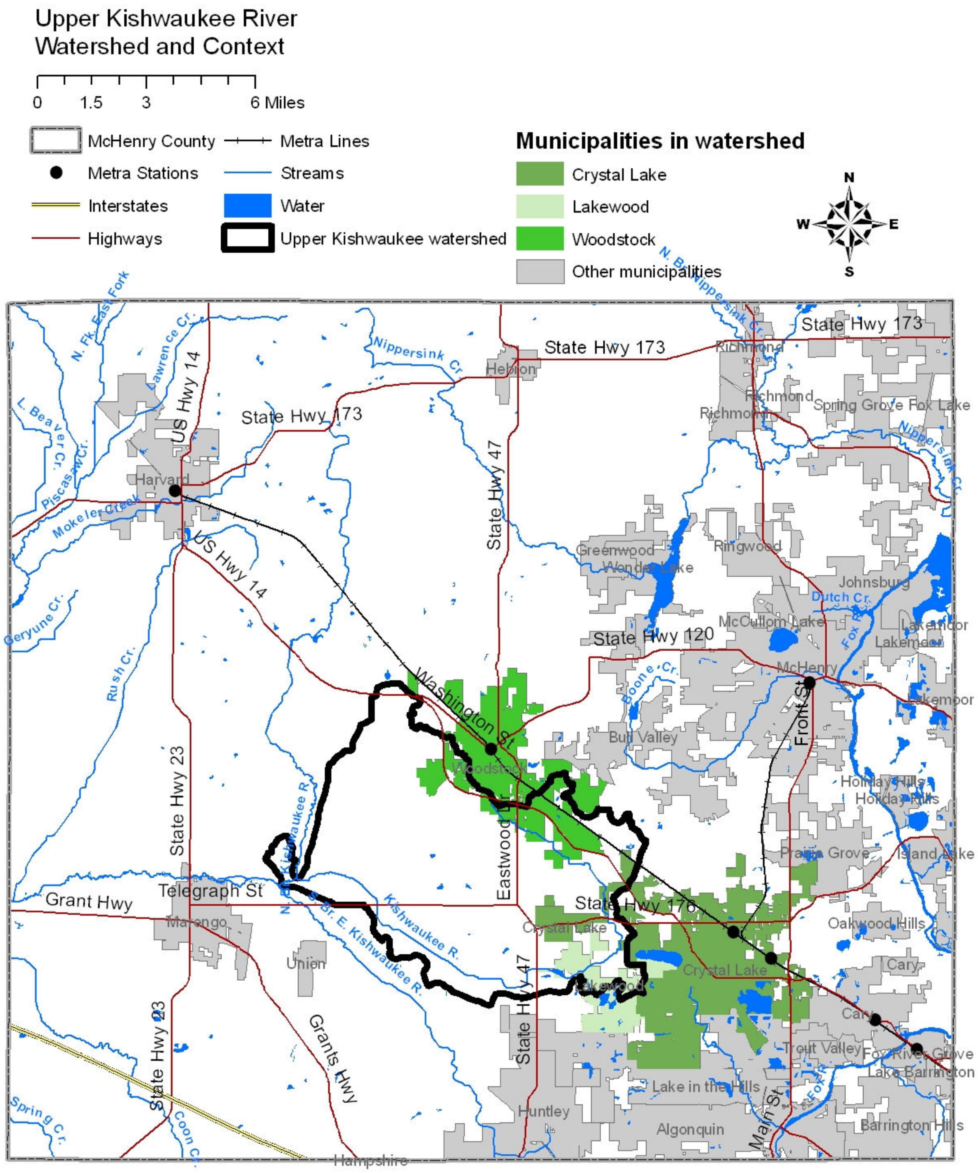
The source of the Kishwaukee River is the Prairie Ridge wetland at northeast corner of Dean Street and US 14, owned and protected by the City of Woodstock through a conservation easement with the Land Conservancy of McHenry County. From this wellspring, the main stem of the Kishwaukee River flows 61 miles downstream and discharges into the Rock River just west of Rockford Airport. The South Branch of the Kishwaukee flows through DeKalb County and connects with the main stem 12 miles upstream from the Rock River. Collectively, the South Branch and the main stem drain a watershed of 1,250 square miles. The main stem drains almost 600 square miles of this total. The main stem carries waters from Woodstock, Crystal Lake, and Lakewood downstream and directly through the communities of Marengo, Belvidere, Cherry Valley, Rockford, and many others.

The Kishwaukee is perhaps best known for being one of the biologically richest river systems in Illinois. It supports 59 species of fish and 26 species of mussels, while the surrounding watershed is home to 12 amphibian, 21 reptile, and 299 bird species. The river is also characterized by Illinois DNR as a *Biologically Significant Stream* from the Pleasant Valley Conservation Area all the way to the Rock River. Many subwatersheds within the Kishwaukee basin are now urbanizing, especially in McHenry and Boone Counties. Past experiences with suburban growth in the Fox River basin and eastward have resulted in degraded river systems that are polluted, expensive to manage, and destructive to property. But in the

[1] This term has a technical meaning that is explained in more detail in Section 2.

Kishwaukee there remains the opportunity to make sure growth takes account of conservation values so that residents can nurture and the rare biological diversity of the river and the surrounding lands.

Figure 1-2.



1.2 Focus Area

The plan concentrates on the 15 miles of stream from the headwaters at US 14 to approximately the intersection of Pleasant Valley and McCue Roads, all in McHenry County, with a watershed of approximately 27 square miles. As a secondary focus, it also makes recommendations for the Franklinville Creek watershed. The entire watershed is about 49 square miles, or about four percent of entire Kishwaukee basin. The City of Crystal Lake, Village of Lakewood, and City of Woodstock are all partly within the watershed on the eastern, more urbanized side, but most of the watershed remains agricultural (Figure 1-2). There are also large holdings by the McHenry County Conservation District along the stream in the eastern and central portions of the watershed. There is a hilly area that runs roughly from the northwest corner to the south central edge of the watershed, but the western, mostly agricultural side of the watershed is extremely flat. The stream itself is low gradient and silty, and much of it has been channelized. Finally, there are two wastewater treatment plants on the Upper Kishwaukee: the Lakewood plant discharges near Haligus Road and the much larger Woodstock South plant discharges almost at the headwaters.

The Franklinville Creek watershed has not been monitored by Illinois EPA, and so its condition is undefined. This plan incorporates the Franklinville Creek watershed but does not include all of the required elements for a watershed to be awarded Clean Water Act Section 319 grants because of the lack of information available at this time from the IEPA. Nonetheless recommendations are made for the Franklinville Creek watershed, including the development of baseline water quality and habitat assessments, so that the watershed can be understood more thoroughly.

1.3 Plan Guidance

There are two major sources of guidance for this plan. One is the U.S. Environmental Protection Agency guidelines for watershed based plans[2] under the Clean Water Act (CWA) and for the award of CWA Section 319 grants to control nonpoint source pollution, the type of pollution that includes sediment running off of cropland or oil from a parking lot but not a direct discharge from an industrial operation or a wastewater treatment plan. The guidelines specify that watershed plans should contain nine minimum elements, which are summarized in Table 1-1 along with the section of this plan where each element is addressed.

Table 1-1. Nine minimum elements of watershed plan and section of this plan where addressed

Element		Section
(a)	An identification of the causes and sources that need to be controlled to achieve pollutant load reductions estimated in this plan;	2.1.3 – 2.1.4
(b)	An estimate of the load reductions expected for the management measures described under (c) below;	2.2, 5.1 – 5.3
(c)	A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under (b) above;	4.4 – 5.3
(d)	An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan;	5.1 – 5.3
(e)	An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented;	5.5
(f)	A schedule for implementing the nonpoint source management measures identified in this plan;	5.4
(g)	A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented;	6.2
(h)	A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards; and	6.3
(i)	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) above.	6.1

Plans including these nine elements are meant to help the state program Section 319 grant funds. The other source of guidance is the product of the Basinwide Management Advisory Group (B-MAG), a collection of stakeholders who came together in 2003 to help Illinois EPA devise an alternative to the Facility Planning Area review process.[3] The B-MAG's main recommendation was for local governments, with assistance from an authorized agent, to develop watershed plans to control point source and nonpoint

[2] *Nonpoint Source Program and Grants Guidelines for States and Territories* (Federal Register V. 68, No. 205, October 23, 2003)
[3] See description at http://www.epa.state.il.us/water/watershed/facility-planning/.

source pollution both now and in consideration of expected watershed change. These plans could offer recommendations for watershed-based monitoring and permitting, attempting to address all stressors within a drainage basin rather than addressing individual pollutant sources on a discharge-by-discharge basis. The plans would be formally adopted by local government units. The B-MAG also produced a framework for a watershed plan, as given in Table 1-1,[4] which was used for the overall organization of the plan. A major item of interest regarding the B-MAG framework is that Illinois EPA is expected to make permitting and financial assistance consistent with the plan, pending adoption by local governments and a public comment period.[5]

Table 1-2. B-MAG outline for a locally developed watershed plan

1. Inventorying and Assessment (more detailed than the State plan drawing on local information)
   a. Describe sources of water quality degradation;
   b. Identify current land uses;
   c. Assess existing local regulations; and,
   d. Describe and/or quantify existing protections such as NPDES permits, Phase II plans, existing ordinances, CRP and CREP acreage, etc.
2. Estimation of Future Needs and Concerns
   a. Estimate twenty-year (or different time period, as appropriate to the planning area) growth patterns and land uses;
   b. Estimate expected changes in sources of degradation in water quality ; and,
   c. Identify funding, site-specific projects, policy changes and other resources needed to continue and expand (if necessary) protection programs.
3. A Vision For The Watershed
   a. Outline issues and opportunities, incorporating local communities comprehensive and other plans;
   b. A vision for wastewater treatment and water supply and possibly other infrastructure;
   c. A vision for land use; and,
   d. A vision for protection and/or restoration of water quality.
4. Plan for Implementing the Vision
   a. Identify a plan for protection and/or restoration of water quality;
   b. Identify steps needed to achieve surface water quality protections;
   c. Identify steps needed to protect groundwater quality;
   d. Estimate pollutant reductions that will be achieved through implementing protections;
   e. Identify tools that could be used to achieve these goals;
   f. Identify monitoring and enforcement tools for use by state and local officials;
   g. Identify the amount of funding and technical assistance needed to implement the watershed plan, possible funding and technical assistance sources, site-specific projects, policy changes, and steps to secure the needed resources;
   h. Identify ways to ensure consistency with local communities plans; and,
   i. Set a schedule for implementing the actions identified in steps a. through h.
5. Metrics for Evaluation
   a. Identify interim, measurable milestones for determining whether the action steps above are being implemented;
   b. Criteria to determine whether pollutant reductions are occurring and progress is being made toward water quality goals; and,
   c. A monitoring and evaluation plan to evaluate the effectiveness of the Watershed Plan and its implementation.

[4] *Framework for a Basinwide Planning and Protection Pilot*, p. 29. Retrieved from: http://www.epa.state.il.us/water/watershed/facility-planning/basinwide-framework.pdf
[5] *Ibid.*

2. INVENTORY AND ASSESSMENT

2.1 Sources of Water Quality Degradation

2.1.1 DESIGNATED USES AND BIOLOGICAL ENDPOINTS

The Illinois Pollution Control Board is charged with assigning designated uses to streams. In order to protect those designated uses, it develops water quality standards specific for each use. There are seven different designated uses in Illinois, as listed in the left hand column in Table 2-1. Five of the uses apply to the Upper Kishwaukee, but only two were assessed for attainment in the most recent *Integrated Water Quality Report* (2006).[6] The Illinois EPA found that the Upper Kishwaukee was not supporting these two designated uses and can be considered impaired for aquatic life support and fish consumption.

Table 2-1. Assessment of designated uses in the Upper Kishwaukee

Designated Use[7]	Applies to Upper Kishwaukee?	Assessed in 2006 303(d) list?	Impaired?
Aquatic Life	Y	Y	Y
Fish Consumption	Y	Y	Y
Public and Food Processing Water Supplies	N	—	—
Primary Contact	Y	N	—
Secondary Contact	Y	N	—
Indigenous Aquatic Life	N	—	—
Aesthetic Quality	Y	N	—

Illinois EPA primarily uses biological data to assess whether streams are supporting the aquatic life designated use. These data are combined into an index for fish (the Index of Biotic Integrity) and an index for various animals like insect nymphs, snails, and others collectively called macroinvertebrates (the Macroinvertebrate Biotic Index). As shown in Table 2-2, a score of less than 41 on the Index of Biotic Integrity or a score of more than 5.9 on the Macroinvertebrate Biotic Index indicates that a stream is not supporting aquatic life. (Increasing values of the Macroinvertebrate Biotic Index indicate lower quality.)

Table 2-2. Illinois EPA indicators of impairment

Biological Indicator			
Index of Biotic Integrity (IBI)	≤ 20	20 < IBI < 41	≥ 41
Macroinvertebrate Biotic Index (MBI)	> 8.9	5.9 < MBI < 8.9	≤ 5.9
Interpretation			
Impairment Status	Severe Impairment	Moderate Impairment	No Impairment
Designated Use Support	Not Supporting	Not Supporting	Fully Supporting
Resource Quality	Poor	Fair	Good

Source: Integrated Water Quality Report (2006)

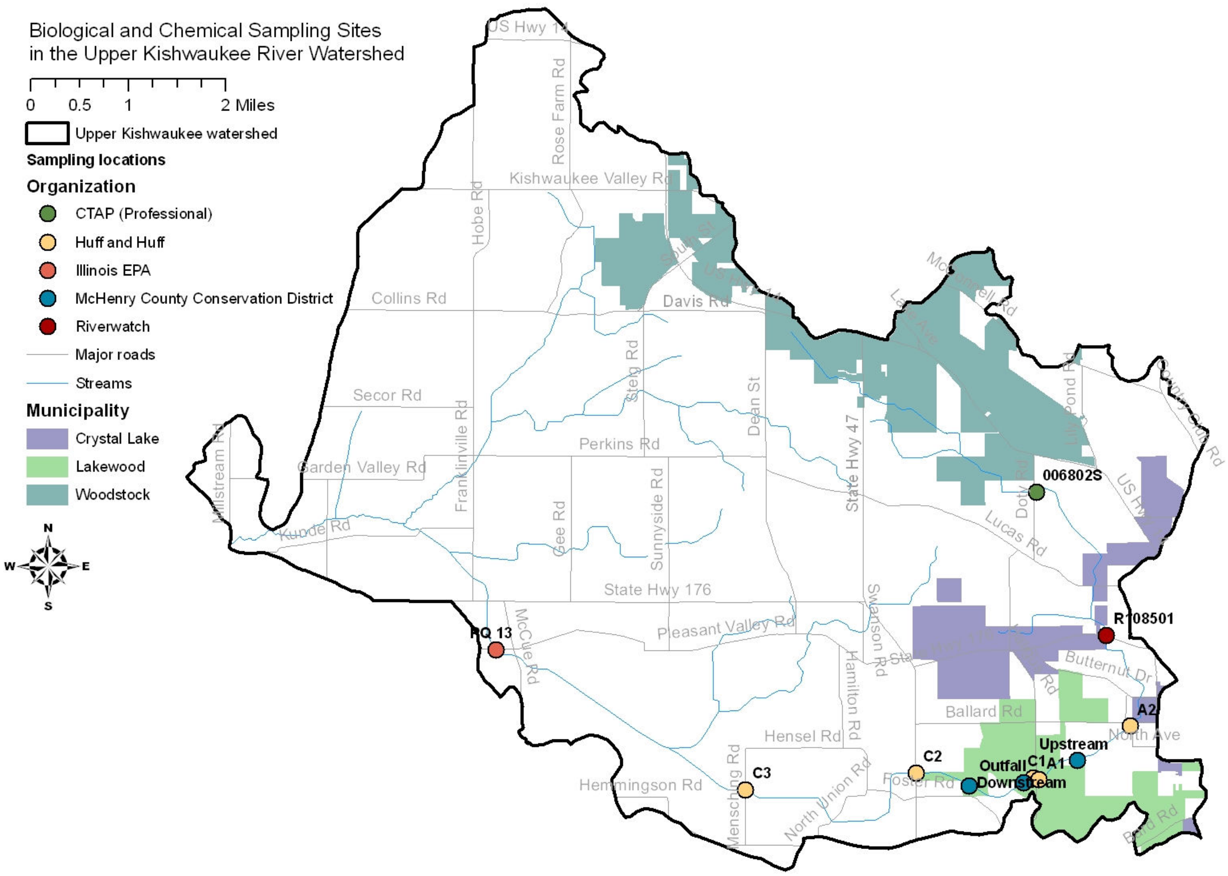
The last assessment Illinois EPA performed was in 2006 and indicated an Index of Biotic Integrity value of 34; macroinvertebrate samples were not collected. However, more data than these are available from the

[6] http://www.epa.state.il.us/water/water-quality/report-2006/2006-report.pdf. The assessment applies upstream from Illinois EPA sample station PQ 13.

[7] Primary contact use is defined as "any recreational or other water use in which there is prolonged and intimate contact with the water [where the physical configuration of the water body permits it] involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard, such as swimming and water skiing" (35 Ill. Adm. Code 301.355). Secondary contact is "any recreational or other water use in which contact with the water is either incidental or accidental and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, commercial and recreational boating, and any limited contact incident to shoreline activity" (35 Ill. Adm. Code 301.380). Like primary and secondary contact, aquatic life use and aesthetic quality are also elements of the general use standards that apply to almost all streams in the state. Use support for Public and Food Processing Water Supplies only applies to rivers and lakes that have those uses, and the Indigenous Aquatic Life use applies only to the Chicago Area Waterway System

antidegradation study[8] conducted by the Village of Lakewood for its wastewater treatment plant expansion as well as data collected by the McHenry County Conservation District. These data were collected from 1997 to 2006 and represent sample points spread widely across the stream, although none were taken below Illinois EPA's sample site or on Franklinville Creek (Figure 2-1, Table 2-3). Looking only at the last five years of data available at the time of the 2006 *Integrated Report*, there is no clear trend in the ten observations over space or time; thus, we elected to group them together. This yields an average score of 37 ± 3 (mean ± 95% confidence interval) and a median score of 40 for the Index of Biotic Integrity, indicating nonsupport but nonetheless a fair quality stream.

Figure 2-1.



The Macroinvertebrate Biotic Index as calculated by Huff and Huff and by Riverwatch volunteers had an average score of 4.68, indicating support. Data reported by professional scientists as part of the Critical Trends Assessment Program (CTAP) using a different set of metrics showed that the furthest upstream reach scored poorly; however, there is only one data point from 1997 in the CTAP program. Thus, it appears that the macroinvertebrate community is generally healthy through the middle stretch of the stream under consideration, while the upstream reach closest to Woodstock may be compromised and the lower reaches downstream of Huff and Huff's C3 site have not been assessed.

[8] Data collected by Huff and Huff, Inc. and quoted in Baxter and Woodman, Inc. and Kabbes Engineering, Inc. 2004. *Anti-Degradation Assessment*. Prepared for the Village of Lakewood, Illinois.

Table 2-3. Biological samples collected on the Upper Kishwaukee River

Point	Organization	Year	MBI	IBI
PQ 13	Illinois EPA	1997	—	34
R108501	Riverwatch	1997	4.98	—
R108501	Riverwatch	1998	4.48	—
Outfall*	McHenry County Conservation District	1999	—	40
R108501	Riverwatch	1999	4.31	—
R108501	Riverwatch	2000	4.33	—
PQ 13	Illinois EPA	2001	—	23
Upstream*	McHenry County Conservation District	2001	—	32
Outfall*	McHenry County Conservation District	2001	—	40
Downstream*	McHenry County Conservation District	2001	—	44
R108501	Riverwatch	2001	4.50	—
C2	Huff and Huff	2003	—	40
C3	Huff and Huff	2003	4.09	40
C1	Huff and Huff	2003	3.96	34
A1	Huff and Huff	2003	6.98	40
A2	Huff and Huff	2003	3.80	40
R108501	Riverwatch	2003	4.61	—
PQ 13	IEPA	2006	—	34
Average (2001 – 2006)			**4.68**	**37**
95% confidence interval			0.8	3

* Samples taken upstream from, at, and downstream from Lakewood WWTP outfall prior to plant expansion and relocation of the outfall

In order to fully support aquatic life use and have "good" resource quality, the Index of Biotic Integrity should be above 41. It is recommended that the IBI be used as the chief endpoint by which to measure biological improvement because it is what Illinois EPA has based its impairment determination on.[9]

2.1.2 FISH CONSUMPTION

Thus far the discussion has centered on aquatic life support. The fish consumption designated use has also been assessed and shown to be in nonattainment, with the cause of impairment inferred to be polychlorinated biphenyls (PCBs). However, this is because of the presence of a fish advisory on the Kishwaukee River and applies to a number of different stream reaches within the basin.[10] It does not imply that the source of the PCBs is within the Upper Kishwaukee watershed, as contaminated fish are able to move from one reach to another. Furthermore, the level of PCBs in sediment in the Upper Kishwaukee is not elevated. The sediment guideline for aquatic life support is 180 μg/kg, whereas sediment in the Upper Kishwaukee was measured at only 10 μg/kg in the Illinois EPA Intensive Basin Survey from 2001. It is not likely that the watershed plan will be able to recommend actions for the Upper Kishwaukee to render fish consumption safe. Therefore, we propose to concentrate on aquatic life support, which we expect plan implementation can affect positively.

[9] It has been hypothesized that IBI may not be an appropriate measure for the stream as it is less applicable to headwaters and because the Upper Kishwaukee may not always have been as riverine as it is now, i.e., that the defined channel of the stream is due primarily to ditching for drainage purposes (stakeholders at Kishwaukee "brain trust" meeting, April 4, 2008). In regard to the latter, an examination of the 1872 McHenry County Land Atlas suggests that the stream had a defined channel up to approximately the headwaters area near the Woodstock treatment plant. Comparison of the Atlas to current conditions also shows that extensive channelization took place after 1872. In regard to IBI, it appears that headwaters-specific IBI measures have been developed chiefly to overcome the problem of intermittency. While the Upper Kishwaukee was probably intermittent in the past, wastewater discharges ensure that it has constant flow now. Nevertheless, headwaters IBI scores may be a better fit if they employ different fish species or sampling protocols adapted to smaller streams.

[10] Illinois Fishing Digest. 2007. Retrieved from: http://dnr.state.il.us/fish/digest/

2.1.3 CAUSES OF AQUATIC LIFE IMPAIRMENT

Once aquatic life is determined to be impaired, Illinois EPA tries to determine potential causes of impairment based, if possible, on exceeding numeric water quality standards, but on other measures if necessary. The Illinois EPA has determined sedimentation, total nitrogen, and alteration in streamside or littoral vegetative covers to be potential causes of aquatic life impairment in the Upper Kishwaukee. As indicated in Table 2-4, the Illinois Pollution Control Board has not developed numeric standards for any of these.[11] Thus we have to rely on the narrative standards that qualitatively describe conditions to be achieved or avoided, seek observations of impairment, or use the statistical guidelines. The latter are not standards relating to biological conditions, but statistically high values (generally over the 85th percentile of samples taken from the Illinois EPA statewide Ambient Water Quality Monitoring Network) that are thought to signal a problem in the stream.[12] In Section 4.4 and Section 5 of this plan, specific recommendations are provided to correct the potential causes of impairment introduced here.

Table 2-4. Basis for identifying causes of aquatic life impairment

	Numeric standard		**Statistical guideline**		**Other**	
Potential Causes of Impairment	Acute	Chronic	In water	In sediment	Narrative Standard	Recorded Observation
Alteration in streamside or littoral vegetative covers	—	—	—	—	—	Various metrics
Sedimentation	—	—	TSS >116 mg/L	> 34% silt/mud substrate	Sludge or unnatural bottom deposits	Site-specific observation or knowledge
Total nitrogen	—	—	Nitrate + Nitrite >7.8 mg/L	Kjeldahl N >4,680 mg/kg	—	—
Total phosphorus	—	—	0.61 mg/L	2,800 mg/kg	—	—

Source: Integrated Water Quality Report (2006), pp. 45–46.

2.1.3.1 Nitrogen

Nitrate and nitrite as measured by Illinois EPA averaged 2.5 mg/L over three samples in 2001, well below the 7.8 mg/L statistical guideline. The reason for Illinois EPA's determination that total nitrogen is a potential cause of impairment appears to be that Kjeldahl nitrogen[13] in sediment was 4,840 mg/kg on one sample date in August 2001.[14] Sediment Kjeldahl nitrogen levels were similarly elevated in the Illinois EPA's 1997 sampling. However, in the Lakewood antidegradation study, three out of five water column samples taken in 2003 upstream and downstream from the Lakewood outfall were above the nitrate + nitrite statistical guideline (Table 2-5). Thus, the markers of nitrogen enrichment are in both sediment and the water column. Observational evidence from CTAP in 1997 also suggests that floating mats of algae occur at the Doty Road sampling site, a general indicator of nutrient enrichment,[15] and field investigations as part of the current planning project found the same conditions eleven years later (see Section 5.3).

[11] However, Illinois is in the process of trying to develop nutrient standards in response to USEPA's directive. Research is currently being conducted and can be found at http://www.ilcfar.org/research/waterqualityforum.html.
[12] A more detailed description of this procedure can be found in the Integrated Water Quality Report (2006), p. 43.
[13] Kjeldahl nitrogen combines the ammonia form of nitrogen (NH_3) with organic nitrogen, which is found bound in proteins. Total nitrogen is the sum of nitrate/nitrite, ammonia, and organic nitrogen. Equivalently, total nitrogen is Kjeldahl nitrogen plus nitrate/nitrite.
[14] Although water chemistry was evaluated in the 2006 Intensive Basin Survey for the Kishwaukee basin, these data are not yet available.
[15] Critical Trends Assessment Program. 1997. Fact sheet for Site 006802S. Retrieved from http://ctap.inhs.uiuc.edu/indexValue_EPT/EPT_index_value.asp?siteID=006802S.

Table 2-5. Water quality samples from Lakewood antidegradation assessment (pre-expansion).

	Constituent (mg/L)			
Sample Point*	Dissolved oxygen	Total phosphorus	Ammonia	Nitrate/nitrite
A2 (upstream of Lakewood outfall)	8.5	1.31	0.51	11.45
A1 (upstream of Lakewood outfall)	7.6	0.3	0.31	5.87
C1 (downstream of Lakewood outfall)	5	0.88	0.16	11.41
C2 (downstream of Lakewood outfall)	9.4	0.77	0.31	10.44
C3 (downstream of Lakewood outfall)	7.5	0.42	0.16	6.11

Source: Data collected by Huff and Huff, Inc. and quoted in Baxter and Woodman, Inc. and Kabbes Engineering, Inc. 2004. *Anti-Degradation Assessment*. Prepared for the Village of Lakewood, Illinois.
* Samples taken prior to plant expansion and relocation of the outfall. Mean of four samples.

The causal relationship between nutrient enrichment and biological impairment is generally that nitrogen and phosphorus, aided by warmer temperatures and sunlight during summer, drive up algal production, and the ensuing algae die-off drives down dissolved oxygen, which in turn is a stressor to aquatic life. Except for the low dissolved oxygen values recorded just downstream of the Lakewood outfall before expansion (Table 2-5), there is little evidence that dissolved oxygen is low on the whole, although data are very limited. This plan treats total nitrogen as a potential cause of impairment.

2.1.3.2 Sedimentation

The determination of sedimentation as a potential cause of impairment is also due to exceedance of statistical guidelines. Substrate composition at Illinois EPA station PQ 13 in 2001 was 61 percent mud/silt, well above the guideline of 34 percent. However, total suspended solids were not elevated in 2001, ranging from 26 to 58 mg/L. Recorded observations by scientists associated with the Illinois DNR (CTAP site in Figure 2-1) also suggest that the substrate contributes to the impairment:

> The segment sampled receives treated effluent from the town of Woodstock. Habitat quality was poor due to a narrow riparian zone, channelization, and a flocculant bottom. I suspect that the stream originally drained a marsh. Channelization not only straighted [*sic*], but deepened the channel below rich marsh soils. This promotes oozing of fine, black soils into the stream bed. This deposit is occasionally >1 ft deep.[16]

This observation by CTAP is consistent with nutrient elevation in sediments, as fine organic soils have a relatively larger surface area per unit mass to which nutrients can adhere. The stream survey undertaken for the Lakewood plant's antidegradation assessment also suggests that silty bottom composition is prevalent in the middle stretch of the river (Table 2-6). Thus, it is apparent that siltation has occurred throughout the stretch of the river upstream from PQ 13.

Table 2-6. Bottom composition in the Upper Kishwaukee River

Site	A2	A1	C1	C2	CM2	C3
Bottom composition	Mostly St with some Cb/Gr/Sd	Mostly St; few spots with Cb/Gr/ Sd	Cb/Gr/Sd; St along banks	Mostly St, some Cb/Gr	Mostly Sd or St over Sd; Gr along banks	Bd/Cb/Gr/ Sd; St along banks

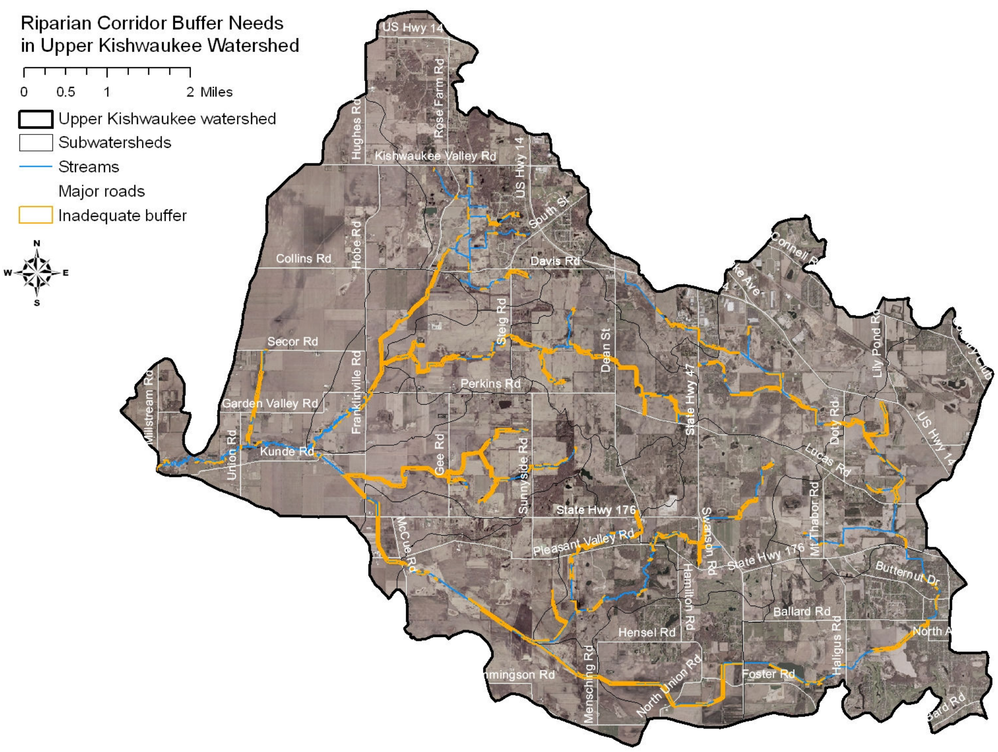
Source: Huff and Huff, Inc. 2003. *Biological Assessment of the Kishwaukee River: McHenry County, Illinois.*
Cb = cobble, Gr = gravel, Sd = sand, Bd = boulder, St = silt

[16] *Ibid.*

2.1.3.3 Alteration in Streamside or Littoral Vegetative Covers

This stressor as described by Illinois EPA is qualitative and somewhat vague. In an attempt to clarify and measure this potential cause of impairment, it was interpreted as degradation or loss of riparian buffers. To quantify changes to riparian buffer, we assumed that the minimum required buffer to protect water quality is 100 feet[17] and identified the areas in the watershed that lack this minimum requirement. Inadequate buffer was considered to include buildings, urban grass, roads, cropland, and active pasture, which were identified by direct examination of aerial photography. The results are shown in Figure 2-2. Across all the mapped streams in the watershed, 31 percent of the area within the 100-foot stream corridor (396 acres) was determined to have inadequate vegetative buffers.

Figure 2-2.



Source: CMAP

2.1.3.4 Phosphorus

The data from the 2003 antidegradation assessment for the Lakewood plant indicate that total phosphorus was above the 0.61 mg/L statistical guideline (Table 2-4) in three out of five samples. Using Illinois EPA's criterion, this implicates total phosphorus as a potential cause of impairment, although the samples were not taken at the Illinois EPA station (PQ 13). Thus, this plan treats phosphorus as a potential cause of impairment. Its sources are discussed below.

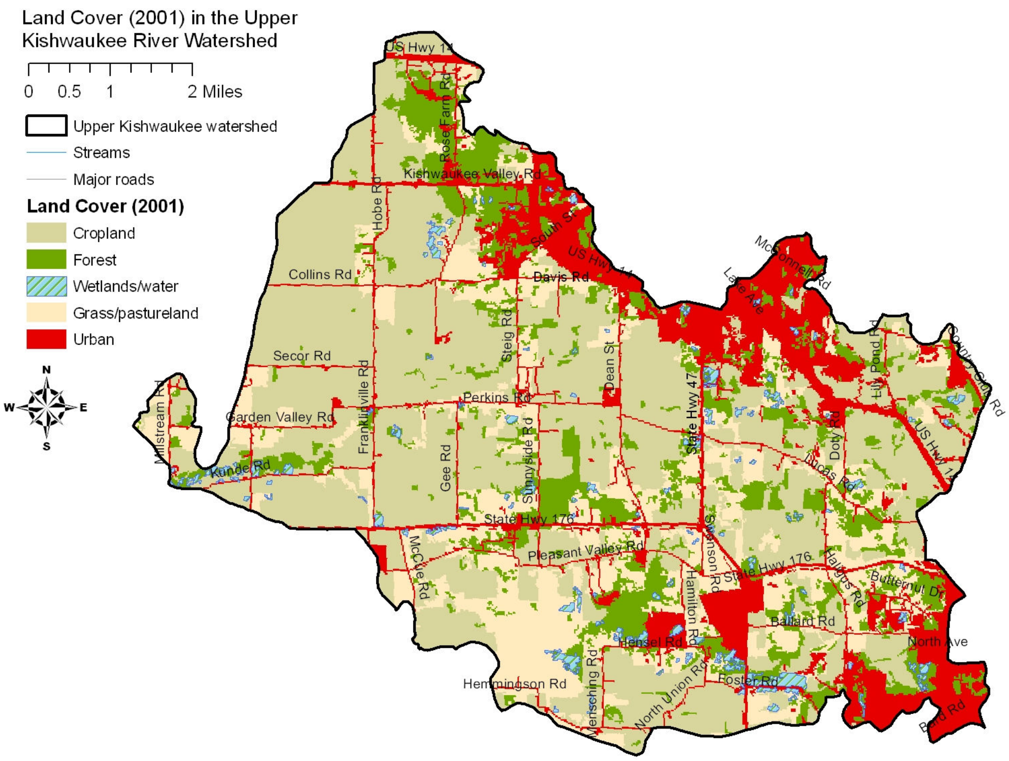
[17] The McHenry County Stormwater Management Ordinance requires a 100-foot buffer around streams with an Index of Biotic Integrity value over 35 (as the Upper Kishwaukee has).

2.1.4 POLLUTANT LOADING AND SOURCES

2.1.4.1 Overview

As part of its Intensive Basin Survey, Illinois EPA also identifies potential sources of impairment, that is, the sources of pollutants or the historical origins of the causes of impairment. In the 2006 *Integrated Report*, these included channelization, crop production, contaminated sediments, municipal point source discharges, and unknown sources, the latter most likely applying to PCBs. A sketch planning tool called STEPL (Spreadsheet Tool to Estimate Pollutant Loads) was employed to estimate the existing load of nutrients and sediment from the watershed, compute total load reduction needed, break the load down by source area, and break it down by source type or contributor, e.g., crop production, urban runoff, etc. It is not possible to estimate current pollutant loads resulting from historical channelization, and nor has a source of PCBs been identified in the Upper Kishwaukee watershed.

