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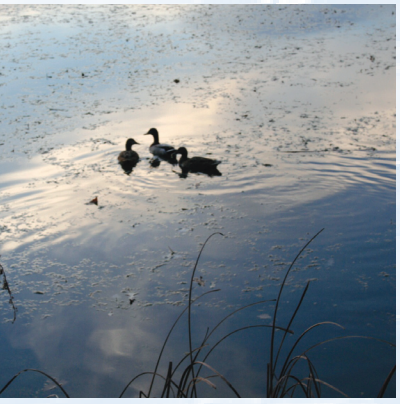
Beaver Creek Watershed Action Plan

Technical Report




September 2008

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The planning process was coordinated by CMAP and KREP. Contributions to the plan include Jesse Elam, Kristin Heery, Lori Heringa, and Tim Loftus of CMAP, Mike Foutch of the Boone County Soil and Water Conservation District, and Dan Kane of the Boone County Conservation District; the latter two organizations are members of 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 the planning process. The authors especially thank numerous landowners along Beaver Creek, elected officials of the Village of Capron and Village of Poplar Grove, staff from the Belvidere-Boone County Planning Department and USDA Natural Resources Conservation Service.

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 Beaver Creek 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

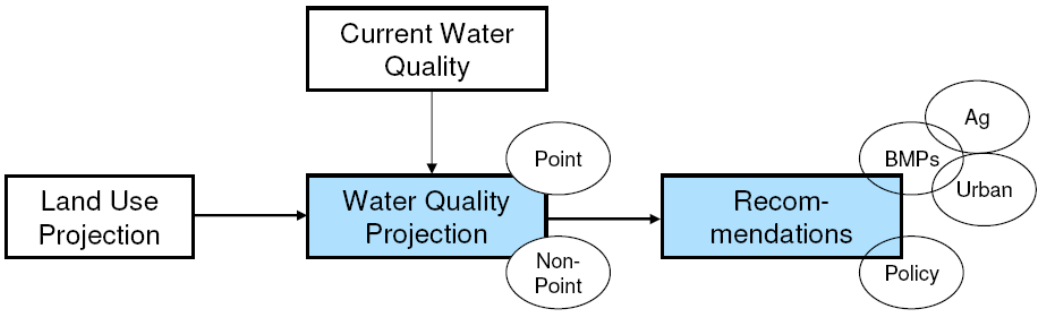
1.1 Purpose

The Beaver Creek Watershed (Hydrologic Unit Code 0709000604) is located in Boone County, northeastern Illinois. Beaver Creek is a mostly rural watershed dominated by agricultural land use in the upper reaches (>90%) while the lower portion of the watershed features a more mixed land-use pattern that is increasingly becoming more urbanized.

Beaver Creek, including both the upper and lower sections as well as the tributary, Mosquito Creek (now renamed *Meander Creek*), is not presently identified as impaired by Illinois EPA for any of its designated uses[1]. It has not been badly degraded by agriculture, urbanization, or wastewater treatment plant discharges, but it has been affected. The Kishwaukee River Ecosystem Partnership (KREP) has identified hydromodification and poor riparian corridor conditions as impacts on water quality and attendant aquatic resources. Additionally, sedimentation, nutrient enrichment, and fecal coliform pose threats to water quality.

Projections in this Beaver Creek Watershed Action Plan (BCWAP) suggest some conditions will worsen without protective actions in response to expected land-use change and increased loading from wastewater treatment plants. The goal of the BCWAP is to protect a healthy aquatic community currently found in the watershed. In more precise language, it is to ensure that the stream remains in full attainment of its aquatic life designated use as tracked by the fish Index of Biotic Integrity. The recommendations offered below focus on enhanced implementation of agricultural best management practices and new policy recommendations aimed at both county and municipal levels of government. A conceptual model of the process is shown in Figure 1-1.

Figure 1-1. Conceptual model of planning process in the Beaver Creek Watershed



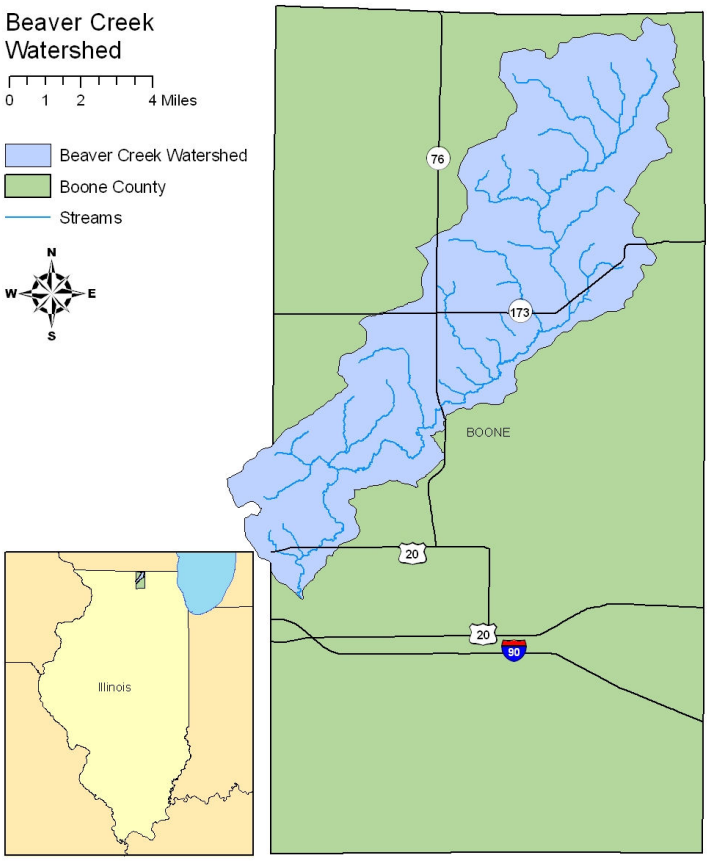
1.2 Study Area

The Beaver Creek Watershed encompasses approximately 70 square miles and dominates the central third of Boone County with a stream network that generally flows from the northeast to the southwest. The Village of Poplar Grove (population of 3,869 according to U.S. Census 2007 estimate) and Village of Capron (population of 1,497 according to U.S. Census 2007 estimate) are the primary municipalities in the watershed. Candlewick Lake is a relatively large unincor-

[1] Illinois Integrated Water Quality Report and Section 303(d) List – 2006. Illinois EPA, Bureau of Water. IEPA/BOW/06-002

porated community that is home to approximately 7,300 people. The stream itself is a medium gradient, 4th order stream. The Upper Beaver Creek subwatershed has been more heavily channelized than the Lower Beaver Creek subwatershed, but in both areas the degree of channelization is below the average of all Kishwaukee River Basin watersheds. More detailed descriptions of the watershed features can be found in early versions of subwatershed plans developed by KREP[2]

Figure 1-2.



Source: CMAP

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[3] 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, at a minimum, contain the following nine elements:

(a) An identification of the causes and sources that need to be controlled to achieve pollutant load reductions estimated in this plan;

[2] The Upper Beaver Creek Subwatershed Plan and Lower Beaver Creek Subwatershed Plan, both prepared by KREP, May 2005, are available at: http://krep.bios.niu.edu/

[3] Federal Register / Vol. 68, No. 205 / Thursday, October 23, 2003 / Notices. Environmental Protection Agency [FRL-7577-6] Nonpoint Source Program and Grants Guidelines for States and Territories. Pp. 60653-60674.

(b) An estimate of the load reductions expected for the management measures described under (c) below;
(c) A description of the non-point source management measures that will need to be implemented to achieve the load reductions estimated under (b) above;
(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;
(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;
(f) A schedule for implementing the non-point source management measures identified in this plan;
(g) A description of interim, measurable milestones for determining whether non-point source management measures or other control actions are being implemented;
(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
(i) A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) above.

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.[4] 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 source pollution both now and in consideration of expected watershed change. The B-MAG also produced a framework for a watershed plan, as given in Table 1-1,[5] which was used for the overall organization of the plan. However, the major relevance of the B-MAG framework is that Illinois EPA is expected to make permitting and financial assistance consistent with the watershed action plan, pending adoption by local governments and a public comment period.[6]

Table 1-1. Framework for a Basinwide Planning and Protection Pilot

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

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

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.

1.4 The Planning Process

The planning process in the Beaver Creek Watershed was designed to be stakeholder driven and inclusive of citizens and elected officials alike. Meetings were co-facilitated by staff from both CMAP and the Boone County Soil and Water Conservation District. While each meeting had an agenda, the format for discussion was interactive and informal. Meeting location changed from month-to-month in an attempt to move around the watershed and offer convenience for all watershed residents to attend.

Watershed planning was launched with a well-attended meeting in April 2007. Six additional stakeholder meetings were conducted during 2007 and stakeholders met four more times in 2008. Thus, a total of eleven stakeholder meetings took place over the eighteen month planning period. Participation was generally very good and diverse including a number of landowners and officials who regularly attended the meetings. Meetings were consistently held at night, generally from 7:00-9:00 p.m., and it is thought that nighttime meetings were helpful with attracting watershed residents and landowners whose jobs are unassociated with resource planning and management.

A compendium of meeting agendas and attendee sign-in sheets is included in Appendix D.

2. INVENTORY AND ASSESSMENT

2.1 Designated Uses and Biological Conditions

2.1.1 OVERVIEW

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 Beaver Creek, but only one has been assessed for attainment – Aquatic Life – by Illinois EPA.[7] The Illinois EPA determined that Beaver Creek was Fully Supporting the Aquatic Life designated use and thus, Beaver Creek has avoided being identified as impaired on the 303(d) List of state waters.

Table 2-1. Assessment status of designated uses in Beaver Creek

Designated Use	Applies to Beaver Creek?	Assessed in 2006 305(b) Reporting Cycle?	Impaired?
Aquatic Life	Yes	Yes	No
Fish Consumption	Yes	No	—
Public and Food Processing Water Supplies	No	—	—
Primary Contact	Yes	No	—
Secondary Contact	Yes	No	—
Indigenous Aquatic Life	No	—	—
Aesthetic Quality	Yes	No	—

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 (IBI) and another index, the Macroinvertebrate Biotic Index (MBI), for small organisms that live in close relationship with the bottom substrate of a body of water: larval insects, insect nymphs, crustaceans, mollusks (e.g. snails), worms, and others collectively called benthos or benthic macroinvertebrates. As shown in Table 2-2, a score of less than 41 on the IBI or a score of more than 5.9 on the MBI indicates that a stream is not supporting aquatic life. (Increasing values of the MBI indicate lower water quality.)

Table 2-2. Illinois EPA biological indicators of impairment

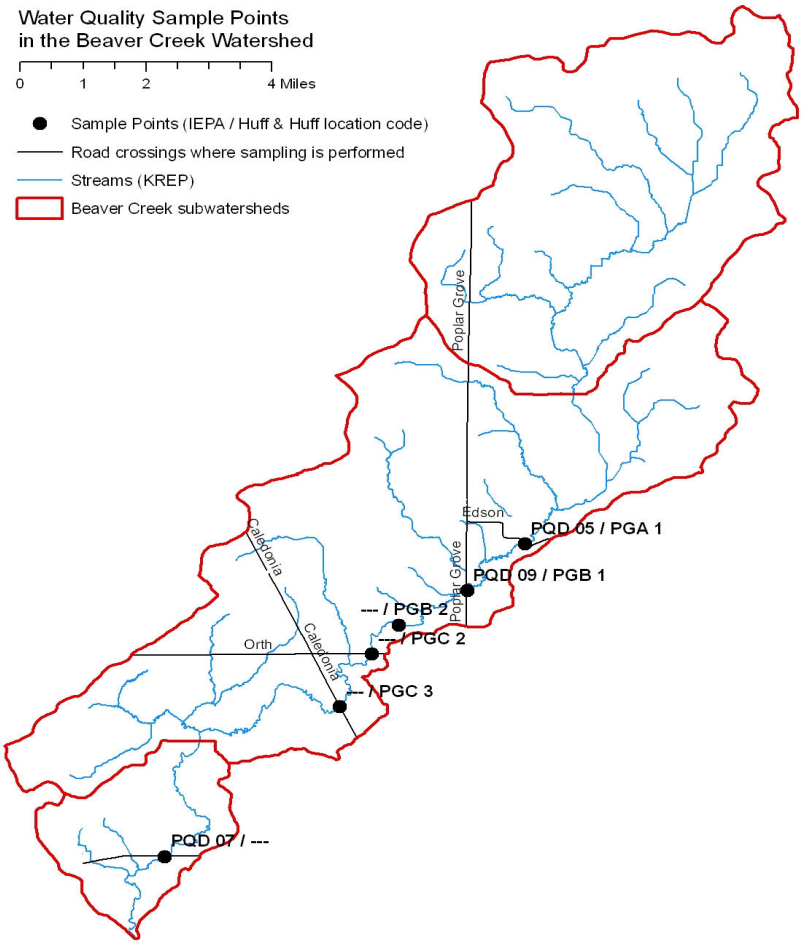
Biological Indicator			
Index of Biotic Integrity (IBI)	≤ 20	20 < IBI < 41	≥ 41
Macroinvertebrate Biotic Index (MBI)	> 8.9	5.9 < MBI < 8.9	≤ 5.9
Interpretation			
Impairment Status	Severe Impairment	Moderate Impairment	No Impairment
Designated Use Support	Not Supporting	Not Supporting	Fully Supporting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

Source: Illinois Integrated Water Quality Report and Section 303(d) List -2006

[7] Illinois Integrated Water Quality Report and Section 303(d) List – 2006. Clean Water Act Sections 303(d), 305(b) and 314: Water Resource Assessment Information and Listing of Impaired Waters. Illinois EPA, Bureau of Water. IEPA/BOW/06-002 http://www.epa.state.il.us/water/water-quality/report-2006/2006-report.pdf.