Figure 2-3.



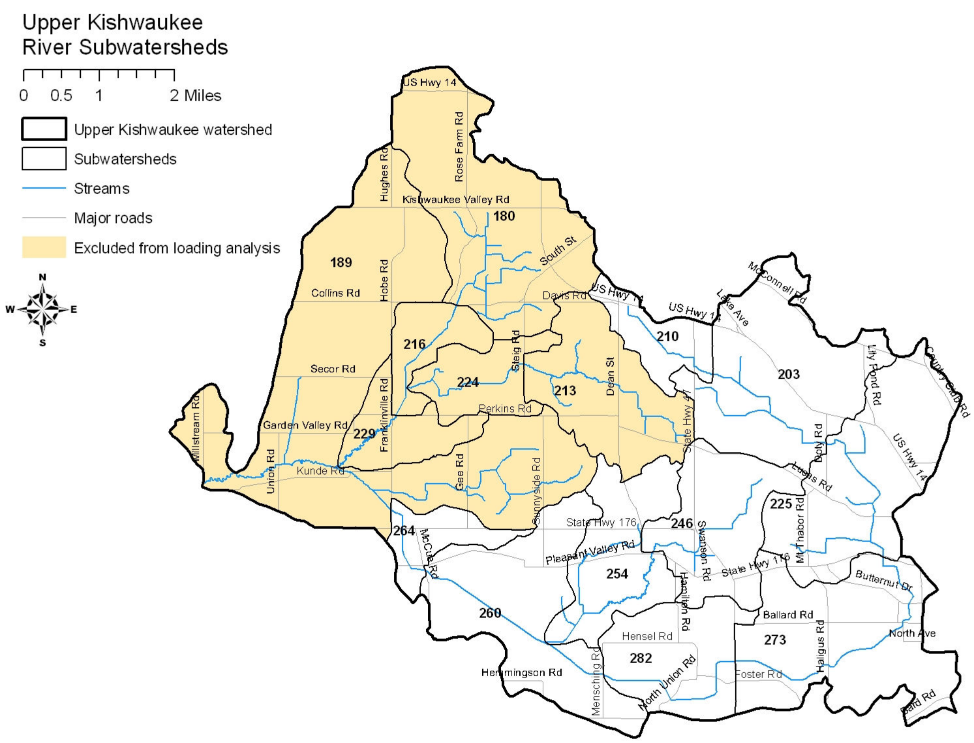
Source: National Land Cover Dataset (2001)

A number of different watershed models were first evaluated to determine which best met the needs of the project. The universe of potential models was restricted to those discussed in detail in the U.S. EPA's draft *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*, Chapter 8.[18] The deciding factors in favor of STEPL were its moderate sophistication but usability in the absence of data for calibration and validation,[19] applicability to mixed urban and agricultural watersheds, its relative transparency and the ease of use of the model for stakeholders, and the inclusion of a load reduction model using BMP data. It is also available as a free download from U.S. EPA.[20] This section presents the results of the tool; further documentation of the data and assumptions employed is presented in the appendix.

[18] Available online at http://epa.gov/nps/watershed_handbook/.
[19] There is no stream gage on the Upper Kishwaukee or any of its tributaries, and water quality sampling over the years has been infrequent.
[20] See http://it.tetratech-ffx.com/stepl/models$docs.htm.

The primary input to STEPL is land cover and land use information. Land cover categories are grouped into urban, cropland, forest, grass or pastureland, and a user-defined category that in our implementation was wetlands and water (Figure 2-3).[21] STEPL also allows the urban land cover classification to be broken down further, which was done by subcategorizing urban areas using the (draft, unreleased) CMAP land use inventory for 2005. This also allowed us to update the land cover information from 2001 with more recent information.[22] The model output from STEPL is average annual pollutant loads from nonpoint sources and is shown by source in Figure 2-4. First, the gross pollutant load from the landscape is computed, and second, the mitigating effects of existing best management practices (BMPs) are incorporated (Table 2-6). Contributions from wastewater are calculated separately and added to the STEPL results as described in Section 4.3. It is important to understand that STEPL is not a comprehensive physical model. It computes only watershed loading, not water quality response, and makes use of highly generalized data at some points.

Figure 2-4.

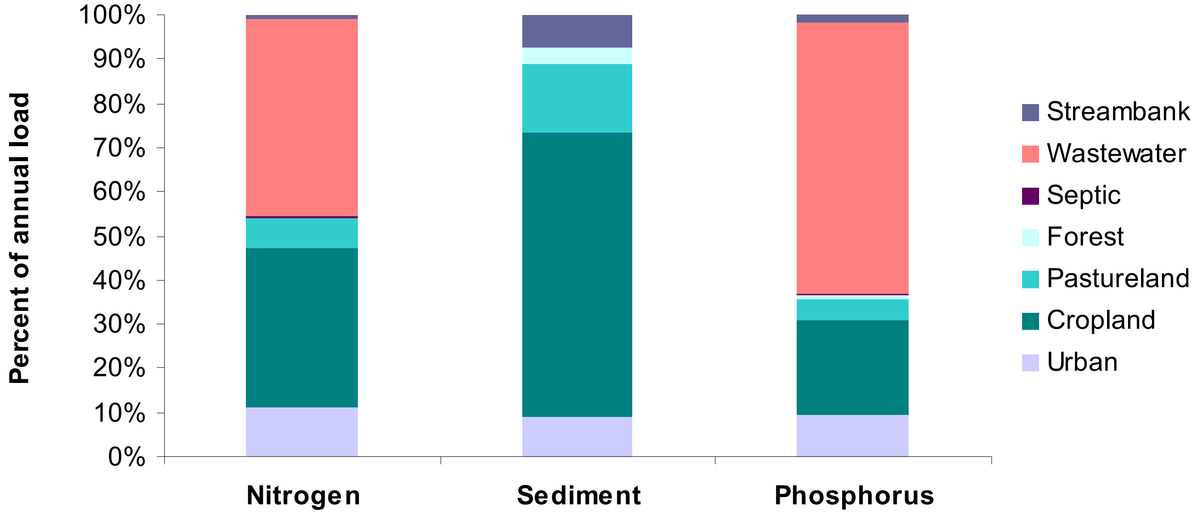


The Illinois EPA sample point (PQ 13) at which the loading targets were established (see Section 2.2 below) is near Pleasant Valley and McCue Roads. Thus it was necessary for the loading analysis to exclude pollutant contributions from runoff from the subwatersheds draining to the Upper Kishwaukee downstream from this intersection, including Franklinville Creek and its largest tributary, Apple Creek.[23] The size of the watershed without these subwatersheds is 17,328 acres, or about 45 percent smaller (Figure 2-

[21] The land cover data for wetlands were supplemented with the 1999 McHenry County ADID study, which provides much better accuracy.
[22] However, two large developments that started in 2007, the Bryn Mawr subdivision north of Route 176 in Crystal Lake and the Apple Creek development in Woodstock, are not reflected in the map.
[23] These are subwatersheds 180, 189, 213, 216, 224, and 229. They were excluded from the analysis.

4). As the remaining watershed is more urbanized, one side effect is to accentuate slightly the impact of urban runoff and wastewater and decrease the contribution of agriculture on a percentage basis. Section 6 includes a proposal for monitoring Franklinville Creek to establish baseline information for that watershed.

Figure 2-5. Estimated contributions to current pollutant load by source (excluding Franklinville Creek).



Note: This chart uses lower nitrogen and phosphorus loading rates for the Lakewood plant to reflect post-expansion conditions. Thus current conditions actually reflect 2005 land use and 2007 wastewater information.

2.1.4.2 Results

The results of the STEPL tool suggest that agriculture (cropland and pastureland) contributes 43 percent of the nitrogen load, while wastewater contributes 45 percent and urban runoff contributes most of the remainder (Figure 2-5). Wastewater and agriculture appear to be approximately equal contributors to nitrogen loading. Septic systems appear to play a very minor role. The majority of total phosphorus loading, however, originates from the wastewater treatment plants, while cropland contributes much of the remainder. The sediment load is almost entirely from nonpoint sources, much of it from agricultural land uses. The estimated sediment contribution from urban sources is loosely equated to total suspended solids, which may contain a variety of solids other than sediment and may have different physical properties. The existing urban BMPs that help control total suspended solids include dry and wet ponds, which chiefly work by allowing solids to settle out of the water column. Septic systems of course do not contribute sediment to waterways, and total suspended solids in wastewater is controlled by NPDES permit limits.

Table 2-7. Estimated current (2005) annual pollutant load by source (area downstream from PQ 13 station excluded).

Sources	N Load (lb/yr)	P Load (lb/yr)	Sediment Load (t/yr)
Urban	23,369	3,327	489
Cropland	76,863	7,824	3,510
Pastureland	13,625	1,633	833
Forest	846	332	219
Septic	280	110	0
Streambank	2,097	692	388
Wastewater	94,275	21,961	11
Total	**211,356**	**35,879**	**5,451**

* information has not been collected on locations and extent of gully erosion ** ignored in model

There are a few other potential sources treated in STEPL for which no estimates have been made because of data limitations. Gully formation would require fieldwork to estimate, but this has not been done. Furthermore, shallow groundwater via baseflow can be a source of nutrient loading to streams, but no data have been identified that would allow an estimate to be made.

2.1.4.3 Consistency

While STEPL is designed to be used without calibration, it can and should be checked for consistency with other methods. It is not, of course, possible to estimate loads based on empirical data as these are very sparse. The only long-term estimate for a hydrologic parameter in the watershed is streamflow from the Illinois State Water Survey's Illinois Streamflow Assessment Model.[24] For river mile 44.61 — just upstream from the confluence with the North Branch of the Kishwaukee and approximately the outlet of the HUC 10 watershed — the State Water Survey's method gives a long-term mean streamflow of 35.6 cubic feet per second, or 25,773 acre-feet of discharge per year (Table 2-8). This includes contributions from wastewater treatment plants.[25] Once the average annual wastewater discharge for the two plants in the watershed[26] is added to the runoff computed by STEPL, the State Water Survey and the STEPL estimates are almost exactly equal.

Table 2-8. Comparison of discharge estimates by STEPL and State Water Survey methods

Model	Annual Average Discharge (ac-ft)	Ratio	Annual Average Wastewater (ac-ft)	Total Discharge including wastewater (ac-ft)	Ratio including wastewater
STEPL	24,448.8	0.95	1,657.7	26,106.5	1.01
ILSAM	25,773.2				

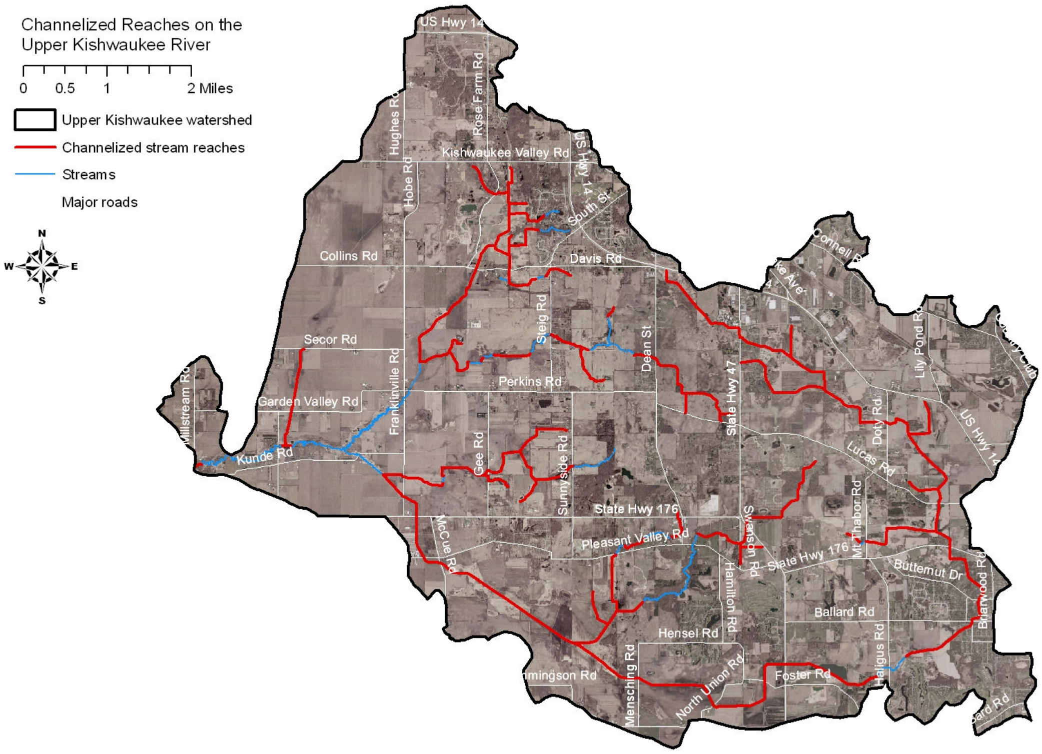
Source: http://www.sws.uiuc.edu/data/ilsam/.

2.1.4.4 Summary of Sources of Impairment

The relative contribution of nutrients and sediment from urban runoff, crop production, and municipal point sources was described in the previous sections. While important, watershed stakeholders and professional judgment suggest that the dominant source of impairment to aquatic life is most likely historic channelization. It has been quite extensive, as Figure 2-6 indicates. Straightening, deepening, and cleaning out channels drastically simplifies the aquatic environment and removes habitat features. One issue that has been raised by stakeholders is the extent to which the stream channel is wholly artificial, a product of digging a ditch through marshland to promote drainage. An examination of the 1872 Land Atlas[27] suggests that the main stem has always had a defined channel up to approximately the Kishwaukee Headwaters Conservation Area. The ditch through this wetland area has now been filled in as part of a restoration project. However, some of the tributaries to the main stem are simply ditches.

[24] Available online at http://www.sws.uiuc.edu/data/ilsam/.
[25] For methods used in the Illinois Streamflow Assessment Model, see Knapp, H.V. and A.M. Russell. 2004. *Rock River Basin Streamflow Assessment Model*. Illinois State Water Survey, Champaign, IL. Retrieved from: http://www.sws.uiuc.edu/pubdoc/CR/ISWSCR2004-02.pdf
[26] The U.S. EPA's Permit Compliance System was queried to determine average wastewater flow values. Lakewood's plant (IL0045446) was estimated to discharge an average of 0.308 million gallons per day based on records from June 2003 to October 2007, while the Woodstock South plant plant (IL0034282) was estimated to discharge an average of 1.172 million gallons per day based on records from March 2005 to October 2007.
[27] Provided by Ed Collins, Natural Resource Manager, McHenry County Conservation District

Figure 2-6.



Source: Illinois Department of Natural Resources, Illinois Stream Information System and KREP

The problem of channelization is somewhat independent of nutrients and sediment as causes of impairment and has to be addressed directly. How to do so depends on the context and the extent of recovery that can be hoped for. Fish habitat can be partly addressed by instream measures that do not attempt to reshape the channel, but more extensive measures are in order that serve to reconnect the floodplain to the river (i.e., address the deepening of the channel and remove the high spoil piles on the banks) or add sinuosity back to a straightened channel (i.e., remeandering). Recommendations are developed in Section 5. The central point is that IBI, the biological endpoint of the plan, most likely will not improve by reducing nutrient and sediment inputs alone. Direct habitat and hydrological improvements to the stream will have to be made to accomplish this.

2.2 Load Reduction Targets

As mentioned above, there are no numeric standards in Illinois for nutrients or clean sediment. Yet in order to achieve the aquatic life designated use, reductions in the cause of impairment ("load reductions") need to be connected to some target that reflects aquatic life support.

2.2.1 NUTRIENTS

A form of the reference stream method was used to set nutrient loading targets. This involved examining the nutrient criteria guidelines that USEPA has developed for insight into desirable conditions in the stream. USEPA assembled multi-decadal water quality samples for the Corn Belt and Northern Great Plains ecoregion of the U.S. ("Ecoregion VI") and aggregated the data to smaller Level III ecoregions. Northeastern Illinois falls into the Central Corn Belt Plains Level III ecoregion. USEPA has suggested that nutrient criteria can be developed by treating streams with nutrient concentrations below the 25th percentile of all streams as nonimpacted,[28] and has published values for the 25th percentile for the Central Corn Belt Plains.[29] Concentrations above this value can then be taken as unacceptable, or states can develop a classification system ranging in quality from reference to acceptable to degraded. Since the latter approach has not been taken in Illinois,[30] this study treats values above the cutoff as degraded. In this way the nutrient criteria define the load reduction target.

Table 2-9. Concentration reductions needed according to USEPA criteria

Nutrient	25th percentile (mg/L)	2001 Concentration (mg/L)	Reduction needed
Total nitrogen	2.461	3.85	–36%
Total phosphorus	0.0725	0.27	–73%

The results of this procedure are shown in Table 2-9. Actual concentrations in the stream are simple averages of the three samples Illinois EPA collected in summer 2001 at station PQ 13 near the intersection of Pleasant Valley and McCue Roads (water chemistry data for the 2006 Intensive Basin Survey are not yet available). Notwithstanding any objections to USEPA's statistical procedure for setting criteria, the chief issue with the method here is the limited number of water quality samples in the Upper Kishwaukee River. For one, the samples were taken in summer, most likely under low flow conditions in which nutrient enrichment from nonpoint sources would be minor. For another, it is clear that concentrations upstream are much higher because of the wastewater treatment plants (see Section 4.3). Most significantly, however, the data and model available to us do not allow us to back-calculate directly the allowable load required to keep concentrations under the nutrient criteria; we therefore assume that the percent decrease in sample concentration needed ≅ percent reduction in annual load needed. Using the modeled loads in Table 2-7, the required load reduction for nitrogen is 76,088 pounds per year and 26,191 pounds per year for phosphorus. It should be noted again that STEPL is not calibrated. Because of this it cannot be known whether modeled loading and thus whether the load reductions reflect actual conditions; they should be considered provisional.

It will be noted that the nutrient criteria used here differ from the statistical guidelines Illinois EPA uses to assess whether streams are impaired by nutrient enrichment. The State simply uses its statistical guidelines as a "flag" to signal elevated nutrient concentrations rather than a definite target to be achieved by load reductions. The state's statistical guideline is much higher than the criterion produced by USEPA's approach: the former uses the 85th percentile of all streams in the state, whereas the latter uses the 25th for the ecoregion. It is doubtful that the Illinois EPA's guideline is protective, but then it is not billed as a standard or even a criterion. When the Illinois Pollution Control Board adopts nutrient standards, this analysis will need to be revised.

[28] USEPA. 2000. *Nutrient Criteria Technical Guidance Manual: Rivers and Streams*. EPA-822-B-00-002. Available at http://www.epa.gov/waterscience/criteria/nutrient/guidance/rivers/. The 25th percentile as USEPA calculates it is the median of the 25th percentiles of samples taken in each season of the year. The guidance manual also suggests criteria can be developed by establishing reference streams known to be in good condition and treating values above the 75th percentile in those streams as signaling degradation.
[29] USEPA. 2000. *Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregion VI.* EPA 822-B-00-017. Data are from Table 3d. Available at http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/rivers_6.pdf.
[30] USEPA (ibid.) provided three options for developing nutrient criteria: the reference stream approach, using predictive relationships, and using published nutrient thresholds or recommended algal limits. Illinois has opted to develop predictive relationships (see Illinois Council on Food and Agricultural Research at http://www.ilcfar.org/research/waterqualityforum.html), so it has not prepared a classification system based on percentiles in the frequency distribution of nutrient samples. It is not clear when nutrient criteria might be established in Illinois.

2.2.2 SEDIMENT

It was not readily possible to use the reference stream approach for sediment, chiefly because of inadequate data, but a number of avenues were first explored. First, we examined the State Water Survey's annual load estimates for various tributaries to the Illinois River[31] and classified each tributary by impairment status according to the Illinois EPA (using the 2004 305(b) report). There was no difference in unit sediment loads between fully supporting, partly supporting, and nonsupporting streams. Furthermore, the unit loads measured by the State Water Survey were considerably higher than the STEPL output in most cases, but we were unable to determine whether this reflected geomorphic differences between the Illinois and Rock River basins or whether the (uncalibrated) STEPL tool underestimates sediment delivery.[32] Second, we considered computing sediment loads from each HUC 12 watershed in the Kishwaukee basin using STEPL and to compare unit loads between impaired and nonimpaired streams. This method, however, was unable to account for differences in best management practices between watersheds and would have been extremely time consuming as well.

As an alternative to the reference stream approach, we attempted to find a direct relationship between an indicator of sedimentation and the aquatic life impairment as measured by the Index of Biotic Integrity. The increase in the Index of Biotic Integrity necessary to achieve full support of aquatic life would then be assumed proportional to the necessary decrease in the sediment indicator. The various problems with the method include the fact that IBI is composed of weighted metrics that vary from researcher to researcher and state to state and that few studies actually report regression equations rather than merely correlation coefficients. However, there is a Predicted Index of Biotic Integrity (PIBI) in use by Illinois EPA that computes IBI based on a regression equation[33] taking various stream habitat metrics as its terms, one of which is the percent substrate that is mud/silt. As noted in Section 2.1.3.2, substrate composition is the observed cause of impairment as well as a direct interpretation of the narrative water quality standard for sedimentation. Using this equation, the percent change in bottom composition required to achieve a PIBI of 41 could be computed. Illinois EPA data as well as data from the 2003 antidegradation assessment were used for this operation. The 2003 data were reported in narrative format, so they were reinterpreted as percentages as shown in Table 2-10.[34] The average decrease in silty bottom composition needed throughout the stretch under review is then 56 percent if all other conditions are held constant (Table 2-10).

STEPL generates sediment yield at a watershed outlet by calculating sheet and rill erosion and multiplying by a *sediment delivery ratio* (SDR) that is a power function of drainage area. SDR is purely empirical and is meant to account for (1) re-deposition of detached sediment on hillslopes and in floodplains and (2) storage of sediment within the channel.[35] Because the objective is to reduce sedimentation in the channel upstream of PQ 13, the quantity of interest is the second. However, this cannot be isolated using the available information. It is therefore assumed that eroded soils become either suspended sediment load and flow out of reach PQ 13 or are deposited in the channel, and that none is deposited on hillslopes. Thus the sediment load is assumed to be total erosion × (1 – SDR), giving 5,451 tons per year. The same SDR was applied to both urban and nonurban sources. The annual sediment accumulation rate at these

[31] Misganaw Demissie, Renjie Xia, Laura Keefer, and Nani Bhowmik. 2004. *The Sediment Budget of the Illinois River*. Contract Report 2004-13. Retrieved from: http://www.sws.uiuc.edu/pubdoc/CR/ISWSCR2004-13.pdf

[32] As discussed below, our implementation of STEPL does not account for gully erosion, in addition to other potential model errors.

[33] PIBI = 40.1 – (0.126 × MUD) – (0.123 × CLAYPAN) + (0.0424 × POOL) + (0.0916 × WIDTH). Taken originally from Hite, R. L. and B. A. Bertrand. 1989. *Biological Stream Characterization (BSC): A Biological Assessment of Illinois Stream Quality*. IEPA/WPC/89-275. Illinois Environmental Protection Agency, Illinois State Water Plan Task Force, Special Report Number 13, Springfield, Illinois.

[34] While this method is rough, varying the percentages by 20 points suggests that the results are not very sensitive to the percentage values chosen.

[35] This is a fertile area of research, as hydrologists are only fairly recently beginning to propose physically-based models of sediment deposition on hillslopes and in the channel.

sites is unknown. It is therefore conservatively assumed that the annual load of deposited sediment needs to be reduced by 56 percent or 3,053 tons per year.

Table 2-10. Numeric interpretation of substrate composition

Site	A2	A1	C1	C2	CM2	C3
Mud (text)	Mostly St with some Cb/Gr/Sd	Mostly St; few spots with Cb/Gr/ Sd	Cb/Gr/Sd; St along banks	Mostly St, some Cb/Gr	Mostly Sd or St over Sd; Gr along banks	Bd/Cb/Gr/ Sd; St along banks
Mud %	80%	80%	20%	80%	33%	20%
Pool (text)	Riffle/run/ shallow pool	Mostly pool, minor rif-fle/run	Pool, runs, submerged macrophytes	Mostly run/pool	Pool, run, logjams	Riffle/pool, log jams
Pool %	33%	90%	50%	50%	50%	50%

Source: Huff and Huff, Inc. 2003. *Biological Assessment of the Kishwaukee River: McHenry County, Illinois.*
Cb = cobble, Gr = gravel, Sd = sand, Bd = boulder, St = silt

Table 2-11. Predicted IBI values based on substrate conditions

Site	A2	A1	C1	C2	CM2	C3	PQ 13
Mud %	80%	80%	20%	80%	33%	20%	61%
Claypan %	0%	0%	0%	0%	0%	0%	0%
Pool %	33%	90%	50%	50%	50%	50%	18%
Width %	12	6	7	9	11	12	23
PIBI	32.5	34.4	40.3	33.0	39.1	40.8	35.3
Target mud %	13%	27%	14%	16%	17%	18%	15%
Change needed	-84%	-66%	-30%	-80%	-48%	-10%	-75%

There are a number of unresolved issues regarding the computation of a load reduction for sediment in the Upper Kishwaukee. For one, the relationship between PIBI and observed IBI can be poor in some situations,[36] leading to significant uncertainty about the recommended load reduction in this stream. The PIBI values calculated for the stream survey sites in Table 2-11 do not fit the observed IBI values in Table 2-3 very well. Also, because mud/silt substrate accumulates over time and this cumulated amount is the denominator, so to speak, it may be the case that the calculated load reduction overstates the decrease in annual sediment deposition necessary to prevent further build up. Finally, the assumption that all sediment is deposited in the channel and none on hillslopes produces an over-estimate of the reduction needed.

2.2.3 SUMMARY

Table 2-12 summarizes the recommended load reductions. Total nitrogen and total phosphorus should be decreased by 76,088 and 26,191 pounds per year, respectively, and the amount of sediment deposited in the channel should be decreased by 3,053 tons per year. The target load given in the right hand column of Table 2-12 is the annual load estimated to protect aquatic life: it represents desirable conditions in the Upper Kishwaukee River.

[36] Using data from a USGS study on the Des Plaines River system (Fitzpatrick, F.A., Harris, M.A., Arnold, T.L., Richards, K.D. 2004. Urbanization influences on aquatic communities in Northeastern Illinois streams. *Journal of the American Water Resources Association*. April 2004, 461-475), we found that r^2 = 0.0503 for a regression between PIBI and observed IBI (n = 34, P = 0.202).

Table 2-12. Summary of load reductions

	Load reductions		
	Percent	Load	Target load
Total nitrogen	–36%	76,088 lb/y	135,267 lb/y
Total phosphorus	–73%	26,191 lb/y	9,687 lb/y
Sediment	–56%	3,053 t/y	2,398 t/y

2.3 Existing Protections

2.3.1 LOCAL ORDINANCES

2.3.1.1 Stormwater Management

The minimum standard to which local stormwater management ordinances should be compared in this region is the set of model ordinances prepared by the Northeastern Illinois Planning Commission (NIPC), as these were developed to codify the nonpoint source management policies of the Areawide Water Quality Management Plan. The municipalities in the watershed have generally adopted by reference the McHenry County Stormwater Management Ordinance or incorporated the language with changes. Facility Planning Area Amendment application reviews by CMAP have shown that the countywide ordinance is generally consistent with the NIPC model ordinances, with the minor exceptions that it:

- Does not designate a minimum 75 foot setback zone from the edge of identified wetlands and waterbodies in which development is limited to the following types of activities: minor improvements like walkways and signs, maintenance of highways and utilities and park and recreational area development;
- Does not prohibit watercourse relocation or modification except to remedy existing erosion problems, restore natural conditions, or to accommodate necessary utility crossings; and require mitigation of unavoidable adverse water quality and aquatic habitat impacts; and it
- Does not discourage culvert crossings of streams unless necessary for allowing access to a property.

In regard to the first bullet, the ordinance does specify that the minimum buffer width should be 100 feet where IBI is over 35. The available data, described above, suggest that on average this is the case in the Upper Kishwaukee, at least in the middle section of the stream. In the absence of additional site-specific data, it is recommended that enforcement officers require buffers of 100 feet on both the main stem and the tributaries. The ordinance also requires wetland buffers whose width depends on the size and quality of the wetland. Most of the wetlands in the Upper Kishwaukee watershed are eligible for 50 foot buffers. For the land use projection described in Section 3, the protections for isolated wetlands and the stream and wetland buffering requirements were assumed to prevent increases in nonpoint source loading that would have otherwise occurred.

The City of Woodstock has adopted the McHenry County Stormwater Management Ordinance as municipal ordinance number 05-0-01. The Village of Lakewood has adapted the language of the countywide ordinance with minor changes. For instance, section 25.05-C in the Lakewood ordinance (V.C.5.c in countywide ordinance) exempts buffer areas from vegetation height limits otherwise enforced in the Village, but not from noxious weed rules. Also, the types of best management practices used are by Village approval and are not necessarily contained in the county Technical Reference Manual. The City of Crystal Lake has also adapted the language of the MCSMO, but with more substantial exceptions. One is that Section 595-17 replaces a general list of BMPs in Section V.B.2 of the countywide ordinance with a requirement for the use of infiltration basins with pretreatment, allowing resort to wetland detention facilities if infiltration is infeasible. This section also includes a reporting requirement for infiltration devices that meet the definition of Class V injection wells under the federal Underground Injection Control program. In addition to minor alterations to the language in the MCSMO, there are the following more substantial changes:

- Detention facilities, storm sewers, and swales may not be connected to existing drain tiles, whereas the MCSMO permits this to be done if the tile is in acceptable condition and a maintenance agreement is recorded.
- A number of additional requirements are applied to infiltration basins.
- Requirements for drainage into and detention within wetlands are generally the same, but Crystal Lake requires that the stage-discharge relationship be unchanged for wetlands, both those in the Corps' jurisdiction and isolated wetlands of McHenry County.
- Developers are given the option of connecting disturbed drain tiles to new storm sewers, provided capacity is increased to accommodate new flow.
- Storm sewer velocities are made discretionary and to be approved by the enforcement officer.
- The requirement for an overland flow path that will pass the 100-year flood is waived for developments only under 10 acres, rather than 20.

Except for Crystal Lake's requirement for the use of infiltration basins, other ordinances do not require particular BMPs and nor do they reference any performance standards for pollutant removal.

2.3.1.2 Zoning and Subdivision Codes

Local ordinances regulating land use and subdivision standards can have either a relatively negative or relatively positive effect on runoff control by, for example, stipulating certain street widths (more or less impervious surface) or by encouraging or not encouraging flexible development. The ordinances of the municipalities in the Upper Kishwaukee were compared to a checklist from the Center for Watershed Protection (CWP) for guidance.[37] The results are shown in Table 2-13.

Table 2-13. Comparison of municipal ordinance requirements to CWP checklist

Area	Code element	Woodstock	Score	Crystal Lake	Score	Lakewood	Score	**McHenry County**	**Score**	**CWP Guideline**	Max score
1	Street width	28-31'	0	28'	0	22-28'	0	31'	0	**18-22'**	4
	Queuing allowed?[38]	Unclear	0	Unclear	0	Unclear	0	NL[39]	0	**Yes**	3
2	Try to minimize street length?	NL	0	NL	0	NL	0	NL	0	**Minimize**	1
3	ROW width	60'	0	60'	0	60'	0	60'	0	**<45'**	3
	Placed utilities under paved part of ROW?		0		0	Discouraged	0	Yes	1	**Yes**	1
4	Cul-de-sac radii	50'	0	55'	0	43'	1	70'	0	**<35', <45'**	3, 1

[37] Center for Watershed Protection. 1998. *Better Site Design*. Retrieved from: http://www.cwp.org/Store/bsd.htm
[38] "Queuing streets" are intended for two-way traffic and are comprised of a single traffic lane and a parking lane on one or both sides. When two vehicles meet on a queuing street, one of the vehicles must yield by pulling over into a vacant segment of the adjacent parking lane.
[39] NL = no language

Area	Code element	Woodstock	Score	Crystal Lake	Score	Lakewood	Score	**McHenry County**	**Score**	**CWP Guideline**	Max score
	Allow landscaped island in cul-de-sac?	Unclear	0	Yes	1	Unclear	0	Yes	1	**Yes**	1
	Allow alternative turn-arounds?	Unclear	0	Unclear	0	Culs-de-sac discouraged	1	Yes	1	**Yes**	1
5	Curb and gutter required?	Yes unless CD[40]	2	Yes	0	No	2	No	2	**No**	2
	Established swale criteria?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
6	Parking ratio, professional office	4	0	5	0	4	0	4	0	**<3**	1
	Parking ratio, shopping ctr	4	1	4	1	5	0	5	0	**≤4.5**	1
	Parking ratio, single family detached	2	1	2	1	2	1	2	1	**≤2**	1
	Parking ratios given a max rather than min?	No	0	No	0	No	0	No	0	**Yes**	2
7	Promote shared parking?	No	0	No	0	No	0	Yes	1	**Yes**	1
	Provide model shared parking agreements?	No	0	No	0	No	0	No	0	**Yes**	1
	Reduce parking ratios w/ shared parking?	Yes	1	Yes	1	Yes	1	No	0	**Yes**	1
	Parking ratio reduced near transit?	No	0	No	0	No	0	No	0	**Yes**	1
8	Parking stall width	9'	1	9'	1	9'	1	9’-10’	1	**≤9'**	1
	Stall length	18'	1	19'		19'	0	18’-22’	1	**≤18'**	1
	Smaller dimensions for compact cars?	No	0	Yes	1	No	0	NL	0	**Yes**	1
	Pervious area for spillover parking?	City discretion	2	No	0	No	0	NL	0	**Yes**	2
9	Incentives for structured parking?	No	0	No	0	No	0	NL	0	**Yes**	1

[40] CD = conservation design

Area	Code element	Woodstock	Score	Crystal Lake	Score	Lakewood	Score	**McHenry County**	**Score**	**CWP Guideline**	Max score
10	Require minimum landscaping for parking lots?	Yes (20% if >20 spaces)	2	Yes (1 island/ 10 stalls)	2	Yes (15%)	2	No	0	**Yes**	2
	Bioretention islands allowed?	Unclear	0	Yes[41]	2	Yes	2	Yes	2	**Yes**	2
11	CD or open space design allowed?	Yes	3	Yes	3	Yes	3	Yes	3	**Yes**	3
	Land conservation or impervious cover a major goal of open space design ordinance?	Yes	1	No	0	Yes	1	Yes	1	**Yes**	1
	Additional submittal or review requirements for CD?	Yes	0	Yes	0	Yes	0	Yes	0	**No**	1
	Is CD by-right form of development?	Yes	1	No	0	No	0	No	0	**Yes**	1
	Have flexible site design criteria?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
12	Irregular lot shapes allowed?	Yes	1	Yes	1	Yes	1	Yes	1		1
	Front setback for 0.5 ac residential lot	30'	0	50'	0	40'	0	30’	0	**≤20'**	1
	Rear setback for 0.5 ac residential lot	30'	0	20'	1	30'	0	10’	1	**≤25'**	1
	Min side setback for 0.5 ac residential lot	10'	0	10'	0	15'	0	10’	0	**≤8'**	1
	Frontage for 0.5 ac residential lot	85'	0	100'	0	100'	0	100’	0	**≤80'**	2
13	Min sidewalk width	4'	2	4'	2	4'	2	4’	2	**≤4'**	2
	Sidewalks required on both sides of street?	Yes	0	Yes	0	No	2	No	2	**No**	2
	Sidewalk sloped to drain to yard, not street?	Unclear	0	No	0	Unclear	0	NL	0	**Yes**	1

[41] Implied allowed for watershed district, but does not apply to Upper Kishwaukee

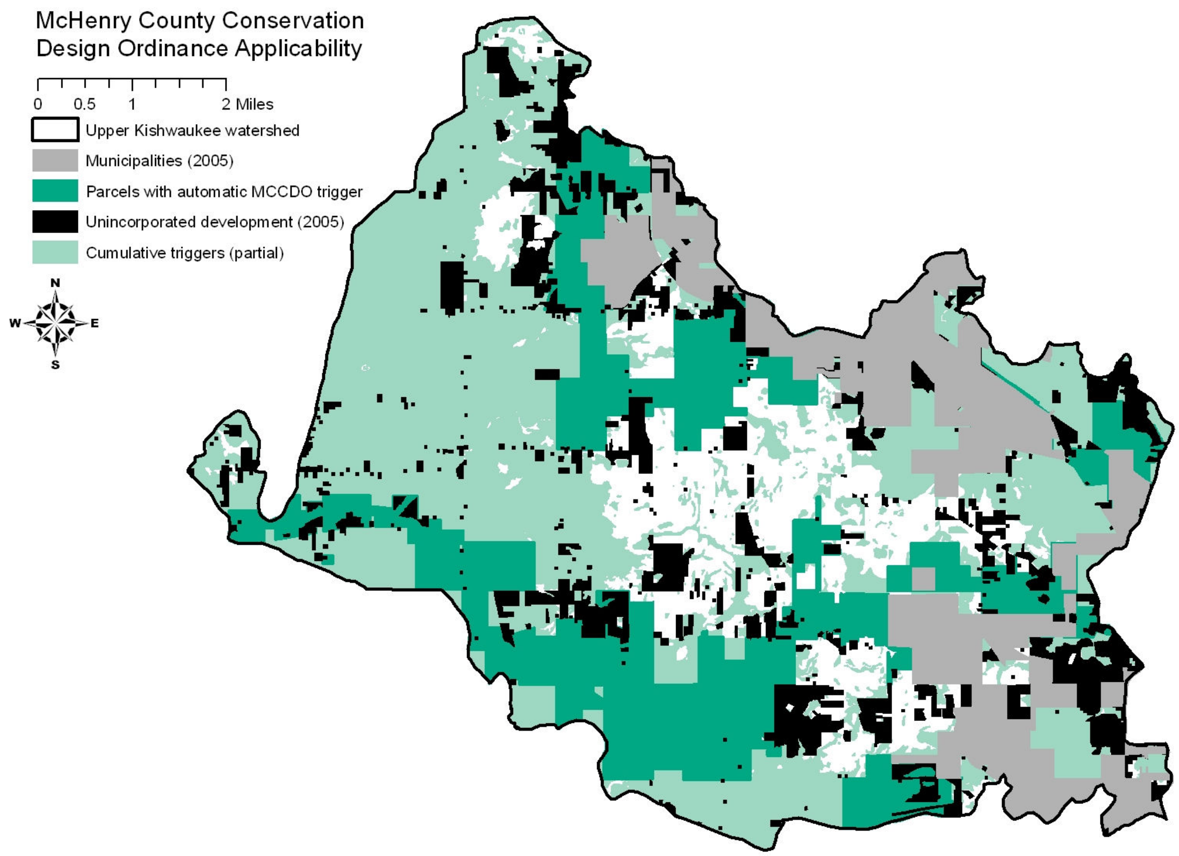
Area	**Code element**	Woodstock	Score	Crystal Lake	Score	Lakewood	Score	**McHenry County**	**Score**	**CWP Guideline**	Max score
	Can alternate pedestrian networks be substituted?	Yes	1	No	0	Yes	1	NL	0	**Yes**	1
14	Minimum driveway width?	10'	0	None	2	10'	0	NL	0	**≤9'**	2
	Can pervious materials be used on drive-way?	No unless CD	2	No	0	No	0	NL	0	**Yes**	2
	Use two-track design?	NL	0	NL	0	NL	0	NL	0	**Yes**	1
	Shared drive-ways permit-ted in residen-tial develop-ments?	Yes	1	NL	0	NL	0	NL	0	**Yes**	1
15	Require asso-ciation to man-age open space?	Yes	2	No	0	No	0	NL	0	**Yes**	2
	Require con-solidation of open space?	Yes	1	No	0	No	0	Yes	2	**Yes**	1
	Keep percent-age of open space in natu-ral condition?	Yes	1	No	0	No	0	Yes	1	**Yes**	1
	Uses defined for open space?	Yes	1	No	0	No	0	Yes	1	**Yes**	1
	Can open space be managed by third party?	Yes	1	No	0	Yes	1	Yes	1	**Yes**	1
16	Discharge roof runoff to yard?	Yes in CD	2	NL	0	Re-quired	2	NL	0	**Yes**	2
	Allow tempo-rary ponding on yard or roof?	NL	0	NL	0	NL	0	NL	0	**Yes**	2
17	Have stream buffer ordi-nance?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
	Requires min buffer width?	100' (IBI > 35)	1	100' (IBI > 35)	1	100' (IBI > 35)	1	100' (if IBI > 35)	1	**≥75'**	1
	Include wet-lands, steep slope, and floodplain?	No	0	No	0	No	0	No	0	**Yes**	1
18	Require native vegetation in buffer?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2

Area	**Code element**	Woodstock	Score	Crystal Lake	Score	Lakewood	Score	**McHenry County**	**Score**	**CWP Guideline**	Max score
	Does ordinance describe allowable uses in buffer?	Yes	1	Yes	1	Yes	1	Yes	1		1
	Buffer ordinance specifies education and enforcement?	No	0	No	0	No	0	Yes	1	**Yes**	1
19	Encourage preservation of natural vegetation on residential lots?	Yes in CD	2	No	0	No	0	NL	0	**Yes**	2
	Require clearing trees from septic field?	Unclear	0	Unclear		Unclear	0	NL	0	**No**	1
20	Require tree conservation?	Yes	2	Yes	2	Yes	2	NL	0	**Yes**	2
	Limits of disturbance on construction plans adequate to prevent clearing?	—	0	—	0	—	0	NL	0	**Yes**	1
21	Incentives for conserving nonregulated land?	Yes in CD	2	Yes	2	Yes	2	Yes	2	**Yes**	2
	Flexibility to meet regulatory requirements?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
22	Require water quality treatment for stormwater?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
	Effective design criteria for BMPs?	Yes	1	Yes	1	Yes	1	Yes	1	**Yes**	1
	Discharge stormwater directly into wetland without pretreatment?	No	1	No	1	No	1	Yes	0	**No**	1
	Restrict or prohibit development in 100 yr floodplain?	Yes	2	Yes	2	Yes	2	Yes	2	**Yes**	2
	Total		**55**		**41**		**46**		**46**		**100**

The purpose of the CWP's checklist was to scan municipal ordinances to determine whether it would be worth holding a "site planning roundtable," in which officials from municipal engineering, planning, etc.

departments go through ordinances in more detail. Using a facilitated process they would determine which ordinances the group would be willing to change and which they were not, and recommendations would be forwarded for action by elected officials. The value of the maximum score, or weight, for each code element in the checklist is based on what the Center for Watershed Protection's stakeholder group felt was most important and has not been altered. The major areas where Crystal Lake, Lakewood, and Woodstock seem to be out of keeping with the CWP checklist are in (1) street and cul-de-sac requirements, (2) parking ratios, and (3) yard requirements, which all affect watershed imperviousness. While the CWP's exact guidelines may not be ideal for the communities in the Upper Kishwaukee, it would seem that there is value in discussing more protective zoning and subdivision standards, especially as they affect levels of imperviousness.[42]

Figure 2-7.



Notes: The map does not show glacial kettle holes, high potential for aquifer contamination, or any of the resources requiring onsite determination, which are all cumulative triggers. The cumulative triggers are based on the site, which was interpreted as a parcel, plus a 200 foot buffer. Including the buffer proved computationally difficult, so the buffer was neglected in the analysis.
Source: data from McHenry County Soil and Water Conservation District.

It should be pointed out that the municipalities are already taking important steps to add natural resource protections to their development codes. The City of Woodstock has passed an ordinance with conservation design standards; this mostly accounts for the City's high score on the CWP checklist. The Vil-

[42] It is sometimes argued that ordinance requirement s do not matter so much because of the prevalence of planned unit development, to which many of the requirements of by-right development do not apply in the same way. During the PUD process, it is argued, city officials can request more protections or a lower impact form of development than otherwise might be provided for in the zoning and subdivision codes. While the PUD process can and often does lead to high quality results, it relies on the enlightenment of staff and on negotiation. Ordinance review provides a chance to set a baseline with more thorough examination of the issues.

lage of Lakewood zoning code is being rewritten to incorporate conservation design features. Furthermore, the Village of Lakewood hopes to process all development proposals as Planned Unit Developments, allowing the municipality and developer to work together to incorporate best management practices specific to each site.[43] Adapting information from the Woodstock and McHenry County ordinances, the City of Crystal Lake is working on a Unified Development Ordinance that will, among other things, require conservation design in certain areas.[44]

2.3.1.3 McHenry County *Conservation Design Standards and Procedures*

McHenry County passed the *Conservation Design Standards and Procedures* in February 2008 as an addendum to the subdivision code.[45] The requirements of this addendum go into effect automatically if a site has a McHenry County Natural Area Inventory site or a high quality aquatic identified from the ADID study within 100 feet. The presence of a number of other resources, if cumulatively present on more than 20 percent of the site, also triggers the ordinance. Based on a partial mapping of these triggers — glacial kettle holes, high potential for aquifer contamination, or any of the resources requiring onsite determination could not be mapped — much of the unincorporated area in the Upper Kishwaukee would be subject to the conservation design requirements (Figure 2-7). About 90 percent of the parcels that have any of the cumulative triggers on them have them on more than 20 percent of the parcel area, and more would be expected were the other triggers included. Thus, it appears that most unincorporated development in the watershed would need to be processed under the *Conservation Design Standards and Procedures*. The County is urged to apply the ordinance strictly in the watershed when sufficient triggers are present on a site, but also to encourage voluntary compliance with the ordinance even if they are not. This will help ensure that this plan's vision of land use (Section 4.2) is met.

2.3.2 NPDES PHASE II

The 1987 amendments to the Clean Water Act obligated the US Environmental Protection Agency to address stormwater runoff in two phases. Having successfully implemented Phase I, beginning in 1990, Phase II began in early 2003 and expands upon the Phase I program. Phase II requires smaller operators of municipal separate storm sewer systems (MS4s) in urbanized areas and operators of small construction sites, through the NPDES permit system, to implement programs and practices to control water pollution stemming from stormwater runoff.[46] Stormwater discharges from MS4s both large and small pose a water quality threat because of both the concentration and diversity of pollutants carried in these discharges. The impervious surfaces that are commonplace in urbanized areas collect oils, greases, pesticides, fertilizer, road salts, litter, pathogens, and other pollutants that are washed off by precipitation or melting snow and transported to a storm sewer where they are discharged into a water body without having been treated. Such pollution harms aquatic life, renders local water bodies unsafe for swimming or other types of recreation, and can contaminate public drinking water supplies.

The small MS4 stormwater management program must feature six minimum control measures as follows:

(1) public education and outreach,
(2) public participation and involvement,
(3) illicit discharge detection and elimination,
(4) construction site runoff control,

[43] Village of Lakewood comments on July 2008 draft plan, September 5, 2008
[44] City of Crystal Lake Planning Department comments on July 2008 draft plan, August 21, 2008
[45] See http://www.co.mchenry.il.us/common/CountyDpt/PlanDev/PDFDocs/ConservationDesignAddendum-February192008FinalVersionPDF.doc
[46] USEPA Office of Water. 2005. *Stormwater Phase II Final Rule: An Overview.* Fact Sheet 1.0. EPA 833-F-00-001.

(5) post-construction runoff control, and
(6) pollution prevention and good housekeeping.

Additionally, the Phase II program approach outlined by the USEPA advocates for watershed planning and implementation of the stormwater program on a watershed basis.[47]

Table 2-14. Local government compliance with Phase II minimum control measures.

Measure	Lakewood	Crystal Lake	Woodstock	McHenry County
Public Education and Outreach	Semi-annual newsletter	Annual newsletter; press releases	Newsletter; fact sheets for construction permits; educational material for schools; bilingual flyer/fact sheet; website	Brochures; website
Public Participation and Involvement	Contact number for public reporting	Storm drain stenciling	Storm drain stenciling; annual public comment meeting; pet waste management program	Adopt-a-Highway; Citizen's Report Form for illicit discharges and stormwater infrastructure problems
Illicit Discharge Detection and Elimination	Stormwater atlas; local ordinance; tracing program	Local ordinance	Digital storm sewer map; local ordinance; sanitary sewer overflow reporting	Storm sewer map
Construction Site Runoff Control	Local ordinance	Local ordinance	Local ordinance; site inspection/ enforcement;	Local ordinance; site inspection/ enforcement
Post-construction Runoff Control	Local ordinance	Site inspections; lake management program	Site plan review; evaluation of structural/ nonstructural BMPs	MCSMO implementation
Pollution Prevention and Good Housekeeping	Municipal staff training; annual program review; municipal pollution prevention program	Annual maintenance program	Municipal waste disposal program	Staff training; inspection program

The Village of Lakewood, City of Crystal Lake, City of Woodstock, and McHenry County have been issued NPDES permits by Illinois EPA for stormwater discharges from MS4s. Table 2-14 summarizes how these jurisdictions comply with the six minimum control measures. Information was gathered from Annual Facility Inspection Reports collected by Illinois EPA in 2007 and from the County's NPDES website.[48] While certainly a program with positive effects, NPDES Phase II is not an especially significant protection against water quality decline.

[47] *Ibid.*
[48] http://www.co.mchenry.il.us/common/CountyDpt/highway/hwyNPDES.asp

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3. ESTIMATION OF FUTURE NEEDS AND CONCERNS

To estimate potential changes in pollutant loading in the Upper Kishwaukee, point and nonpoint source loads were projected for approximately the year 2030. Projected point source loading was based on design average flows and assumptions about effluent concentrations. Nonpoint source loading was based on the implementation of municipal comprehensive plans and the typical deployment of best management practices in the municipalities.

3.1 Future Land Use Projection

3.1.1 CURRENT LAND USE

The starting point for the land use analysis was the (draft, unreleased) CMAP 2005 land use inventory, which for this project was taken as existing conditions (Table 3-1). The housing market slowdown of the last year or two probably means that the 2005 inventory describes current conditions relatively accurately within the subwatershed units subject to this analysis (Figure 2-4).[49] As discussed in Section 2.1.6.1, the Illinois EPA sample point for which loading targets were developed is near Pleasant Valley and McCue Roads. Therefore present and future land use was only considered for subwatersheds draining to the Upper Kishwaukee approximately upstream of that intersection.

Table 3-1. Land use (2005) in the Upper Kishwaukee River watershed.

Land Use	Whole watershed		Downstream of Pleasant Valley and McCue Rds. excluded	
	Acres	Percent	Acres	Percent
Agriculture	17,137	54%	7,093	41%
Commercial	204	1%	191	1%
Industrial	554	2%	391	2%
Institutional	211	1%	149	1%
Multi-family	33	0%	33	0%
Open Space	2,836	9%	2,529	15%
Residential	4,514	14%	2,745	16%
Transportation	60	0%	40	0%
Vacant and Wetland	5,962	19%	4,054	23%
Water	122	0%	85	0%
Total	31,511	100%	17,311	100%

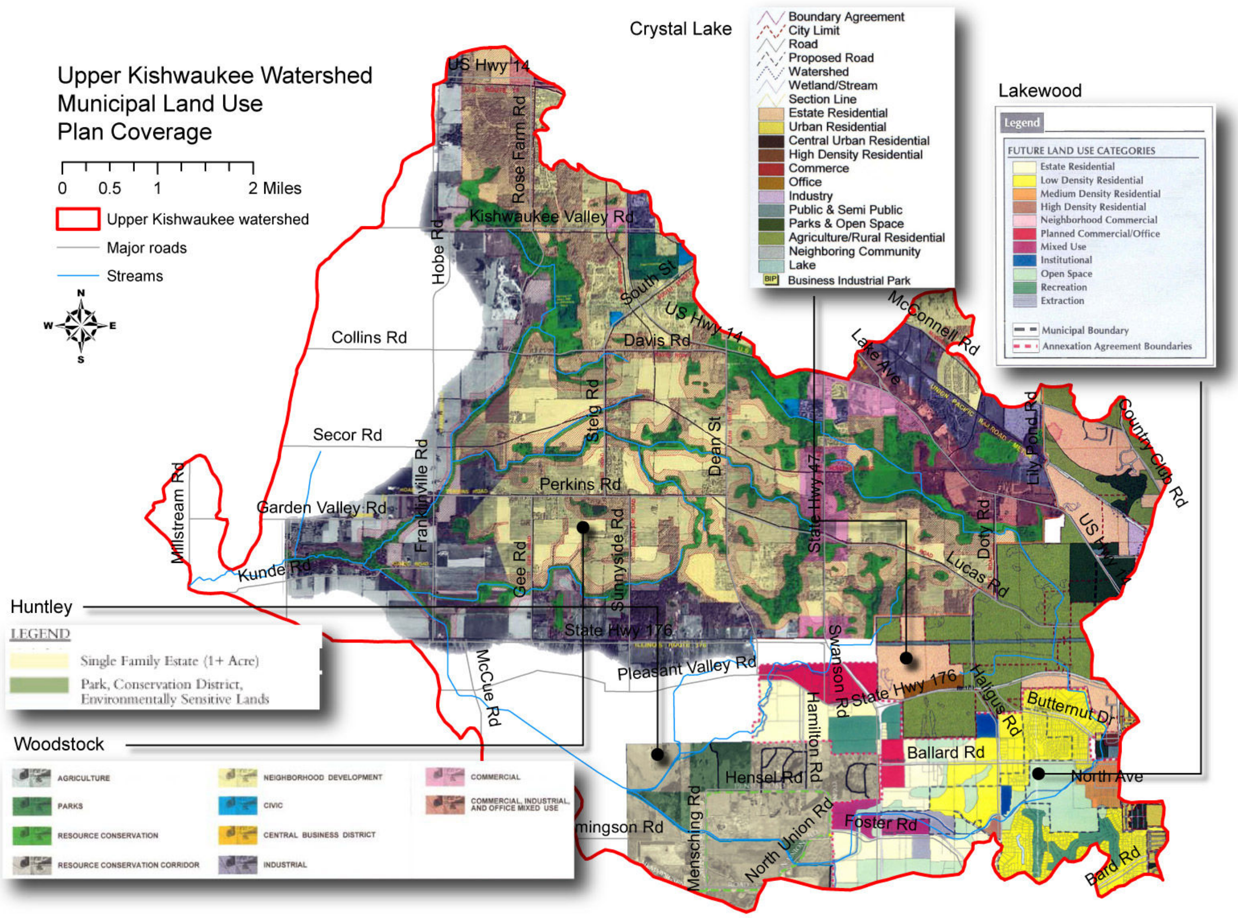
Source: Draft, unreleased CMAP 2005 land use inventory

3.1.2 MUNICIPAL LAND USE PLANS

Three different methods for projecting future land use were considered for use in this project: (1) converting CMAP population forecasts into land use projections, (2) obtaining a custom-area forecast for the watershed from private data providers such as Claritas, or (3) using local government comprehensive plans. For a number of reasons, a blend between the first and the last approach was used. For one, the comprehensive plans in the watershed are relatively recent, completed within the last five years. For another, they represent in principle the adopted will of staff and elected officials, and so relate more to intention than prediction. That is, the land use plan represents what a municipality officially wishes to do, despite the fact that departures from the comprehensive plan occur in response to development pressure. This is discussed below, but the important point is that, using the comprehensive plans, future conditions can be tied to policy decisions in a way that would not be possible with pure predictive forecasting. Thus, this plan essentially evaluates how the implementation of municipal comprehensive plans would affect water quality.

[49] It does not include the Bryn Mawr and Woodland Hills developments which broke ground in 2007.

Figure 3-1.



Source: CMAP and comprehensive plans for Crystal Lake, Huntley, Lakewood, and Woodstock

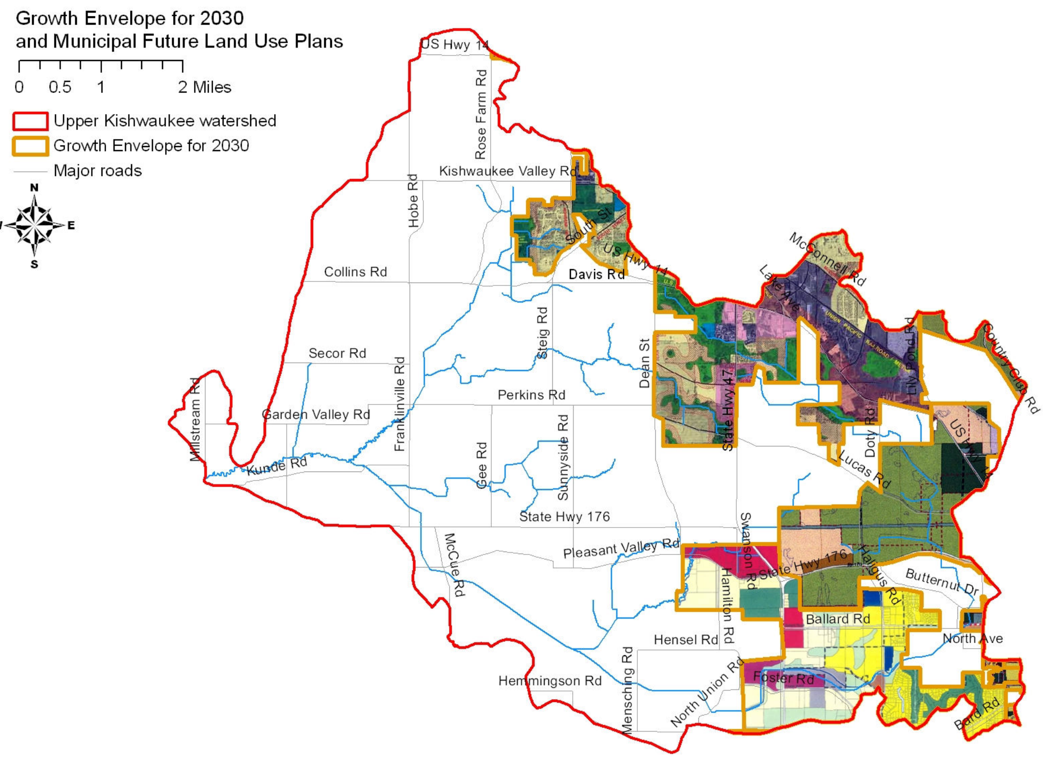
The land use maps for each of the municipalities were combined into the map shown in Figure 3-1. Each of the land use plans has a different horizon year, so to compare future pollutant loads resulting from their implementation would incorrectly lump together different points in time. Because current and future pollutant contributions from wastewater treatment plants were to be compared with nonpoint source loads, furthermore, it was necessary to choose a standard horizon year for the comparison. The year 2030 was selected because (a) it is close to the end of the twenty year planning period for both the Lakewood and Woodstock plants, assuming a new facility plan goes into effect in 2008 for the latter, and (b) the Northeastern Illinois Planning Commission, now CMAP, has estimated municipal boundaries for 2030 (based largely on the growth expectations of municipal officials). In essence, the land use plans from the municipalities were placed inside a "growth envelope" to standardize them to a single horizon year.

Table 3-2. Sources of 2030 growth envelope.

Municipality	Source of 2030 growth envelope
Crystal Lake	Comprehensive plan
Huntley	Not expected to be in watershed (NIPC forecast, discussion with staff)
Lakewood	Comprehensive plan; slightly larger than NIPC 2030 boundary
Woodstock	NIPC 2030 boundary, discussions with staff

The land use plans within the growth envelope are shown in Figure 3-2. In practice, the sources of the line work for the growth envelope varied but are described in Table 3-2. The Village of Huntley does not at present have incorporated area within the watershed. Despite the fact that Huntley's comprehensive plan shows development within the watershed, cross-checking with staff suggested that they do not expect growth in that area within the planning horizon.[50] This conclusion is reinforced by CMAP population forecasts for the area in question.

Figure 3-2.

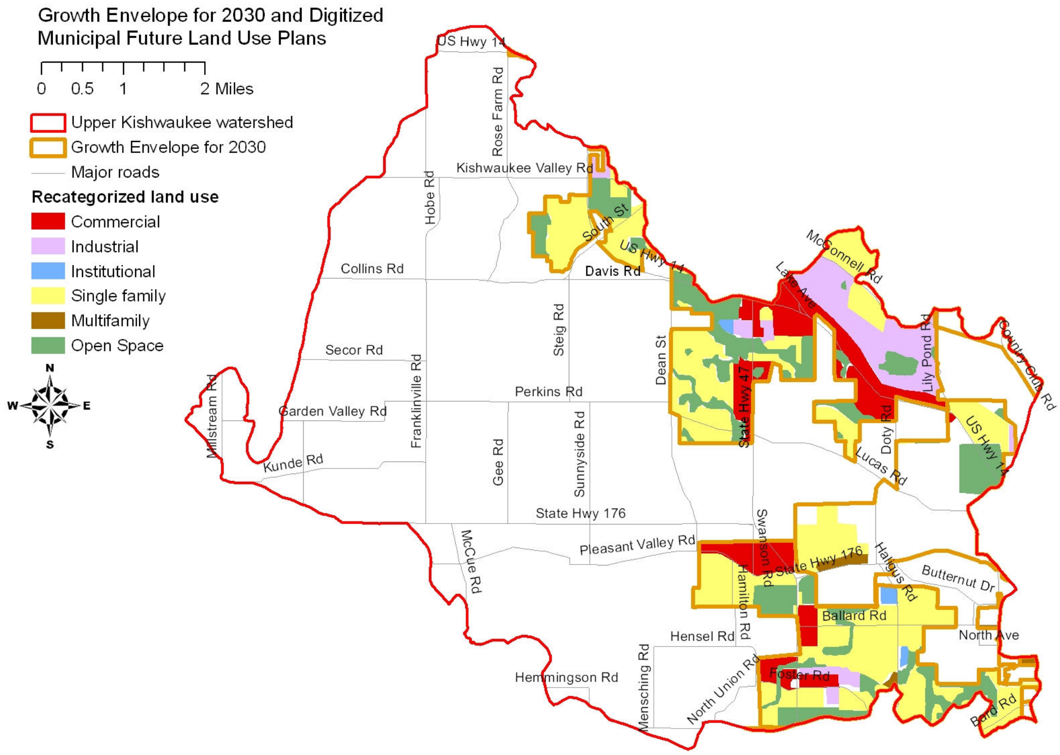


Source: CMAP and comprehensive plans for Crystal Lake, Lakewood, and Woodstock

The land use recommendations from the municipal comprehensive plans were then digitized, i.e., land use categories were aggregated and hand traced in a GIS to generate shapefiles from the paper maps. This result, shown in Figure 3-3, is a simplified set of land use categories that could be represented within STEPL (Spreadsheet Tool to Estimate Pollutant Loads, discussed in general terms in Section 1 and in detail in Appendix A) to estimate future pollutant loads based on the land use change envisioned in the comprehensive plans. The analysis took into account current ordinances through a "regulatory overlay" of ADID wetlands, including the mandatory buffers prescribed by the McHenry County Stormwater Management Ordinance (MCSMO), and a 100-foot buffer around streams, the latter also required by the Ordinance when the Index of Biotic Integrity is greater than 35 as it is in the Upper Kishwaukee. For purpose of the analysis, areas under the regulatory overlay were assumed undevelopable. Finally, the original municipal land use plans did not make a distinction between existing land use and planned future land use. In order to estimate land use change from the maps, existing land use from the (draft, unreleased) 2005 CMAP land use inventory was essentially "subtracted" from the land uses as presented in the municipal comprehensive plan maps.

[50] Meeting with Lisa Armour, Development Services Director, and Charles Nordman, Senior Planner, Village of Huntley, February 5, 2008

Figure 3-3.



Source: CMAP and comprehensive plans for Crystal Lake, Lakewood, and Woodstock

The STEPL tool requires land cover information to generate nonpoint source loading estimates. Table 3-3 shows the calculated change in land cover by implementing each municipality's future land use plan. It indicates how much of a 2005 land cover of, for example, cropland would still be cropland in 2030 given comprehensive plan implementation. Continuing with the cropland example, approximately 2,200 acres is projected to be converted to another land cover, and that 1,041 acres of cropland to urban conversion is projected to occur in response to Woodstock's plan, 609 in response to Lakewood's, and 462 in response to Crystal Lake's.

Table 3-3. Land cover in 2005 versus projected 2030 land cover by municipality, Franklinville Creek included.

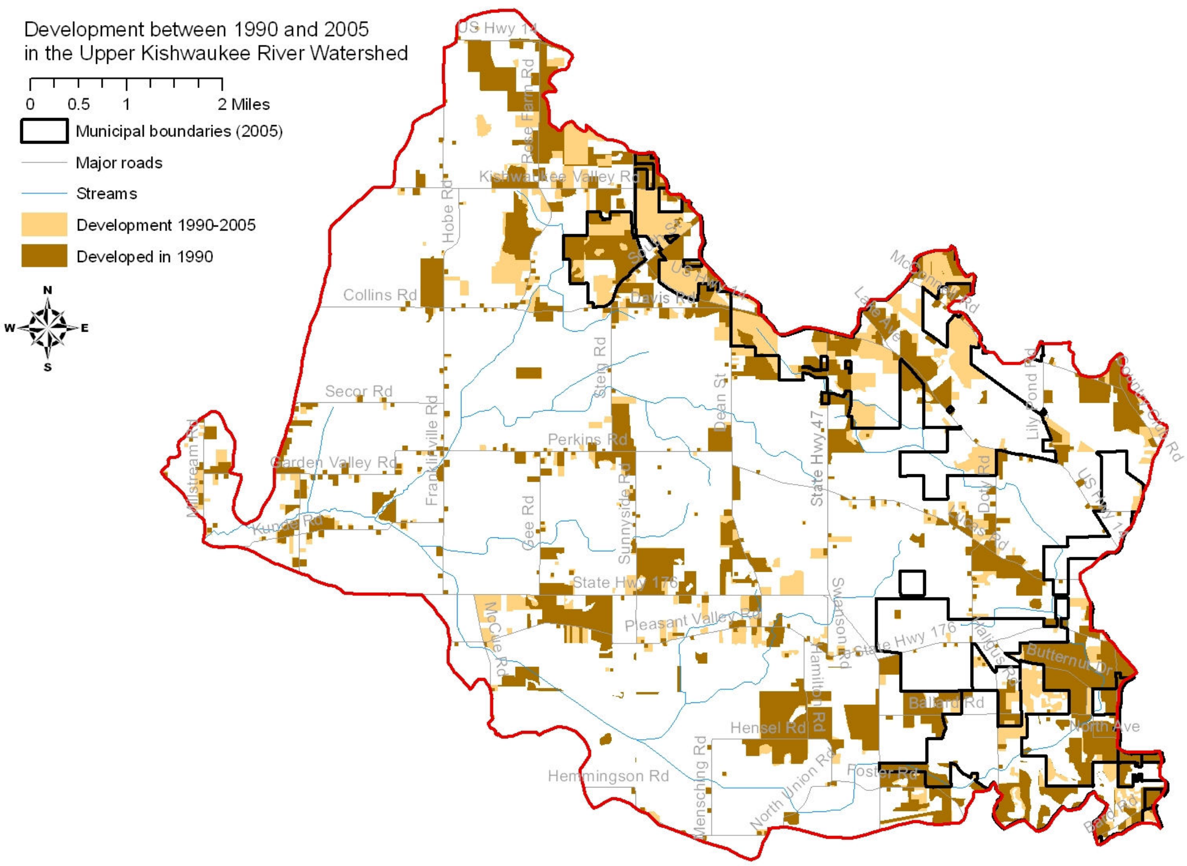
		Projected 2030 Land Cover					
2005 Land Cover	**Municipality**	Cropland	Forest	Pasture	Urban	*Wetland/H_2O	Total
Cropland	Crystal Lake	**441			462	44	948
	Lakewood				609	27	635
	Woodstock				1,041	73	1,115
	Unincorporated	9,997					9,997
	Total	**10,439**			**2,112**	**144**	**12,695**
Forest	Crystal Lake		95		13	45	154
	Lakewood				200	72	272
	Woodstock				247	91	339
	Unincorporated		1,294				1,294
	Total		**1,389**		**461**	**208**	**2,058**
Pastureland	Crystal Lake			260	47	65	372
	Lakewood				375	34	409
	Woodstock				45	23	68
	Unincorporated			3,723			3,723
	Total			**3,983**	**467**	**122**	**4,572**
Urban	Crystal Lake				365	37	403

		Projected 2030 Land Cover					
2005 Land Cover	**Municipality**	Cropland	Forest	Pasture	Urban	*Wetland/H_2O	Total
	Lakewood				1,081	104	1,185
	Woodstock				1,795	228	2,023
	Unincorporated				4,318		4,318
	Total				**7,559**	**370**	**7,928**
Wetland/water	Crystal Lake				8	387	394
	Lakewood				107	214	321
	Woodstock				162	351	513
	Unincorporated					3,200	3,200
	Total				**277**	**4,152**	**4,429**
Total		**10,439**	**1,389**	**3,983**	**10,875**	**4,997**	**31,682**

* Wetland/water category includes the wetland and stream buffer requirements under the MCSMO. For the purposes of land use projection, the buffers are treated as "created" wetland areas. Although conceptually awkward, on a practical level this approach makes it easier to reconcile the various datasets used in the analysis. Also, the combined acreage of these "created" areas is only about 2.5 percent of the watershed area. ** Crystal Lake includes an agriculture/rural residential category in its comprehensive plan

The projections developed here underestimate land use change, particularly for Woodstock. Again, the approach taken in this analysis was to project the impact of growth according to adopted plans, not to try to forecast the growth that seems most realistic at the moment. As indicated in the sections to follow, land use change according to the comprehensive plans is expected to reduce long-term annual nutrient and sediment loading. It is probably the case that more growth within the watershed will decrease post-development nonpoint source loading somewhat further.

Figure 3-4.



Source: Draft, unreleased CMAP 2005 land use inventory and 1990 Northeastern Illinois Planning Commission land use inventory

3.1.3 FUTURE LAND USE IN UNINCORPORATED AREAS

It is important to note that this analysis of future growth only accounts for development that would take place within municipal boundaries. The new comprehensive plan for the county is not complete at this point, so a future land use analysis similar to that done for the municipalities cannot be produced for unincorporated areas. It can be seen from Figure 3-4 that most of the growth in the past 15 years for which there are land use data is now within municipal boundaries. While it may be the case that some development was subsequently annexed, the amount is probably small relative to the amount within municipal boundaries at groundbreaking. Unincorporated development is expected to continue, particularly west of Woodstock in the upper part of the Franklinville Creek watershed and along the Pleasant Valley Road corridor, but more slowly than within the municipalities.

3.2.4 IMPERVIOUS COVER PROJECTION

Impervious cover was also projected forward based on comprehensive plan implementation, starting with imperviousness in 2001 from the National Land Cover Dataset as the base layer. Combining this with the 2001 NIPC land use inventory, average levels of imperviousness were determined for each land use category. Impervious cover values were developed for incorporated and unincorporated areas because of the greater intensity of land use allowable within the municipalities. The values for the incorporated areas were used to project each subwatershed's total imperviousness given comprehensive plan implementation (Table 3-4; subwatershed map shown in Figure 2-4).

Table 3-4. Imperviousness by subwatershed (upstream from station PQ 13)

		Impervious Cover	
Subwatershed	**Total area**	**2001**	**Projected 2030**
203	2,816	7.9%	25.5%
210	711	14.3%	18.5%
225	2,696	2.0%	8.1%
246	1,711	3.1%	13.9%
254	1,612	1.2%	6.8%
260	2,598	0.8%	3.6%
264	624	3.9%	3.9%
273	2,993	7.1%	16.0%
282	1,551	4.3%	9.8%

Source: 2001 National Land Cover Dataset, NIPC 2001 and 2005 land use inventory, and municipal comprehensive plans.
Note: The subwatersheds that are part of the Franklinville Creek watershed eliminated from this analysis are also low growth subwatersheds. *Total impervious area includes all impervious surfaces, whether or not hydraulically connected to the drainage system.