The last assessment Illinois EPA performed was in 2006 and resulted in an IBI value of 54. More data than these are available, however, from the antidegradation study[8] conducted by the Village of Poplar Grove for its wastewater treatment plant expansion. These data were collected in 2005 (Figure 2-1 and Table 2-3). When grouped together, a mean average score of 42 and a median score of 41 for the IBI results and thus, confirms the Fully Supporting aquatic life designated use determination. There appears to be no room for lower scores, however, without risk of failure to attain the designated use. Should such a determination be made in the future, Beaver Creek will be deemed impaired and placed on a future 303(d) List.

Figure 2-1.



Source: IEPA and Huff and Huff, *Biological Assessment of Beaver Creek: Boone County, Illinois* (2005)

The Macroinvertebrate Biotic Index as calculated by IEPA in 2001 had a mean score of 5.6. This metric also indicates that Beaver Creek is Fully Supporting its aquatic life designated use. Combined data collected between 2000 and 2005 by Huff and Huff (2005), professional scientists as part of the Critical Trends Assessment Program (CTAP; 2000–2003) and EcoWatch (2000) in addition to IEPA data yield an average score of 5.3. Thus, it appears that the macroinvertebrate

[8] Data collected by Huff and Huff, Inc., December 2005: *Biological Assessment of Beaver Creek Boone County, Illinois*. Prepared for the Village of Poplar Grove. Illinois.

community is generally healthy and indicative of good water quality, yet as suggested below there may be a trend of declining quality in macroinvertebrate communities.

Table 2-3. Biological sample scores - MBI and IBI - collected in Beaver Creek since 2000

Point	Organization	Date	MBI	IBI
Unknown	CTAP	2000	4.3	—
Unknown	CTAP	2000	3.7	—
Unknown	EcoWatch	2000	4.2	—
Unknown	CTAP	2001	5.1	—
PQD 05	Illinois EPA	2001	5.4	42
PQD 05	Illinois EPA	2001	5.7	—
PQD 07	Illinois EPA	2001	5.5	52
PQD 07	Illinois EPA	2001	5.8	—
Unknown	CTAP	2002	5.9	—
Unknown	CTAP	2003	4.8	—
PGA 1	Huff and Huff	2005	5.1	36
PGB 1	Huff and Huff	2005	6.7	28
PGB 2	Huff and Huff	2005	5.4	40
PGC 2	Huff and Huff	2005	6.4	40
PGC 3	Huff and Huff	2005	5.6	44
PQD 07	Illinois EPA	2006	—	54
Average			**5.3**	42

Source: Illinois EPA and Huff and Huff, Inc. 2005. *Biological Assessment of Beaver Creek: Boone County, Illinois,* Table 2-5

An analysis was also undertaken to determine how MBI and fish IBI scores have changed over time in an effort to identify trends in biological condition. The data could not be analyzed for spatial trends because the locations in Beaver Creek where CTAP and Riverwatch collected data are unknown.[9] While the apparent trend is toward decline, the results for fish IBI are not statistically significant and suggest that there is no temporal trend. For MBI, only values from 1999 and onward were plotted because there is a data gap of 15 years prior to that (Figure 2-2). Scores for MBI have also become poorer, but in this case the trend is statistically significant (P = 0.003). Yet MBI scores from the early 1980s were poorer than those in 1999–2002. Furthermore, the trend analysis is not comparing fixed sites over time. It may be the case that the unknown sites at which CTAP sampled in 1999~2001 were simply higher quality sites than those sampled by Huff and Huff and IEPA and would have a higher quality regardless of an overall trend.

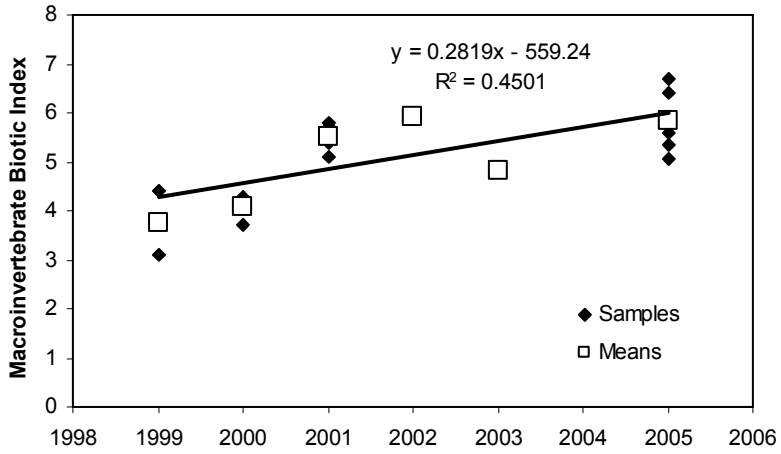
2.1.2 THREATS TO CONTINUED DESIGNATED USE ATTAINMENT

Illinois IEPA reports forty-nine potential causes of impairments for all designated uses in streams throughout the state. Based upon the number of stream miles affected, the major causes of impairment are high levels of pathogenic bacteria, low dissolved oxygen, high levels of polychlorinated biphenyls in sediments or fish tissue, excessive sedimentation/siltation, alteration in streamside or littoral vegetative covers, nutrient enrichment (i.e. total phosphorus and total nitrogen), high concentrations of metals (i.e. manganese and mercury), and high total suspended solids. A statewide summary reveals as many as forty-one potential sources of all use impairments in streams. The major sources of impairment based upon number of stream miles af-

[9] Huff and Huff, Inc. 2005. *Biological Assessment of Beaver Creek: Boone County, Illinois,* Table 2-5. A review of CTAP site locations provided by the Illinois Natural History Survey did not show any stream sample sites in Boone County (provided by James Ellis, personal communication, March 13, 2008).

fected are crop production, stream channelization, municipal point-source discharges, and urban runoff/storm sewers.

Figure 2-2. Changes in MBI values over time.



Data collected to assess Beaver Creek suggest that protective actions are necessary in order to maintain the Fully Supporting status of the aquatic life designated use. With stakeholder input and professional judgment, pollutants such as excessive sedimentation and nutrient enrichment (e.g. total nitrogen, total phosphorus) along with the (nonpollutant) alteration of the physical and habitat characteristics of the streamside or riparian area, are probably the most significant potential causes of future impairment. Sources of these pollutants are row-crop agriculture, wastewater treatment plants (i.e. municipal point-source discharges), and urban runoff/storm sewers.

Table 2-4. Basis for identifying potential causes of aquatic life impairment in Illinois streams

	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: Illinois Integrated Water Quality Report and Section 303(d) List — 2006.

As indicated in Table 2-4, the Illinois Pollution Control Board has not developed numeric standards for any of these pollutants.[10] Thus, stakeholders and other concerned citizens must 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 statewide percentile) that are thought to signal a problem in the stream.[11]

2.1.3 NUTRIENT ENRICHMENT: TOTAL NITROGEN AND TOTAL PHOSPHORUS

Water-chemistry data in Beaver Creek for the relevant species of nitrogen are somewhat sparse (Table 2-5). The mean concentration of 4.42 mg/L calculated from the IEPA-collected samples, well below the 7.8 mg/L (in water) statistical guideline, confirms lack of impairment. The additional data collected more recently for the abovementioned antidegradation study, while not completely comparable, seem to corroborate the Fully Supporting attainment status as determined by IEPA.

A different conclusion, however, can be reached when applying the USEPA's nutrient criteria for rivers and steams in Nutrient Ecoregion VII.[12] The USEPA has divided the contiguous states into fourteen "nutrient ecoregions" that represent aggregations of Level III ecoregions.[13] The Beaver Creek Watershed falls predominantly in the Southeastern Wisconsin Till Plains, Level III Ecoregion 53.[14] Based on the nutrient criteria recommendations offered by USEPA, there appears to be room for improvement in water quality based on water chemistry criteria.

Table 2-5. Nutrient data collected by IEPA and Huff & Huff compared to reference conditions.

		Constituent (mg/L)			
Sample Point	Date	Total Phosphorus	Kjeldahl N	Nitrate/ nitrite	Total Nitrogen
PQD 05	6/19/2001	0.22	0.85	5.3	6.15
PQD 05	8/22/2001	0.37	1.05	2.8	3.85
PQD 05	9/25/2001	0.12	*0.78	4	4.78
PQD 07	6/19/2001	0.20	0.56	4.1	4.66
PQD 07	8/21/2001	0.24	0.65	1.95	2.60
PQD 07	9/25/2001	0.17	*0.78	3.7	4.48
IEPA mean average		0.22	0.78	3.64	4.42
Huff & Huff mean of mean values**		1.43		2.05	
USEPA 25th Percentile****		0.08			1.59

* estimated values represent the mean average of the other four sample values collected by IEPA
** antidegradation study reference in footnote no. 2
*** reported values are for nitrate only; nitrate values were consistently reported as < 0.25
**** Table 3c. Reference Conditions for Level III Ecoregion 53; 25th percentiles; see footnote no. 8

[10] However, Illinois is in the process of developing 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.
[11] A more detailed description of this procedure can be found in the Integrated Water Quality Report (2006), p. 43.
[12] *Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria.* Rivers and Streams in Nutrient Ecoregion VII. USEPA, Office of Water. EPA 822-B-00-018, Dec. 2000. Available at: http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/rivers/rivers_7.pdf
[13] A bibliography on ecoregion-related publications is available at: http://www.epa.gov/wed/pages/ecoregions/pub_list.htm
[14] Ecoregions of Illinois. USEPA, 2006. Available at: http://www.epa.gov/wed/pages/ecoregions/il_eco.htm

2.1.4 EXCESSIVE SEDIMENTATION/SILTATION

Data on total suspended solids (TSS) concentrations have generally not been collected for Beaver Creek. Illinois EPA collected sediment *quality* data as part of its 2001 data collection effort, but this refers to constituents and potential pollutants found in the sediment rather than sediment or TSS concentrations in the water column. The antidegradation study, however, provided total suspended solids data despite not being a primary component of the report. The average mean concentration of TSS was calculated to be 32 mg/L (n = 60) for samples collected between August 30 and September 22, 2005 as compared to the statistical guideline of 116 mg/L that is listed as the basis for identifying causes of impairment of aquatic life use in Illinois (Table 2-4).

The habitat assessments conducted by Illinois EPA in 2001 at PQD 05 and PQD 07 showed mud/silt compositions of 54.9 and 9.4 percent, while the statistical guideline is 34 percent. Thus PQD 05, receiving drainage from primarily cropland in the northern part of the watershed, appears to have elevated levels of silt. Scores for IBI and MBI at that site showed fair to good conditions, although IBI was much lower than at PQD 07. Conditions at the additional sites visited by Huff and Huff in 2005 did indicate siltation or mucky conditions in some places, but the report did not note this as a significant problem and nor did it quantify stream bottom composition.

2.2 Pollutant Loading and Sources

2.2.1 NONPOINT SOURCE LOAD ESTIMATES

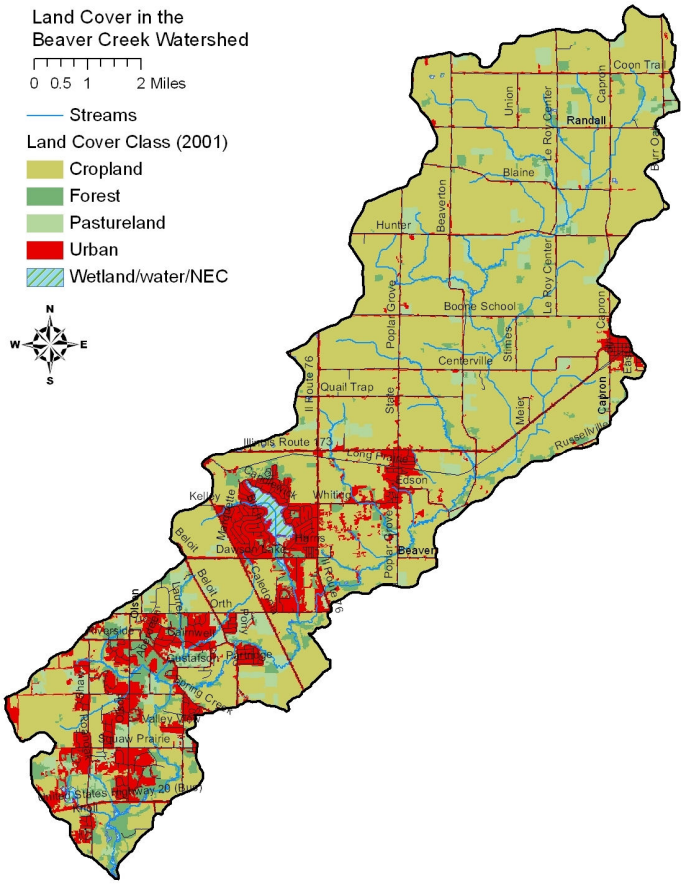
A sketch-planning tool called STEPL (Spreadsheet Tool to Estimate Pollutant Loads) was employed to estimate the existing load of nutrients and sediment coming from sources within the watershed, compute the total load reduction needed, break the load down by source area, and break it down by source type or contributor, e.g., crop production, urban runoff, etc. It is not possible for STEPL to estimate current pollutant loads resulting from historical channelization. A number of different watershed models were first evaluated to determine which one 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.[15] The deciding factors in favor of STEPL were its moderate sophistication but usability in the absence of data for calibration and validation,[16] 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.[17] This section presents the results of the tool; further documentation of the data and assumptions employed is presented in Appendix A.

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 is defined as wetlands and water (Figure 2-3). The model output from

[15] http://epa.gov/nps/watershed_handbook/.
[16] There is no stream gage on the Beaver Creek or any of its tributaries, and water quality sampling over the years has been infrequent.
[17] http://it.tetratech-ffx.com/stepl/models$docs.htm.

STEPL is average annual pollutant loads from nonpoint sources. Contributions from wastewater are calculated separately and added to the STEPL results as described in the next section. It is important to understand that STEPL is not a comprehensive physically-based model. It computes only watershed loading, not water quality response, and makes use of highly generalized data at some points.