3.2 Wastewater Discharge Projection

An attempt was also made to estimate future loading from wastewater plants based on future flow and concentration information, as described more fully in Section 4.3. Lakewood is required to meet the 1 mg/L phosphorus standard and Woodstock South will be required to do so when it is expanded. Lakewood has biological nitrogen removal capabilities and it is recommended that Woodstock do so at the South plant as well as part of its expansion. These controls dramatically reduce nutrient inputs, yet increases in discharge would erode these gains over time. Thus, pollutant loading projections were made for the near-term future, immediately after installation of nitrogen and phosphorus controls, and for 2030, when it was assumed that average flow would be at the design average flow, the amount of flow the treatment plants are built to treat on an average or sustained basis. Like the comprehensive plans, the design average flow represents a policy decision to build capacity for new population and employment growth. This plan attempts to evaluate the impact of making such a policy decision, not to forecast the exact flow rate in 2030.

Potential contributions by septic systems were also examined as part of this watershed plan and discussed in more detail in Section 4.3. While information on septic systems and specifically their rate of failure is scant, it appears that they are a very minor contributor to nutrient enrichment. To estimate the number of septic systems at the horizon year, it was assumed that additional septic systems would be installed to serve unincorporated developments and that none of the existing septic systems would be disabled or decommissioned. Furthermore, it was assumed that unincorporated development would have a density of 1 dwelling unit per acre with one septic system per unit. Development was assumed to continue at the same rate as unincorporated residential growth between 1990 and 2005 in the watershed upstream from PQ 13 (Figure 3-4), about 37 acres per year on average. The failure rate was assumed to be the same in 2030 as in 2005 simply for lack of a defensible means of trending the failure rate forward. Even with increased numbers of septic systems in the horizon year,[51] they still do not appear to be a major source of nutrient loading. Furthermore, most development is still expected to take place within municipal boundaries, where centralized treatment will be preferred.

3.3 Change in Sources of Water Quality Degradation

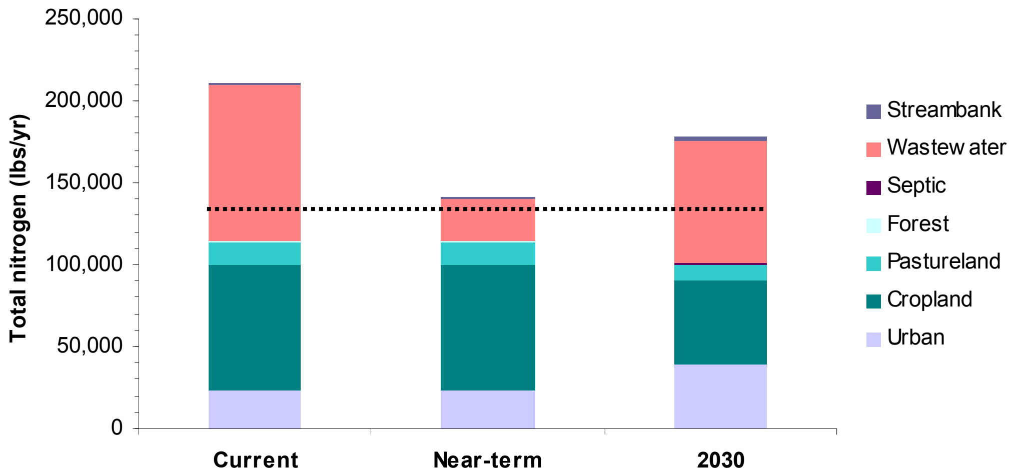
This section reexamines the causes of impairment — nitrogen, phosphorus, sediment, and riparian buffer alteration —described in Section 2 based on future conditions. Changes in the severity of these causes of impairment are projected based on the land use and wastewater discharge projections described above. The projections represent the trend case, where development follows existing ordinances and use of conventional best management practices. Finally, potential future threats are identified beyond the existing causes of impairment.

3.3.1 NUTRIENTS

The change in nutrient loading from point and nonpoint sources is shown in Figures 3-5 and 3-6. It can be seen that installation of nutrient controls would have a major positive impact on nitrogen and especially phosphorus loading. In Section 2.2.1, the reduction needed in present loading of nitrogen and phosphorus was estimated at 76,088 lb/y and 26,191 lb/y respectively. Approximately 91 percent of the needed nitrogen load reduction could be obtained if nitrogen removal were performed at the Woodstock South plant. For phosphorus, 73 percent of the load reduction needed could be obtained when the Woodstock South plant is required to meet the 1 mg/L effluent standard.[52] Thus, approximately 9 percent and 27 percent of the reduction in nitrogen and phosphorus loading, respectively, would need to come from nonpoint source controls. Over time, however, it appears that nutrient loading would creep upward again, and this would be due solely to increased loading from the wastewater treatment plants as flow rates increase with population growth. This is because the urban land uses envisioned in the municipal comprehensive plans generally speaking have lower nutrient loading rates than cropland, leading to a net reduction in loading from nonpoint sources. The projections above suggest that by 2030 annual loadings of nitrogen would increase by 31 percent and of phosphorus by 111 percent over load targets because of increased wastewater loading.

[51] Septic systems in 2030 ≅ 37 ac/y × 1 du/ac × 1 system/du × (2030 – 2005 y) + septic systems in 2005
[52] This assumes that the average phosphorus concentration in Woodstock's effluent would be similar to that of the Lakewood plant, which is now about 40 percent below the standard. See Section 4.3.

Figure 3-5. Current and projected total nitrogen loading



Note: dashed line shows loading target from Table 2-12.

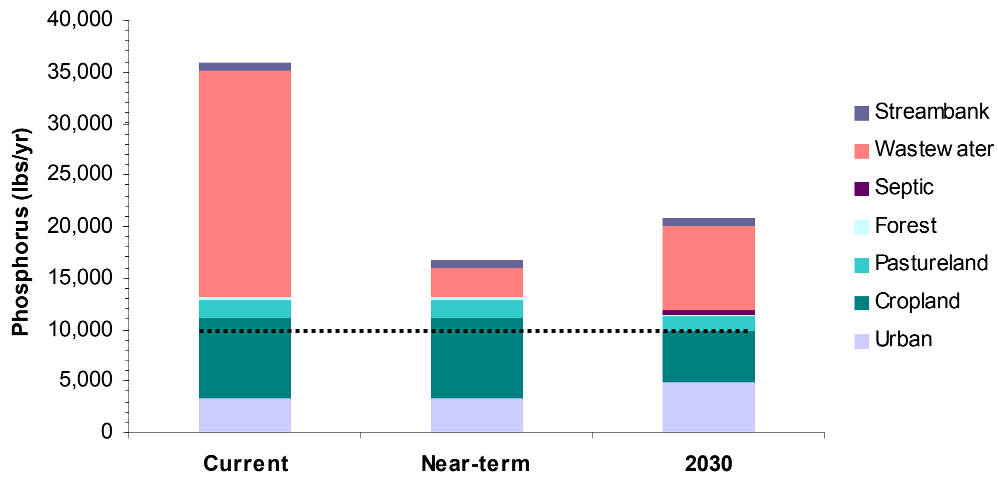
It was assumed that all new development would be served by wet detention facilities, which do provide water quality benefits in addition to runoff rate control. However, this overestimates the impact of current ordinances, as at least some development would occur at a scale small enough to come in under the size thresholds for post-construction BMPs. Under the McHenry County Stormwater Management Ordinance (MCSMO), detention — and thus the water quality benefits of wet detention — is only required for projects that create 20,000 square feet or more of new impervious surface (Section V.F.4.a). A study of building permit data from King County, Washington, which had approximately the same threshold at the time, revealed that a quarter of the impervious area added in the county's watersheds over a six year period was in projects small enough that no detention was required.[53]

3.3.2 SEDIMENT

Sediment deposition in the channel is projected to decrease significantly because of conversion of farmland to urban land (Figure 3-7), although the amount of sediment exported from reach PQ 13 is not expected to change very much. No attempt was made to estimate increased streambank erosion from increased runoff rates; streambank erosion is assumed to be the same in 2030 as in 2005. The annual volume of runoff is expected to increase by about 6.5 percent with comprehensive plan implementation, and while changes to peak flows have not been estimated, they can of course be expected to increase as well. In keeping with recommendations from the Northeastern Illinois Planning Commission, the MCSMO does require a release rate of 0.04 cfs/ac for the two-year storm to control the smaller storm events that are thought to cause the majority of bank erosion. Although this requirement will go a great distance toward protecting the stream from erosion, streambank erosion will certainly increase somewhat, but it cannot be projected readily.

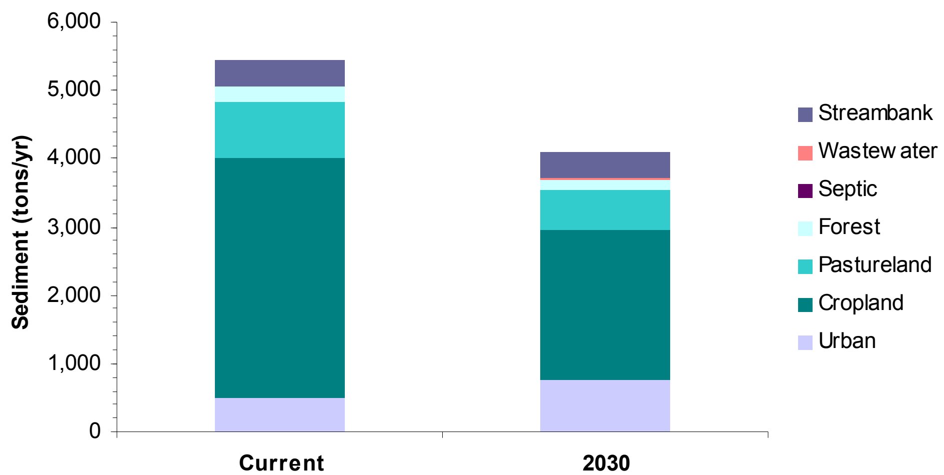
[53] Booth, D.B. and C.R. Jackson. 1997. Urbanization of Aquatic Systems: Degradation Thresholds, Stormwater Detention, and the Limits of Mitigation. *Journal of the American Water Resources Association* 33(5): 1077–1090. This rather pessimistic paper goes on to say that "under current regulatory thresholds, debates over the relative merits of [stormwater BMP] design standards are largely moot — even the most restrictive design standard is unlikely to maintain future aquatic-system function at any but a recognizably degraded level" (p. 1087).

Figure 3-6. Current and projected total phosphorus loading



Note: dashed line shows loading target from Table 2-12.

Figure 3-7. Current and projected long term annual sediment deposition



To what extent would future construction activities contribute to sedimentation? The change in annual sediment loads produced by STEPL describes only average post-construction conditions; no attempt was made to quantify and annualize future contributions by construction sites. Runoff from construction sites is regulated by Illinois EPA under the NPDES Phase II program as well as by the County and certified communities under the MCSMO, meaning that making a load estimate would require determining the frequency with which sediment and erosion control BMPs fail, are incorrectly installed, or are illegally disregarded. This cannot be done readily. It has been pointed out that sedimentation from construction sites without proper sediment and erosion control BMPs could easily overshadow the long term annual post-construction averages computed by STEPL.[54] The McHenry County Soil and Water Conservation District inspects construction sites for erosion control practices under an interagency agreement with the Illinois EPA. The SWCD considers most development sites in the Upper Kishwaukee over the past few years to have been managed responsibly, but has noted significant problems in some cases. A few con-

[54] Ed Weskerna (McHenry County Soil and Water Conservation District), watershed stakeholders meeting, February 14, 2008

struction sites with poor soil erosion and sediment control will outweigh even the long term benefits of post-construction BMPs. They can also rival cropland on a mass basis, as the *Illinois Urban Manual* indicates that construction sites with no BMPs can generate 20–200 tons per acre per year of sediment whereas row crops generate only 1–20. In summary, general knowledge and anecdotal evidence suggests construction sites can be significant sources of sediment, but their contribution cannot be quantified.

3.3.3 RIPARIAN BUFFERS

As discussed in Section 2.1.3.3, Illinois EPA has identified "alteration in streamside or littoral vegetative covers" as one of the potential causes of impairment in the Upper Kishwaukee, and this is being treated as a loss of riparian buffers. Development in the watershed is expected to have a positive effect on stream buffers because of the requirements in the MCSMO. If a 100-foot buffer planted with native vegetation is required throughout the watershed, as this plan argues it should be because IBI is over 35, then approximately 58 acres of new buffer or 15 percent of the total needed should result from development by 2030.

3.3.4 CHANNELIZATION

As noted in Section 2.1.4.4, channelization has probably been the single largest negative influence on the aquatic community in the Upper Kishwaukee River. It may be ameliorated to some extent with the passage of time if the channel begins to recover by meandering within its banks, but this will only happen if channel incision is not severe. The practice of farmers straightening the channel with a backhoe, removing trees and shrubs along the banks, etc. is mostly a relic in the Chicago metropolitan region now because of the vigilance of the Army Corps of Engineers Chicago District, the Soil and Water Conservation Districts, and other interested parties, although it continues to occur elsewhere in Illinois.[55] Also, the several drainage districts in the Upper Kishwaukee watershed are defunct or inactive.

3.3.5 EMERGING THREATS

For the most part the discussion has focused on how the causes of impairment identified by Illinois EPA may grow more or less severe. Nutrient loading and sedimentation from *nonpoint* sources would most likely decrease given growth according to comprehensive plans. However, it is possible that other causes of impairment of the aquatic life use could arise. It is also possible that other designated uses besides aquatic life and fish consumption could become impaired.

Professional judgment suggests the primary contact use is most threatened. Primary contact use is any use in which there is prolonged contact with the water involving risk of ingesting water in significant quantities, such as swimming and wading. Impairment of the primary contact use is measured by the amount of bacteria in the stream, typically fecal coliform. Illinois EPA has not taken fecal coliform samples at PQ 13 since 1983 and therefore has not assessed the Upper Kishwaukee for primary contact use support. Section 6 provides recommendations for local monitoring of fecal coliform. Regardless of current bacterial conditions, it is generally the case that urbanization — the land use change envisioned in the municipal comprehensive plans — tends to bring with it increased numbers of dogs and other pets, larger populations of geese attracted by manicured lawns and wet detention ponds,[56] and other potential sources of fecal contamination. Impairment of primary contact poses a danger to the vision expressed in Section 4.2 that the river and its tributaries are treated as integral parts of conservation developments — as water features meant to be enjoyed by neighborhood residents. The BMPs typically in use in the water-

[55] See Prairie Rivers Network's *Citizen's Guide to Illinois Agricultural Drainage Practices and Law* (http://prairierivers.org/Projects/AgDrainage/DrainageHandbook.pdf)
[56] See for example the discussion in Nancy Shepherdson. Winter 2002. "Wild and Messy." *Chicago Wilderness Magazine*. http://chicagowildernessmag.org/issues/winter2002/wild_messy.html.

shed do remove some pathogens, and the infiltration devices recommended in Section 4 are expected to remove more, but source control must also play a role in reducing bacterial contamination.

The additional pollutants and other causes of impairment that could become significant in the stream are numerous. Only a few of the potential impacts are described here. Chloride levels can be expected to increase as road density and salt use increases with development in the watershed, especially since conventional BMPs are ineffective at removing it. Trace metals (copper, zinc, nickel, lead, etc.) in sediment have been shown to increase with urbanization in this region (the Upper Illinois River basin),[57] but this may be a more significant concern in older areas. It has also been shown that the number of organic wastewater compounds detected in streams increases with urbanization,[58] although this is not caused directly by land use change *per se* but by the use of centralized wastewater treatment to serve suburban population growth. Finally, there are a range of currently unregulated "emerging contaminants," such as pharmaceuticals, found in wastewater whose levels could be expected to go up as a result of increased wastewater discharge.

3.4 Loss of Prime Farmland

The B-MAG *Framework for a Basinwide Planning and Protection Pilot* makes repeated mention of a need to investigate ways to protect prime farmland as part of the watershed planning process. The olive and tan colors in Figure 3-8 together show all prime farmland identified in the McHenry County Soil Survey that was in an agricultural use in 2005. The olive color represents prime farmland that would be converted to an urban use at buildout — not the 2030 envelope — if the comprehensive plans in the watershed were implemented. Almost all of the prime farmland expected to be converted is also within existing Facility Planning Areas. It should be pointed out that, at least in the case of nutrients and sediment, there is an *apparent* conflict between the goals of protecting prime farmland and protecting the creek. While according to the sketch planning model used in this plan the long-term consequence of urbanization is a decrease in nutrient and sediment loading, it does not follow that the only or best way to decrease nutrient and sediment loading from farmland is to develop the farmland. A number of recommendations are provided in Section 5 to reduce nutrient and sediment loading from the agricultural landscape.

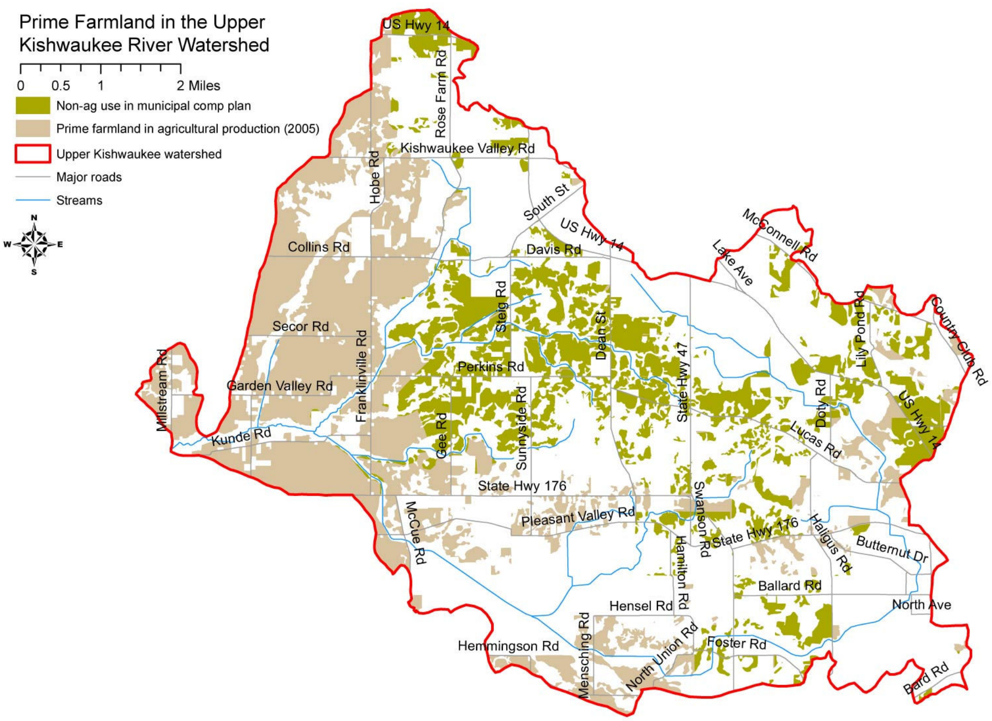
The municipalities have no policies in place to protect prime farmland, with the exception of Crystal Lake as discussed below. However, county government adopted an agricultural protection policy in 2007 and appointed a committee to review potential applicants for federal agricultural protection match funding.[59] Some farmland protection activities have occurred in the Upper Kishwaukee watershed already. The Land Conservancy of McHenry County received a conservation easement donated on a 150-acre farm on Franklinville Road in 2007. The best farmland in the watershed, the flat area west of Franklinville Creek, is partly within two Agricultural Protection and Conservation Areas under the Agricultural Areas Conservation and Protection Act (505 ILCS 5/1 et seq.). These "ag areas" offer weak protections to farmland and do not cover much of the area in question, but the area west of Franklinville Creek is not expected to see development pressure for the foreseeable future.

The loss of the farmland is not confined to actual development of formerly agricultural parcels. For a number of reasons the viability of farming itself is also compromised with surrounding urbanization: in-

[57] Harris, M.A., Scudder, B.C., Fitzpatrick, F.A., and Arnold, T.L. 2005. *Physical, chemical, and biological responses to urbanization in the Fox and Des Plaines River Basins of northeastern Illinois and southeastern Wisconsin.* U.S. Geological Survey Scientific Investigations Report 2005-5218.
[58] *Ibid.*
[59] See NRCS Farm and Ranch Lands Protection Program at http://www.nrcs.usda.gov/programs/frpp/ (now called the Farmland Protection Program in the 2008 Farm Bill)

creases in traffic, which is incompatible with farm machinery on roads, loss of farm supply stores and distribution centers, and the perceived nuisance of farming to residential neighbors, among other factors. From this standpoint it may be best for the municipalities to consider supporting a kind of farming different from traditional large-scale corn and soybean farming. Instead, smaller market gardening operations could be supported that take advantage of mounting consumer preference for locally grown foods and the increasing number of channels to distribute them, e.g., farmer's markets, community supported agriculture (CSA) subscriptions, etc. Beyond working directly with local organizations to hold downtown farmers markets, the municipalities and the county should consider establishing a zoning classification, potentially a floating zone, that would protect small agricultural uses within corporate limits. As a local example, the City of Crystal Lake is identifying certain areas for organic farms in its Northwest Sub-Area Plan (Section 4.1.2). Planned development might also be allowed to have an area where boutique farming takes place as well. This zoning review should be pursued along with the Site Planning Roundtable recommended in Section 2.3.1.2.

Figure 3-8.



Source: McHenry County SSURGO, CMAP 2005 land use inventory, and municipal comprehensive plans
Note: does not include areas considered prime if drained.

4. A VISION FOR THE WATERSHED

This section presents the general policy framework of the *Upper Kishwaukee River Watershed Plan*. The first subsection presents findings from meetings with local officials, describes the positive steps being taken by the municipalities and land management agencies in the watershed, and identifies common policy statements in the municipal comprehensive plans. The second subsection proposes a general land use policy based on the comprehensive plans and other sources of information. Wastewater treatment practices are analyzed in the third subsection, and the fourth describes the overall reductions in pollutant loading expected from implementing the plan.

4.1 Issues, Opportunities, and Beneficial Initiatives by Local Government

4.1.1 VILLAGE OF LAKEWOOD

Approximately 1,100 acres in the watershed were within the corporate limits of the Village of Lakewood as of 2005. Land use in the Village is mostly low density residential, with three main subdivisions in the watershed: Brighton Oaks, Turnberry, associated with the Turnberry Golf Course, and a newly developing conservation subdivision called Woodland Hills (Figure 4-1). Drainage in these subdivisions is mostly open, with minimal curb and gutter. The Village has no storm discharges to the Kishwaukee beyond drainage from two bridge decks.

Figure 4-1. Kishwaukee River in Lakewood, looking west from Haligus Road. Woodland Hills development is in background (April 2008).

Lakewood is a small village and does not have a formal five-year capital improvement program, which could potentially be used to identify planned drainage projects to which water quality benefits could be added at a relatively small additional cost. One possibility for enhancing pollutant removal from residential runoff is altering existing ditch designs to a wider swale with softer slopes. But while there are occasional drainage problems in Lakewood subdivisions, they are too sporadic for a retrofit program, and feasibility is dependent on site conditions. Another possibility is detention basin retrofits for ponds with failing shore protection or short-circuited flow paths. There are a number of candidates in the village. Increased street sweeping is not an option. The Village does not own a sweeper, and while a sharing arrangement could possibly be made with a neighboring municipality, the low density of housing and open drainage makes it less relevant. Only a short segment of the stream actually passes through the village and does not appear to have excessive erosion problems. This area is just now developing. Infiltration practices have not been widely used in the past, as soils are not as sandy as they are in the Crystal Lake watershed. However, it has been done on a site-specific basis. Runoff from buildings associated with the new wastewater treatment plant is infiltrated.[60]

The Village deserves praise in its approach to protecting and restoring natural resources. Among other things, the Village has teamed with the Land Conservancy of McHenry County in an oak savannah restoration project upslope from the stream just east of Haligus Road. The Village also supported Illinois Nature Preserve dedication of the Turnberry Fen it owns. Furthermore, the Woodland Hills development

[60] Information in this section provided during meeting with Catherine Peterson, Village Manager, and Paul Ruscko, P.E., Public Works Director, Village of Lakewood, March 19, 2008

was required to take out a conservation easement and management agreement with the Land Conservancy of McHenry County for a large wetland area. Village staff also expressed interest in securing a connected corridor of protected open space running along the creek from the Butternut Nature Preserve in Crystal Lake through the MCCD's Lussky property to the oak savannah restoration area. Village staff have also considered the idea of purchasing prairie plant mix in bulk to supply to homeowners. Finally, the Village has passed a phosphorus fertilizer ban affecting the entire village.

4.1.2 CITY OF CRYSTAL LAKE

While the City of Crystal Lake has annexed 1,200 acres into the Kishwaukee watershed, very little of the area has been developed. At present Crystal Lake's storm sewers discharge at only two points to the Kishwaukee, one along Ballard Road and the other along Butternut Road. Both are discharges from outside the (topography-based) watershed. The Bryn Mawr subdivision (built by Ryland Homes) has developed estate homes with open drainage at Routes 176 and 47 in Crystal Lake. The City fairly recently ran water mains and trunk sewer lines into the Kishwaukee basin along a utility right of way and Route 176, respectively, to serve that and other new development. The Bryn Mawr Corporation has also petitioned to build the 270 acre Barton Stream development along the Kishwaukee River at approximately Lucas Road and US 14. However, the initial site plan was rejected and the developer was told to return with a conservation design. Because very little of the watershed has been built, retrofit BMPs are not relevant. Furthermore, the City's five-year capital improvement program does not include drainage projects within the Kishwaukee watershed. Finally, the Crystal Lake Park District has long been active in resource conservation and education in the watershed, a mission expanded from the traditional recreational focus of park districts. Its Butternut Nature Preserve, north of Ballard Road, has a good tree canopy and a stable section of the stream and could present opportunities for enhancement.

The City of Crystal Lake has adopted a Northwest Sub-Area Plan which includes all of Crystal Lake's boundary in this sub-watershed. The Plan identifies natural features from the McHenry County Natural Areas Inventory and ADID Wetlands. It recommends a 100-foot buffer around all natural features. The Plan has also identified properties with high quality soils to be developed as organic farms. Properties within the Plan boundary are required to identify natural features and soils on-site and plan development appropriately around these, including limiting mass grading and incorporating BMPs.

4.1.3 CITY OF WOODSTOCK

Approximately 2,700 acres in the watershed were within the corporate limits of the City of Woodstock in 2005. Land use in Woodstock within the watershed varies more than in the other municipalities, ranging from older estate residential areas to industrial developments to large format retail to newer, higher density residential. New development in Woodstock within the watershed has also taken a turn toward conservation design, aided by the conservation design standards in the City's Unified Development Ordinance which go into effect when a development is proposed that adjoins or contains a resource conservation corridor as designated in the comprehensive plan. The 600-plus acre Apple Creek development includes 181 acres of open space primarily buffering Apple Creek, one of

Figure 4-2. Apple Creek development in Woodstock (April 2008).

the tributaries to Franklinville Creek. The open space is being restored with deep-rooted prairie grasses and includes wetland and some creek restoration. The City required the open space to be placed in a conservation easement held by the Land Conservancy of McHenry County. In addition, the City has also established a partnership with the Land Conservancy to manage the 63-acre Westwood Conservation Area at the northeast edge of the watershed. Finally, the City has been engaged in a number of progressive environmental initiatives, including the recent establishment of an Environmental Commission to advise City Council on planning and development issues. In 2007 the Commission provided recommendations to City Council on anti-degradation policy related to the proposed expansion of the City's South wastewater treatment facility.

There are a few opportunities for BMP retrofits in Woodstock; these are described in more detail in Section 5.2. The mainly industrial area approximately north of US 14 in Woodstock within the Kishwaukee watershed is mainly served by natural infiltration facilities within the glacial kettle geography of the northeast part of the watershed. No discharge of stormwater flow to the Upper Kishwaukee occurs from the kettles although some may discharge through subsurface flow to wetlands to the south. The City's current five-year capital improvement program does not include any drainage projects within the Kishwaukee watershed. With regard to source control, the City does conduct street sweeping, although it is infrequent (~4 passes per year), and has a regenerative air sweeper, a type of device that is much more effective at removing fine particulate matter than mechanical brush sweepers.

Just north of the Woodstock South wastewater treatment plant is a municipal landfill that was placed on the National Priority List (NPL), i.e., made a Superfund site, in 1989. It has since been partially cleaned up. A municipal sports complex was placed on the remediated portion in 2007. While physical cleanup activities have been completed, the site has not yet been formally removed from the NPL. USEPA has determined that human exposure and migration of contaminated groundwater are under control.[61] The City of Woodstock was deemed a potentially responsible party under Superfund since it owned the landfill at the time of listing and had used it for disposal of municipal waste. This meant that the City had to bear a significant portion of the clean-up costs.

4.1.4 UNINCORPORATED AREA

A fairly small amount of unincorporated urbanized area is on the eastern side of the watershed. Some of this is a neighborhood of older cottages east of the McHenry County Conservation District's Lussky property and west of Lakewood corporate boundaries. It is fairly dense, but does not have either detention facilities or sewer service. Public works and engineering officials from Crystal Lake and Lakewood were unaware of any flooding problems in the neighborhood. Little is known about the septic systems on these properties except that they most likely old and undermaintained. The neighborhood is close to the river, increasing the probability that septic leakage enters the stream. The STEPL analysis presented in Section 2.1.6 suggested that septic systems were unimportant as contributors to nutrient enrichment, but conservative assumptions were made about the rate of failure.[62] It would be valuable to conduct a monitoring study to determine whether nutrients are elevated through this stretch of the stream as a result of septic systems in the neighborhood.

[61] USEPA. Superfund Information Systems. Retrieved from: http://cfpub.epa.gov/supercpad/cursites/csitinfo.cfm?id=0500585
[62] No systematic information is available regarding the rate of failure of septic systems in the county according to personal communication from Mike Eisele, McHenry County Health Department, December 13, 2007

4.1.5 MCHENRY COUNTY CONSERVATION DISTRICT

The McHenry County Conservation District owns or manages four sites in the watershed (Figure 2-4). Three abut the Kishwaukee River and so are discussed here.

4.1.5.1 Pleasant Valley Conservation Area

The Pleasant Valley preserve is a large site sitting on three different physiographic systems. In the northeast, the Yorkville Morainal Outwash physiographic system is situated on moraines with low relief and varied slope steepness. The original vegetation of this portion of the site was primarily woodlands and prairies. A small relic wet to wet/mesic prairie is here, as well as scattered remnants of highly disturbed oak woodland and savanna communities. The Cary-Crystal Lake Outwash Physiographic system also bisects Pleasant Valley, containing the Kishwaukee River, which is heavily channelized in this area. The northeast portion of the site, on the southern edge of the Barlina Moraine, was heavily wooded and rolling with small wetlands and open prairies interspersed throughout the timber. Moving off the moraine and proceeding west and south, the flat outwash plain of the Kishwaukee River supported a vast, nearly one thousand acre wetland complex. On the western edge of the site scattered oak openings were interspersed with a large prairie covering dozens of square miles.

The Pleasant Valley Conservation Area is part of a macrosite, i.e., it is the core that forms the main building block of a biologically viable preserve. The core preserve is a large block of habitat often containing remnant natural communities or populations of key plants and animals, usually within a matrix of degraded but restorable land. Core preserves are capable of sustaining plants and animals that require large home ranges or habitat blocks to survive. They allow species that are sensitive to genetic isolation or require large blocks of continuous habitat to maintain viable populations. There are three main restoration goals for the property:

(a) Creation of a mosaic of native grasslands, oak savanna and woodland and wetland ecosystems typical of this portion of McHenry County prior to settlement by Euro/Americans in the 1840's.

(b) Restoration of the large wetland complex (600-800 acres) of sedge meadow, wet prairie, and marsh formerly located along the Kishwaukee River and drained for agricultural purposes in the early twentieth century.

(c) Reconnection of the Kishwaukee River with surrounding floodplain to create wildlife habitat, increase flood storage capacity, and improve water quality for the stream.[63]

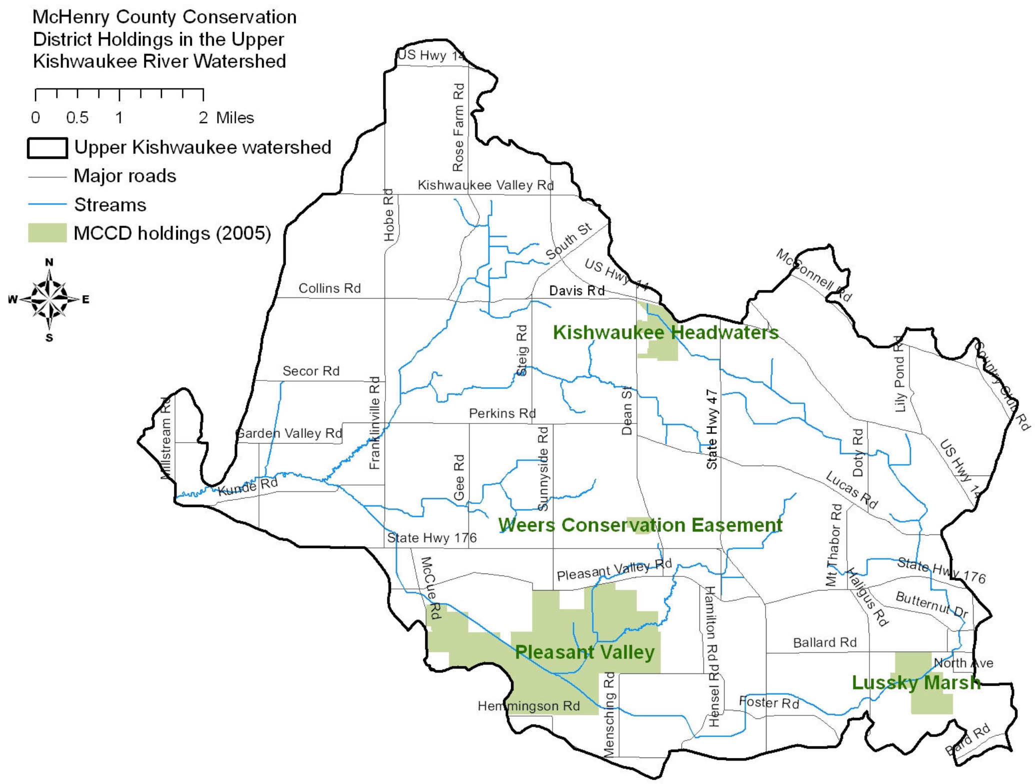
Figure 4-3. Pleasant Valley Conservation Area from main parking lot off Pleasant Valley Road (April 2008)

It is expected that MCCD will undertake this work in the next 3 – 4 years using mostly its own resources. It will represent a major improvement in natural resource conditions in the watershed and could directly address the causes of impairment in the Upper Kishwaukee. The restoration of the site as a flowing marsh could have a major water quality benefit if the restoration were designed with the objective

[63] Information provided by Ed Collins, Natural Resources Manager, McHenry County Conservation District, April 9, 2008; June 11, 2008

(among others) of maximizing nutrient removal, so long as the resulting changes do not compromise MCCD's primary objective of restoring the area to approximately presettlement conditions. The specific conditions that would maximize pollutant removal have to be determined through on-site analysis, but in general they include (for nitrogen) maximizing the amount of stream diverted to or flowing through the marsh during both low and high flow conditions, ensuring adequate detention time, making sure there are low or no-oxygen areas within the wetland (thus the wetland needs to have primarily emergent vegetation), and ensuring dense enough vegetation to provide a carbon source for microbial action. Other conditions may conditions may be relevant for phosphorus removal. As MCCD is now beginning conceptual design for the restoration (as of June 2008), it is encouraged to take into account nutrient removal as a design criterion in the wetland restoration. Available evidence suggests that wetlands could generally remove 25 percent of total nitrogen and over 40 percent of total phosphorus flowing into them. Because most of the area tributary to the Illinois EPA sample station PQ 13 is also tributary to Pleasant Valley, the nutrient removal potential of this project overshadows any of the other projects.

Figure 4-4.



Source: McHenry County Conservation District

4.1.5.2 Kishwaukee Headwaters Conservation Area

This 146-acre site is located just upstream of the Woodstock South wastewater treatment plant at the corner of Dean Street and US 14. It is part of a slightly larger site known as the Woodstock Greenway, with additional parcels owned by the City of Woodstock, McHenry County Soil and Water Conservation District, and the McHenry County Defenders. The site is a wetland complex that had had a ditch dug through it for drainage purposes. MCCD filled in that channel in 2007 as part of an effort to restore the native hydrology of the wetland. In addition, MCCD has announced that it will develop a master plan for the site during 2008 and 2009 which is meant to determine the appropriate balance between natural resource protection and public access.[64]

4.1.5.3 Lussky Property

The Lussky site was purchased by MCCD over a decade ago and is partly in farm leases. It has rolling terrain as well as a number of wetland areas, one of which receives drainage from a subdivision in Lakewood to the north. MCCD has no short term plans for restoration on the site, but has suggested that if external funding could be secured it would consider viewing the property as a higher priority. The site could be an important part of establishing a network of restored land along the Kishwaukee main stem as described in the vision of land use in Section 4.2. From a nutrient reduction standpoint the most important restoration activity would be reconnection of the stream with the floodplain and reconstruction/ restoration of associated wetlands. However, the stream is deeply incised through the property as well as upstream, making such a project difficult. The property is also extensively tiled; there are concerns that restoring the hydrology of the site would have off-site impacts to private land owners. At a provisional level, it would be desirable from this plan's standpoint to try to achieve objectives like goals (b) and (c) for the Pleasant Valley restoration, although a more in-depth engineering and hydrological study on the area is necessary. Such a study on the Lussky property should be supported through external funding.

4.1.6 RECOMMENDATIONS FROM MUNICIPAL COMPREHENSIVE PLANS

This section examines the natural resource and land development policies in the comprehensive plans of Woodstock, Crystal Lake, and Lakewood. The general categories of plan components addressed here include selected stormwater best management practices, conservation of open space, and land development pattern and design.

4.1.6.1 Stormwater Management

For the purposes of this survey, stormwater best management practices include natural landscaping, soil erosion and sediment control, pervious surfaces, natural features for stormwater drainage, connection of natural features and trails, and groundwater recharge area protection. The Woodstock and Lakewood plans incorporate language on natural landscaping and also include a policy on soil erosion control. In addition to strategies to limit erosion from surface runoff by aligning structures with the contour of the land, Woodstock's plan recommends discouraging construction activity if slope is more than 15 percent, and prohibiting such activity on areas having over 25 percent.

All of the plans include statements about the desirability of minimizing impervious surface. For example, the Woodstock plan encourages consideration of impervious cover limits based on zoning category, lot size, land use, and existing natural features, and the Lakewood plan allows for reduction in road pavement width up to 20 feet curb to curb when compatible with traffic volumes.

All of the communities in the watershed refer to using natural features for stormwater drainage. The Crystal Lake plan recommends natural areas for surface water retention, percolation and snow storage, and proposes development of a wetland ordinance to protect wetlands outside of the Army Corps' jurisdiction, although this has been accomplished now in the McHenry County Stormwater Management Ordinance. Lakewood's plan notes that while engineered drainage systems are necessary to control runoff rates, they can be designed to maximize habitat value. Open drainage systems are also recommended.

[64] *Connections in Conservation*. Spring 2008. Retrieved from: http://www.mccdistrict.org/assets/publications/press%20releases/MCCDConnections%20in%20Conservation.pdf

4.1.6.2 Conservation Areas and Open Space

The three communities recognize the value of interconnected green corridors. Woodstock's approach is primarily environmental and recommends connecting isolated natural features with environmental corridors to connect ecosystems; connecting open spaces and establishing a system of permanent greenways or green corridors throughout the city; and developing connections with other jurisdictions. Crystal Lake's approach is both environmental and recreational, while Lakewood's primary focus is on connecting bikeways and trail facilities. Woodstock designates Resource Conservation Areas for preservation and protection of habitat, wetlands, floodplains, open water, groundwater recharge, farmland, woodlands, and other natural features. Resource Conservation Buffer Overlays are identified that adjoin these to function as transition between conservation areas and other land uses. Development is not encouraged unless substantial mitigation measures and conservation design techniques are used.

Open space recommendations in Woodstock's plan are to create/protect open landscapes at city approaches; support landscape easements along major streets leading to city; connect open landscapes with trails; use open space to separate neighbor communities; promote development that provides contiguous and connected open landscapes and natural resource areas; support acquisition of public open landscapes; and incorporate the Northeastern Illinois Regional Greenways and Trails Plan recommendations. Crystal Lake's plan recommendations on preserving sensitive environments include establishing a greenway policy and ordinance, an open space or landscape easement ordinance, and using Transfer of Development Rights to secure future use of a natural resource. The plan recommends that no development take place in floodplains, wetlands and other sensitive areas.

Lakewood's open space related recommendations focus on park dedication requirements for new developments and promotion of cluster subdivisions, where, as it states, the common open space is generally located in areas which are characterized by existing natural features. The plan notes that while the community has a surplus of public and private open space/special use parks, they are deficient in neighborhood and community parks. Protection of natural resources is a feature of some of the open space/special use category of parks.

4.1.6.3 Site Design

Cluster development or conservation design is encouraged in all three communities. Woodstock encourages conservation design, especially in planned developments. In the Ridgefield Corridor (outside the Kishwaukee basin), Crystal Lake encourages cluster development with greater flexibility in street, building and open space layout, and recommends concentrating impervious coverage of buildings and paved areas for stormwater and other benefits. Lakewood also allows cluster development design, and calls for new development to respect natural topography, soils and geology and blend new construction into the natural landscape and minimize earthwork. Mixed uses and contiguous development are recommendations for at least some areas in all three communities in the watershed.

4.2 Vision of Land Use

The vision for land use in the Upper Kishwaukee watershed is described in this section. It consists of a vision for enhancing natural resources in the watershed and a vision for the future development pattern in the municipalities, the latter consisting of three principles: planned developments in the watershed should be conservation design, the stream and tributaries should be incorporated as integral parts of site design when they are within a development, and effective impervious area should be limited.

4.2.1 DEVELOPMENT PATTERN

The vision of land use in the Upper Kishwaukee watershed is largely shaped by the locally adopted comprehensive plans for Crystal Lake, Lakewood, and Woodstock, shown graphically in Figure 3-1 and whose policy statements are summarized in Section 4.1.6. These plans reflect a wide variety of considerations that cannot be addressed in this watershed plan, with its limited focus on water quality and aquatic habitat. The forgoing analysis of future land use taken from the comprehensive plans suggests that nutrient and sediment loading would decrease somewhat as a result of comprehensive plan implementation. This is positive, although that growth, plus development in adjoining watersheds, is projected to keep loading above target values via increased wastewater discharges, even with planned nutrient removal.

4.2.1.1 Conservation Design

The vision of this plan is that all new planned developments in both the incorporated and unincorporated areas of the watershed be conservation design subdivisions. The comprehensive plans for the municipalities all support conservation design, and the general trend of recent residential development in the watershed is toward conservation design. As noted in Section 2.3.1.2, the City of Crystal Lake and Village of Lakewood are working on enabling ordinances for conservation design, while the City of Woodstock has already passed such an ordinance. Conservation design would be as defined in the municipalities' planning documents, the McHenry County *Conservation Design Standards and Procedures*, or more generally the Northeastern Illinois Planning Commission and Chicago Wilderness publication *Conservation Design Resource Manual*[65] and its key references. The technique can be described as "a design system that takes into account the natural landscape and ecology of a development site and facilitates development while maintaining the most valuable natural features and functions of the site.

The main principles of conservation design are: (1) flexibility in site design and lot size, (2) protection and management of natural areas, (3) reduction of impervious surface areas, and (4) sustainable stormwater management.[66] The philosophical underpinning of the technique is that by allowing flexible lot design standards that are density-neutral, such as implementing standards for the overall density on a site without minimum lot size requirements, it is possible to meet the business objectives of developers while conserving natural areas and systems. An equivalent number of residences can be clustered, potentially yielding an added benefit to developers by reducing site infrastructure costs (roads, sewer, streetlights, water, etc.), as well as reducing the long-term infrastructure maintenance costs borne by the public sector.

4.2.1.2 Impervious Surface Reduction

In addition to conservation design as a broad concept, the other key element of the vision of future land use is limiting the creation of impervious area. Although conservation design tends to reduce imperviousness, as noted above, this plan recommends more specific guidance. Table 3-4 indicates that total impervious surface is projected to increase substantially in a number of subwatersheds as a result of development. Yet local comprehensive plans include policy statements to reduce impervious surface. In order to add definition to the policy, this plan recommends a specific goal to prevent impervious surface from reaching a threshold value in the subwatersheds. This is quite important to protecting a high quality river system, as it has been shown by many researchers that the Index of Biotic Integrity, the biological endpoint of this plan as described in Section 2.1.1, tends to decline with increasing imperviousness.[67] It will provide a key strategy to help overcome the problem that best management practices do not seem to be

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[65] Available at http://www.chicagowilderness.org/pubprod/miscpdf/CD_Resource_Manual.pdf
[66] *Conservation Design Resource Manual*
[67] Among others, see for example Dreher, D.W. 1997. Watershed Urbanization Impacts on Stream Quality Indicators in Northeastern Illinois. *Proceedings from the National Symposium on Assessing the Cumulative Impacts of Watershed Development on Aquatic Ecosystems and Water Quality*. Chicago, Illinois, pp. 129-135.

able to mitigate fully the effects of increased imperviousness, especially when they are only required in larger developments.[68]

The most recent available literature review has shown effects on biotic communities (fish and benthic macroinvertebrates) begin when the watershed becomes 3 ~ 15 percent impervious, depending on conditions and study assumptions.[69] The relationship between IBI and imperviousness was established by statistical means, comparing IBI observations and imperviousness in many watersheds. A single definite watershed threshold is elusive because of the statistical nature of the problem, but for practical reasons a single threshold is needed. A cutoff of 10 percent is an accepted generalization of the research, and has been promoted extensively by the Center for Watershed Protection.[70]

There is a difference between total imperviousness and *effective* impervious area, or impervious cover that is hydraulically connected to the drainage system. For example, a roof with gutters draining to a rain garden would not be considered effective impervious cover. A driveway that runs into a storm drain, into a detention pond, and into a creek would be considered effective impervious cover, but a driveway whose runoff is routed to an infiltration basin would not be. It has been found previously that effective impervious cover tends to correlate more strongly and negatively with fish IBI than total impervious cover.[71] Limiting hydraulically connected impervious area seems to address the more relevant variable as well as potentially to enable more intense use of land. Thus, total imperviousness in the subwatershed could be higher than 10 percent, but the goal of this plan is to have no more than 10 percent hydraulically connected impervious cover in each subwatershed. Use of the effective impervious cover limit would tend to promote infiltration practices or so-called low impact development techniques and runoff volume reduction in general. While a goal of reducing effective imperviousness may appear to represent a challenge to industrial and commercial development, it should be noted that much of this is planned for the US 14 corridor, where most runoff from existing development can be or is already being infiltrated into kettles.

The definition of effective impervious area is still somewhat vague. Among various technical issues, it may be necessary to specify, for instance, how many feet of pervious area runoff from a hard surface would have to travel over before that hard surface could be considered hydraulically disconnected. A number of other performance standards may be called for. Rather than making such judgment calls, this plan encourages local governments to develop their own definitions. A reasonable interpretation is that effective impervious area is hard surface from which all or most of the volume, even from small storms, is discharged to surface waters. This plan offers a number of recommendations to help ensure that effective impervious cover remains under 10 percent in each subwatershed:

(a) The stormwater permit submittal requirements for the county and municipalities should be modified to also include a statement of how much effective impervious area is proposed; a statement of how much new total impervious area is proposed is already required. Each local government should formally track the amount of effective impervious area created in each subwater-

[68] Booth and Jackson, *op. cit*.

[69] Reviewed in detail in Brabec, E., S. Schulte, and P.L. Richards. 2002. Impervious Surfaces and Water Quality: A Review of Current Literature and Its Implications for Watershed Planning. *Journal of Planning Literature* 16: 499–514.

[70] See the Center for Watershed Protection's most recent comprehensive statement of its case in *The Impacts of Impervious Cover on Aquatic Systems*. March 2003. Watershed Protection Research Monograph No. 1. This publication is available from the CWP website.

[71] Wang, L., Lyons, J., Kanehl, P., Bannerman, R., 2001. Impact of urbanization on stream habitat and fish across multiple spatial scales. *Environmental Management* 28(2): 255–266. It should be cautioned that imperviousness remains a surrogate for other stressors that have not been identified, but because they probably will not be adequately controlled by current mitigation practices EIA can be used in their stead. This is reviewed in Novotny, V., A. Bartosova, N. O'Reilly, T. Ehlinger. 2005. Unlocking the relationship of biotic integrity of impaired waters to anthropogenic stresses. *Water Research* 39: 184–198.

shed over time and compare it against the baseline total imperviousness in Table 3-4. (The effective imperviousness of existing developed areas is not known, as a study has not been conducted to estimate it.) When this plan is updated in five years, it will be valuable to be able to determine the extent of new effective imperviousness that has been created.

(b) Reduce hard surfaces in developments by allowing narrower streets, shorter setbacks, etc., such as reviewed in Section 2.3.1.2. While subdivision standards like this become negotiable during planned development, as well as (generally speaking) in a specially designed process to permit conservation developments, a review of these standards helps improve the baseline from which negotiation proceeds. During the planned development process, local governments should strive to point out ways to developers that they can reduce imperviousness. This is already part of the volume reduction hierarchy in the MCSMO and in the municipalities' ordinances; this plan's recommendation is simply to emphasize impervious surface more in the development approval process. Neither the countywide nor municipal stormwater ordinances have specific performance standards for volume reduction. This plan recommends that local governments consider establishing volume reduction standards.

(c) Require or encourage the use of infiltration practices. The area of the watershed in which growth is foreseen has relatively permeable soils (Figure 4-6) that should be able to support such practices, although they are not as permeable as in the Crystal Lake watershed to the east.

(d) Existing impervious area can be reduced by helping property owners disconnect impervious surfaces, e.g., redirecting roof leaders to grassy areas. Local governments may wish to begin a program to contact property owners and offer assistance to those interested in reducing runoff from their properties.

(e) A planning strategy can be pursued to encourage more development in subwatersheds where the imperviousness cutoff has already been significantly exceeded and discourage it elsewhere. This could be done by upzoning higher-imperviousness watersheds and downzoning others. The extension of municipal infrastructure could also be timed to encourage full build-out of higher imperviousness subwatersheds before building in uncompromised subwatersheds, but this approach is more complex.

4.2.1.3 Model Erosion Control Measures

Finally, while average annual sedimentation is projected to decrease slightly as a result of comprehensive plan implementation, it was noted in Section 3.3.2 that construction sites, despite regulation, continue to contribute to sedimentation. Increased enforcement to ensure proper use of soil erosion and sediment control (SESC) measures would help reduce construction site erosion, but an enforcement officer cannot be everywhere at once. Only a thoroughgoing commitment to SESC by developers and contractors will minimize construction site erosion. To this end it is recommended that the municipalities and the county each engage with the Soil and Water Conservation District (SWCD) and the developer of at least one new conservation design subdivision to produce a minimal-erosion development as a model. This model, contingent on SWCD resources, would involve enhanced education for the contractors as well as upfront technical assistance from the SWCD to ensure that SESC measures are properly designed and installed.

4.2.2 NATURAL AREA PRESERVATION AND RESTORATION

Many studies have shown a positive relationship between natural land cover in a watershed and the health of aquatic communities. For instance, the Index of Biotic Integrity generally correlates well with total forest area in a watershed as well as the percent of the stream corridor in forest.[72] The restoration of

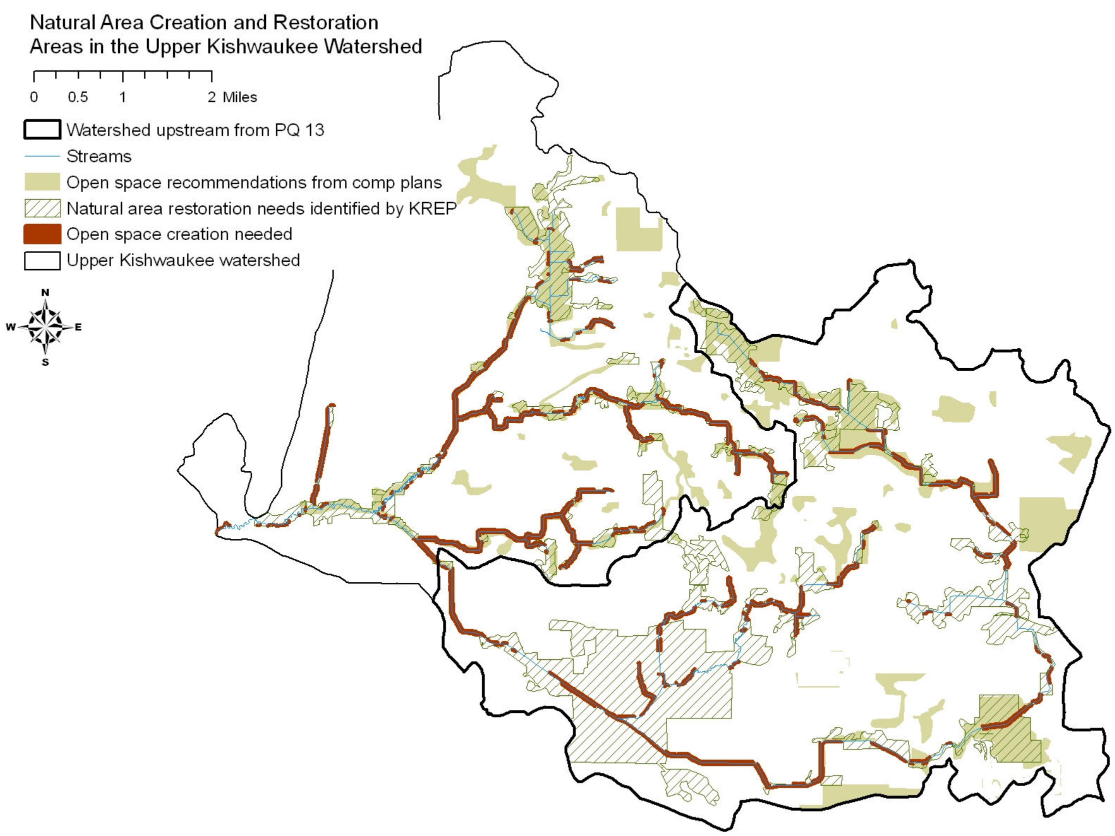
[72] See Brabec, et al., *op. cit.* However, many of these studies were done in eastern watersheds whose original land cover was forest. Early land records by the first federal surveyors in McHenry County in the 1830's indicate that savannas were a common land

riparian corridors along the river and its tributaries to wetland or savanna habitats will result in significant hydrological and ecological benefits. The open space recommendations in comprehensive plans of the municipalities in the watershed also attest to the importance of restoring natural cover in the watershed. This plan's vision includes the following elements:

- Restoration of important natural areas,
- Creation of forested stream buffers where they are now inadequate,
- Legal protection of important natural areas,
- Minimizing the loss of forest in the watershed,
- Reconstruction of streamside wetlands,
- Stream restoration and instream habitat improvement.

As noted above, the reconstruction of streamside wetlands that were drained for agriculture will help remove nutrients from the water column. Improvements to instream habitat would directly support fish communities and help raise the Index of Biotic Integrity. Stream restoration would tend to improve conditions for fish communities that have not recovered from historic channelization. Thus, natural area protection, wetland restoration, and habitat improvement will tend to either reduce the causes of impairment in the Upper Kishwaukee or directly improve IBI, the biological endpoint of the plan.

Figure 4-5.

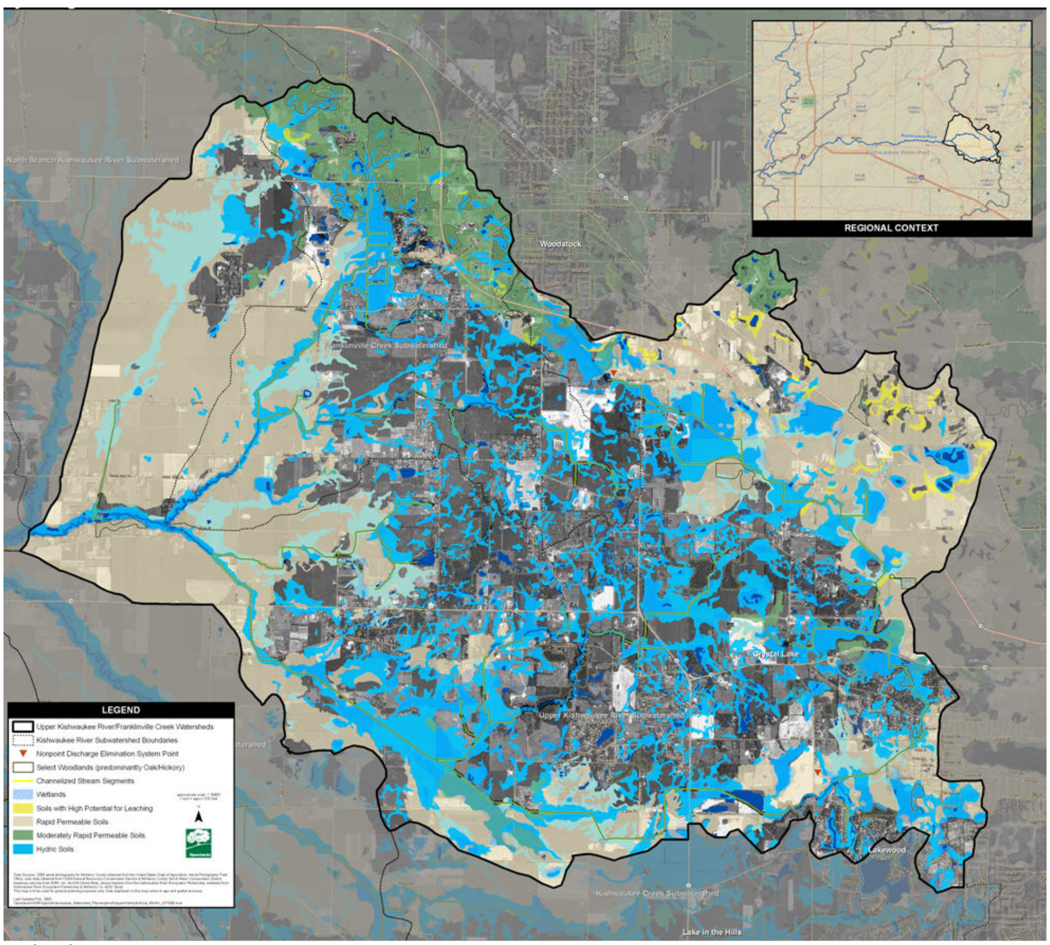


Source: Municipal comprehensive plans, the Kishwaukee River Ecosystem Partnership, and CMAP

cover on upland soils adjoining the wetland soils. NRCS soil maps show tree-based soils paralleling wetland swales of the upper Kishwaukee River watershed. After farmers dug channels through the swales to drain the water table aggressive native (box elders) and nonnative trees and shrubs (mulberry, buckthorn, honeysuckle) tended to populate these stream corridors.

To provide the "skeleton" of an open space network along the streams, the vision of this plan is that the stream should be buffered by at least 100 feet with native vegetation. In agricultural areas, this should be accomplished by planting filter strips on cropland. In developing areas, the vision should be accomplished by buffer establishment during development. The areas in need of buffer establishment are shown in Figure 4-5 as "open space creation needed." This plan interprets the MCSMO as requiring 100 foot buffers along both the main stem and tributaries because Index of Biotic Integrity scores are higher than 35; thus the county and the municipalities processing stormwater permits at the time of development under the MCSMO should require at least 100 foot buffers. Buffer composition should be determined based on inferred pre-settlement vegetation conditions. As a flexible alternative, buffers established in a conservation design development could also be based on the parent soil type, which should be left ungraded to maintain viable soil profiles for restoration, and could be more or less than 100 feet depending on site conditions. Benefits generally increase when buffers extend beyond 100 feet, for example through floodplain and wetland set-asides or conservation design, which protects entire hydric soil assemblages and upland buffers along river and creek corridors (Figure 4-6).[73] A financing mechanism for ongoing management should be applied to all such buffers because of the great potential for invasive species to degrade their value over time.

Figure 4-6. Hydric, rapidly permeable, and moderately permeable soils



Source: Openlands

[73] Rapidly permeable soils which border riparian corridors, wetlands, and hydric soils will carry surface runoff quickly to the subsurface hydrology which sustains these aquatic features and habitat restoration areas.

This plan's vision also emphasizes the restoration of natural areas, and to the extent possible these natural areas should form a continuous corridor along the stream. The Kishwaukee River Ecosystem Partnership has also developed a coverage of target areas that are especially important to restore along the stream corridor, as shown in Figure 4-5. A more specific action plan for restoration projects is provided in Section 5. Target restoration sites in Figure 4-5 within areas covered by municipal comprehensive plans are located within the open spaces and environmental corridors defined in the municipal comprehensive plans.

As noted above, the amount natural land cover in a watershed correlates with aquatic community health, and this is particularly the case for forest. However, many thick groves of aggressive native and nonnative trees now exist in the watershed where prairie or savannah existed before settlement; it would be desirable ultimately to remove these and restore to presettlement conditions. In developing areas, it is recommended that (1) the clearing of savannah tree species such as oak, hickory, hazelnut, and wild plum should be minimized while (2) selectively removing aggressive/invasive trees and shrubs. The increased attention to natural features in a conservation development will help ensure that tree removal is selective. The municipalities also have tree preservation ordinances, as noted briefly in Section 2.3.1.2, which require a permit to remove trees. They also require identification of trees on the property at the time of development and require tree replacement if any are removed, although it is not clear that the ordinances prevent a net loss of trees. It is recommended that the municipalities try to utilize their ordinances to substitute savannah species in upland areas in return for removal of aggressive native and nonnative species along stream corridors.

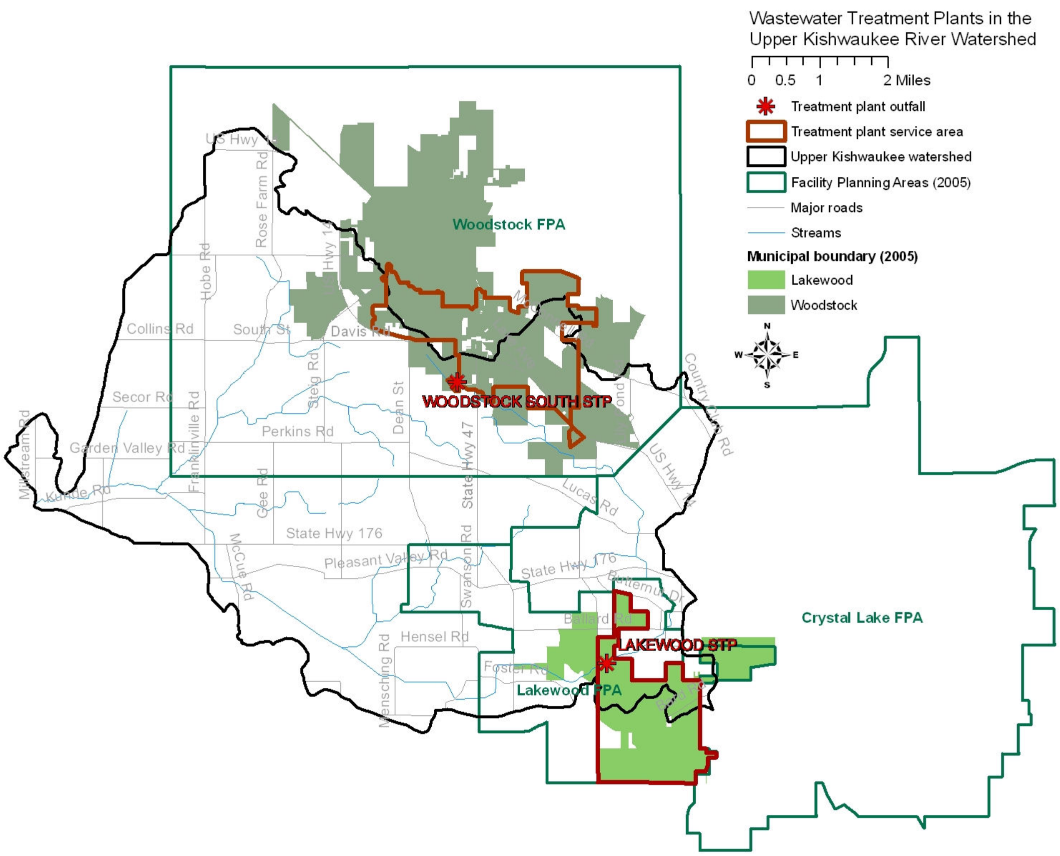
Wetland reconstruction should be considered (1) within any development which sets aside drained hydric soils as conservations areas, (2) in agricultural areas with drained hydric soils as described in Section 5.1.4, and (3) on McHenry County Conservation District (MCCD) property. Sites for reconstruction of wetlands on cropland should be sited to maximize the amount of drainage area served by the wetland and should be funded as much as possible using the Farm Bill cost share programs. MCCD is already planning to undertake large-scale marsh reconstruction and restoration at the Pleasant Valley Conservation Area. This plan recommends that MCCD undertake similar efforts on the Lussky property. These large blocks of land owned by MCCD, which has the capacity and the conservation commitment to undertake major work, are ideal for stream restoration projects such as floodplain reconnection and potentially dechannelization or remeandering.

4.3 Vision for Wastewater

The Village of Lakewood and the City of Woodstock both have wastewater treatment plant discharges on the Upper Kishwaukee, Lakewood's slightly east of Haligus Road and Woodstock's just downstream from the headwaters. The Lakewood plant just came online in August 2007 and provides tertiary treatment, employing an activated sludge process, biological nitrogen removal, and phosphorus removal using alum as a precipitant. The Woodstock South plant provides secondary treatment via activated sludge. Woodstock also has another higher-capacity plant, the North STP, which discharges into Silver Creek, a tributary of Nippersink Creek in the Fox River basin. Figure 4-7 shows the relationship of the two plants and their service areas to municipal boundaries and Facility Planning Areas. The North plant serves small areas of the city within the Upper Kishwaukee watershed, while the South plant treats parts of city both inside and outside the Upper Kishwaukee watershed. Woodstock is expected to request an expansion of the South plant sometime in 2008. Part of the City of Crystal Lake and the Crystal Lake FPA are within the watershed, but its treatment plants discharge to Crystal and Sleepy Hollow Creeks and into an unnamed tributary that flows into Thunderbird Lake, all in the Fox basin. Finally, a very small area of the Bull Valley FPA is within the watershed at the northeast end of the boundary of the Woodstock and Crystal Lake FPAs, but it is insignificant and is not shown in Figure 4-7.

The older neighborhoods of Lakewood on the south shore of Crystal Lake are sewered but receive wastewater service from the City of Crystal Lake. These neighborhoods are almost entirely within the Fox River watershed. The newer neighborhoods of Lakewood, west of Huntley Road, are all located in the Kishwakee watershed. The Facility Planning Area boundaries of all three communities extend into undeveloped and currently unsewered areas. Each of the three communities has boundary agreements with one another with regard to future annexations, which generally conform to these FPA boundaries. These boundaries suggest that each community intends to serve future development in these FPAs, which are generally down gradient from existing treatment plants, by either (1) utilizing lift stations to pump raw effluent back to existing plants or by (2) constructing new centralized treatment facilities or other processing alternatives.

Figure 4-7.

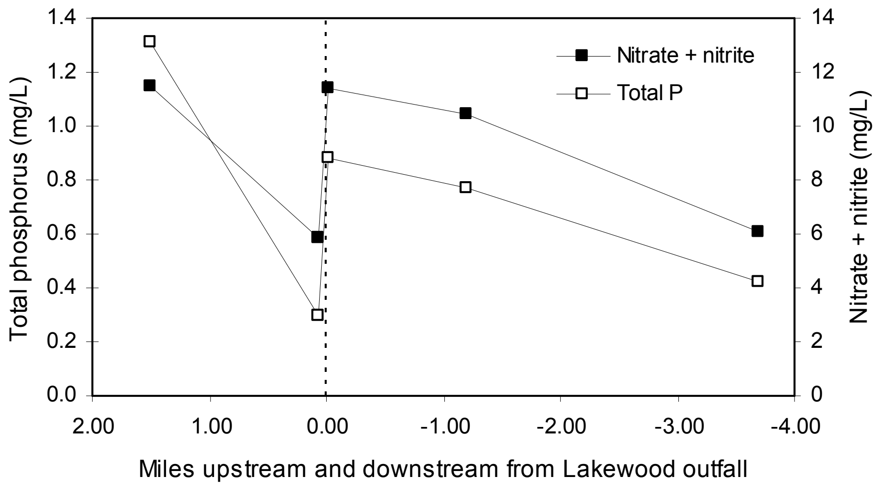


Source: Service areas digitized from maps provided by Public Works departments of the Village of Lakewood and City of Woodstock. Note that municipal boundaries include land that has not been developed or laid with sewer infrastructure. Village of Lakewood service area includes only areas developed in 2005. FPA boundaries and treatment plant outfalls are from the geodatabase maintained by Illinois EPA.

4.3.1 NUTRIENT ENRICHMENT

The wastewater treatment plants on the Upper Kishwaukee contribute substantially to nutrient enrichment in the stream, although treatment practices at the two plants are anticipated to become more protective in the future. Wastewater presently accounts for 45 percent and 62 percent of annual nitrogen and phosphorus loads, respectively (see Section 2.1.6.2). Figure 4-8 plots the water quality samples taken in 2003 for an antidegradation assessment prior to the Lakewood plant expansion and installation of nutrient controls. Negative numbers indicate downstream and positive numbers upstream. It is evident that, prior to the Lakewood plant expansion, nitrate + nitrite[74] as well as total phosphorus concentrations increased sharply at the outfall and then declined downstream as the effluent was diluted. The cause of nutrient elevation upstream (at 1.5 miles above the Lakewood outfall) is most likely effluent from the Woodstock plant, although data were not collected far enough upstream to make this clear (the Woodstock outfall is 7.4 miles upstream). However, considering that Woodstock discharges almost four times the volume of Lakewood and has less dilution from natural flow, it is probable that the plant is the chief contributor and that concentrations are considerably higher further upstream.

Figure 4-8. Nutrient concentrations above and below Lakewood discharge prior to expansion and outfall relocation



Nutrient concentrations in the effluent from both plants may decrease in the future, given that Lakewood's expansion included biological nitrogen removal (BNR) and, while the facility plan for Woodstock's expansion has not yet been submitted, plant operators have suggested that they plan to include nitrogen removal as well as the phosphorus removal now required by Illinois EPA for discharges over 1 mgd.

Table 4-1. Typical range of nutrient concentration in effluent by treatment technology (mg/L).

	Activated sludge		Activated sludge w/ filtration		Activated sludge w/ BNR		Activated sludge, BNR, filtration	
	Low	High	Low	High	Low	High	Low	High
Total N	15	35	15	35	3	8	2	5
Average		25		25		5.5		3.5
Total P	4	10	4	8	1	2	<1	2
Average		7.0		6		1.5		<1.5

Source: Asano, Takashi, Franklin Burton, Harold Leverenz, Ryujiro Tsuchihashi, and George Tchobanoglous. 2007. *Wastewater Reuse: Issues, Technologies, and Applications*. Metcalf and Eddy. Data are from Table 3-14.