Figure 2-3.



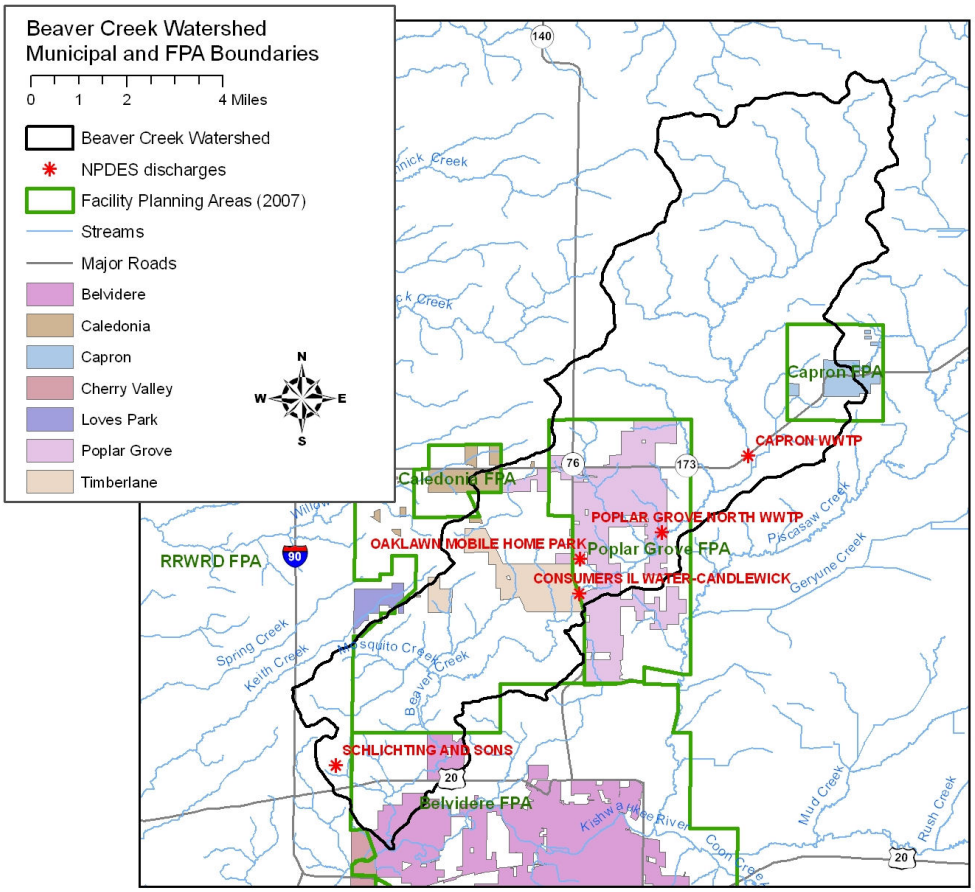
Source: National Land Cover Dataset (2001)

2.2.2 POINT SOURCE LOAD ESTIMATES

There are six regulated point source discharges to Beaver Creek or its tributaries (Figure 2-4). The Village of Poplar Grove operates two wastewater treatment plants, the North and South plants (NPDES permits IL0023451 and IL0071447, respectively). These WWTPs utilize an activated sludge process (sequencing batch reactor) to deliver secondary treatment. The Village of Capron operates a similar plant further upstream (NPDES permit number IL0027855). All three plants have similar capacities. The Candlewick Lake community is served by a plant (IL0045527) operated by Aqua Illinois — formerly Consumers Illinois — which also delivers secondary treatment and has about twice the capacity of the municipal plants. Finally, the Oak Lawn mobile home park is served by a small (0.05 mgd) package plant that discharges to a tributary (NPDES permit ILG551047). Oak Lawn and Poplar Grove are in discussions to decommission the Oak Lawn plant and treat sewerage from the mobile home park at the Poplar

Grove South WWTP. There is one industrial discharger, Schlichting and Sons Excavating, Inc., with an outfall on a tributary to Beaver Creek near the bottom of the watershed.

Figure 2-4.



Source: FPA boundaries and treatment plant outfalls are from geodatabase maintained by Illinois EPA.

The wastewater treatment plants on Beaver Creek contribute significantly to nutrient enrichment in the stream. Wastewater is estimated to account for 14 percent and 20 percent of current annual nitrogen and phosphorus loads, respectively (see Section 2.2.3 below). However, it is not straightforward estimate nutrient loading from wastewater because the plants do not monitor total nitrogen or total phosphorus. Literature values on the typical range of nutrients in wastewater given the treatment technology were used in lieu of monitoring data (Table 2-6).

Table 2-6. 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.

Taking the midpoint of the values for activated sludge plants with filtration, effluent from the WWTPs is estimated to contain 25 mg/L total nitrogen and 6 mg/L total phosphorus. Multiplying this by current flow and converting units gives annual nutrient loading for wastewater (Table 2-7).[18] Future loading for the WWTPs was assumed to be at the design average flow, the amount of flow the treatment plants are built to treat on an average or sustained basis, taken from facility information in the USEPA Permit Compliance System.[19] Because it is expected that Oak Lawn will be connected to the Poplar Grove South plant, future flow for the plant at the mobile home park was assumed to be zero.

Table 2-7. Estimated current and future flow and loading from wastewater treatment plants.

		Discharger						
	Unit	Capron	Pop Grv N	Pop Grv S	Candle-wick	Oak Lawn	Schlichting	Total
Flow								
Current flow	mgd	0.17	0.14	0.12	0.52	0.03	0.72	1.70
Design average flow	mgd	0.30	0.25	0.25	0.52	0.03	0.72	2.07
TSS								
Current concentration	mg/L	5.26	3.48	7.59	5.56	6.15	13.82	—
Current load	t/y	1.31	0.91	1.46	4.93	0.33	15.13	24
Future load @ DAF	t/y	2.40	1.32	2.88	4.38	0.00	15.13	26
Nitrogen								
Current concentration	mg/L	25	25	25	25	25	—	—
Current load	lb/y	12,724	10,871	9,090	39,390	2,610	—	74,685
Future load @ DAF	lb/y	22,813	19,011	19,011	39,390	0	—	100,225
Phosphorus								
Current concentration	mg/L	6	6	6	6	6	—	—
Current load	lb/y	3,054	2,609	2,181	9,454	626	—	17,924
Future load @ DAF	lb/y	5,475	4,563	4,563	9,454	0	—	24,054

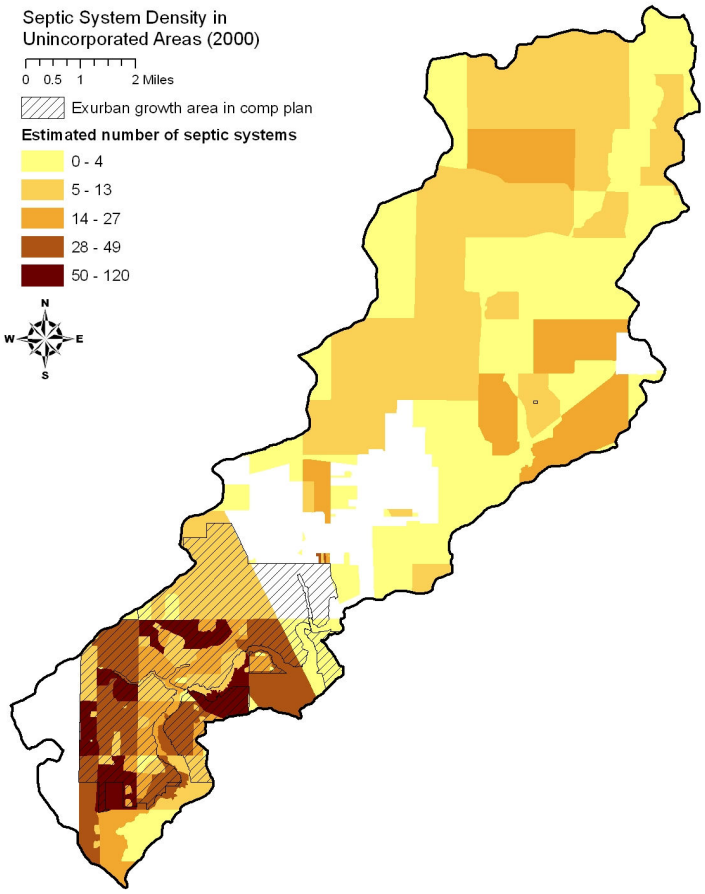
Source: Flow and concentration data are from U.S. EPA Permit Compliance System (data extracted on December 20, 2007).

The sketch planning tool STEPL assumes that total suspended solids (TSS) 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, as 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 ~24 tons per year (Table 2-7), a tiny fraction of the whole watershed load. Much of this results from the TSS in the Schlichting and Sons discharge. The average concentration of TSS in the Schlichting discharge is about 15 mg/L, well under various benchmarks. Nevertheless, the operation has violated its permit limits on a number of occasions over the past few years. It is possible that the discharge is harmful to aquatic life in the immediate vicinity, especially considering the sensitive areas downstream, but this has not been verified. A Facility-Related Stream Survey by Illinois EPA could be helpful in this regard.

[18] Average daily flow (mgd) × average concentration (mg/L) × 3,042 (L-d-lb/gal-y-mg)
[19] Poplar Grove had plans to increase its South plant to 1 mgd, but it is unclear whether this will be necessary given the downturn in the housing market.

Finally, septic systems are a potential contributor to nutrient loading, although they are not point sources. The STEPL tool estimates their contribution based on available information or assumptions about failure rates. Figure 2-5 indicates the distribution of septic systems in the watershed. Most occur in the southern part of the watershed, which is also an area in which more are expected based on the exurban nature of growth envisioned there in the Boone County Comprehensive Plan.

Figure 2-5.



Source: Estimated from Census 2000 by assuming that the number of housing units in unincorporated areas — excluding the Candlewick community, which has centralized treatment — would be equal to the number of septic systems.

2.2.3 RESULTS

The load estimates suggest that agriculture (cropland and pastureland) contributes 84 percent of the nitrogen load, while wastewater treatment plants contribute 10 percent and urban runoff contributes most of the remainder (Table 2-8). Septic systems appear to play a very minor role. The majority of total phosphorus loading also originates from agricultural land use, while wastewater treatment plants are the second largest contributor. Cropland by far is the chief contributor of sediment loads to Beaver Creek.[20] The estimated sediment contribution from ur-

[20] Sediment loading is calculated as the yield at the mouth of the stream. That is, the estimate of sediment in runoff calculated using the RUSLE equation is multiplied in STEPL by a delivery ratio to account for hillslope and channel deposition of sediment.

ban sources is loosely equated to total suspended solids. Total suspended solids are determined by quantifying the actual weight of particulate matter in sample of the water column. Total suspended solids (TSS) typically contain a variety of constituents in addition to sediment and as a result, may have different physical properties than sediment alone. Septic systems of course do not contribute sediment to waterways, and TSS in wastewater is controlled by NPDES permit limits.

Table 2-8. Estimated current (2001) annual pollutant load by source in Beaver Creek.

Sources	N Load (lb/yr)	P Load (lb/yr)	Sediment Load (t/yr)
Urban	29,813	3,921	802
Cropland	403,578	53,357	11,168
Pastureland	20,090	2,864	665
Forest	2,325	860	222
Septic	1,509	591	0
Wastewater	74,685	17,924	24
Total	532,000	79,519	12,882

* information has not been collected on locations and extent of gully erosion
** ignored in model
*** value in sediment load column is for total suspended solids (TSS)

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.

2.2.4 LOAD REDUCTION TARGETS

As mentioned above, there are no numeric standards in Illinois for ambient concentrations of nutrients or sediment in the water column. Yet in order to protect water quality (i.e. maintain attainment of the aquatic life designated use), reductions of pollutant loads can be pursued and ideally should be connected to some target that reflects aquatic life support.

2.2.4.1 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, first introduced in Section 2.1.3 above, for insight into desirable conditions in the stream. While the majority of northeastern Illinois falls into the Central Corn Belt Plains, Level III Ecoregion 54, Beaver Creek lies predominantly in the Southeastern Wisconsin Till Plaines, Level III Ecoregion 53. USEPA suggests that nutrient criteria can be developed by treating streams with nutrient concentrations below the 25th percentile of all streams as nonimpacted,[21] and has published values for the 25th percentile streams across all Level III ecoregions within each nutrient ecoregion.[22] Concentrations above the 25th percentile can then be judged as unacceptable or states can develop a classification system ranging in quality from reference to acceptable to degraded. Since the latter ap-

[21] 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.
[22] *Supra* note 8

proach has not been taken in Illinois,[23] values above the 25th percentile are considered here as symptomatic of a deteriorating stream condition. In this way, a comparison of Beaver Creek water quality data to the nutrient criteria for reference streams in Ecoregion 53, can define a load-reduction target. The results of this procedure are shown in Table 2-9.

Table 2-9. Data for setting target reductions in nutrient concentrations using USEPA criteria for Level III Ecoregion 53.

Nutrient	25th percentile (mg/L)	2001 IEPA data (mg/L)	Target Reduction
Total nitrogen	1.59	4.42	64%
Total phosphorus	0.08	0.22	64%

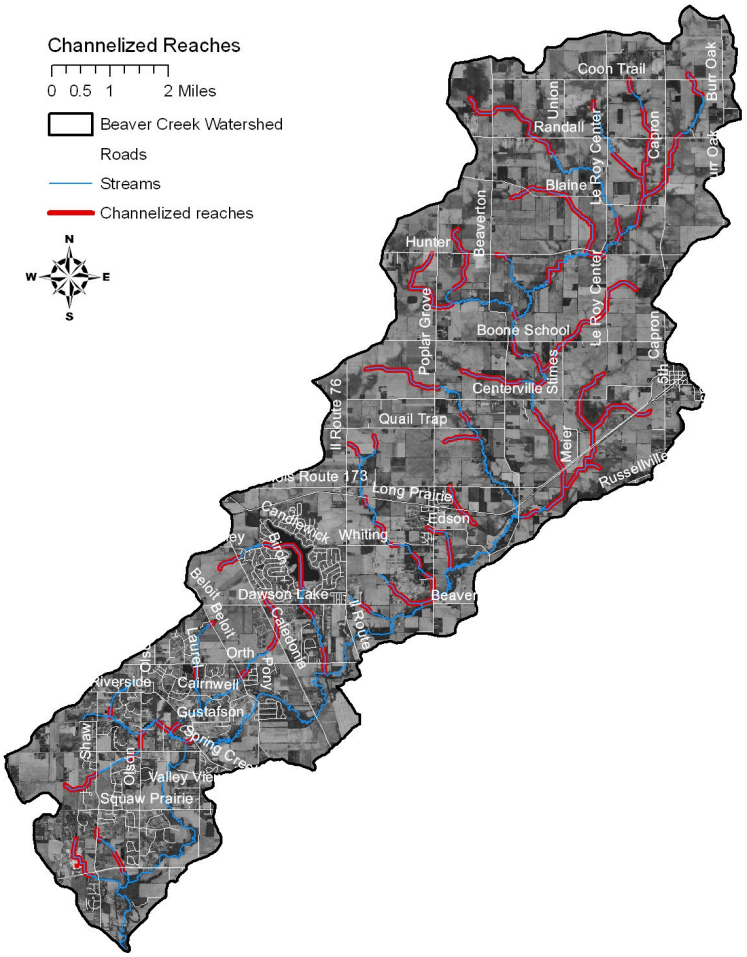
As the data in Table 2-3 suggest, the method applied here and subsequent results are based on a less than robust set of water quality sample data from Beaver Creek. The samples were taken in summer and early fall, quite likely under low-flow conditions in which nutrient enrichment from nonpoint sources would be relatively minor. Most significantly, however, the available data and model capability do not allow modelers to back-calculate directly the allowable load required to keep concentrations under the nutrient criteria; a key assumption is made, therefore, that the percent decrease in sample concentration needed ≅ percent reduction in annual load needed. Using the estimated loads in Table 2-8, the recommended load reduction for nitrogen is 340,480 pounds per year and 50,892 pounds per year for phosphorus. The limitations of STEPL and available data mean that it cannot be known with some certainty how closely loading estimates and load reductions reflect actual landscape conditions. Thus, they should be considered provisional. It is worth noting that the nutrient criteria used here differ from the statistical guidelines that 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 higher than the guideline generated using 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 must be revised.

2.2.4.2 Sediment

As noted in Section 2.1.4, the Illinois EPA station PQD 05 seems to have elevated levels of silt, while the downstream station does not. Not enough data are available to calculate load reductions for sediment. Thus, it is recommended simply that the agricultural BMPs recommended in Section 5 be implemented to the maximum extent possible, with the ideal objective of 100 percent adoption of the recommendations. This will significantly reduce sedimentation, although a load reduction goal cannot be specified.

[23] USEPA (*Id.*) 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.

Figure 2-6.



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

2.2.5 CHANNELIZATION

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. 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.

2.3 Existing Protections

This section focuses on natural resource protections in local ordinances. The minimum standard to which local ordinances should be compared in this region is the set of model ordinances prepared by the Northeastern Illinois Planning Commission (NIPC) for stormwater management, soil erosion and sediment control, floodplain management, and stream and wetland protection. These model ordinances were developed to codify the nonpoint source management policies of the Areawide Water Quality Management Plan.[24] Table 2-10 includes a series of checklist questions adapted from the model ordinances, utilized to measure and compare the county and municipal ordinances for their water quality standards.

Table 2-10. Comparison of County and Municipal Ordinances to Model Water Quality Standards.

Model Ordinance Element	Boone County	Belvidere	Capron	Poplar Grove
Stormwater Management				
Stormwater drainage and detention ordinance?	(in progress)	No	No, defers to Boone County	No
Include purpose to control of runoff volume, rate, and quality?	Addressed in Subdiv Code	Addressed in Subdiv Code	Mentioned in Subdiv Code	Mentioned in Subdiv Code
Promote use of natural drainage practices?	No	No	No	No
Require that peak post-development discharge from events less than or equal to 2-year, 24-hour be limited to 0.04 cfs/ac of watershed?	Peak of 0.2 cfs/ac for 100-yr event	Yes	No; 1.3"/hr for 5-yr event	No
Require detention design standards to maximize water quality benefits, preference for wet bottom/wetland basins?	No	Limited water quality design standards, no	No	No
Prohibit detention in the floodway?	Yes	Discouraged	No	No
Prohibit on-stream detention, unless provides regional stormwater storage, with accompanying BMPs?	Yes	Yes (but no BMP standards)	No	No
Prohibit direct discharge of undetained stormwater into wetlands?	No	Yes	No	No
Require formal maintenance contracts for new detention facilities?	No	Agreements required	No	No
Soil Erosion and Sediment Control				
Erosion and sediment control ordinance?	No Addressed in Subdiv Code	No Addressed in Subdiv Code, Natural Resource Protection Standards	No (small section of Subdiv Code mentions protection of top soil)	No (Zoning sometimes requires Erosion Control Plan)
Include purpose to limit sediment delivery to pre-disturbance levels and minimize effects on water quality, flooding?	No	No	No	No
Principles to minimize sediment transport from the site for all storms up to the 10-year frequency event?	Yes, limited	Yes, limited	No	No
Require ordinance applicability for any land disturbing activity >5,000 ft^2, or 500 ft^2 if adjacent to waterbody?	Yes, exceptions for Ag land	No	No	No

[24] Boone County and the municipalities within the county are outside of the seven counties for which the Areawide Water Quality Management Plan, administered by CMAP, applies. Illinois EPA is directly responsible for these jurisdictions' adherence to the Illinois Water Quality Management Plan.

Model Ordinance Element	Boone County	Belvidere	Capron	Poplar Grove
Site design requirements for sediment control measures, soil stabilization, construction, etc?	Yes, limited	No	No	No
Adopt "Illinois Urban Manual" and "Illinois Procedures and Standards for Urban Soil Erosion and Sediment Control"?	Yes, "Illinois Urban Manual"	Yes, "Illinois Urban Manual"	No	No
Require routine maintenance for all erosion and sediment control practices?	Yes	Yes	No	No
Require inspection of construction sites?	Yes	Yes	No	No
Provide effective enforcement mechanisms?	No	Yes	No	No
Floodplain Ordinance				
Floodplain management ordinance?	No, but in Zoning Code, overlay district	Yes, and in Zoning Code, Subdiv Code	No, defers to Boone County	No
Include a purpose of protection of hydrologic functions, water quality, habitat, recreation, and aesthetics?	No relation to water quality	No relation to water quality	No	No
Restrict modifications in floodway to appropriate uses?	Yes, some limits on uses (No increase in base flood elevation)	Yes, some limits on uses (No increase in base flood elevation)	No	No
Discourage stream channel modification and require mitigation?	No, defers to FEMA	Yes	No	No
Discourage onstream impoundments?	No	Yes	No	No
Require effective soil erosion and sediment control measures for all disturbances in the floodway?	No	No, not specific to floodway	No	No
Require protection of a minimum 25 ft native vegetation buffer along the channel?	No	25 ft wetland buffer; 75 ft shore buffer (no vegetation requirements)		
Stream and Wetland Protection				
Stream and wetland protection ordinance?	No	No	No	No
Include a purpose of protecting hydrologic, hydraulic, water quality, habitat, aesthetic, and social and economic values and functions of wetlands?	Mildly addressed in Zoning Code, no specifics	Addressed in Natural Resource Protection Ordinance	Mildly addressed in Subdiv Code	Mildly addressed in Subdiv Code
Protect beneficial function of streams, lakes, and wetlands from damaging modifications?	Yes, limited	Yes, mitigation allowed	No	No
Prohibit modification of high quality wetlands, lakes, and stream corridors?	No	No	No	No
Discourage modification of wetlands for stormwater management purposes?	No	No	No	No
Designate min 75 ft setback from edge of waterbodies, where development limited to minor improvements like walkways, signs, parks, etc?	No	75 ft buffer required (Subdiv Code)	No	No
Establish min 25 ft wide protected native vegetation buffer strip?	No	Yes, for wetlands	No	No
Prohibit watercourse relocation or modification (with exceptions if mitigated)?	No	Yes, mitigation allowed	No	No
Discourage armoring of channels and banks?	No	No	No	No

Model Ordinance Element	Boone County	Belvidere	Capron	Poplar Grove
Discourage culvert crossings of streams?	No	No	No	No
Discourage onstream impoundments?	No	No	No	No
Require adequate mitigation measures for approved waterbody modifications, including 1.5 to 1 acreage replacement, monitoring and maintenance, and full restoration of function?	No	Defers to IDNR standards	No	No

The purpose of this checklist was to scan county and municipal ordinances to determine whether Boone County, Belvidere, Capron, and Poplar Grove were meeting minimum recommended standards for protecting water quality. Through this comparison, it is evident that these jurisdictions have few specific stormwater management, soil and erosion control, floodplain management, or stream and wetland protection ordinances, with the exception of Belvidere's floodplain management ordinance. In some cases, these elements were addressed in zoning codes or subdivision regulations, but none met all the minimum requirements of the model ordinances. Capron and Poplar Grove have very little language in their ordinances dealing with water quality at all. It has been suggested that detention for at least the 100-year storm is being provided in some jurisdictions through plat review even though subdivision regulations do not strictly speaking require it.[25] However, it is rate control for smaller, more frequent storms that helps prevent stream degradation, and other BMPs may not be generally required either.

Boone County is presently developing a countywide stormwater management program under Public Act 94-675 (55 ILCS 5/5-1062.2) and is expected ultimately to adopt an ordinance containing minimum stormwater management standards for the municipalities and unincorporated area of the county. It should be clear that the present opportunity before Boone County to develop a countywide stormwater management ordinance is important for making the critical decisions necessary for protecting Beaver Creek and other county water resources. It is recommended that Boone County follow the model ordinance elements presented above and in doing so, develop a stormwater management ordinance that is both effective in practice and successful in achieving its purpose.

[25] Roger Day, Village of Poplar Grove. Watershed stakeholder meeting, July 24, 2008.

3. ESTIMATION OF FUTURE NEEDS AND CONCERNS

To estimate potential changes in pollutant loading in Beaver Creek, point and nonpoint source loads were projected for approximately the year 2050. Projected point source loading was based on design average flows and assumptions about effluent concentrations. Nonpoint source loading was based on the implementation of the comprehensive plan and the typical deployment of best management practices in the municipalities.

3.1 Current Land Cover

The starting point for the land use analysis was the 2001 National Land Cover Dataset (NLCD), which for this project was taken as existing conditions (Table 3-1). The vast majority of land within the watershed is agriculture, primarily cultivated crops such as corn and soybeans, as well as pastureland and hay. At a distant second, agriculture is followed by "developed open space," or areas of mainly turf grass with minor structures and minimal canopy cover. There is almost the same amount of low intensity development, which primarily includes single-family housing lots, but with higher levels of impervious surface than developed open space.

Table 3-1. Land use (2001) in the Beaver Creek watershed.

Land Use	Acres	Percent
Developed, open space	3,263	7.2%
Developed, low intensity	3,076	6.8%
Developed, medium-high intensity	210	0.5%
Forest/barren land/grassland	3,082	6.8%
Pasture/hay	2,937	6.5%
Cultivated crops	32,239	71.5%
Wetlands	51	0.2%
Open Water	230	0.5%
Total	45,088	100%

Source: 2001 National Land Cover Dataset

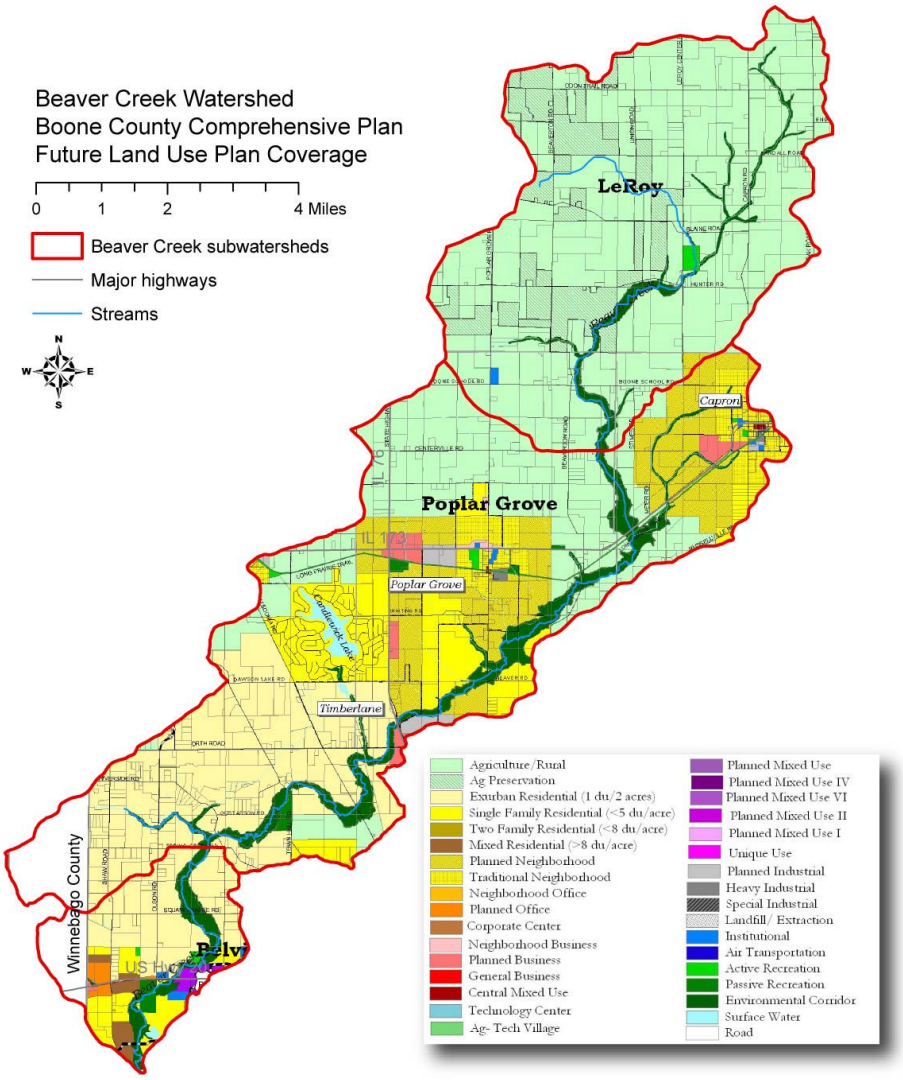
3.2 Future Land Use

3.2.1 LAND USE PLANS

The Boone County Comprehensive Plan[26] was used to project future land use based on the implementation of the plan. It represents in principle the adopted will of staff and elected officials, and so relates more to intention than prediction. That is, the land use plan represents what the county officially wishes to do, despite the fact that departures from the comprehensive plan occur in response to development pressure. 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 the comprehensive plans would affect water quality.