It is not straightforward to determine the current nutrient load from wastewater because the plants do not monitor total nitrogen. Literature values on the typical range of nutrients in wastewater given the treatment technology were used in lieu of monitoring data (Table 4-2). Since Lakewood has installed BNR

[74] These constituents generally makes up the majority of total nitrogen.

at its new plant, it is assumed that the plant's effluent contains ~5.5 mg/L total nitrogen.[75] The Village of Lakewood is also removing phosphorus. It provided phosphorus concentration data for March 2008 indicating that phosphorus is ~0.61 mg/L in effluent, a reduction of approximately 90 percent from influent concentrations. For the Woodstock plant at its present build-out, it is assumed that the effluent contains ~25 mg/L total nitrogen, the midpoint of the typical range. The Woodstock plant is assumed to have total phosphorus at ~6 mg/L in its effluent, the average literature value and similar to the influent concentration at the Lakewood plant. These values and the resulting annual loads are summarized in Table 4-2.

Future loading from wastewater plants was projected based on future flow information taken from personal communication or approved facility plans. Lakewood's design average flow is 0.95 mgd, while Woodstock is expected to request 3.5. Assuming that Woodstock is able to achieve an average concentration of 5.5 mg/L total nitrogen after plant expansion, the plant would have no increase in nitrogen loading even at design average flow, although increased loading at DAF would tend to exceed the targets described in Section 2.2.1 and 3.3. Woodstock will also be required to meet the 1 mg/L phosphorus standard after expansion. For purposes of analysis, we assumed that phosphorus concentration in Woodstock's effluent will be the same as that in Lakewood's effluent (~0.61 mg/L). This is expected to hold phosphorus loading from wastewater in the horizon year to about 65 percent of the current load. Overall, then, it is expected that nutrient removal will be able to more than offset increased wastewater flow. Actual nutrient loading from the treatment plants needs to be validated, however. It is recommended that plant effluent be monitored for total nitrogen.

Table 4-2. Estimated current and future flow and loading from wastewater treatment plants.

	Woodstock	Lakewood	Total
Flow			
Current average (mgd)	1.172	0.308	1.48
Horizon year design average flow (mgd)*	3.5	0.95	4.45
Total Nitrogen			
Estimated current average concentration (mg/L)	25.0	5.5	
Estimated current load (lb/y)	89,122	5,153	94,275
Future average concentration (mg/L)	5.5	5.5	
Horizon year load (lb/y)	58,553	15,893	74,446
Total Phosphorus			
Estimated current average concentration (mg/L)	6.0	0.61	
Estimated current load (lb/y)	21,389	571	21,961
Future average concentration (mg/L)	0.61	0.61	
Horizon year load (lb/y)	6,494	1,763	8,257

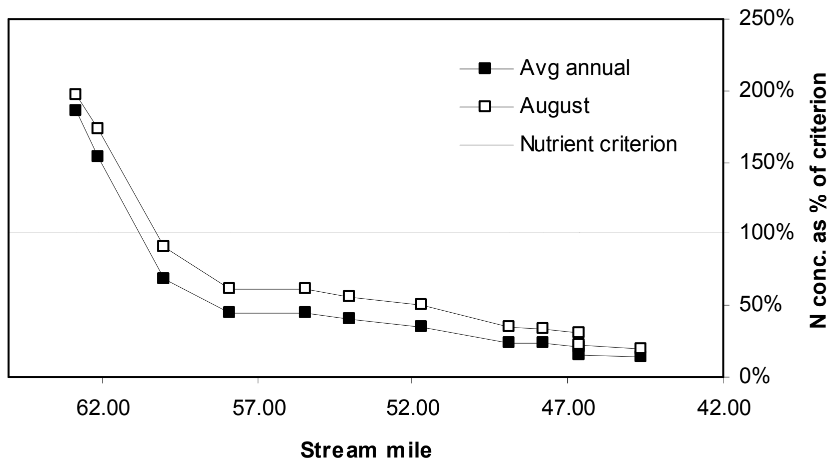
Source: Flow data are from U.S. EPA Permit Compliance System (data extracted on December 20, 2007). * Horizon year design average flow for Lakewood is based on the Phase 1 expansion from the village's 2004 facility plan amendment. Woodstock's horizon year DAF is based on personal communication with the plant operators. In both cases the horizon year is ~2030 (see Section 3 for more information on the horizon year).

Will the recommendations for nutrient removal prevent ambient water quality from exceeding nutrient criteria? A planning level analysis of wastewater's contribution to instream concentrations was undertaken assuming *current* effluent discharge rates and the expected nutrient removal discussed above, i.e., we examined conditions in the years soon after plant expansion. Section 2.2.1 discussed the application of USEPA's instream nutrient criteria of 2.461 mg/L total nitrogen and 0.0725 mg/L total phosphorus. As can be seen in Figure 4-9, the concentration of total nitrogen from point sources would decrease rapidly

[75] Because flow is only about one-third of capacity at the Lakewood plant, nutrient removal may be somewhat less effective than this at present.

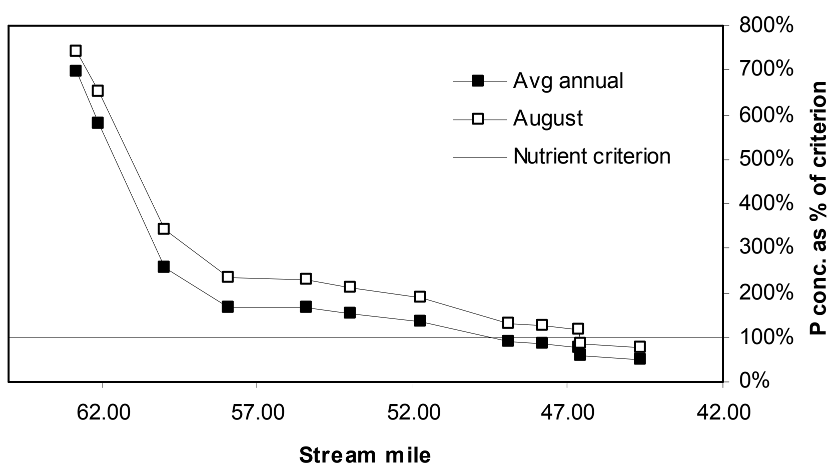
downstream so that — disregarding nonpoint sources for the moment — the nutrient criterion would be met approximately two miles downstream from the Woodstock discharge under average annual flow conditions. No account was taken of algal uptake or any attenuation process other than dilution. The method used to develop flow estimates is described in a section below. River mile 64.20 is the beginning of the stream, with stream mile positions descending numerically downstream. Low flow conditions, with August taken as the lowest flow month, do not appear to increase instream nitrogen concentrations substantially because effluent volume in the upper reaches dominates during both average and low flow conditions.

Figure 4-9. Total nitrogen as a percent of the nutrient criterion for the stream



Wastewater will keep phosphorus levels above the criterion well downstream from the plants (Figure 4-10). However, the methods used here suggest that at Illinois EPA's monitoring station (PQ 13) wastewater would be about 10 percent less than the phosphorus criterion during average flow conditions. Thus, it appears that if nutrient removal has the efficiency assumed in this analysis, wastewater would not in itself cause nutrient levels to rise above the criterion at sample point PQ 13 that Illinois EPA uses for 305(b) and 303(d) purposes, although of course it will exacerbate nutrient inputs from nonpoint sources.

Figure 4-10. Total phosphorus as a percent of the nutrient criterion for the stream



Yet following the installation of BNR technology, instream nutrient concentrations are still expected to increase in the future because of increased wastewater flow. Wastewater flow could triple under existing and proposed facility plans, while runoff is only expected to increase by 6.5 percent owing to land use change. It should be evident that the methods used here are rough approximations. Since this plan is expected to be updated in five years, a proposal for additional monitoring and modeling has been proposed (Section 6) which should be able to provide better certainty as to the extent to which wastewater contributes to nutrient criteria exceedance.

4.3.2 SEDIMENTATION

The causes of impairment in the Upper Kishwaukee also include sedimentation. The sketch planning tool STEPL assumes that total suspended solids in urban runoff can be equated with sediment from other sources, such as cropland, and treated as a contributor to sediment yield at the watershed outlet. Wastewater can be treated similarly, but it contributes a very small amount of the load. NPDES permits control total suspended solids loading. Taking average monthly concentrations from the two plants, it can be seen that the resulting “sediment” yield from wastewater is only ~14 tons per year (Table 4-3), or well below 1 percent of the whole watershed load. In fact, wastewater likely helps dilute total suspended solids of nonpoint source origin.

Table 4-3. Total suspended solids loading from wastewater plants

	Woodstock	Lakewood	Total
Current average concentration (mg/L)	5.19	8.98	
Current load (t/y)	9	4	14
Future average concentration (mg/L)	5.19	8.98	
Horizon year load (t/y)	28	13	41

Source: U.S. EPA Permit Compliance System (Woodstock data extracted on December 20, 2007; Lakewood data extracted on February 22, 2008).

4.3.3 ADDITIONAL PARAMETERS AND VIOLATIONS

Besides nutrients, the parameters typically of most concern from smaller wastewater treatment plants serving primarily residential and light commercial users are biological oxygen demand, ammonia, total suspended solids, and dissolved oxygen. Violations of NPDES permit limits for these constituents have been very rare at the Woodstock South plant (Table 4-4) — only four over almost 11 years — and those at the Lakewood plant are probably associated with start-up of a new plant. Neither plant is required to develop a pretreatment program, and the metals and toxics most closely associated with industrial users have not resulted in any permit violations. In general, effluent from the Woodstock plant has lower pollutant concentrations than Lakewood’s (Table 4-5). However, the higher flow from the Woodstock plant ensures that loading is still higher from Woodstock than from Lakewood, except in the case of ammonia, which is remarkably low in the Woodstock plant’s effluent.

Table 4-4. Effluent violations at Lakewood and Woodstock South WWTPs

Parameter	Woodstock South	*Lakewood
TEMPERATURE, WATER DEG. FAHRENHEIT	—	—
OXYGEN, DISSOLVED (DO)	—	—
BOD, 5-DAY (20 DEG. C)	—	—
PH	—	—
SOLIDS, TOTAL SUSPENDED	4	1
OIL & GREASE	—	—
NITROGEN, AMMONIA TOTAL (AS N)	1	2
CYANIDE, WEAK ACID, DISSOCIABLE	—	—

Parameter	Woodstock South	*Lakewood
CYANIDE, TOTAL (AS CN)	—	—
FLUORIDE, TOTAL (AS F)	—	—
ARSENIC, TOTAL (AS AS)	—	—
BARIUM, TOTAL (AS BA)	—	—
CADMIUM, TOTAL (AS CD)	—	—
CHROMIUM, HEXAVALENT (AS CR)	—	—
CHROMIUM, TOTAL (AS CR)	—	—
COPPER, TOTAL (AS CU)	—	—
IRON, TOTAL (AS FE)	—	—
IRON, DISSOLVED (AS FE)	—	—
LEAD, TOTAL (AS PB)	—	—
MANGANESE, TOTAL (AS MN)	—	—
NICKEL, TOTAL (AS NI)	—	—
SILVER, TOTAL (AS AG)	—	—
ZINC, TOTAL (AS ZN)	—	—
PHENOLICS, TOTAL RECOVERABLE	—	—
FLOW, IN CONDUIT OR THRU TREATMENT PLANT	—	—
CHLORINE, TOTAL RESIDUAL	1	—
MERCURY, TOTAL (AS HG)	—	—
COLIFORM, FECAL GENERAL	1	—
BOD, CARBONACEOUS 05 DAY, 20C	—	—
FLOW, TOTAL	—	—
Total number of effluent violations	**7**	**3**
Months monitored	130	6

Source: USEPA Permit Compliance System. Data extracted April 16, 2008.
* Only since the expanded plant went online in August 2007

Table 4-5. Average concentrations for parameters of concern from wastewater treatment plants.

	Woodstock		Lakewood	
	Conc (mg/L)	Load (lb/d)	Conc (mg/L)	Load (lb/d)
Biological oxygen demand	2.35	24	3.01	13
Ammonia	0.11	1.04	0.67	2.79
Total suspended solids	5.19	49	8.98	22
Dissolved oxygen	7.00	—	7.35	—

Source: USEPA Permit Compliance System. Data extracted April 16, 2008.

4.3.4 CHANGES TO STREAMFLOW

Woodstock and Lakewood together presently add about 1.48 million gallons per day (2.3 cubic feet per second) to the Upper Kishwaukee. Discharging at the future design average flow would increase this to about 6.9 cfs, while design peak flows could be much higher. The estimated overall effect of future wastewater discharge on mean streamflow, together with the approximately 6.5 percent increase in total annual runoff by 2030 given land use changes, is shown in Figure 4-11. Current flow conditions were derived from the State Water Survey's Illinois Streamflow Assessment Model.[76] Future mean streamflow at each stream mile was estimated as current natural streamflow × (future annual runoff volume ÷ current annual runoff volume) + future wastewater flow.[77] Considering that the projected increase in runoff is only 6.5 percent, the chief source of increased flow is wastewater discharge. As can be seen in Figure 4-12, even under average conditions, wastewater is estimated to constitute about 80 percent of streamflow at

[76] Available online at http://www.sws.uiuc.edu/data/ilsam/. For methods used in the Illinois Streamflow Assessment Model, see Knapp, H.V. and A.M. Russell. 2004. *Rock River Basin Streamflow Assessment Model*. Illinois State Water Survey, Champaign, IL. Retrieved from: http://www.sws.uiuc.edu/pubdoc/CR/ISWSCR2004-02.pdf
[77] Natural flow in cubic feet per second was estimated as 0.0738 × drainage area × (precipitation − evapotranspiration), the method used in the State Water Survey's ILSAM model, taking data from the appendix, *ibid*. Runoff in current and future conditions is that produced by the STEPL model.

the Woodstock discharge at present. The Lakewood discharge at stream mile 55.40 then flattens out the dilution curve. At the future design average flow the fraction of total flow that is wastewater would not increase much in the upstream reaches, mainly because effluent is already overwhelmingly dominant. Further downstream, flow increases simply shift the curve upward.

Figure 4-11. Total flow including wastewater by stream mile under current and future average annual conditions.

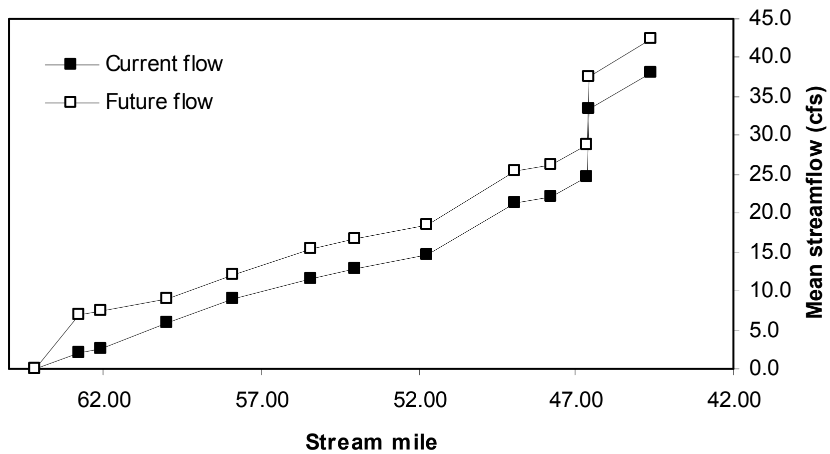
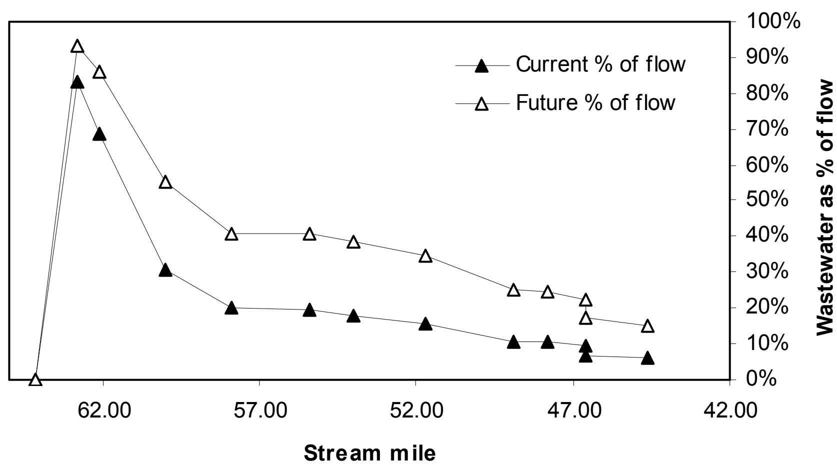


Figure 4-12. Wastewater as a percent of total flow under average annual streamflow conditions.



It is difficult to determine the extent to which increased flow in itself impairs the stream. However, it is clear that the hydrologic regime is being fundamentally changed. In McHenry County, for one, sourcing drinking water from groundwater and discharging effluent to waterways causes a large scale transfer of water from ground to surface. For another, discharging to small streams like the Upper Kishwaukee increases flow far beyond natural volume and cause streams to become effluent dominated, as can be seen in Figure 4-12. On the other hand, increased flow could help prevent the formation of algal mats by physical action and by decreasing nutrient residence time in pools. Increased flow could also increase colonization of the upper reaches by more and larger fish species.

The main reason wastewater discharge increases is growth in population and employment. This is independent of development type in the sense that if settlement occurs within an area to be served by centralized treatment, the same amount of wastewater will be generated regardless of whether the settlement is one high rise, many acres of single family housing, or several conservation developments. Unlike stormwater, wastewater volume is not sensitive to design strategies or to "doing development differently." Its only remedies are, on the one hand, growth management to reduce the impact of discharging to sensitive streams, technologies that limit the volume of wastewater from a centralized facility that needs to be disposed, or the use of no-discharge systems. Focusing on a fifty square mile area in a watershed plan does not offer a realistic opportunity to develop broad strategies for optimizing development location. This is the province of regional planning. However, several technologies could reduce future wastewater discharge from the projections discussed above. If effluent nutrient concentrations remain constant with wastewater flow reduction, then these technologies would also reduce nutrient loading.

4.3.4.1 Water Conservation

One approach to reduce wastewater volume is for municipalities to adopt indoor water use conservation measures. If household appliances, bathroom fixtures, and other indoor uses are or become more efficient, less water becomes wastewater. Several indoor water-use conservation measures are available for adoption. Not all measures require changes in behavior, but all are designed to effect long-term reductions in per capita water demand. While the California Urban Water Conservation Council is a prime resource on conservation and efficiency, the measures listed below have been implemented in many places throughout the country as part of a comprehensive program to increase efficiency, reduce waste, and lower water and wastewater utility operating costs:

- Water-survey programs for residential customers
- Residential plumbing retrofit
- Metering with commodity rates for all new connections and retrofit of unmetered connections
- High-efficiency clothes washing machine financial incentive programs
- Conservation programs for commercial, industrial, and institutional accounts
- Conservation pricing
- Residential ultra-low-flush toilet replacement programs

Adoption of these measures will soon find strong support at both county and regional levels of planning. For example, a new Groundwater Protection Program in McHenry County is emphasizing water conservation among other measures that aim to enhance stewardship of countywide water resources that show signs of stress. Woodstock, Crystal Lake, and Lakewood are among those participating in the Task Force that is charged with developing an enhanced approach to water resource management.

Furthermore, the Northeastern Illinois Regional Water Supply Planning Group, an outcome of Governor Blagojevich's Executive Order 2006-1, has adopted the seven conservation measures listed above along with seven additional measures for the regional water supply plan currently under development. It is expected that the regional plan recommendations, due in mid-2009, will be implemented by municipal and county governments along with water utilities and individuals where appropriate. Thus, the City of Woodstock and Village of Lakewood are encouraged to show support for both county and regional planning initiatives and undertake municipally led conservation programs to implement these measures.

4.3.4.2 Water Reuse

Another technique for reducing wastewater volume is water reuse, i.e., putting treated effluent to a beneficial use. CMAP's current FPA review process requires applicants to conduct an alternatives analysis that includes land application, which is one form of reuse. It is expected therefore that the City of Woodstock will submit its review of this option as part of its submittal package to CMAP and to Illinois EPA. The City of Woodstock is currently irrigating nearby soccer fields at Kishwaukee Park with effluent from the South plant. Other options include agricultural irrigation or reuse in an industrial setting, either as cooling or process water. Discharge from the Lakewood plant also goes to a de facto reuse application. The irrigation ponds in the Turnberry Lakes Golf Course in Lakewood have a direct connection with the stream. Rather than discharge at the former outfall some distance downstream, the outfall location agreed upon during permit negotiations for the new Lakewood plant is the confluence between the river and the ditch leading to the Turnberry ponds. The effect is that during the summer, when irrigation draws down the ponds, the effluent from the Lakewood discharge flows down the ditch and into the ponds where it is used for irrigation.[78]

Woodstock and Lakewood have done an excellent and creative job in taking advantage of opportunities to reuse treated effluent from their treatment facilities. In addition to watering ball fields the City of Woodstock has also considered diverting some of its discharge to the Kishwaukee Headwaters Conservation Area owned by the McHenry County Conservation District.[79] This would have provided final polishing to the effluent as well as potentially helping to restore hydrology affected by historic wetland ditching. However, the District had no set policy regarding acceptance of treated effluent and rejected that particular project. The District has since set up a Land Application Task Force to determine the context in which the use of reclaimed water on District properties could be acceptable. It is recommended that MCCD be considered a potential partner in land application, particularly insofar as such a partnership could help reduce the land costs that typically are seen as the major barrier to land application.

Decentralized treatment with land application (i.e., no-discharge systems) should be seen as an important and beneficial option. Land application tends to become more attractive with decentralized treatment. In particular, effluent from a treatment system could be used to irrigate common open space in a development if the system were designed in from the outset, as in the Sheaffer wastewater treatment system. The McHenry County *Conservation Design Standards and Procedures*, for example, allow for the use of land application in common open space areas.

4.3.4.3 Inflow and Infiltration (I&I) Reduction

In areas with a high water table, groundwater tends to seep into sewer lines. This is called infiltration. In other cases, inflow occurs where roof gutters, sump pumps, and so forth are attached to sanitary sewer lines, contributing stormwater to sewage during wet weather. Both tend to increase the volume of wastewater that needs to be treated and discharged. Both the City of Woodstock and Village of Lakewood have I&I control programs.

4.3.5 NEW OR EXPANDED DISCHARGES

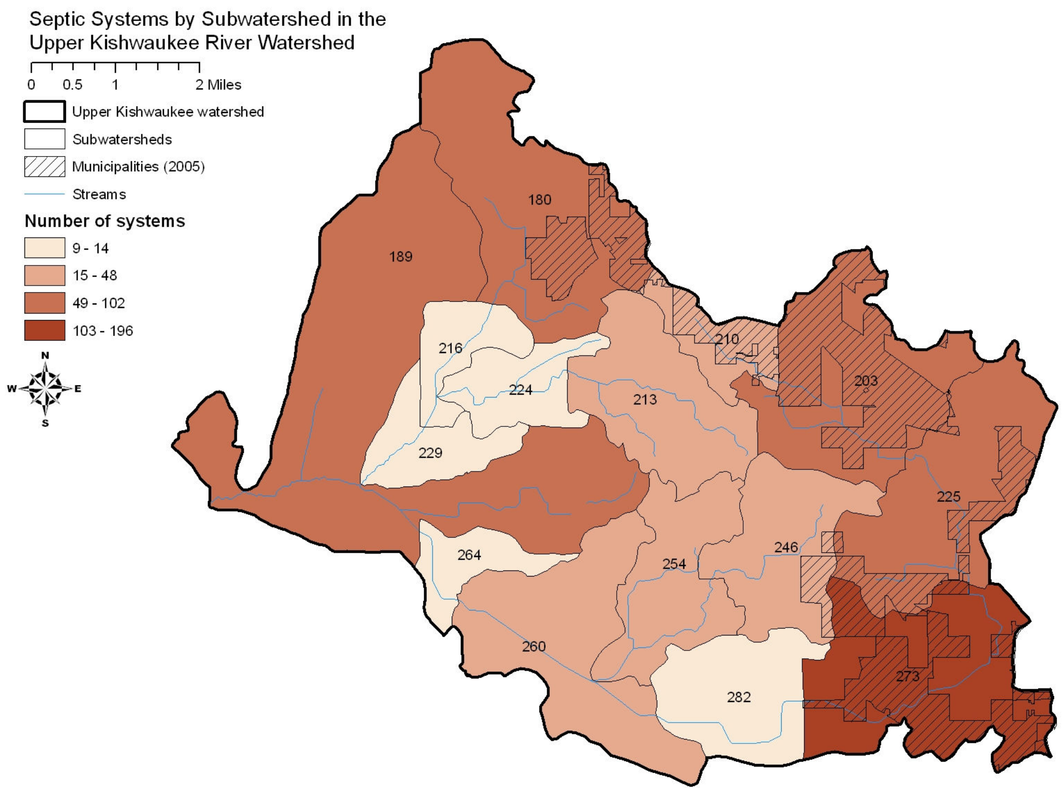
This plan has tried in Section 4.3 to review the effects of future wastewater loading, particularly with regard to the soon-to-be-proposed expansion of the Woodstock South plant. It appears that, from the standpoint of the identified causes of impairment in the Upper Kishwaukee, the expansion will have a positive effect on the stream at the outset so long as it includes nitrogen and phosphorus removal and these technologies deliver at least average performance. Specific nitrogen effluent limits for either the Woodstock or Lakewood plants are not recommended because of uncertainty in the loading analysis and the performance of the nitrogen removal technology. Considering only the potential causes of impair-

[78] Meeting with Catherine Peterson, Village Manager, and Paul Ruscko, P.E., Public Works Director, Village of Lakewood, March 19, 2008

[79] Meeting with John Isbell, P.E., Public Works Director, and Jeffrey Van Landuyt, Assistant Public Works Director, City of Woodstock, April 25, 2008

ment identified by Illinois EPA, the Woodstock expansion should be considered acceptable and eligible for construction financing from the state. There would be no effect on sedimentation. However, the increased capacity at the plants means that nutrient loading as well as total flow could increase substantially in the stream by the horizon year of the plan, and this should be controlled using the methods described.

Figure 4-13.



Source: 1990 Census, 1990 Northeastern Illinois Planning Commission land use inventory, and draft, unreleased 2005 CMAP land use inventory

Any additional increase in wastewater discharge will tend to make it more difficult to reach the nutrient target loads and would exacerbate the flow alterations discussed above. Woodstock and Lakewood are, so to speak, built around the availability of the Upper Kishwaukee as a receiving body for effluent discharge. Other growing municipalities should be able to identify alternatives to the Upper Kishwaukee, but this does not mean that discharging elsewhere, generally to another small stream nearby, would have less negative impact. With this in mind, it does not appear appropriate to recommend rejecting new point source discharges to the Upper Kishwaukee. However, it is recommended that any nutrient loading from a new discharge be fully offset by reductions from other sources. Illinois EPA should establish a form of water quality trading[80] for any new discharge to the Upper Kishwaukee containing nitrogen or phosphorus to offset increases in nutrient loading by requiring dischargers to fund nonpoint source projects aimed at nutrient removal, such as agricultural BMPs or wetland reconstruction. In particular, the Illinois EPA should closely consider using a portion of a State Revolving Fund loan to fund such offsetting non-

[80] The USEPA has recently released a manual on water quality trading aimed at permit writers. See http://www.epa.gov/owow/watershed/trading/WQTToolkit.html. It tends to focus more on formal programs with tradeable credits and may presume an unnecessary level of complexity for the issues in the Upper Kishwaukee; however, it still provides useful guidance. For a more accessible background on nutrient trading, see also the Wetlands Initiative at http://www.wetlands-initiative.org/CompEconomics.html and http://www.wetlands-initiative.org/images/pdfs_pubs/Nfarm4Workshops.pdf.

point source control projects, with hookup fees repaying the loan for the cost of the BMPs in addition to the treatment facility capital cost. If the recommended monitoring program (Section 6) is carried out, considerably more information will be available to design a trading program. An antidegradation assessment that finds no impact from a proposed new discharge should not be considered a sufficient condition for an NPDES permit if nutrient loading to the Upper Kishwaukee would still increase as a result of the discharge. The water quality trading program is envisioned to apply, again, to *new* discharges, not to expansions of capacity in existing plants. The recommendations in Section 4.4.2 are meant to address loading from the existing/expanded WWTPs as their flow increases.

There would be significant benefits to land application via the reduction or elimination of discharge to the river. It would be especially valuable to a community proposing a new treatment plant which, if this plan's recommendations are followed, would need to fully offset nutrient loading if the plant discharges to the Upper Kishwaukee. Pursuing land application would avoid this problem either partly or entirely, depending on whether the alternative were a partial reuse system or a no-discharge system.

4.3.6 SEPTIC SYSTEMS

Existing septic systems do not appear to contribute substantially to nutrient enrichment, although a study is needed to verify this (Section 6). The highest concentration of onsite systems is in subwatershed 273 because of the relatively dense unsewered neighborhood in the unincorporated area between Lakewood and Crystal Lake (Figure 4-13). The municipalities all require hookup to the sewer system unless no sewer is available within a set distance of the property, generally about 200 feet, and it is expected that municipalities would extend sewers to serve all or most new development. Septic systems are expected to increase in number in the watershed as a result of growth in unincorporated areas. This plan takes no position on additional septic systems except that, insofar as the scattered, low density development patterns septic systems allow tend to promote inefficient urban form, they should be discouraged.

4.3.7 CONTROL OF EMERGING CONTAMINANTS

"Emerging contaminants" is the collective term for the large number of pollutants which may enter environment but that are not currently regulated by the USEPA or Illinois EPA. As noted in Section 3.3.4, concentrations of these pollutants as well as the number of them found in the stream can be expected to increase as wastewater flow increases. To some extent more would be expected from urban runoff over time, although agricultural chemicals would decrease. These contaminants may have varying effects on life, but specific impacts are still the subject of investigation. Perhaps the best known effect is an increase in the number of fish that have both male and female characteristics as a result of exposure to endocrine-disrupting compounds. Emerging contaminants, which have been detected frequently in the Upper Illinois basin and are primarily discharged by wastewater treatment plants, include the partial list in Table 4-6.

Table 4-6. Partial list of emerging contaminants in streams in the Upper Illinois basin

Estrogen and other hormones	Stimulants	Fluoranthene
Painkillers	Antioxidants	Pyrene
Blood pressure medications	Fumigants	Napthalene
Antibiotics	Fire retardants	Cholesterol
Caffeine	Pesticides	Detergents
Fragrances	Steroids	Analgesics
Flavoring chemicals	Polymers	Plasticizers

Source: George E. Groschen, Terri L. Arnold, Mitchell A. Harris, David H. Dupré, Faith A. Fitzpatrick, Barbara C. Scudder, William S. Morrow, Jr., Paul J. Terrio, Kelly L. Warner, and Elizabeth A. Murphy. 2004. *Water Quality in the Upper Illinois River Basin: Illinois, Indiana, and Wisconsin, 1999–2001.* U.S. Geological Survey Circular 1230

It is not anticipated that wastewater treatment plant operators — the typical target of pollutant load limits — will be required to remove any emerging contaminant from the wastewater stream within the five-year framework of this plan, but state or federal regulation of the highest priority contaminants should not be unexpected in the future. This plan recommends that the county and the municipalities embark on source control initiatives to combat emerging contaminants that focuses on community education. The county is encouraged to undertake a source control initiative as septic systems may threaten shallow groundwater supplies and potentially the stream via baseflow. Doing so would put jurisdictions in the watershed well ahead of other places in the state and would demonstrate their leadership. Some potential strategies are as follows:

- Establish and publicize drop-off locations at public buildings for unused medicines, or to include them in household hazardous waste collections
- Include in village newsletter information about emerging contaminants and provide recommendations such as:
  - Use nonantibiotic soaps
  - Use natural alternatives to household chemicals and personal products
  - Compost food waste rather than use garbage disposal

4.4 Vision for the Protection and Restoration of Water Quality

4.4.1 CURRENT LOADING

Current nutrient loading appears to be well above the target levels established in Section 2. The reductions needed in current nutrient and sediment loading are described in Table 4-7 along with the recommended allocation of the reductions to different sources. Wastewater reductions are based on the expected decrease in loading described in Section 4.3 above, and the remaining reductions are allocated to urban and cropland runoff based on their estimated relative contribution to the total load. Section 5 lays out the potential best management practice opportunities that have been identified for urban and agricultural areas in the Upper Kishwaukee. The procedure was to identify projects based on feasibility and likely impact and compare their expected load reductions to the targets. The load reductions expected from implementing all of the projects are shown in Table 4-8. Because of the expected efficiency of nitrogen removal in the wastewater treatment plants, it will not be especially difficult to achieve the remaining reduction in nonpoint source loads. However, phosphorus will be considerably more difficult. Installation of the identified agricultural and urban BMPs still would not result in meeting the recommended load reductions. The same is true of sedimentation, although as discussed in Section 2.2.2 the sediment reduction targets are quite conservative and therefore difficult to achieve.

Table 4-7. Reductions in current loading needed to meet load targets

	Nitrogen		**Phosphorus**		**Sediment**	
	Percent	lb/yr	Percent	lb/yr	Percent	t/yr
Wastewater	91%	69,515	73%	19,215	—	—
Urban	2%	1,532	8%	2,081	39%	1,098
Cropland	7%	5,040	19%	4,895	61%	1,687
Total reduction	**100%**	**76,088**	**100%**	**26,191**	**100%**	**2,785**

In one sense the proposed way of distributing load reductions among sources is inequitable, as the expected load reduction from wastewater sources (91 and 73 percent for N and P, respectively) is out of proportion to their contribution to current loading (45 and 61 percent for N and P, respectively). With nutrient removal, however, the expected average concentration of nitrogen and phosphorus in wastewater would be much more similar to expected nutrient concentrations in agricultural runoff. On a unit basis, parity between agriculture and wastewater would be improved. Also, the treatment plants are major contributors to nutrient loading and need to reduce loading, but it does not appear to make sense to scale treatment to remove less of the nutrient load than it is possible to treat. Finally, we have not been able to identify BMPs sufficient to meet the P reduction target, so nonpoint sources cannot make a larger contribution for this nutrient. On the other hand, there is not enough information presently to justify specific nitrogen effluent limits for the treatment plants or to try to enact the recommended load reduction of 91 percent through an NPDES permit, and it is not recommended that Illinois EPA try to do so.

Table 4-8. Load reductions expected from implementation of identified BMPs

	Nitrogen	Phosphorus	Sediment
Agricultural BMPs			
Agricultural target	5,040	4,895	1,687
Reduction from identified opportunities	17,930	2,460	516
Additional reduction needed	(12,890)	2,435	1,171
Urban BMPs			
Urban target	1,532	2,081	1,098
Reduction from identified opportunities	2,122	689	82
Phosphorus ban	—	413	—
Wastewater reuse (@ 10% current flow reused)	1,960	217	—
BMP retrofit projects	162	59	82
Additional reduction needed	(590)	1,392	1,016

There is considerable uncertainty in the estimates of loads and needed load reductions. However, it appears that improvements at the Woodstock plant will go a long way toward reducing nutrient loading to acceptable levels, even if these levels are not known with great exactitude. Furthermore, major wetland reconstruction projects, one of which is already programmed, could reduce nutrient loading even more. In light of these considerations, it is probably best to prioritize not small urban retrofit projects with impacts much smaller than the error band but to focus on improving conditions for the fish community, the indicator of primary interest for this plan, and restoring the original hydrology of the watershed. However, urban practices that rely on policy changes rather than public resource allocation should still be pursued regardless. Agricultural BMP projects also remain important because of their impact on sedimentation.

4.4.2 FUTURE LOADING

A way needs to be found to limit the growth in loading projected to occur as wastewater flow increases. A number of alternatives are available to do so: (1) the wastewater treatment plants could undertake further nutrient removal; (2) more stringent structural BMPs or conservation design could be required in new developments to control nonpoint sources; (3) the amount of projected development in the watershed could be reduced; (4) source control could be employed; or (5) additional agricultural BMPs could be installed; (5) conservation or wastewater reuse could result in wastewater flow reduction with the side benefit of nutrient reduction; or (6) streamside wetlands could be reconstructed.