[26] The Village of Poplar Grove recently adopted a comprehensive plan which is not reflected in this map.

Figure 3-1.

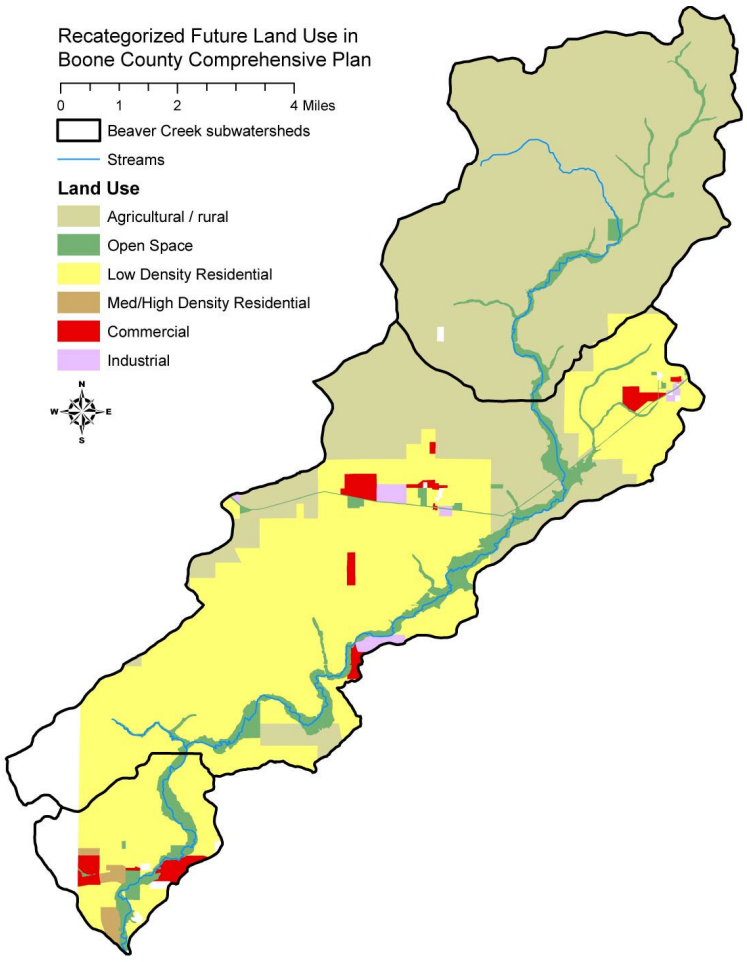


Source: Boone County Comprehensive Plan

The land use map for Boone County was georeferenced to the watershed in the map shown in Figure 3-1. The land use categories were then aggregated as shown in Figure 3-2 into a simplified set that could be represented within STEPL (Spreadsheet Tool to Estimate Pollutant Loads, discussed in general terms in Section 2 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 the presence of wetlands, which for the purpose of the analysis were assumed undevelopable. It will be noticed that the "low density residential" category blends together unincorporated areas expected to be developed at estate or "exurban" densities and areas intended for higher densities in municipalities (refer to densities provided in legend of Figure 3-1). However, their estimated contributions to pollutant loading are not the same because of the different best management practices assumed in each case. Finally, the original county land use plans did not make a distinction between existing land use and planned future land use. In order to esti-

mate land use change from the maps, existing urban land cover from the 2001 NLCD was essentially "subtracted" from the land uses as presented in the county comprehensive plan map.

Figure 3-2.



Source: Boone County Comprehensive Plan
Note: Due to the constraints of STEPL, this map does not distinguish between what characterizes "low density residential" in the County versus the municipalities.

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 the 2001 land cover of, for example, cropland would still be cropland in the future, given comprehensive plan implementation.

Table 3-2. Land cover in 2001 versus land cover with plan implementation.

Land Cover	Percentage of Watershed Existing (2001)	Percentage of Watershed with Comp Plan Implementation
Agricultural	78%	47%
Developed land	14%	37%

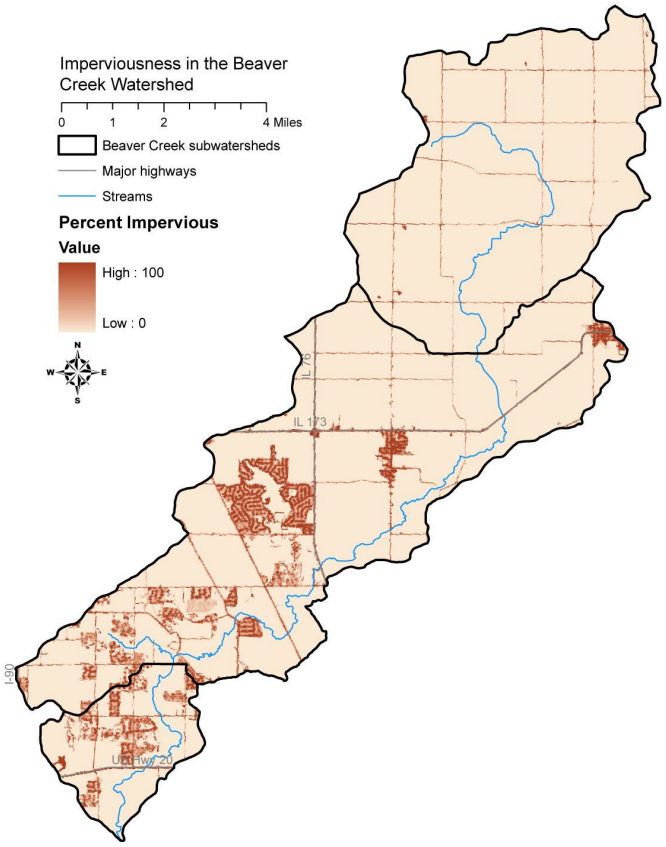
Again, the approach taken in this analysis was to project the impact of growth according to an adopted plan, not to try to forecast the growth that seems most realistic at the moment. The estimates produced in this analysis indicate that there may be a major shift in the land cover

make-up of the watershed in the future. Over three-quarters (78 percent) of the watershed was in agriculture in 2001. If development occurs as envisioned in the comprehensive plan, less than half (47 percent) of the watershed will remain agricultural, whereas developed land would more than double (14 percent to 37 percent).

3.2.3 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. Average levels of imperviousness were determined for each land use category using Natural Resources Conservation Service methodology. Impervious cover values were developed for incorporated and unincorporated areas because of the greater intensity of land use allowable within the municipalities. Depending on assumptions made to project future development and growth, the watershed's total imperviousness may increase from 3 percent currently (according to 2001 NLCD) to 9~11 percent in the future (according to the comprehensive plan).

Figure 3-3.



Source: 2001 National Land Cover Dataset

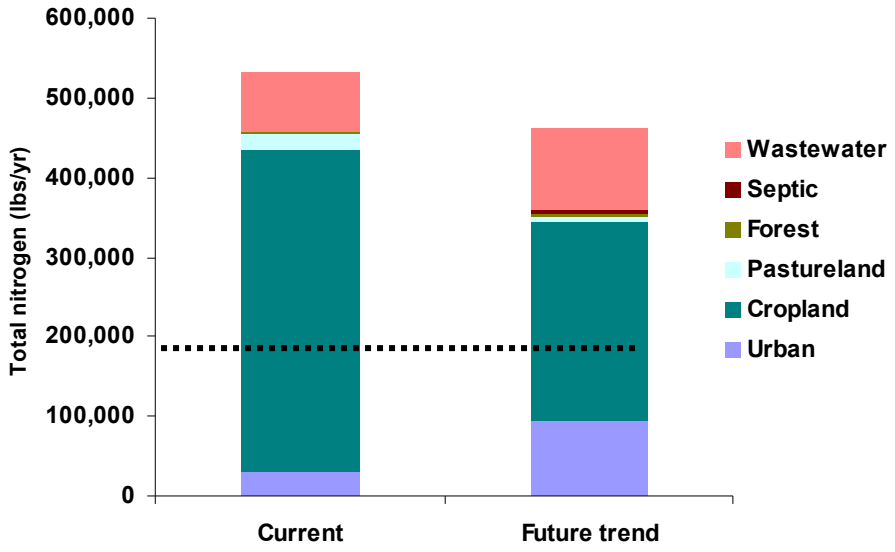
3.3 Wastewater Discharge

Future loading from the wastewater treatment plants was based on the plants' design average flow ratings, the amount of flow the treatment plants are built to treat on an average or sus-

tained basis. Like 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 the future. Table 2-7 shows current flow from the point source discharges in the watershed in comparison with the design flow. It was assumed that at comprehensive plan build-out discharge would be equal to design average flow. For the trend case it was not assumed that Illinois EPA would require wastewater treatment plants to install nutrient removal technology.

Potential contributions by septic systems were also examined as part of this watershed plan. While information on septic systems and specifically their rate of failure is scanty, it appears that they are a very minor contributor to nutrient enrichment. For the purposes of projection, it was assumed that the number of septic systems would increase in proportion to the amount of land planned for exurban residential in the Boone County Comprehensive Plan (Figure 3-1) at the rate of one per two acres, the planned dwelling unit density. This land is outside of current Facility Planning Area boundaries (Figure 2-4). The failure rate was assumed to be the same at comprehensive plan build-out.

Figure 3-4. Current and projected total nitrogen loading



3.4 Water Quality Projections

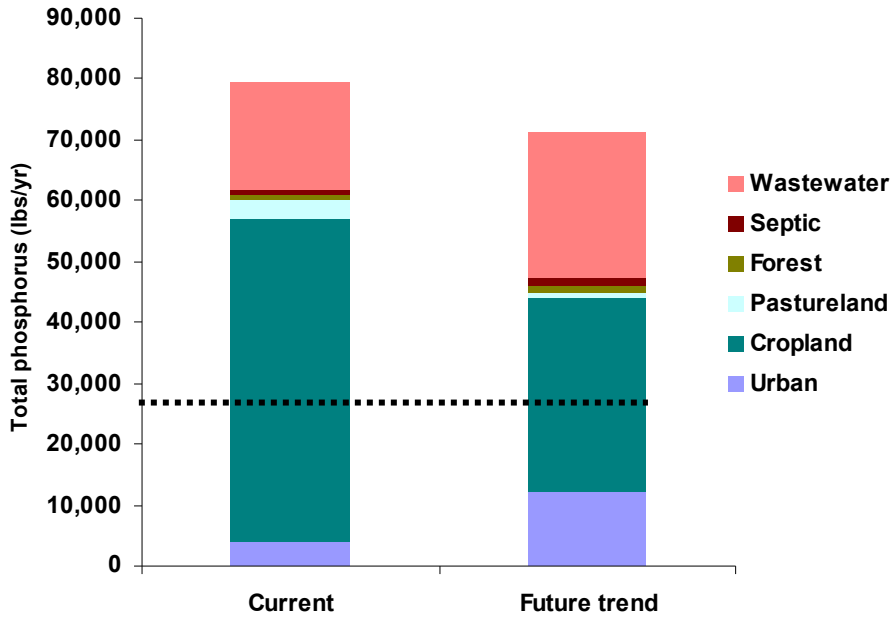
As indicated in the sections to follow, land use change according to the comprehensive plans in the trend case is expected to reduce long-term annual nutrient and sediment loading, but it is important to understand that while sedimentation can go up dramatically with construction site erosion, this has not been measured. Furthermore, a number of other pollutants and hydrological changes could harm the stream even though nutrient loading is projected to decrease. The trend case represents growth without water quality BMPs and largely without any ordinance-driven stormwater controls because, as discussed in Section 2, local ordinances generally lack

these requirements. As mentioned above, for the trend case it was not assumed that Illinois EPA would require wastewater treatment plants to install nutrient removal technology.

3.4.1 NUTRIENTS

The change in nutrient loading from point and nonpoint sources is shown in Figures 3-4 and 3-5. As described in Section 2.2.4.1, the reduction needed in present loading of nitrogen and phosphorus was estimated at 340,480 lbs/year and 50,892 lbs/year respectively. For total nitrogen and total phosphorus, the STEPL tool projects a slight decrease from current loading (13 and 10 percent, respectively), due entirely to a shift from agricultural to urban uses in the watershed with the implementation of the Boone County Comprehensive Plan. Nitrogen and phosphorus loading from municipal wastewater treatment plants and septic systems would increase, but would be offset by the decrease in nonpoint source contributions from agricultural land.

Figure 3-5. Current and projected total phosphorus loading

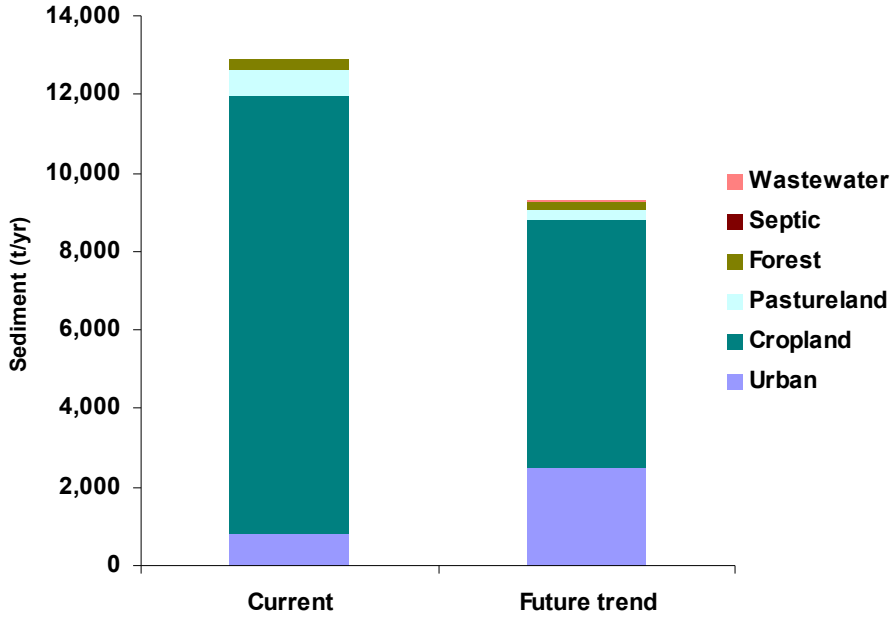


3.4.2 SEDIMENT

Sedimentation is projected to decrease substantially because of conversion of farmland to urban land (Figure 3-6). The change in annual sediment loads 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, 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. On the technical side, this is partly due to the inclusion of a sediment delivery ratio in STEPL that is meant to account for the storage of some sediment in the channel and in the floodplain: sediment in

STEPL is measured at the watershed outlet, not at the point of origin. But it is true that a few construction sites with poor soil erosion and sediment control will outweigh even the long term benefits of post-construction BMPs, pointing to the paramount importance of ongoing construction site monitoring and enforcement. The Boone County Soil and Water Conservation District inspects construction sites for erosion control practices under an interagency agreement with the Illinois EPA.

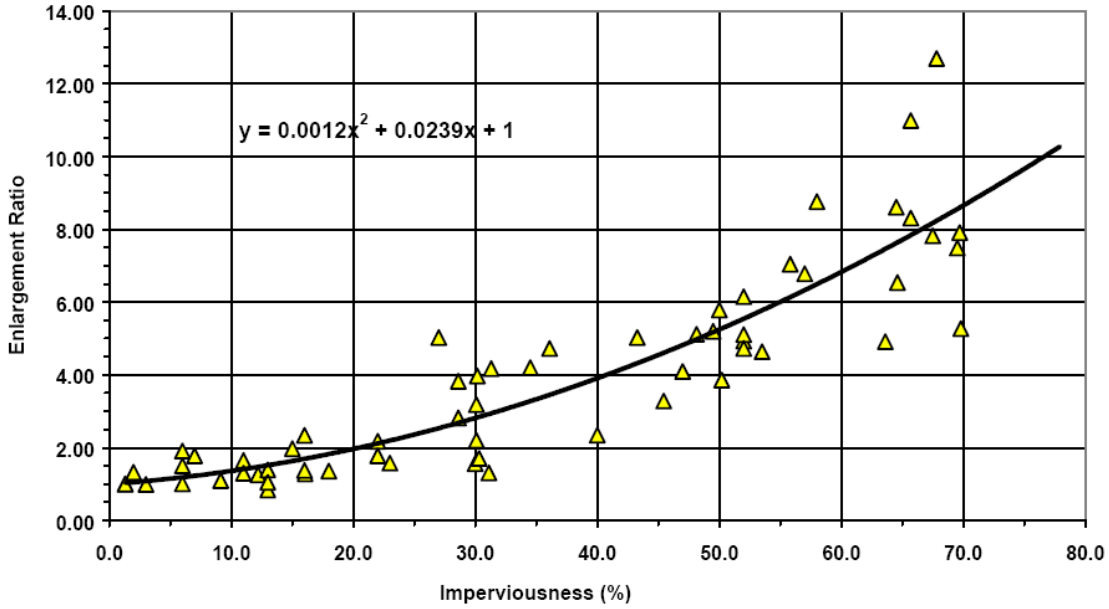
Figure 3-6. Current and projected sediment loading



3.4.3 HYDROLOGIC EFFECTS

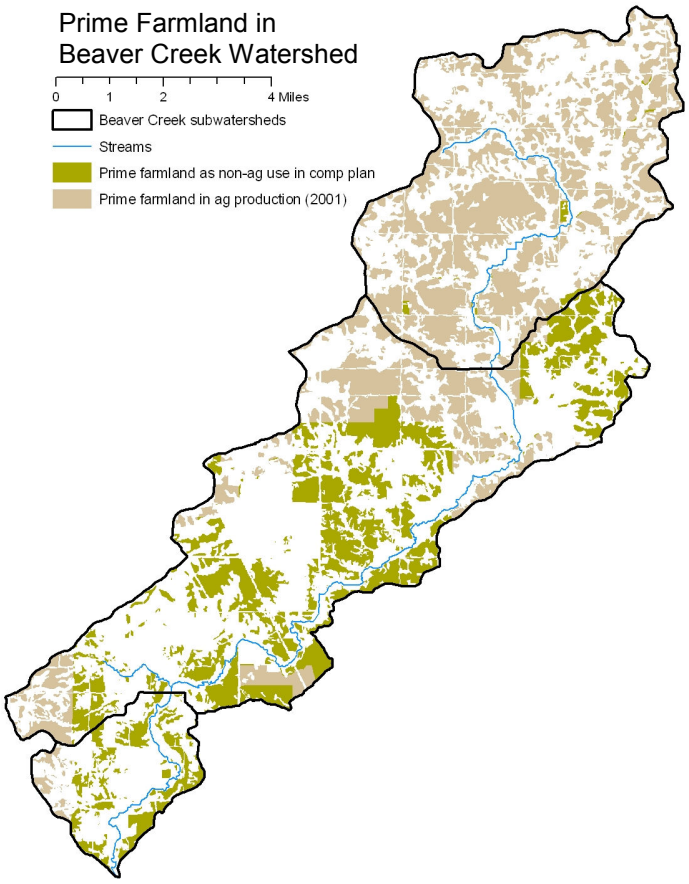
Little will be said here about the probable hydrologic effects of urbanization in the watershed. However, the annual volume of runoff in the watershed is expected to increase by approximately 20 percent at build-out as a result of urbanization, according to the STEPL tool, due primarily to the increase in impervious surface. Peak runoff rate will also increase, and controlling this should be a major focus of the countywide stormwater ordinance. It is recommended that, in addition to controlling extreme flooding events, the ordinance should also control the storm event corresponding to bankfull discharge (often taken as the 2-year event) with the purpose of helping to prevent increased erosion and channel enlargement. Bankfull discharge — the flow at which the stream is just up to its banks but not overflowing — is thought to be mostly responsible for establishing channel size and shape. It has been shown that increases in imperviousness in watersheds, without adequate detention, leads – over a period of many years – to the enlargement of channels several times over their original widths (Figure 3-7). While imperviousness is only projected to increase by a factor of ~3 at comprehensive plan build-out, the relationship shown in Figure 3-7 would suggest that a channel enlargement of ~1.3 times could occur downstream on an average stream segment if smaller storms are not controlled.

Figure 3-7. Ultimate channel enlargement as a function of watershed imperviousness.



Source: New York State Stormwater Management Design Manual. http://www.dec.ny.gov/docs/water_pdf/swdmch2part2.pdf

Figure 3-8.

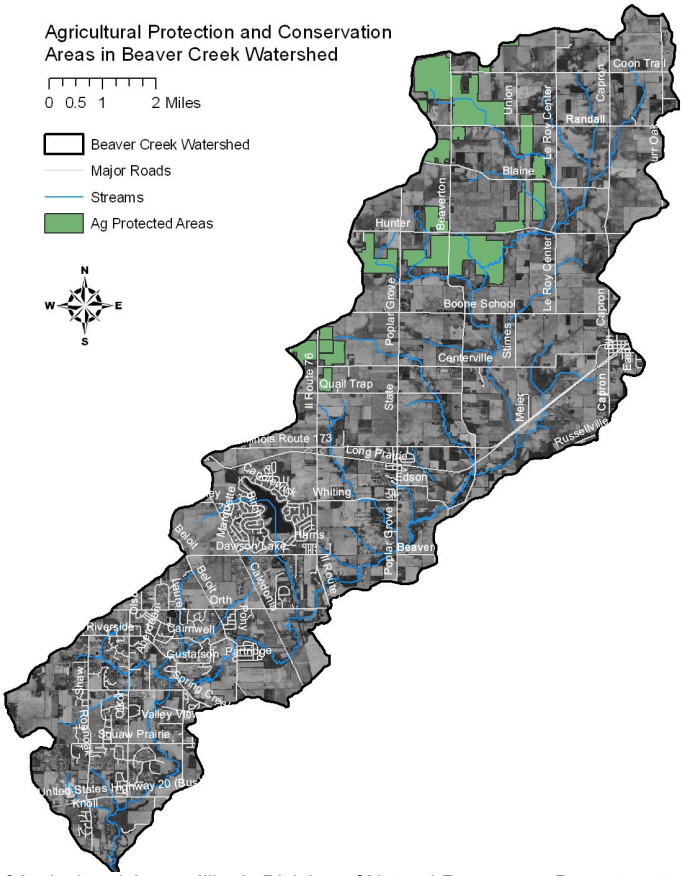


Source: Boone County SSURGO, and municipal comprehensive plans. *Note:* does not include areas considered prime if drained.

3.5 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 Boone County Soil Survey that was in an agricultural use in the 2001 National Land Cover Dataset. The olive color represents prime farmland that would be converted to an urban use at buildout if the County Comprehensive Plan were implemented. The Boone County Comprehensive Plan text recommends retaining the rural character of the county, and calls for protecting 65 to 75 percent of the rural/agricultural land. Three large areas are identified for protection in unincorporated Boone. Techniques recommended include using holding zones, continuing the use of LESA (Land Evaluation and Site Assessment), promoting the Right-to-Farm Act and educating residents on the value of farmland. The Plan also recommends exploring Purchase of Development Rights (PDRs) and Transfer of Development Rights (TDR) as additional measures for protecting farmland. As of 2002, 5,853 acres of farmland in the watershed were 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 core agricultural area in the northern part of the watershed is not expected to see development pressure for the foreseeable future (Figure 3-9).

Figure 3-9.



Source: 2002 Annual Report of Agricultural Areas, Illinois Division of Natural Resources, Department of Agriculture

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4. A VISION FOR THE WATERSHED

This section presents the general policy framework of the *Beaver Creek Watershed Action Plan*. The first subsection presents findings from meetings with local officials and other stakeholders throughout the planning process, and describes activities underway that are most relevant to the watershed planning effort. The second subsection proposes a vision of land use based on various sources of information and stakeholder meeting discussions. 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 Boone County Planning Activity

4.1.1 BOONE COUNTY SOIL AND WATER CONSERVATION DISTRICT

The Boone County Soil and Water Conservation District in conjunction with the Natural Resource Conservation Service has been working to conserve soils and protect water resources since 1942. These agencies work to promote and implement conservation programs of the Illinois Department of Agriculture and the United States Department of Agriculture. These programs help to control soil erosion, manage nutrients, protect water quality, and provide wildlife habitat. The Boone County Soil and Water Conservation District also works with the Illinois Environmental Protection Agency, the City of Belvidere and Boone County to control erosion on construction sites.

4.1.2 BOONE COUNTY CONSERVATION DISTRICT

The Boone County Conservation District (BCCD) is one of only five county conservation districts in the state. The BCCD adopted a Master Plan in December 2006. The Master Plan states a "level of service goal for land acquisition" that is 50 acres of land per 1,000 county residents. The goal also includes a minimum level of land acquisition of 44 acres / 1,000 county residents. The BCCD uses the Boone and Winnebago Regional Greenways Plan as its primary guide for land acquisition, but goes a step further in acknowledging the importance of aquifer recharge areas.

The Master Plan emphasizes the importance of conserving riparian corridors, including Beaver Creek, while acknowledging the value of preserving large tracts of land and acquiring buffers to significant natural areas throughout the county. The BCCD acquired its first parcel at Flora Prairie in 1968 and currently owns and/or manages 2200 acres of land with 15.3 miles of paved biking/walking paths, 4.5 miles of equestrian trails, 16.8 miles of mowed hiking trails, one canoe launch, two softball diamonds, seven public shelters, and one basketball court. Additionally, the BCCD has one administration building/nature center, two buildings used for educational programs, and two maintenance buildings.[27]

The following is a list of BCCD owned properties within Beaver Creek:

Tuttle/Clarkson Natural Area

[27] Boone County Conservation District Master Plan. December 2006.

Beaver Bluffs Conservation Area
Edwards Park and Conservation Area
Schneeman/Leeson Conservation Area
Youssi Conservation Area
McKiski Fen Conservation Area
Unnamed floodplain area east of Town Hall Rd.

4.1.3 BOONE COUNTY COMPREHENSIVE PLAN

This section examines the natural resource and land development policies in the comprehensive land use plans of the county and five communities in the subwatershed. The Boone County Comprehensive Plan, adopted in 1999, is a "blueprint for the short-range and long-range growth and development" for not just the county, but the City of Belvidere and Villages of Caledonia, Capron, Poplar Grove, and Timberlane (and hamlet of Garden Prairie).[28] Where applicable, the plan includes policies and recommendations specific to each community as well as to unincorporated Boone County. The general categories of information addressed in this section include stormwater best management practices, agricultural policies, resource conservation and open space, sewer and water planning, and land use development patterns.