The first option is premature given that the nitrogen removal rate at the Lakewood plant and the potential N and P removal rates at Woodstock South are unknown. Actual removal rates may be lower or higher than the literature estimates (Section 4.3.1) used to develop the projections. Furthermore, if Lakewood and potentially Woodstock have nutrient removal in place, additional removal even if practicable would probably be expensive at the margin. Option three is not favored either, as it is not in line with the vision of land use. Option two holds the most potential to be seen as a win-win approach, despite the fact that the increased loading is expected to come from the treatment plants rather than nonpoint sources. It is also in line with the emerging character of conservation-oriented development in the watershed, as evidenced in Woodstock's Apple Creek development, Lakewood's Woodland Hills, and Crystal Lake's Barton Stream. However, estimates from STEPL, on the assumption that new development would be served solely by infiltration practices, suggest that reductions of N, P, and TSS would not be dramatic relative to the wet pond status quo, the unquantifiable benefits of conservation design and impervious surface reduction notwithstanding. The only source control possibility (option 4) identified is regulating phosphorus in lawn fertilizer, i.e., a phosphorus ban. Based on evidence from Wisconsin described briefly in Section 5.2.2, this is expected to have a noticeable impact. Option five does not appear to be satisfactory given that implementing all the agricultural BMPs identified in Section 5.1 still would not result in meeting the agricultural portion of the current load reductions needed. Flow reduction from the wastewater treatment plants, either through conservation or reuse, could provide additional pollutant removal. It is reasonable to think that a combination of the two could result in a reduction of 15 percent of flow by 2030.

Table 4-9. Future load reductions expected from plan implementation

	Nitrogen	Phosphorus	Sediment
Total reduction from *target* needed	41,495	10,787	1,349
Reduction from identified opportunities	70,123	9,715	245
Infiltration practices in new development	5,534	587	245
Phosphorus ban (residential)		218	—
Wastewater reuse	2,927	325	—
Water conservation	5,855	649	—
Wetland restoration	42,917	7,936	—
Ag BMPs overage	12,890		—
Additional reduction needed	(28,628)	1,072	1,104

Wetland reconstruction is likely the most important measure. Besides the programmed MCCD restoration at Pleasant Valley, a number of other opportunities have been identified in Section 5.3. The load reductions in Table 4-9 assume that all streamflow could be treated by one or another of these wetland reconstruction projects by suitable flow diversions, and the resulting loading reductions could produce the lion's share of the needed decrease. Thus, the Upper Kishwaukee has a unique opportunity for habitat restoration with water quality and hydrology benefits, not to mention quality of life enhancement if accompanied by educational programming: because of the large blocks of drained organic soils along the stream corridor, significant wetland reconstruction projects are possible. Phosphorus still is not projected to meet its target. However, the uncertainty connected with current loading is more pronounced with projections; it is best to see future load reductions needed as guideposts.

One means of funding additional wetland restoration would be to utilize the provisions of the McHenry County Stormwater Management Ordinance (Sections V.H.6 and V.H.7), which permits developers in some cases to obtain wetland mitigation credits by paying into a wetland restoration fund established by the county or by certified communities (which all of the municipalities in the Upper Kishwaukee are). The county and the municipalities have not yet established these funds or developed fee schedules. It is recommended that the county and municipalities activate these funds and that the restoration projects described in Section 5 should be considered high priority projects to mitigate wetland impacts in the Upper Kishwaukee watershed. Furthermore, it would be ideal for each jurisdiction to place the fees it collects in the Upper Kishwaukee watershed into a single fund or otherwise coordinate the use of the fees to expedite the completion of the projects in this plan. While this approach will not directly address increases in loading with increased wastewater flow, the fees and wastewater flow will tend to increase in tandem as development occurs, providing an indirect linkage.

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5. A PLAN FOR IMPLEMENTING THE VISION

This section describes the opportunities for water quality (nonpoint-related) and habitat improvement that have been identified as part of the planning process, providing background information, locations, cost estimates, and expected pollutant load reductions. It should be taken in conjunction with the vision presented in Section 4.

5.1 Urban Nonpoint Best Management Practices

The Upper Kishwaukee River watershed was evaluated for potential implementation of urban BMPs, both retrofits to existing developments and policies for source control and future growth. For the most part, the retrofit projects are intended to address areas of older development that do not have adequate water quality BMPs or to improve the treatment capability of existing detention basins. The projects are also focused on urban areas adjacent to the river that do not have long or complex flowpaths prior to discharge. The projects were identified through meetings with municipal representatives, review of available mapping, and limited field observations. The estimated costs do not include the purchase of land or drainage easements. Site locations are provided in Figure 5-1. Opportunities for urban nonpoint source projects are limited, have a low ratio of benefits to costs, and have a small pollutant reduction benefit relative to the uncertainties in the estimates of the load reductions needed. Therefore the urban nonpoint projects are not priorities for implementation in this plan. See discussion in Section 4.4.

5.1.1 STRUCTURAL RETROFITS

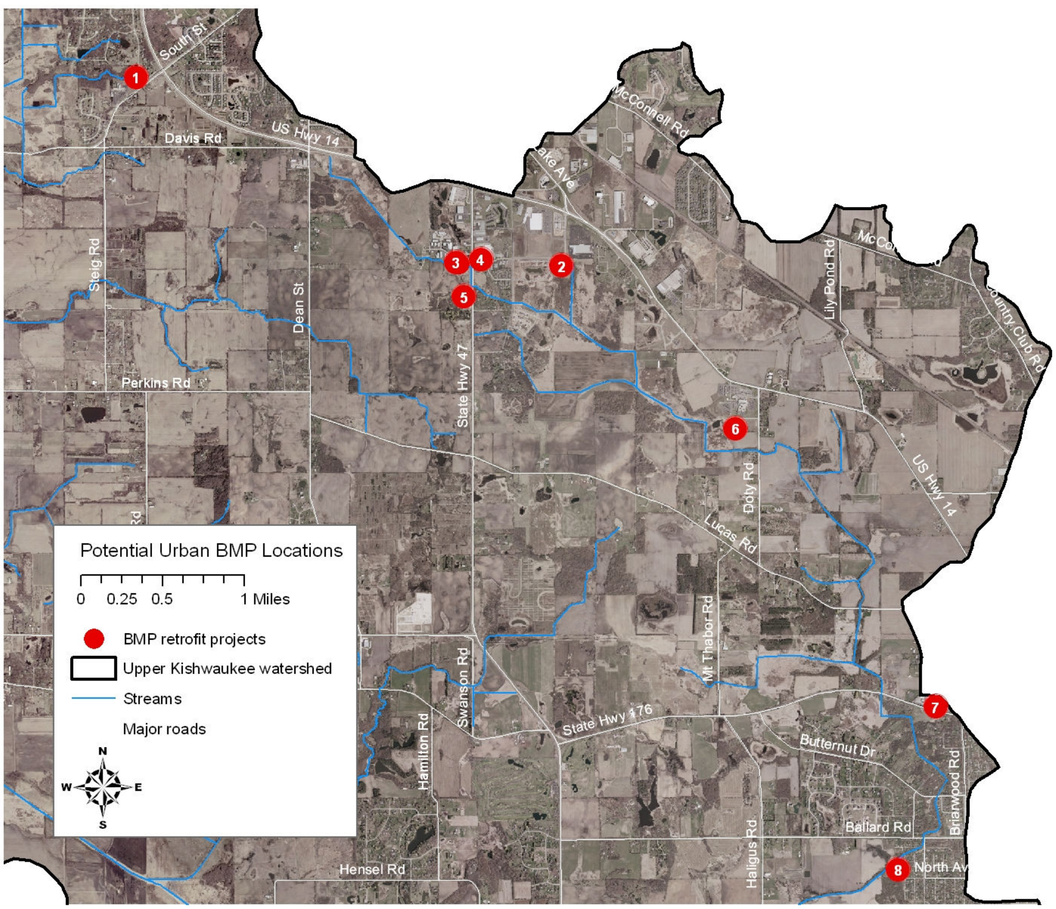
Drainage channel stabilization (1). This potential project is located just west of the intersection of West South Stream Road and Morraine Drive and is in the Franklinville Creek subwatershed. The drainage channel conveys flow away from the west side of Woodstock. The channel just downstream of West South Street Road has severe erosion. The banks are heavily wooded and there is a steep grade in this area. A bank stabilization project would reduce erosion and the sediment load generated from this area. The stabilization project would cover approximately 600 linear feet of channel. The estimated cost for implementing the stabilization project is $200,000.

Detention basin water quality enhancements (2). This project involves the detention basin located south of the intersection of Lake Avenue and Cobblestone Way. This relatively new detention basin, which is managed by Woodstock, serves several properties just north of it. The basin is designed as a dry basin and is relatively flat bottomed. The basin could be enhanced by providing several wetland pockets. Trash deposition at the inlet was also noted as a problem at this basin. If wet pockets are established they should be positioned a short distance away from the inlet to facilitate trash pickup in the basin. Approximately 25 percent of the five-acre basin could be converted to wetlands. This would create approximately three percent of wetlands over the 40-acre tributary area. Some grading would be desirable to create pockets of emergent marsh within a larger wet prairie feature. Sediment forebays would also be desirable. Sideslopes should be planted to mesic prairie vegetation to eliminate the need for mowing. The estimated cost for implementing 1.25 acres of wetlands within the existing basin is $70,000.

Bioswales near light industrial properties (3). These industrial properties are located just north of the Kishwaukee River and west of Route 47. These older properties (predating detention requirements), occupy approximately 11 acres and are constructed directly north of the river. Two parking areas are less than 20 feet from the river. There are several open areas where bioswales could be implemented adjacent to these buildings and parking lots. Due to space constraints at the farthest east property, very little could be accomplished unless the pavement itself was removed or modified. Approximately 0.5 acres of bioswales would be needed to capture and treat the first 0.5 inch of runoff from the impervious areas in this 11-acre area. The estimated cost for implementing this project would be $60,000. A second alternative would be to relocate this channelized segment of the Kishwaukee River to the south by 100 feet. A 2-acre wetland area would then be in place between the industrial properties and the new channel alignment. The estimated cost for implementing this project would be $200,000.

Detention basin water quality enhancements (4). A commercial building (Kmart) is located just northeast of the river and east of Route 47. This property is served by two small detention basins that appear to have been sized under outdated stormwater regulations. Both basins have a small amount of water in the bottom, but it does not appear that they were designed to be wet or wetland bottom basins. There is a parcel of open land adjacent the southwestern basin that would allow for enhancement of the detention basin by expanding its size and incorporating water quality treatment features such as a plunge pool and treatment wetlands. The existing 0.1-acre serves approximately 4 acres of impervious area. The basin could be expanded to approximately 0.25 acres. The estimated cost for implementing this project is $60,000.

Figure 5-1. Potential urban best management practice retrofit locations



Bioswales near light industrial property (5). A light industrial property (AdvanTechPlastics) is located south of the river and east of Route 47. Stormwater runoff appears to exit this site as sheet flow directed to the north and west. A ditch along Route 47 also collects flow on the east side. Bioswales could be constructed to capture and treat stormwater runoff from adjacent impervious surfaces. Approximately 0.05 acres of bioswales would capture and treat the first 0.5 inches of runoff from 1.2 acres of impervious surfaces. The estimated cost for implementing this project is $20,000.

Expand existing pond with wetlands (6). A hospital campus (Centegra Memorial) on the southeast side of Woodstock occupies approximately 45 acres and is 40 percent impervious. The nearly 20 acres of impervious surfaces are collected in storm sewers and routed through one or more open swales prior to discharging to a one-acre wet detention pond. An opportunity exists to expand the pond by adding up to two acres of treatment wetlands to its east. While the 45-acre site is already served by grass swales and a wet pond, this would augment the treatment capabilities of the water quality BMPs serving this development. The estimated cost for implementing this project is $150,000.

Table 5-1. Costs and load reductions expected for urban retrofit projects.

				Pollutant Removal		
Project ID	**Proposed Project**	**Cost**	**Acres treated**	TSS (t/yr)	TN (lb/yr)	TP (lb/yr)
1	Bank stabilization	$200,000	—	52.8	28.0	14.0
2	Wetland detention	$70,000	40	4.7		9.4
3a	Bioswale	$60,000	10	4.9	28.7	6.8
3b	Wetland treatment	$200,000	11	5.3	30.8	7.3
4	Wetland Detention	$60,000	4	0.5		0.9
5	Bioswale	$20,000	1.2	0.6	3.4	0.8
6	Wetland Detention	$150,000	45	5.2		
7	Wetland Detention	$80,000	6	2.9	16.8	4.0
8	Wetland detention	$130,000	45	5.4	54.0	16.0
		$970,000		**82.3**	**161.7**	**59.1**

Note: In the case of retrofits to existing BMPs, pollutant removal is given as incremental reduction over current removal.

Implement or retrofit detention basin at industrial property (7). This light industrial property (Horizon Cartage) in Crystal Lake is a hauling company with some materials storage onsite. Stormwater runoff appears to sheet flow to a ditch and depressional area before passing under Route 176. The open area north of Route 176 could be enhanced by employing native vegetation filter strips and a wetland pocket. Approximately 0.6 acres of BMPs would treat runoff from six acres of impervious area. The estimated cost to implement this project would be $80,000.

Wetland detention for undetained subdivision (8). The Crystal Gardens subdivision in unincorporated McHenry County is located south of Ballard Road and west of Briarwood Road. There is a four-acre grassed open space located between Georgine Street and the river. This lot may be appropriate for implementing a two-acre wetland basin. More detailed information on drainage patterns will be needed to determine if runoff from the subdivision can be directed to the lot. The two-acre wetland would provide treatment for runoff from up to 45 acres of residential subdivision. The estimated cost to implement this project is $130,000.

5.1.2 POLICY

The Village of Lakewood has banned the use of phosphorus-containing fertilizer. The majority of total phosphorus in runoff from residential areas is from lawns,[81] and information from Dane County, Wisconsin suggests that such a ban would decrease phosphorus concentrations in runoff from residential areas

[81] R.J. Waschbusch, W.R. Selbig, and R.T. Bannerman. 1999. *Sources of Phosphorus in Stormwater and Street Dirt from Two Urban Residential Basins in Madison, Wisconsin, 1994–95*. U.S. GEOLOGICAL SURVEY Water-Resources Investigations Report 99–4021

by about 23 percent.[82] If such a phosphorus ban were implemented in the watershed, phosphorus loading from incorporated areas in the watershed would likely decrease by approximately 413 pounds per year, with additional reductions by unincorporated land. Another 218 pounds would be removed at the 2030 build-out as described in the comprehensive plans. An alternative to the phosphorus ban is for local governments to buy phosphate-free fertilizer in bulk for a volume discount and resell it at cost to residents. Many local governments have taken this approach for rain barrels, backyard composters, and so on. This may be a more effective and softer approach in a metropolitan area where people can go elsewhere to avoid point-of-sale restrictions. Lake communities have also taken this tack: for instance, the Candlewick Lake Association in Boone County has done bulk purchasing/resale with good results.

If the subwatershed effective impervious area goals are implemented as described in Section 4.2.1, then the use of infiltration practices for stormwater management will likely become the norm during development. At 2030 build-out, this would be expected to reduce nitrogen and phosphorus loads by 5,534 and 587 pounds per year, respectively, and sediment/solids loading by 245 tons per year. Finally, it is recommended that local governments provide native seed packets for prairie plantings in residential yards. This is inexpensive, but could be provided through the native seed collection activities of the volunteer restoration efforts going on in various parts of the region, such as on the North Branch of the Chicago River or the Calumet.

In Section 3.3.4, pathogens and chloride were identified as two nonpoint source related contaminants that almost invariably tend to increase with urbanization, although they have not been identified as causes of impairment yet. Source control is the most effective strategy in both cases, as BMPs do not seem to be able to remove chloride and coliform bacteria adequately. For chloride this can include (1) improved storage and handling practices for road salt, (2) use of pre-wetting or other salt application management techniques, and (3) the use of alternative deicing compounds.[83] The McHenry County Groundwater Protection Program Task Force has also pulled together a substantial amount of information on chloride reduction.[84] It is expected that the Task Force will make recommendations for chloride reduction. For fecal coliform, the two recommended strategies are elimination of pet waste and control of geese. Pet waste can be reduced by public outreach, signage and provision of plastic bags in parks, and pet waste ordinance enforcement. Goose management options can be classed broadly as habitat modification, aversion, and depredation. The chief habitat modification is to plant a taller vegetative fringe around stormwater ponds. Taller vegetation is thought to reduce the attractiveness of the pond for geese as it could harbor predators. This is the ideal approach since it serves multiple goals and helps prevent the problem from occurring in the first place. Aversion is not thought to work consistently once geese adapt to it. Finally, depredation can also be attempted by various parties such as homeowner's associations, park districts, and golf courses;[85] the municipalities may wish to promote this to them as a means of controlling goose populations, although it may be controversial.

[82] See http://www.danewaters.com/management/PhosphorusControlPresentation.aspx
[83] Camp Dresser McKee. 2007. *Chloride Usage Education and Reduction Program Study*. Prepared for DuPage River Salt Creek Workgroup. Retrieved from: http://www.drscw.org/reports/ChlorideRecomendations.Final_Report.pdf
[84] http://www.co.mchenry.il.us/common/countyDpt/WaterRes/Weblinks.asp
[85] While the Migratory Bird Treaty Act provides the Canada goose with certain legal protections, individual federal permits have been approved for land owners and public land managers to depredate nests and eggs to reduce population. As of August 2006, permits are no longer necessary as long as landowners/managers register online with the U.S. Fish and Wildlife Service. There is no fee for the registration. Depredation can occur between March and June and a report of the number of nests/eggs destroyed must be made to the Service by October of each year.

5.1.3 RELATION TO MS4 REQUIREMENTS

The NPDES general permit for municipal separate storm sewer systems (MS4s) requires permittees to implement total maximum daily load allocations or approved watershed management plan performance criteria where they exist.[86] Because urban loads are small relative to the uncertainty in the estimates, however, the load reductions assigned to urban land uses in Section 4.4.1 and the implementation of the corrective urban BMPs discussed in this section should not be considered obligations of the MS4s. Instead, the projects should be seen as elective actions by the municipalities, supported by their own funds, external grants, or a combination of the two. However, the municipalities should still report on their progress toward achieving the recommendations of this plan as a whole in their annual reviews under the MS4 program.

5.2 Habitat and Ecosystem Restoration

A windshield survey of stream, concentrating on the main stem, was undertaken in an effort to identify potential habitat restoration projects. The proposed projects are intended primarily to improve habitat for fish – with the objective of increasing the Index of Biotic Integrity – and in some cases to improve stream buffering. The potential habitat restoration projects are summarized in Table 5-2; locations are shown in Figure 5-17. Priorities were assigned qualitatively based on expected benefits and implementability. In the case of the smaller projects the preferred and most cost effective approach, should the opportunity arise, is to undertake the project as part of a development. As noted in Section 4.1.5.1, MCCD will also be reconstructing 600 – 700 acres of marsh in the Pleasant Valley Conservation Area. This could also have a major water quality benefit on the main stem downstream if the restoration were designed with the objective (among others) of maximizing nutrient removal, so long as the resulting changes do not compromise MCCD's primary objective of restoring the area to approximately presettlement conditions.

Large open area south of Woodstock Commons Townhomes (1). Water here was clear but there is extensive filamentous algae and a mucky bottom in this channelized reach. Banks appeared to be stable. There is opportunity here to place cobble in the stream bottom at various points to create scour pools. The exact areas for riffle placement would need to be identified for maximum habitat benefit. For budgetary purposes, the riffles would be approximately $15,000 (assume 5 riffles at $3,000 each).

Figure 5-2. South of Woodstock Commons Townhomes.

Near Doty Road (2). The river in this area is a deeply-incised run within stable, well vegetated banks and with an extensive tree canopy. The bottom is comprised of sand and gravel along with some cobble. Some filamentous algae was present at the time of the field work. Opportunities here

[86] http://www.epa.state.il.us/water/permits/storm-water/general-ms4-permit.pdf, Part II.C.

[87] A stream barb is a rock structure that projects out from the bank to direct the stream current away from the eroding bank to the center of the channel. It provides habitat by increasing flow variability and, assuming the stream barb is vegetated, by increasing cover.

could include expanding riparian buffers if the area upstream of Doty Road and downstream to Lucas Road remains primarily cropland. Stream barbs or other in-stream enhancements also could be added to create channel diversity in this reach. Properly installed stream barbs[87] or similar enhancements run approximately $7,500 each, assuming good construction access.

The Land Conservancy of McHenry County will soon take title to more than a quarter mile of land on the south bank of the Kishwaukee directly across from property on the north bank owned by Centegra Hospital. Part of the hospital property is being marketed for development, and the Land Conservancy property borders an approved development which has not yet broken ground. The entire corridor is Houghton muck soil that could be restored to wetland condition, totaling 40–50 acres if tiles were removed. A tile survey and engineering plan would likely cost $20,000. Tile work and seeding would range between $50,000 to $120,000 on each side of the river.

Near Lucas Road (3). In this reach the river is deeply incised with stable banks and a well developed tree canopy. There is a well-developed riffle area on the downstream side of the Lucas Road bridge. Substrate includes sand, gravel, and cobble. There is not much that could or needs to be done in-stream to enhance conditions. From Lucas Road downstream to Rt. 176 the riparian corridor is primarily wooded providing a good buffer.

At Rt. 176 (4). The river is channelized but more open although a tree canopy is present in some areas. Flow was steady and clear, although some filamentous algae is present. There are opportunities for wetland restoration and enhancements on both the upstream and downstream sides of Rt. 176. Any restoration projects here could include re-meandering of the stream channel to flow through adjoining wetlands. The wetland area affected would be approximately 10 acres. A project to relocate the creek flow into the wetland area to prevent

Figure 5-3. Near Doty Rd.

Figure 5-4. Near Lucas Rd.

Figure 5-5. At Rte. 176

short-circuiting for enhanced water quality and habitat is estimated at $250,000. This budget assumes that excavated materials could be reused or stockpiled locally and would not have to be hauled off-site.

Tributary stream ¼ mile north of Rt. 176 at Mt. Tabor Road (5). The tributary is shallow and channelized with sluggish flow and mucky substrate. There is little opportunity in this area other than clearing of the extensive buckthorn understory to allow greater light penetration.

MCCD Lussky Property (6). At the point where the stream flows southwestward through a 220-acre property owned by the McHenry County Conservation District, there is could be opportunity for wetland creation and restoration adjacent to the stream in an area of what is now cropland, subject to the constraints identified in Section 4.1.5.3. The area for restoration could vary from approximately 30 acres to almost the entire property. With few complications, a drain tile survey and abandonment, seeding and initial management should be budgeted at $125,000 (roughly $4,000 per acre). However, more extensive engineering and hydrology review needs to be undertaken.

North of Ballard Road and south of Butternut Drive (7). There is the potential for improvement in the Butternut Preserve owned by the Crystal Lake Park District. Here the stream is ditched but stable and well vegetated with an extensive tree canopy. Stream barbs and cobble could be installed at strategic locations in the park to improve instream conditions and if there were sufficient funding the stream could also be restored to follow old meanders. The riparian area would also benefit from the clearance of buckthorn, Chinese elm, and honeysuckle. This site is publicly-owned and adjacent to a school. It would provide a good opportunity to showcase a restored section of the Upper Kishwaukee River. Instream enhancements should be budgeted at $50,000. Invasive tree clearing would cost approximately $32,000 ($4,000 per acre at 8

Figure 5-6. Tributary stream ¼ mile north of Rt. 176 at Mt. Tabor Road

Figure 5-7. North of Ballard Road and south of Butternut Drive

Figure 5-8. Near Haligus Road

acres).

Near Haligus Road (8). Upstream of Haligus Road the stream flows in a more meandered condition than in upstream reaches near Woodstock and Crystal Lake. The stream passes the Village of Lakewood WWTF, Turnberry Country Club, and large lot residential subdivisions. Downstream of Haligus Road, the stream flows fast and clear over a sand and cobble substrate. There are construction disturbances in the riparian corridor in this area although soil erosion measures are in place that appear to be functioning adequately. Streambanks are stable in this area. Possible improvements here include addition of boulders to create scour holes (approximately $2,500 for a medium sized project) and addition of large woody debris.

Near Woodbine Road (9). The stream widens in this area and has slower flow. Banks and stream bottom conditions are stable. Buffers are adequate and the corridor has a well developed tree canopy. There is not much to be done to improve conditions in this area other than maintaining buffer. As the stream moves westward toward Rt. 47 it passes through an area of active gravel mining north and south of Foster Road that includes several groundwater-fed lakes that were created by mining. It is not known what restoration has been planned for the mining area once extraction operations have ceased.

The Land Conservancy of McHenry County has accepted an easement for the wetland complex in the center of the Woodland Hills development just north of Woodbine Rd and west of Haligus. Restoration and maintenance of the wetland will be required, suggesting that a small amount of supplemental funding ($10,000) could improve conditions there.

At Rt. 47 (10). Here the stream is flat and rather nondescript. It is essentially a wooded ditch with slow flow and a mucky bottom. Opportunities for in-stream improvement are limited but it would be

Figure 5-9. At Route 47, potential wetland reconstruction project.

Figure 5-10. At Foster Road west of Rt. 47

Figure 5-11. Near North Union Rd.

useful to have an expanded riparian buffer beyond that provided by the immediate wooded area along the riverbank. There is an excellent opportunity to create/restore wetlands on poorly-drained cropland on the south side of the river on the west side of Rt. 47. The most obvious area for wetland restoration is approximately 17 acres, with a budget of $3,000 per acre ($51,000 total).

At Foster Road west of Rt. 47 (11). Stream is incised but stable as it flows through a narrow wooded corridor surrounded by croplands. Natural large woody debris provides structural diversity in the stream. A wider buffer area would be desirable here to further protect the stream from nearby agricultural operations. With an assumed corridor of 200 feet (100 feet on either side of the channel), approximately 30 acres of buffer is possible. Planting and initial management of the buffer areas should be budgeted at $3,000 per acre.

Near North Union Road west of Rt. 47 (12). Similar conditions to those at Foster Road. Buffer expansion would seem to offer the best option for improving conditions. Irrigation is practiced in this area and it is not known whether the withdrawals have an affect on river conditions during low flow periods. There appears to be a large drained hydric soil unit that could be restored to wetland near Foster Road and adjacent to the creek. At 90 acres of restoration potential, approximately $360,000 should be budgeted for the design and implementation of the initial planting work.

Near Mensching Road (13). In this area the river is a run with fairly strong flow. The river has been channelized but channel conditions are stable. Bank conditions also are stable and much of the streambank is wooded. Improvements here would center on installation of stream barbs and buffer expansion since the stream is surrounded by cropland. The area could benefit from 6 acres of buffer, at $18,000.

Figure 5-12. Near Mensching Road

Figure 5-13. Near Pleasant Valley and McCue Roads

Figure 5-14. At Franklinville Road

Near Pleasant Valley and McCue Roads (14). Here the stream continues to be channelized and flows through cropland and a large commercial nursery that extends from Pleasant Valley Road north to Rt. 176. Flows were sluggish in this reach during fieldwork. North of Pleasant Valley Road, the streambanks are open (not wooded) and some bank erosion is evident. Buffer expansion would be very desirable in this stream reach. Upstream (south) of Pleasant Valley Road, there is a narrow buffer between the stream and adjacent croplands that could be expanded until the environs become more naturalized upstream in the Pleasant Valley MCCD site. Approximately 18 acres of buffer would be desirable, at budget figure of $54,000.

Figure 5-15. Kunde Road to Near North Union Road to Millstream Road

At Franklinville Road (15). The stream is naturalized and meandered upstream of Franklinville Road and is a stabilized ditch for about 2,000 feet downstream of Franklinville Road before it becomes meandered again. Opportunity here consists primarily of buffer expansion (17 acres at $51,000) along unbuffered reaches bordered by cropland.

Table 5-2. Estimated costs and potential funding sources for habitat restoration projects

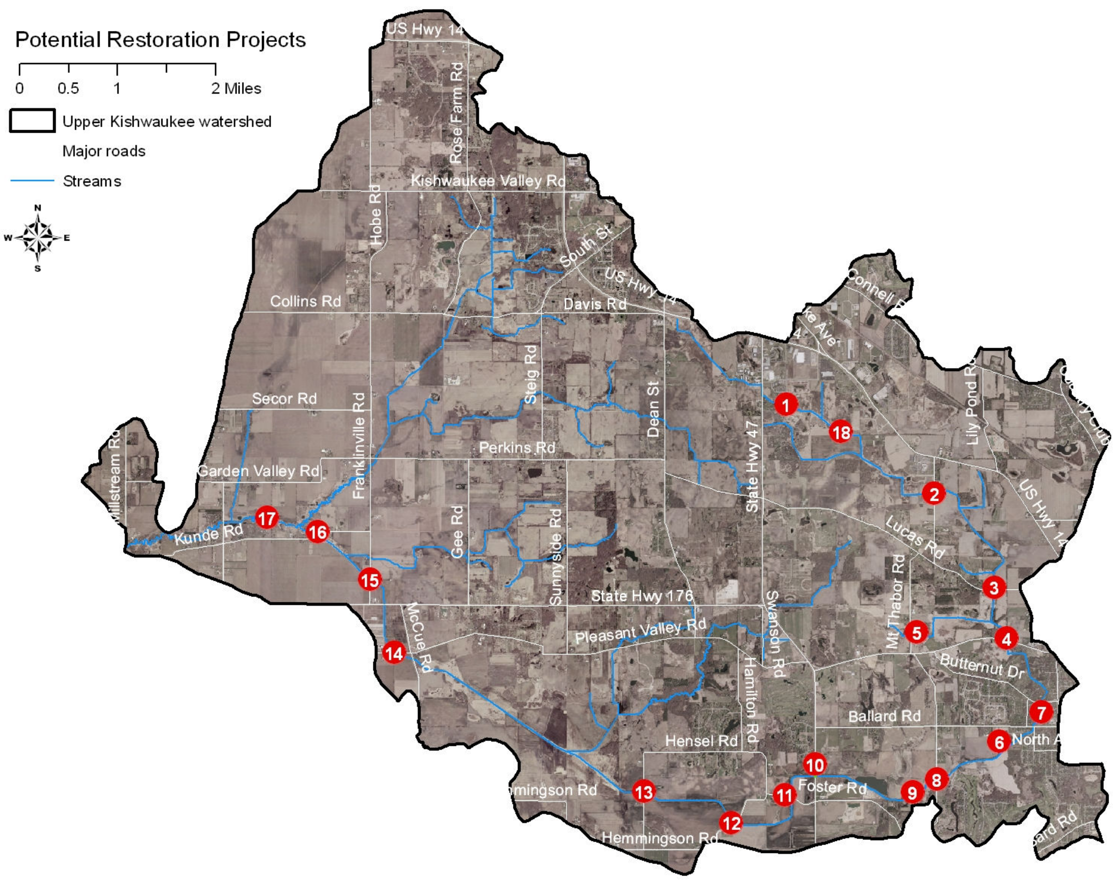
Locations	Proposed Project	Quantity	Unit	Cost	Funding source	Priority
1	Riffle installation	5	each	$15,000	C2000	2
2	Stream barb installation	3	each	$22,500	C2000	5
	Tile work, reseeding on TLC property	1	each	$120–260,000	319/WRF	“ “
3	(Limited opportunities)	—	—	—	—	—
4	Flow diversion to wetland area	1	each	$250,000	319	17
5	(Limited opportunities)	—	—	—	—	—
6	Wetland reconstruction	30–220	acres	$125–650,000	319/WRF	1
7	Stream barb and cobble installation	Varies	—	$50,000	C2000	3
	Invasive species clearing	8	acres	$32,000	C2000	9
8	Boulder clusters	1	proj	$2,500	C2000	4
	Addition of woody debris and planting			NE	C2000	“ “
9	Wetland maintenance	1	ea	$10,000	C2000	—
10	Wetland reconstruction	17	acres	$51,000	319/WRF	15
11	Stream buffer installation	30	acres	$90,000	CRP	11
12	Wetland reconstruction	90	acres	$360,000	319/WRF	8
13	Stream barb installation	3	each	$22,500	C2000	6
	Stream buffer installation	6	acres	$18,000	CRP	12
14	Stream buffer installation	18	acres	$54,000	CRP	13
15	Stream buffer installation	17	acres	$51,000	CRP	14
16	(Limited opportunities)	—	—	—	—	—
17	Acquisition/conservation easements	—	—	NE	OSLAD	16

NE = not estimated, WRF = Wetland Reconstruction Fund (see Section 4.4.2), OSLAD = Open Space Land Acquisition and Development Program, CRP = Conservation Reserve Program, 319 = Clean Water Act Section 319 grant program, C2000 = state Conservation 2000 program, now called Partners in Conservation

Kunde Road to Near North Union Road to Millstream Road (17). In this 2.5 mile stretch, the Upper Kishwaukee River fairly dramatically transitions from channelized agricultural stream to well-meandered, naturalized stream with ample buffers. The river flows steadily through good riparian habitat including wetlands and floodplain forest. There is not much to be done here other than placement of boulders to create scour holes in the predominantly sand substrate and preserving the buffers from intrusion. Given sufficient funds and cooperative sellers, public acquisition and management of this section of stream would be very desirable since all land ownership in this reach appears to be private. If fee simple acquisition proves infeasible, it may be possible to preserve riparian floodplain/wetlands in this reach via conservation easements.

Lake Avenue / US 14 area wetland acquisition and dechannelization (18). There is a large complex of wetland and drained hydric soils just south of US 14 and east of Lake Avenue, part of which has a sod farm on it. The stream through this area has been channelized to the extent that there is a 90-degree bend in the channel. The area is held by several different landowners. It could be purchased and converted into a flowing marsh, with the particular benefit that if designed correctly it could provide nutrient removal very close to the Woodstock South plant. Up to 300 acres of organic soils could potentially be acquired and restored.

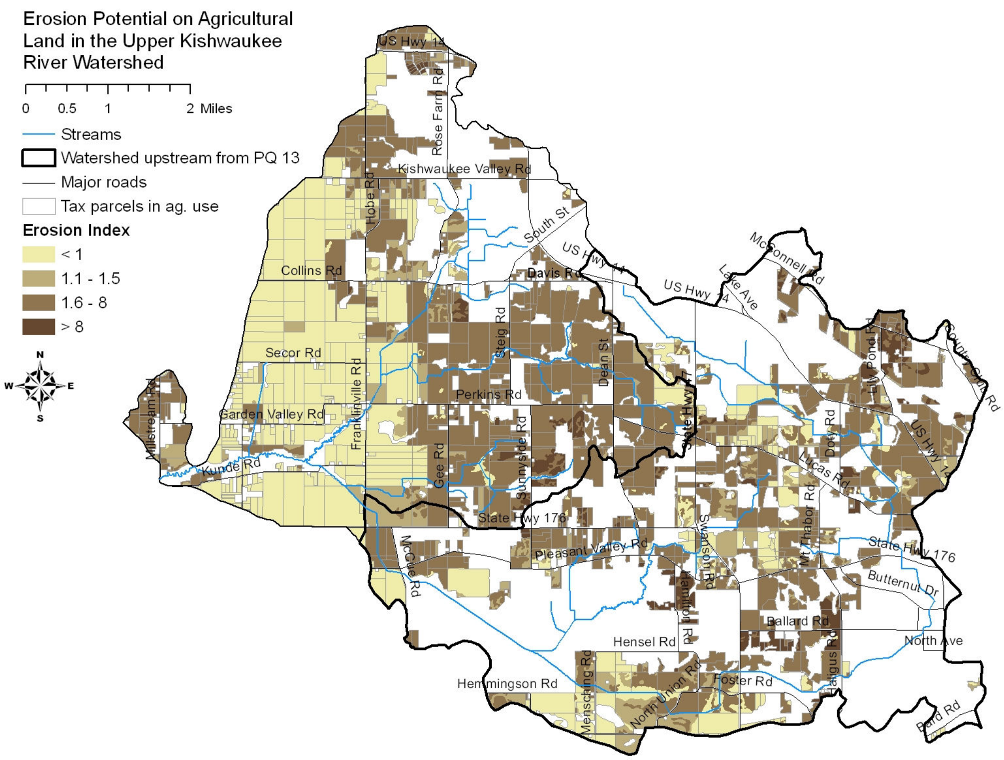
Figure 5-16.