4.1.3.1 Stormwater Best Management Practices

For the purposes of this analysis, stormwater best management practices include policies and language on natural landscaping, soil erosion, impervious surfaces, natural features for stormwater drainage, connection of natural features and trails, and groundwater recharge. The policies and recommendations in the Boone County Comp. Plan address all of these elements. There is a special emphasis on environmental corridors and, in general, protection of the natural resources contained within the county. The County Plan also recommends a county-wide approach to stormwater management, which is now being established.

4.1.3.2 Conservation of Natural Resources and Open Space

The County Plan's environmental goal is to "Protect natural resources and unique physical features." As specific objectives, it has to (1) protect the water quality of both surface and subterranean resources; (2) protect air quality; and (3) protect sensitive environmental areas, including wetlands, floodplains, wooded areas, steep slopes, drainageways, and habitat areas.

Regarding parks and open space, the County Plan emphasizes protecting and conserving open space using methods such as public acquisition, conservation easements and requiring developer contributions or dedication of parkland. It recommends that a joint park district be formed for the communities of Caledonia, Capron and Poplar Grove. The Boone and Winnebago Regional Greenways Plan identify greenways, defined in the County Plan as green corridors of open land that connect existing parks and open spaces. Furthermore, the County Plan states that all environmental corridors should be protected as development occurs.

4.1.3.3 Water and Sewer Infrastructure

[28] Boone County Comprehensive Plan (1999) available at: <http://www.boonecountyil.org/plan/compplan051507.pdf>

The City of Belvidere, the Villages of Capron, Poplar Grove and the Candlewick community are all served by public or private sanitary sewer and water systems. The remainder of the county is served by private wells and septic systems. The County Plan recommends that public water should be provided in areas to be served by sewer, but would not be required in rural and exurban areas of the county. Conditions specific to the separate communities are noted as follows.

Capron's Plan anticipates that any significant new development would prompt the need for facility expansion. While the County Plan notes that public water should be extended to all new development within the Capron growth area, scattered development not connected to the public water system should not be allowed within the Village's future growth area. For Poplar Grove, the Plan recommends that the Village should continue to develop on a central public sewer system. As with the Village of Capron, it states that public water should be extended to all new development within the Poplar Grove growth area, but scattered development not connected to the public water system should not be allowed within the Village's future growth area.

Development within Timberlane is not planned to be on public sewer and water. However, the County Plan states that the Village should require that future development be designed in such a way to make retrofitting of public sewer and water systems feasible in the future. In Belvidere, the Plan recommends that the majority of future development in Belvidere be located in compact development areas served by sanitary sewer systems.

4.1.3.4 Land Development Pattern

Three alternative land use scenarios were developed in the Plan, and "rural" was the selected alternative. It calls for future land use to be 75 percent rural/agricultural, with 21 percent of anticipated growth to occur in existing centers. Conceptual maps depicting land uses in specific areas of the county are included in the County Plan.

The type of development called for in general is clustered and infill development, and locating new housing in areas with convenient access to shopping, schools, churches, and parks. Mixed uses and contiguous development is particularly stressed in the revitalization of central Belvidere. Caledonia's development is to be contiguous to retain the small town character; Capron is intended to be a planned neighborhood with mostly single family residential housing; Poplar Grove is to remain mostly single family with some neighborhood-compatible commercial uses; and Timberlane is to remain exurban single family residential. One of the key goals of the County Plan is to retain the unique character of each community in the county. To that end, community separation areas are identified and designed to physically separate communities by a series of undeveloped areas – generally located along ridgelines or wide floodplain areas. If developed, conservation design is encouraged.

Lastly, and as suggested in Section 3.2.1, the Beaver Creek watershed appears to be an exception to the county-wide goal of retaining 75 percent agricultural land use. Overlay analysis of the watershed with the county comprehensive plan reveals land-use change to leave just 47 percent

agricultural land use within the Beaver Creek Watershed after full implementation of the comprehensive plan. Admittedly, a county-scale land-use goal is not expected to manifest in all spatial subunits of the county whether they be townships or watersheds. It should be acknowledged, therefore, that any aspiration for Beaver Creek as a "model watershed", as voiced by stakeholders, is driven by objectives and/or principles that may deviate from the County Plan.

4.1.4 CANDLEWICK LAKE ASSOCIATION

The Candlewick Lake Association has been quite active in lake management over the years, collecting a large quantity of data on turbidity and nutrient conditions in the lake, retaining the services of a lake biologist, and undertaking projects to improve water quality and recreation conditions. The lake is on the 2008 303(d) list for potential impairments to the aquatic life and aesthetic quality designated uses, but the assessments of these uses are coded as having insufficient information. The potential causes of impairment include total suspended solids, total phosphorus, and aquatic algae, but sources were not identified. It would be important to undertake a subwatershed planning process focusing on the lake to determine the sources of TSS and TP (the latter likely the problem behind the algae) and to recommend projects to limit inputs from these sources. This could be accomplished through the Clean Lakes Program. Furthermore, the subwatershed of the lake is poised for considerable land use change, as it is surrounded on most sides by now-incorporated areas. The Association's commitment and in-house expertise should be seen as a considerable plus in such a planning process.

4.2 Vision of Land Use

The vision for land use in the Beaver Creek Watershed is described in this section. It consists of recommendations for conserving and enhancing natural resources in the watershed, wastewater treatment as the development expands, and protection of water quality. The vision also reflects elements of the Boone County Comprehensive Plan where appropriate.

4.2.1 NATURAL AREA PRESERVATION AND RESTORATION

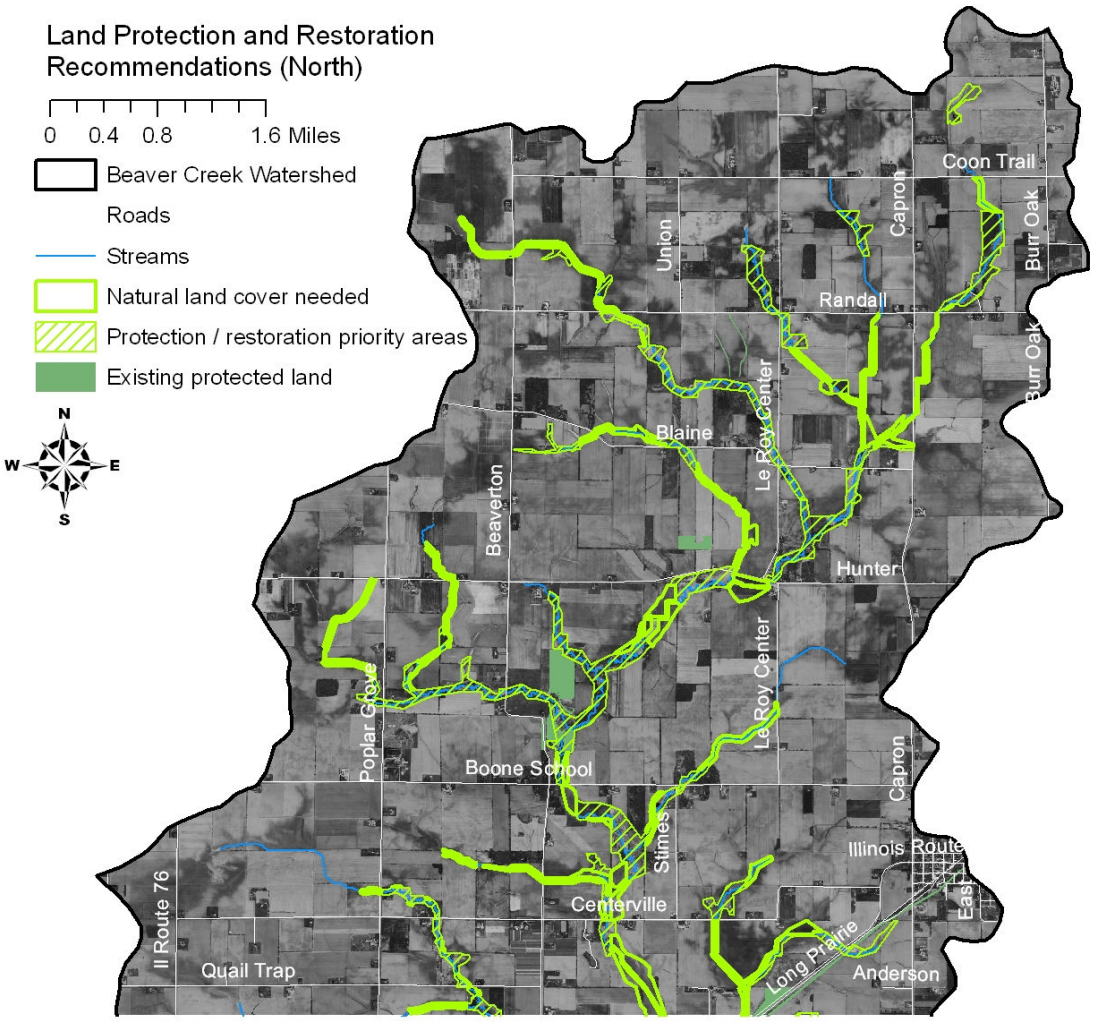
4.2.1.1 Overview

One of the most important strategies for protecting the quality of Beaver Creek is to protect and restore more of the land in the watershed. Little of it is protected now. Many studies have shown a positive relationship between natural land cover in a watershed and the health of aquatic communities as measured by indicators like the fish Index of Biotic Integrity.[29] The Kishwaukee River Ecosystem Partnership has identified priorities for the protection and restoration of natural areas, as shown in Figures 4-1, 4-2, and 4-3 for the northern, central, and southern parts of the watershed. These priorities are based on the presence of wetlands, good quality stands of native trees, the presence of threatened or endangered species nearby, the Illinois Natural Areas Inventory,[30] and other factors. Many of these areas are within the probable area of eventual municipal development as indicated in the Boone County Comprehensive Plan.

[29] 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.
[30] This is a list of areas compiled by the Illinois Natural Heritage Survey that have significant ecological value, whether or not they occur on protected or public land.

Since little of the watershed is held by land management agencies or enrolled in conservation programs, it can be assumed that almost all of the priority areas identified require ecological restoration. Protection could utilize a number of strategies, from acquisition to easements (i.e., acquiring a partial interest in land) to contract enrollment programs like the Wetland Reserve Program,[31] whereas restoration involves returning a landscape to a condition closer to preset-tlement conditions and could involve work ranging from reseeding and periodic burning to major reconstruction projects involving extensive engineering and earthwork. This plan's vision for the preservation and restoration of natural areas includes the elements in the following subsections.

Figure 4-1.



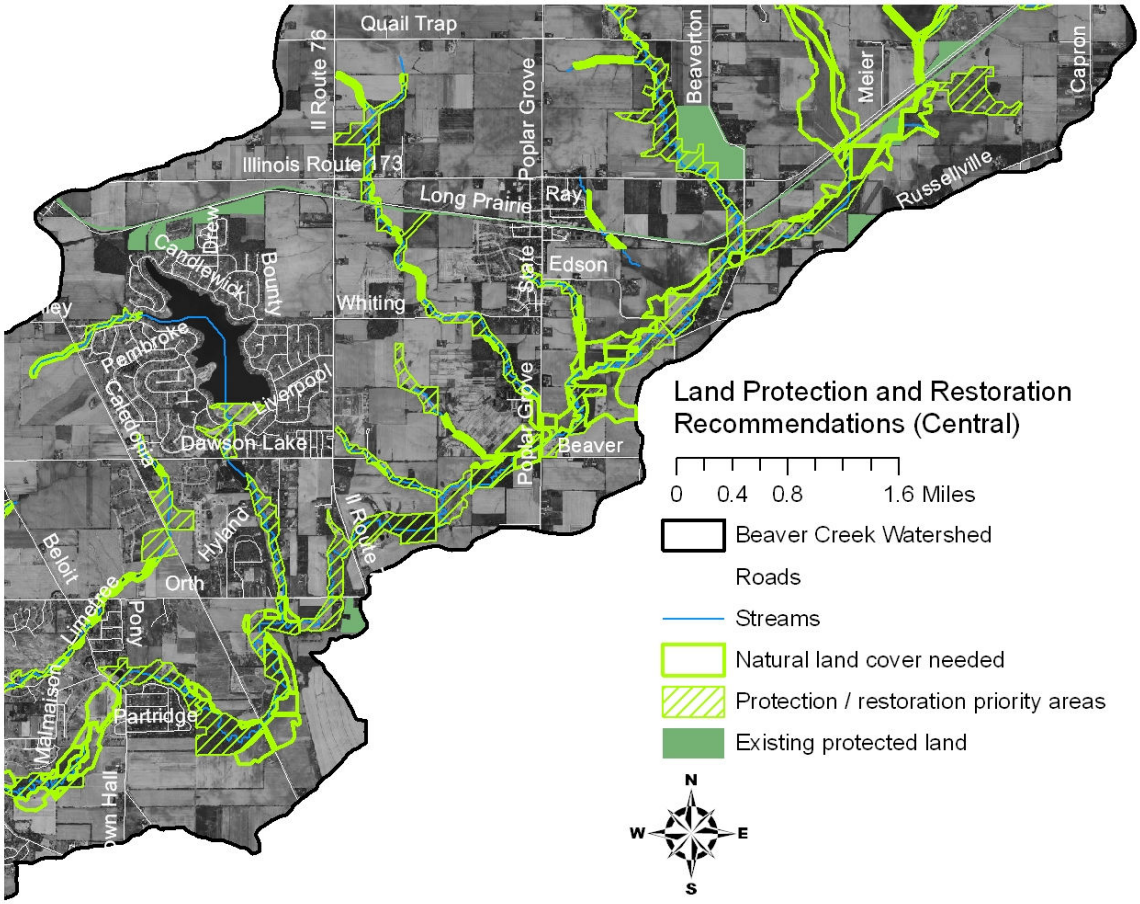
Source: Kishwaukee River Ecosystem Partnership and CMAP

[31] This program provides an opportunity for landowners to receive financial incentives to restore, protect, and enhance wetlands in exchange for retiring marginal land from agriculture. It can involve a ten-year contract or an easement.