5.3 Agricultural Best Management Practices

Agricultural best management practices (BMPs) are generally meant to limit soil loss from cropland and to reduce nutrient concentrations in runoff. Resource agents in McHenry, Boone, and Winnebago Counties identified a short list of the most effective BMPs, resulting in the recommendations in this chapter. Each BMP and its preferred location is discussed in the first section. The second section provides information on the programs recommended to fund BMP implementation as well as expected pollution reduction benefits. The recommendations in this section go beyond the watershed upstream of sample point PQ 13 as there clearly are opportunities for BMP installation in the Franklinville Creek watershed, which is heavily agricultural and is likely to remain so for the foreseeable future.

Figure 5-17.



Source: McHenry SSURGO, USGS 30 meter digital elevation model, McHenry County, CMAP 2005 land use inventory

5.3.1 CONSERVATION TILLAGE

As a means of protecting water quality, conservation tillage — any tillage practice that leaves at least 30 percent of the soil covered with crop residue between growing seasons — is one of the most effective strategies to apply to lands with higher erosion potential. In McHenry County, various forms of conservation tillage accounted for about 39 percent of farm acres planted with corn in 2004.[88] Although the erosion index[89] (Figure 5-17) can be used to prioritize fields for technical assistance for the adoption of conservation tillage methods, resource agency staff more commonly use slope (Figure 5-18). The results are generally similar, as both methods highlight the same areas. Any slope over 7 percent is considered highly susceptible to erosion. Agency personnel with the NRCS also target conservation tillage to farmland with slopes of 4 – 7 percent that are moderately susceptible to erosion. There are 1,902 acres of these fields in agricultural production. Which tillage practice is actually used on a given field varies from year to year, but if the proportion of fields *not* already in a form of conservation tillage in the watershed is the same as in the entire county (61 percent), then an additional 1,160 acres could be targeted for this practice.

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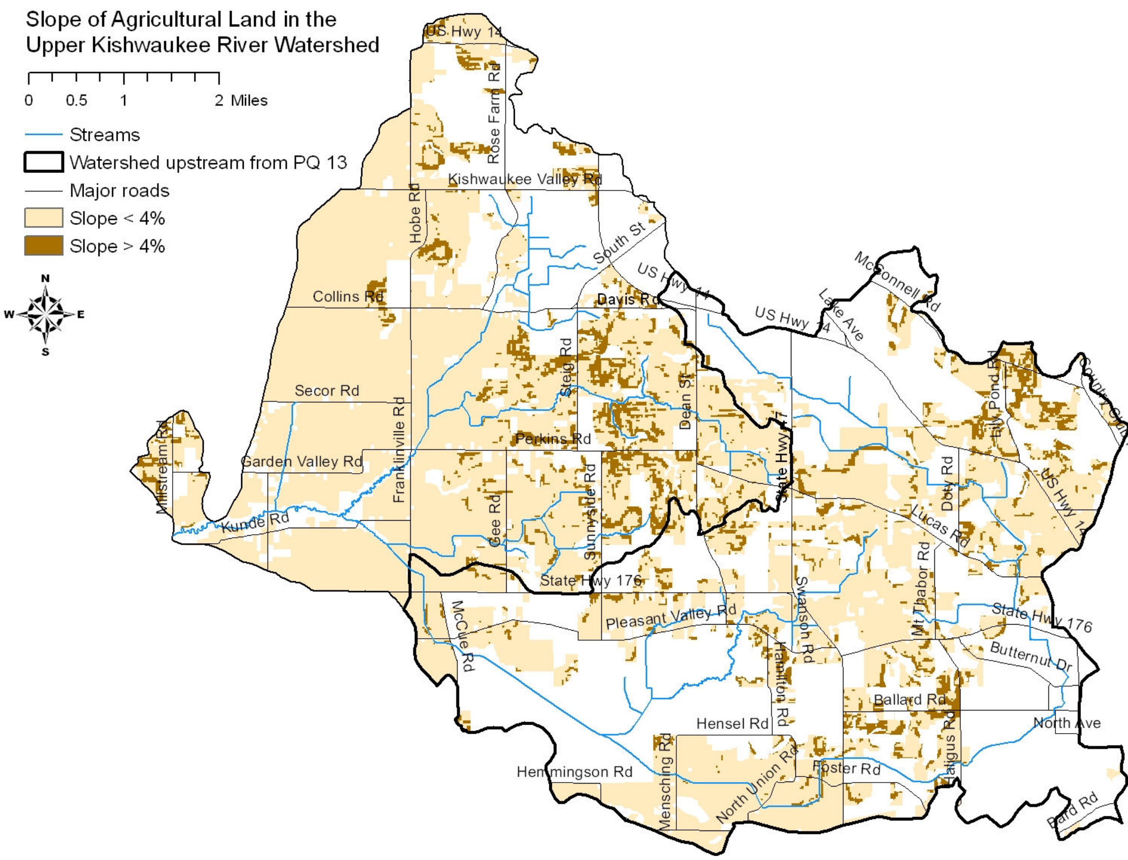
[88] Illinois Department of Agriculture. 2004. *Illinois Soil Conservation Transect Survey*.

[89] The erosion index = $R \times K \times LS \div T$, where T is tolerable soil loss and the other factors are those in the RUSLE equation (R = erosivity of rainfall, K = erodibility of soil, and LS is a combination of slope and the length of the slope). The erosion index gives the potential for soil loss without regard to land cover, the type of crop planted, or management measures. An erosion index value < 1 indicates that soil loss is less than the tolerable rate, while an index value > 8 (under certain conditions) triggers the Highly Erodible Lands provisions of the Farm Bill programs. See http://www.nrcs.usda.gov/Programs/compliance/index.html for more information.

Within just the portion of the watershed upstream from PQ 13, an additional 636 acres could be targeted for conservation tillage.

The main lever for increasing the use of conservation tillage in the watershed is targeted outreach to producers farming erodible soils by the NRCS and the McHenry County SWCD along with technical assistance. Also, the direct costs of implementing conservation tillage may be offset through the state Conservation Practices Program and through the federal Environmental Quality Incentives Program, either of which pay $20 per acre for nutrient management planning, capped at an $800 total payment. Agents at the NRCS office in McHenry County tend to promote the strip till form of conservation tillage — tilling strips where seeds will be planted and leaving area between rows untilled. No-till tends to keep the soil colder and wetter for longer into spring, which delays planting and may potentially decrease yields. In contrast strip till improves drainage and promotes warming. In general, strip till should leave about two-thirds of a field unplowed.

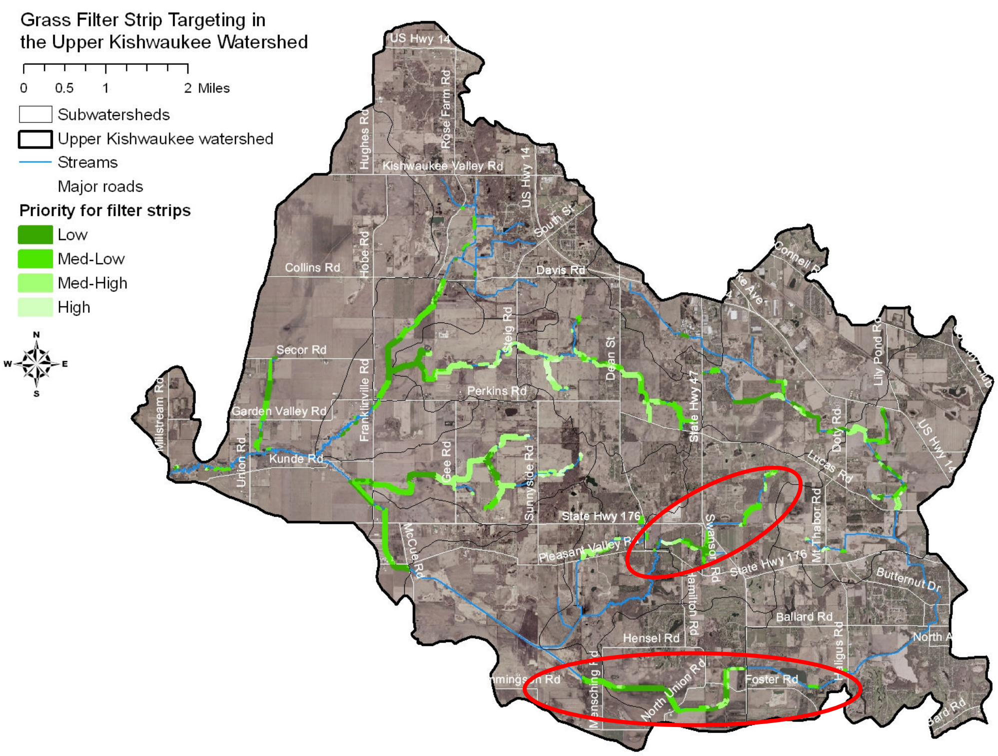
Figure 5-18.



Source: USGS 30 meter digital elevation model, CMAP 2005 land use inventory

There is an additional incentive for conservation tillage available through the Illinois Climate Change Initiative (ICCI) and the Chicago Climate Exchange (CCX). CCX is group of businesses and other organizations that voluntarily agree to reduce their greenhouse gas emissions (GHG) by 6 percent and do so by either changing their operations to emit less GHG or by purchasing credits equivalent to a reduction in GHG. Some of these credits (called "Exchange Soil Offsets" or XSOs) come from farmers who practice conservation tillage or who install filter strips. Conservation tillage is eligible as a credit because it decreases the rate of carbon loss from farm fields, and the monetary value of a credit is determined by its availability and the demand for it on the CCX, much like any other traded commodity. Because each of the XSOs is generally small, they are purchased by the Delta Institute (under contract with the producer) and aggregated into larger credits for resale on the CCX. As of mid-May 2008 the value of the credit itself was about $2.70 per acre after program costs. The producer contracts directly with the Delta Institute,[90] but the SWCD can assist by helping farmers understand the program and fill out the forms. As of February 2008, no contracts had been signed in McHenry County. It is recommended that SWCD staff market the ICCI program in addition to the more familiar federal programs. A question and answer document for Illinois SWCDs has also been provided by the Illinois Climate Change Initiative.[91] While the value of an XSO is low as of 2008, it is expected to rise in value in future years as the importance of climate change mitigation strategies becomes more evident.

Figure 5-19.



5.3.2 AGRICULTURAL FILTER STRIPS

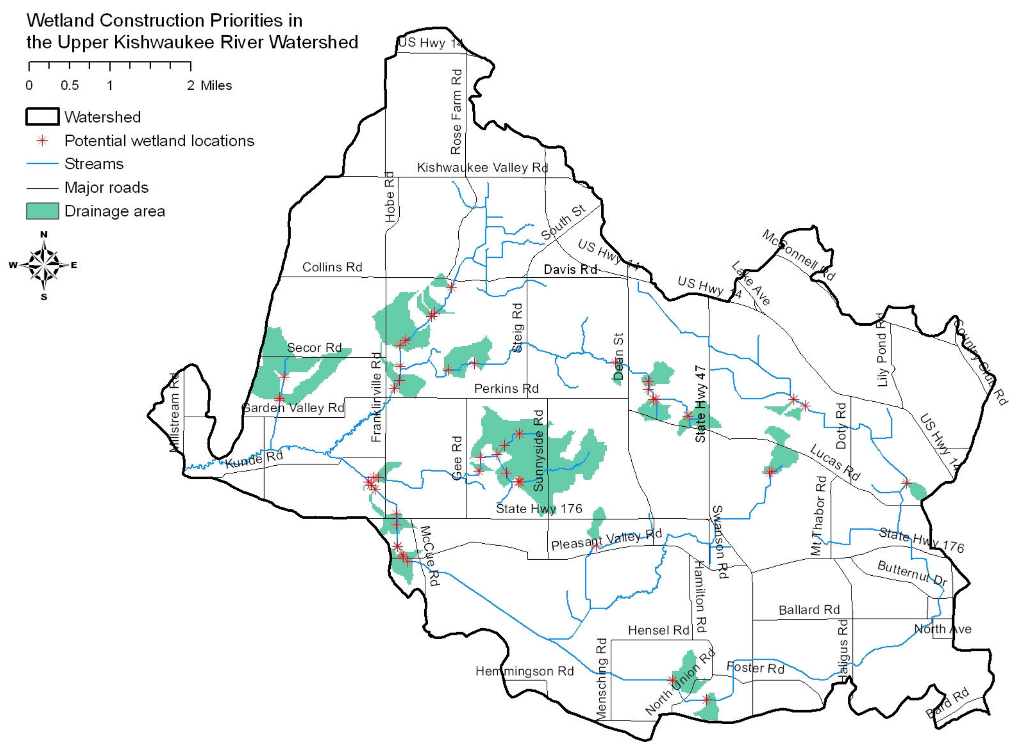
Grass or forest buffers are installed along streams in order to intercept and filter sheet flow from cropped areas. This practice was targeted to agricultural lands where the vegetation within the 100 foot stream corridor is inadequate, as discussed in Section 2.1.3.3. Priorities were then set by determining whether currently inadequate buffer is on tax parcels with high erosion potential, as indicated by the erosion index. Figure 5-19 shows the results. No distinction was made between forest and grass buffers, as we expect a decision between the two to be made based on the preferences of the farmer and the advice of the natural resource agent. Within the watershed upstream of PQ 13, the most important places to target are the area just east and northeast of the Pleasant Valley Conservation area, as shown in red in Figure 5-19. Approximately 50 acres are needed in this area. Buffering along the stream in the other major area of

[90] The documents are at http://illinoisclimate.org/contracts.php
[91] See http://illinoisclimate.org/documents/SWCDFAQ.pdf

need near Woodstock and Crystal Lake can probably be most inexpensively accomplished during development through the buffer requirements in the stormwater ordinance.

There is a practical problem with agricultural filter strips: installing them takes land out of production, reducing yield, and high commodity prices, especially corn, make the practice unattractive to some farmers. While the conservation "problem" of high returns to cropping cannot be surmounted, it can be shown (Section 5.3.5 below) that farmers would pay nothing or make a modest bonus for enrolling in conservation programs to install filter strips. This is because the federal programs provide a number of incentive payments and a signing bonus for filter strips in addition to cost-share payments and soil rental. Also, the Illinois Climate Exchange Initiative accepts filter strips as carbon credits, with a value in mid-May 2008 of $4.51 per acre after program costs.

Figure 5-20.



There is an additional incentive for filter strips that is available through the state. Land on which vegetative filter strips are installed is assessed at one-sixth of its assessed value as cropland.[92] The program is run through McHenry County Soil and Water Conservation District. One of the biggest problems in instituting agricultural BMPs in McHenry County is the prevalence of cash rent farmers and absentee owners. The operators in this case see limited value in installing BMPs since they typically have one-year leases; they have little reason to plan for the long-term productivity of the land since they do not own it or have a longer-term lease on it. Owners are not very involved in the management of their land, and taking land out of production with filter strip contracts may make the land less marketable to cash renters. The tax incentive may help somewhat in this situation because it can only go to the taxpayer and may be a tool to help convince owners, if they can be identified and reached, that conservation programs are important and worthy.

[92] See http://dnr.state.il.us/OREP/C2000/Incentives.htm#VFSA

5.3.3 NUTRIENT MANAGEMENT

All cropland could potentially benefit from improved nutrient management, but to be strategic in controlling nutrient runoff in this watershed the practice could be targeted to areas where other BMPs are not. This would be to the flatter, less erodible areas of the watershed, such as all cropland with an erosion index value of less than one, i.e., where predicted erosion is less than the tolerable rate. There are 1,508 acres of land under the tolerable rate of erosion (averaged by tax parcel) in the watershed upstream from PQ 13. The main selling point for nutrient management planning is the savings in fertilizer inputs. However, there is an upfront cost, paying for soil tests, which are ideally carried out by taking samples in a grid pattern with each cell 2.5 acres (but not more than 5 acres). This is offset through the state Conservation Practices Program and through the federal Environmental Quality Incentives Program, either of which pay $20 per acre for nutrient management planning, capped at an $800 total payment.

5.3.4 WETLAND CONSTRUCTION IN AGRICULTURAL AREAS

Wetland construction using U.S. Department of Agriculture programs would occur only on farmed hydric soils, that is, a hydric soil in an agricultural area without an existing delineated wetland. It is important to note that wetland construction in this instance is being targeted to lands in agricultural production to take advantage of Farm Bill programs. The draft, unreleased CMAP land use inventory for 2005 was used to define agricultural areas, while the 1999 McHenry ADID study provided wetland locations. Actual locations for wetland reconstruction were determined strictly based on potential for water quality benefits. The predicted locations of accumulated flow, which approximate drain tile alignments and first order streams, were followed to the point where they intersect delineated streams. A subset of these tile outlets and first order stream confluences are within farmed wetlands, and for these points the contributing drainage area was determined (Figure 5-20). Using the rule of thumb that a 1:100 ratio of wetland area to drainage area is required for effective treatment we estimate the resulting potential acreage of wetland construction at 21 acres, treating 2,100 acres of cropland. Within the watershed upstream from PQ 13, however, the opportunities are estimated at approximately five acres.

5.3.5 COSTS AND LOAD REDUCTIONS

Table 5-3. Estimated annual load reductions from agricultural BMPs

	Wetland construction	Nutrient Management	Strip-till	Filter strips	Total
Acres installed	4.7	1,508	636	50	
Acres treated	472	1,508	636	600	
Nitrogen (lb/y)	1,831	3,656	5,654	6,789	17,930
Phosphorus (lb/y)	374	871	472	743	2,460
Sediment (t/y)	145	0	204	167	516

Source: removal efficiencies for strip-till and filter strips from STEPL; wetland construction from National Pollutant Removal Performance Database, v3; nutrient management from USEPA *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*

Table 5-4. Estimated costs for agricultural BMPs

Conservation Practice	Ac	Pro-gram	Avg cost / Ac [93]	Capital cost	Cost share	Soil rental /ac[94]	XSO /ac[95]	Total pay-ments to farmers	Total cost to farmers or (savings)
Filter strips[96]	50	CRP	$260	$13,000	90%	$89	$4.51	$10,566	($9,266)
Wetland constr.[97]	5	CRP	$4,100	$20,500	90%	$89		$1,034	$1,016
Strip till	636	CPP	$20	$12,720			$2.70	$14,437	($1,717)
Nutrient mgt plans	1,508	CPP*	$20	$30,160				$30,160	$0
Total	2,199			$76,380				$56,197	($9,967)

Notes: CPP - Conservation Practices Program - State Department of Agriculture; EQIP - Environmental Quality Incentives Program – USDA; CRP - Conservation Reserve Program – USDA. * EQIP will also fund this practice

5.3.6 AGRICULTURAL BMP COORDINATOR

This plan is not proposing new conservation programs or new funding sources per se; it is describing the BMPs needed and recommending funding sources to use to implement them. All of these funding sources are available to farmers now but have not been employed to the extent they could be, whether because they are not designed for tenant farmers or scaled to match current economic conditions. This is because implementation depends ultimately on the willingness of the farmer to implement conservation practices and because the SWCD and NRCS offices do not have the capacity to conduct targeted marketing to potential implementers. The resource agencies respond to requests by producers for federal and state assistance but do not campaign for the use of the programs. Therefore an agricultural BMP or conservation coordinator position is proposed. The purpose of the position is to market Farm Bill and other programs directly to farmers in the watershed. Ideally the person selected would be a retired or semi-retired farmer who is able to speak from experience on the implementation of BMPs and who is familiar with potential objections to their use. The position would probably pay in the neighborhood of $40,000 per year with fringe. To maximize the value of the position, the coordinator should work in all three watersheds of the Kishwaukee for which CMAP and KREP have developed plans, plus other areas in the basin as opportunities arise. The SWCD offices in McHenry and Boone Counties could provide an office and potentially a vehicle for the coordinator as part of match for grant funding. The recommended grant sources are Section 319 and C2000 funds. The most appropriate applicant for the funding would be the Kishwaukee River Ecosystem Partnership. This coordinator could also assist interested farm owners in the county's effort to access federal farmland protection funds and implement agricultural preservation easements.

5.4 Schedule for Implementation

The following is a generalized schedule for implementing the *Upper Kishwaukee River Watershed Plan*. It is based on the expectation that the plan will be updated starting five years after adoption.

[93] Average cost for no-till and nutrient management planning is considered to be equal to the payment of $20 /ac, capped at $800. This appears to cover costs and perhaps yield a slight incentive according to statistics in USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* EPA 840-B-92-002. Retrieved from: http://www.epa.gov/nps/MMGI/Chapter2/ch2-2c.html

[94] Average soil rental rate for soils in Upper Kishwaukee

[95] XSO = Exchange Soil Offset from Illinois Climate Change Initiative/Chicago Climate Exchange. Payment based on market value of $6.34 per metric ton (May 15, 2008) using http://illinoisclimate.org/conservationcalculator.php

[96] Notes: the following incentives apply to filter strips and wetland construction: SIP -Stewardship Incentive Payment - 20% bonus on average Soil rental rate; PIP - Practice Incentive Payment - 90% cost share to establish practice; SP - Signing Bonus - One time Payment of $100 × the number of acres enrolled.

[97] Shallow water wetland estimated 5 acre area with 1 ft soil removed at $2.35/yard and 100 per acre seeding.

Table 5-5. Schedule for implementing recommended actions

Year	Action	Party	Section
2008	Conduct study to determine extent to which nutrient removal should be part of Pleasant Valley marsh restoration design	MCCD	4.1.5.1
	Approval of Woodstock South expansion*	Woodstock/IEPA	—
	Begin monitoring nitrogen in wastewater	WWTPs	6.1.2
2009	Submit applications for funding for agricultural BMP coordinator	KREP/SWCDs	5.1.5
	Begin physical-chemical monitoring program	IEPA/ISWS	6.1.1
	Implement phosphorus ban in Kishwaukee basin	Municipalities/county	5.2.2
	Submit applications for priority 1 & 2 restoration practices	Landowner/KREP	5.3
	Establish Wetland Reconstruction Fund	Municipalities/county	4.4
2010	Agricultural conservation coordinator hired and begins work	KREP/SWCDs	
	Hold site planning roundtable to review ordinances for water quality effects and recommend amendments	Municipalities/county	2.3.1.2
	Expanded Woodstock South plant begins operation*	Woodstock	—
	Submit applications for priority 3 & 4 restoration practice	Landowner/KREP	5.3
	Model development projects undertaken	Municipalities/county	4.2.2
	Begin biological monitoring program	MCCD	6.1.3
2011	Model development projects undertaken (con't)	Municipalities/county	4.2.2
	Submit applications for priority 5 & 6 restoration practice	Landowner/KREP	5.3
2012	Begin water quality model calibration and validation	ISWS	6.1.1
	Submit applications for priority 6 & 7 restoration practice	Landowner/KREP	5.3
	Completion of Pleasant Valley marsh restoration*	MCCD	4.1
2013	Begin plan update	IEPA/KREP/CMAP	—

CMAP = Chicago Metropolitan Agency for Planning, IEPA = Illinois Environmental Protection Agency, ISWS = Illinois State Water Survey, MCCD = McHenry County Conservation District, SWCD = Soil and Water Conservation District

Note: all projects subject to landowner commitment
* assumed for purposes of planning

5.5 Information and Education

The watershed planning process, commencing in April 2007 and ending in September 2008, was instrumental in accomplishing the information/education component of a watershed-based plan. Stakeholders including landowners, nongovernmental-organization staff, and municipal staff were consistent participants during meetings throughout the 18-month planning process that culminated with the Upper Kishwaukee River Watershed Plan.

Additionally, an agricultural BMP coordinator is proposed in Section 5.3.6. This individual will make personal contact with landowners throughout the watershed and promote the benefits of land-conservation practices to landowners, water quality, and the overall environmental health of the watershed alike. These discussions will naturally entail dissemination of information and lead to an increase in awareness of watershed-plan objectives among the many landowners contacted.

Furthermore, it is reasonable to expect that the Kishwaukee River Ecosystem Partnership (KREP) will play an important role in encouraging and facilitating the flow of information and educational activities. KREP has for many years been involved in such activities regarding watershed resources and stewardship. KREP will maintain the database of natural resources that it uses to promote awareness among watershed residents and will hold training sessions for local government officials on the use of the database. KREP will also continue to lead tours throughout the Kishwaukee River Basin to share information with local decision-makers about best management practices to maintain or improve water resources. KREP will prepare a plan for outreach and education specific to the recommendations and needs identified in the watershed plan. Regular reviews of plan implementation status, a recommendation found in Section 6.2, will serve as an additional forum for information and education.

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6. METRICS FOR EVALUATION

6.1 Monitoring Program

6.1.1 PHYSICAL-CHEMICAL DATA COLLECTION AND MODELING

The data available for the Upper Kishwaukee are inadequate to calculate watershed loading or water quality response with acceptable accuracy. Because of this the loads and targets described in Section 2 should be considered provisional. It is recommended that Illinois EPA lead an effort — with partners such as the State Water Survey, a university, CMAP, the municipalities, IDNR — to collect additional data and develop such a water quality model. The study objectives are as follows. First, additional samples of total nitrogen, total phosphorus, and total suspended solids should be collected with optimal spatial resolution. Second, a water quality model (e.g., HSPF, QUAL2K, etc.) should be calibrated and validated using the data, so the frequency of sampling, additional constituents monitored, and length of the sample program should be adequate to do so. It may be necessary to provide a weather station as well. Third, the study should determine monthly and annual loads of total nitrogen, total phosphorus, and total suspended solids as well as the frequency and amount by which concentrations exceed criteria and determine more precisely the reduction in loading necessary to meet the criteria.[98]

Approximately 18 ~ 24 samples per year for about four years are recommended for nutrients and sediment at the site of Illinois EPA station PQ 13 (Pleasant Valley bridge near McCue Road). In situ measurements of temperature, pH, and dissolved oxygen should also be taken for use in modeling. The sample design should include sampling during both high and low flows to get an adequate representation of the distribution of flow and concentration. Flow measurements are also needed from a stage-discharge stream gaging station.[99] However, this still leaves much of the watershed unmonitored. It is therefore recommended either that the same sampling regime also be applied at Union Road on the main stem, which would account for flow and loading from the Franklinville Creek subwatershed, or that it be applied only at Union Road. While having only one sampling/gaging station would certainly save resources, the tradeoff from having the station at Union Road is that there would be no sample continuity with the site Illinois EPA uses for 305(b)/303(d) purposes. Because sedimentation is one of the causes of impairment, it will also be necessary to take cross sections of the channel, about 1 ~ 2 per year over four years, to determine the rate at which sediment is accumulating. Sedimentation can then be related back to watershed loading with a level of accuracy that is at least an improvement over the present state of information. Planning-level cost information has been provided by the Illinois State Water Survey for such a sampling program (Table 6-1) based on the three watersheds in the Kishwaukee basin for which plans are being developed b y CMAP and KREP. The cost for the Upper Kishwaukee would be roughly $165,000 assuming no economy of scale.

Table 6-1. Estimated cost of monitoring for three watersheds in the Kishwaukee basin

	Year 1	Year 2	Year 3	Year 4	Project	**Total**
Personnel						$234,497
Field Staff	$35,000	$36,050	$37,132	$38,245	$146,427	
Data Managemnt	$10,833	$11,158	$11,493	$11,838	$45,321	
Project Manager	$6,941	$4,766	$4,909	$5,056	$21,672	
cross-section survey (1/yr)	$9,270	$3,820	$3,935	$4,053	$21,077	
Totals	$62,044	$55,794	$57,468	$59,192	$234,497	
Fringe	$22,094	$19,868	$20,464	$21,078	$83,504	$83,504

98 By this time the Illinois Pollution Control Board may have adopted nutrient standards. It should be evident from the discussion in Section 2 that nutrient control is an emerging area of water quality regulation in Illinois and in many other states.

99 A stage-discharge stream gaging station is able to show the relationship between the vertical height of the gage and stream flow (i.e., stream discharge) at a particular time. Flow can then be inferred from gage height readings.

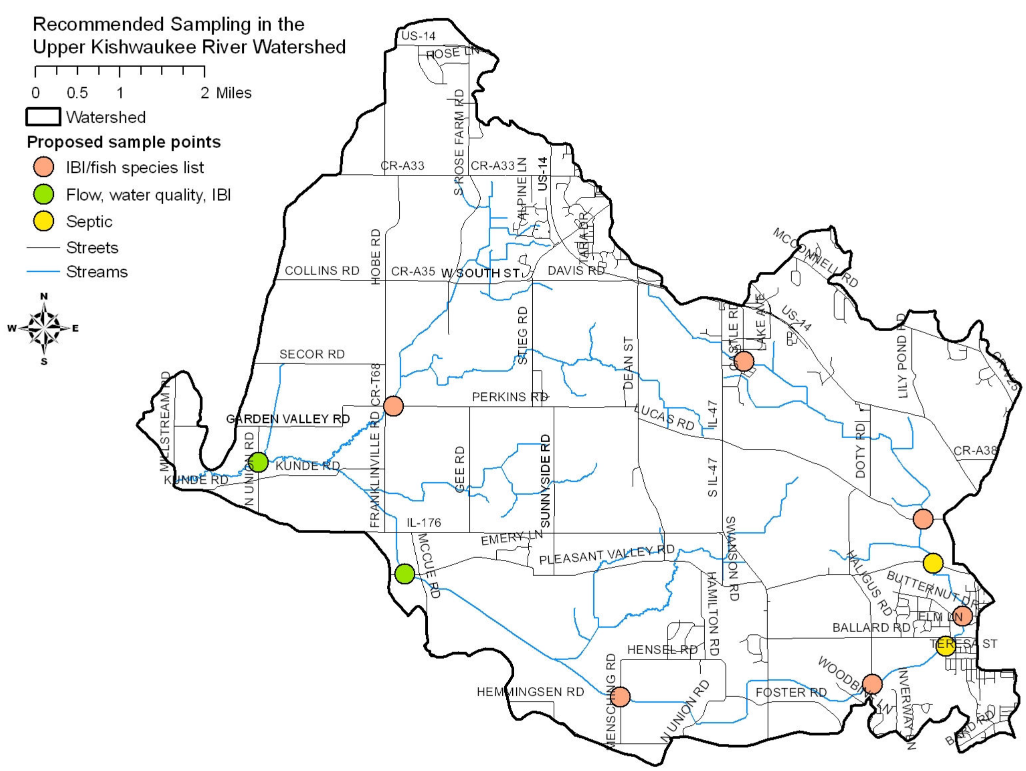
	Year 1	Year 2	Year 3	Year 4	Project	Total
Equipment	$28,500	$500	$525	$551		$30,076
Gage incls pump sampler ($7600)						
CSI Weather Station ($5700)						
Supplies	$2,000	$500	$525	$551		$3,576
Travel	$1,000	$200	$200	$200		$12,364
cross-section survey (1/yr + setup)	$5,200	$1,800	$1,854	$1,910		
Op Auto	$4,348	$2,274	$2,388	$2,507		$11,517
Contractual	$7,700	$8,085	$8,489	$8,914		$33,188
LabAnalyses (24/yr:100/samp)						
Telecomm	$600	$600	$600	$600		$2,400
Subtotal						$411,122
F&A						$82,224
Grand Total	$160,183	$107,545	$111,015	$114,603		**$493,347**

Source: Illinois State Water Survey

6.1.2 DISCHARGE MONITORING REPORTS

As noted in Section 4, the wastewater treatment plants do not monitor total nitrogen. Lakewood is required to monitor total phosphorus as part of the phosphorus limit in its permit, and Woodstock will be required to do so after the South plant is expanded. It is recommended that both plants monitor and report total nitrogen as part of a study partnership with Illinois EPA and the State Water Survey. In this case the municipalities' contributions could also be considered local match.

Figure 6-1.



6.1.3 BIOLOGICAL MONITORING

Since the ultimate measure of the plan's success is the Index of Biotic Integrity, it must be determined whether IBI scores are improving or not. While sampling has been fairly frequent and well distributed spatially in the past few years, this is the happenstance result of a number of different organizations conducting sampling according to their own interest or because of one-off study needs. It is recommended that a reliable program of regular future biological monitoring be instituted. Because the McHenry County Conservation District has the equipment to conduct IBI studies and is located nearby, it is recommended that Illinois EPA provide funding for MCCD staff to undertake IBI measurements once per two to three years, potentially at the sites recommended in Figure 6-1.[100]

There is also a place for volunteer efforts in biological monitoring, although it will not be possible for them to generate IBI scores because of the special equipment needed. There is one historic Riverwatch[101] site on the main stem. It would be desirable to expand the amount of monitoring performed by volunteers, both for the resulting data and for the sense of stewardship it helps sustain. McHenry County College could be a partner in such an effort, particularly if such monitoring became a curriculum component in, for example, an environmental science class. The most important information for a volunteer monitoring effort to generate is Macroinvertebrate Biotic Index (MBI) scores, as the MBI is the other score by which Illinois EPA determines impairment.

6.1.4 SEPTIC SYSTEMS

It is possible that septic systems are significant contributors to nutrient loading, but this cannot be said without further study. Most of the septic systems in the watershed are located in the unincorporated area between Lakewood and Crystal Lake. Some of this is older estate housing and some is older, moderate density cottages. One possible sample design would be to sample at Route 176 above both areas, at Ballard Road downstream from the estate housing, and at the cul-de-sac on Georgine St, or from a point on the Lussky Marsh property, downstream of the cottage neighborhood.

6.1.5 FECAL COLIFORM MONITORING

As discussed in Section 3, primary contact is probably the use most threatened by urbanization. Therefore it is recommended that Illinois EPA collect fecal coliform samples at PQ 13 during its next Intensive Basin Survey in the Kishwaukee basin. In addition, local efforts should be made to collect fecal coliform at various sites on the stream and tributary system. This can be led by Openlands, which has identified perhaps twelve sites to monitor eight times per year in May through October.

6.1.6 WETLAND NUTRIENT REMOVAL

Because of statewide and national interest in the effectiveness of wetland reconstruction in nutrient removal, especially given the contribution of nitrogen in the Mississippi basin to the hypoxic zone in the Gulf of Mexico, it is worthwhile to establish a monitoring regime for the major wetland reconstruction projects discussed in this plan, Pleasant Valley and Lussky. This should be accomplished using external grants, potentially from private foundations.

[100] Sample points are shown at road crossings as access points, but IBI measurements would be taken well away from the bridges to avoid anthropogenic effects. In the higher reaches of the stream (< 10 feet wide), it may not be possible to compute an IBI score; in this case a species list can be made.
[101] This program is not being funded by DNR anymore but does carry on as a local initiative in some places.

6.2 Milestones for Plan Implementation

The milestones for tracking whether plan recommendations are being achieved are the activities described in the schedule in Section 5.5. The municipalities in the watershed are required to submit to Illinois EPA annual reviews of their stormwater management programs under the NPDES general permit for municipal separate storm sewer systems (MS4s).[102] It is recommended that the municipalities report on their progress toward plan implementation in these annual reviews. For all other plan recommendations, the Kishwaukee River Ecosystem Partnership would be relied upon to track implementation progress, again using the schedule in Section 5.5.

6.3 Ensuring Load Reductions Are Being Achieved

Three criteria will be used to determine whether loading reductions are being achieved over time and whether progress is being made towards attaining water quality objectives. First, the water chemistry monitoring scheme proposed as a watershed plan recommendation will generate data at a much improved resolution across both space and time. This data collection effort will enable an analysis of the efficacy of plan recommendations as they manifest in changes or trends in ambient water quality. Secondly, monitoring and reporting nitrogen concentrations in effluent by the municipal wastewater treatments will significantly improve our ability to determine the effectiveness of planned nitrogen-removal technologies and loads over time from these point source dischargers. Thirdly, biological sampling as recommended above is a critical component for judging the efficacy of watershed plan recommendations. It is expected that the expertise present at the McHenry County Conservation District can be taken advantage of to measure IBI scores on a yearly basis in order to track progress towards improving water quality.

[102] http://www.epa.state.il.us/water/permits/storm-water/general-ms4-permit.pdf, Part IV.E.1

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