4.2.1.2 Legal Protection and Restoration of Terrestrial Natural Areas

This plan identifies 4,140 acres of priority areas (Figures 4-1, 4-2, and 4-3), or approximately 9 percent of the watershed, little of which is in public hands or in any form of conservation program. There are four main mechanisms for establishing the legal protection and ultimately restoration of natural areas. (1) The Boone County Conservation District can acquire additional land as part of its conservation mission, using either resources from future bond issues or state and federal grants. The BCCD is encouraged to take the priority areas established in this plan into account in making such acquisitions. (2) Private landowners can take out easements on their properties in conjunction with land trusts and (3) private landowners can enroll in various conservation programs, such as the Wildlife Habitat Incentives Program, etc. Finally, (4) priority natural areas can be legally protected during development. In other words, sensitive site design or "conservation design" would be used to prevent disturbance of a priority area on a development site, and that priority area would have a conservation easement placed on it. The developer would, generally speaking, be eligible for tax benefits for doing so. A financing mechanism for restoration and maintenance would also need to be set up. The county and the municipalities would need to ask for these conditions during development negotiations, a process made easier by having a formal, ordinance-based procedure for permitting conservation design developments.

Figure 4-2.



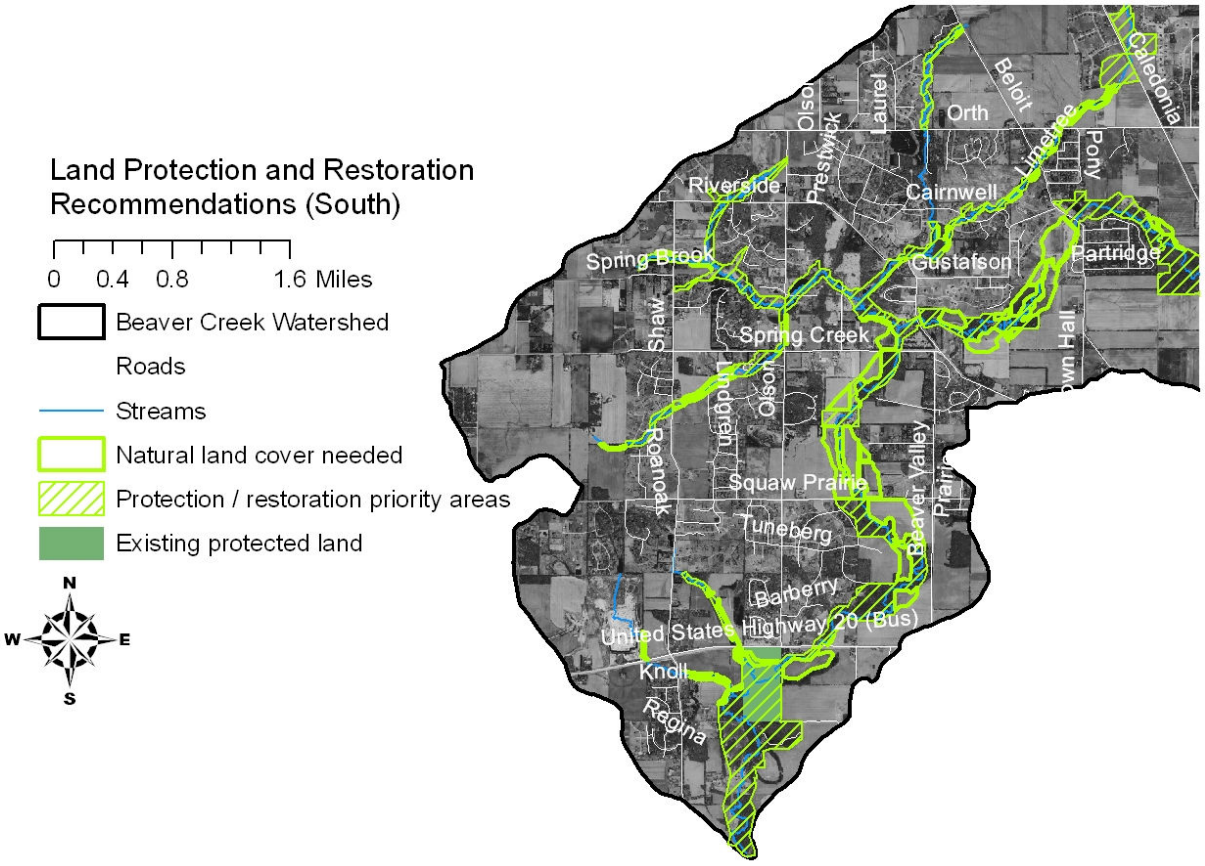
Source: Kishwaukee River Ecosystem Partnership and CMAP

4.2.1.3 Creation of Vegetated Stream Buffers of at Least 100 Feet

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, as shown in more detail in Section 5.1, utilizing the vegetation recommendations of the resource agents at the Boone County SWCD and NRCS. In developing areas, the vision should be accomplished by buffer establishment during development. The areas in need of buffer establishment are shown in Figures 4-1, 4-2, and 4-3 as "open space creation needed."

It is recommended that the eventual Boone County stormwater management ordinance provide for protective buffers, planted with native vegetation, to be reserved during development. The width of the buffer can be based on a variety of factors, but one of the most relevant is the quality of the water body, as measured — in the case of streams — by the Index of Biotic Integrity (IBI) or the Macroinvertebrate Biotic Index. The McHenry County ordinance calls for 100 foot buffers around streams with IBI > 35, while the Lake County ordinance requires 100 foot buffers when IBI > 40. Either ordinance would require 100 foot buffers in Beaver Creek. Buffer composition should be determined based on inferred pre-settlement vegetation conditions or on the NRCS publication *Native Plant Guide for Streams and Stormwater Facilities in Northeastern Illinois*. Buffer averaging should be permitted so long as it remains protective.

Figure 4-3.



Source: Kishwaukee River Ecosystem Partnership and CMAP

4.2.1.4 Wetland Restoration

Many wetlands have been drained by the agricultural practices of channelizing streams and laying drain tile. In agricultural areas, it is recommended that wetland reconstruction be undertaken with the goal of treating agricultural runoff to remove nutrients, as discussed in Section 5. Additionally, a number of the priority areas in Figure 4-1, 4-2, and 4-3 include wetlands that should be managed and restored. Sites for reconstruction of wetlands on cropland should be sited to maximize the amount of drainage area treated by the wetland and should be funded as much as possible using the Farm Bill cost-share programs.

4.2.1.5 Stream Restoration and Instream Habitat Improvement

In contrast to the other elements of this vision which are more terrestrially focused, stream restoration and instream habitat improvement hold the potential to directly improve conditions for aquatic life, increasing scores on the main indicators for this plan, the Index of Biotic Integrity for fish and the Macroinvertebrate Biotic Index for aquatic "bugs." As noted previously, much of the stream network has been channelized, drastically reducing its habitat value, and agricultural land in the watershed has been subject to extensive draining. Thus, any section of the stream that has been channelized (Figure 2-5), that flows past drained wetlands, or that lacks a natural stream corridor is a potential candidate for restoration. Section 5.2 describes the results of a strategic survey of the stream intended to identify a list of potential projects that would make up a medium-term program for implementing the vision, but fully restoring the stream system in the watershed will involve a long-term effort.

4.2.2 DEVELOPMENT PATTERN

The vision of this plan is for conservation design to be used whenever a development site lies wholly or partially within one of the priority areas in Figures 4-1, 4-2, or 4-3. This is a minimum standard, as conservation design could be used profitably on any site in the county. Conservation design 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. Conservation design includes a collection of site design principles and practices that can be combined to create environmentally sound development. The main principles for conservation design are: (1) flexibility in site design and lot size, (2) thoughtful protection and management of natural areas, (3) reduction of impervious surface areas, and (4) sustainable stormwater management."[32] Much as described above in Section 4.2.1.2, the use of conservation design should help ensure that priority protection and restoration areas are not damaged by future development. The most straightforward way to do so would be to pass a conservation design ordinance that provides performance standards, a review process, and maintenance and financing requirements, as for example the City of Woodstock has done.[33] An ordinance passed by the county for unincorporated areas could be adapted by the municipalities as well.

[32] Northeastern Illinois Planning Commission and Chicago Wilderness. 2003. *Conservation Design Resource Manual.* http://www.chicagowilderness.org/pubprod/miscpdf/CD_Resource_Manual.pdf. This is a straightforward, accessible, and useful reference on conservation design, but there are numerous references available.

[33] See Chapter 8B of the Unified Development Ordinance of the City of Woodstock at http://www.woodstockil.gov/index.asp?Type=B_BASIC&SEC={25456C1D-7A0F-4B55-BE47-1E78F326DF8E}

4.3 Vision for Wastewater

As noted in Section 2.2.2, Beaver Creek receives discharge from a number of wastewater treatment plants. The vision of this plan is that nutrient loading from wastewater and the volume of wastewater itself be reduced as much as feasible. To that end, several approaches or technologies could reduce future wastewater discharge from the projections discussed in Section 2.2.2. If remaining effluent nutrient concentrations remain constant with wastewater flow reduction, then these approaches or technologies would also reduce nutrient loading to a receiving stream.

4.3.1 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. The American Water Works Association and California Urban Water Conservation Council are a couple of prime resources on conservation and efficiency; the measures listed below are being promoted by these organizations and 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 be recommended as part of an ongoing regional water supply planning initiative. 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 Villages of Poplar Grove, Capron, Caledonia, and the City of Belvidere are encouraged to show support for both county and regional planning initiatives and undertake municipally led conservation programs to implement these measures.

4.3.2 WASTEWATER REUSE

One approach to reducing wastewater volume is wastewater reuse, i.e., putting treated effluent to a beneficial use rather than discharge it into a stream. In response to antidegradation regulations adopted by the Illinois Pollution Control Board in 2002, Illinois EPA's current FPA review

process requires applicants to conduct an alternatives analysis that includes land application (i.e. one form of reuse) as an alternative to discharge of treated wastewater to surface waters.[34] Treated wastewater can be applied to golf courses, park district property, and agricultural land. Thus, a potential receiving stream is spared an increase in pollutant load associated with an increase in effluent and otherwise discharged to that stream or other surface water.

It is the recommendation of this plan that as population and local employment increase over time, municipalities find cost-effective strategies for land application as opposed to increasing treated wastewater discharges and associated pollutant loads to Beaver Creek. There will be additional opportunities to implement this recommendation with decentralized treatment. In particular, effluent from a treatment system can be used to irrigate common open space in a conservation development if the system was incorporated into the original design; an example is the Sheaffer System[35] where wastewater is reclaimed in a series of deep, aerated ponds, after which the reclaimed water is filtered and disinfected prior to irrigation on the land.

4.3.3 NUTRIENT REMOVAL FROM EXISTING TREATMENT PLANTS

As of now, nitrogen and phosphorus removal are not practiced at any of the wastewater treatment plants in the watershed. It is recommended that, if any of the plants seek expansion, they use the opportunity to install nitrogen and phosphorus removal capabilities. The expected performance of these technologies is shown in Table 2-6. The goal would be for post-expansion nitrogen and phosphorus loading to be lower than pre-expansion loading.

4.3.4 NEW DISCHARGES

It is recommended that Illinois EPA establish a form of water quality trading[36] for any new discharge to the Beaver Creek 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 nonpoint source control projects, with hookup fees repaying the loan for the cost of the BMPs in addition to the treatment facility capital cost. 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 Beaver Creek would still increase as a result of the discharge.

4.3.5 SEPTIC SYSTEMS

Existing septic systems do not appear to contribute substantially to nutrient enrichment, but little is known about their condition or failure rate. In particular it is not known how many of them are surface discharging systems. A number of new septic systems are also expected in the

[34] Letter dated July 18, 2002 from Thomas G. McSwiggin, P.E., Manager, Permit Section, Division of Water Pollution Control, IL EPA to Design Engineer, regarding Revisions in the Permitting Procedures for All New and Expanded Sewage Treatment Plants.
[35] Sheaffer International, L.L.C. < http://www.sheafferinternational.com/ >
[36] 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.

watershed based on plans for "exurban" or very low density growth. This plan generally takes no position on the installation of new septic systems, except that they should not be placed on soils considered unsuitable by the Boone County Health Department. This should also be treated as a factor in land use planning, i.e., exurban growth should not be planned for areas in which soils are unsuitable for septic systems.

4.4 Vision for the Protection and Restoration of Water Quality

Current nutrient loading appears to be well above the target levels established in Section 2. If development occurs as envisioned in the Boone County Comprehensive Plan, it is expected that reductions in nutrient and sediment loading totals would occur on a long-term average basis because of a small shift from agricultural land use to more urbanized land use. As noted above, erosion from construction sites has to be controlled adequately for this to occur. However, additional improvements could be made if the upcoming countywide stormwater management ordinance and local subdivision/zoning ordinances include protections for water quality and natural resources. The next section describes some of these recommended protections. Section 5 lays out opportunities of implementing best management practices that have been identified for agricultural areas in Beaver Creek. The procedure was to identify projects based on feasibility and likely impact and compare their expected load reductions to the targets. The resulting improvements in nutrient and sediment loading are described in Section 4.4.2.

4.4.1 LOCAL AND COUNTYWIDE ORDINANCES

Section 2.3.1 compared model ordinance language with county and municipal ordinances as they exist today. Adoption of countywide uniform minimum standards for stormwater management *with due attention to water quality* has the potential to improve pollutant removal from runoff in new developments. Thus, it has been recommended that Boone County follow the model ordinance elements presented and develop a stormwater management ordinance that is both effective and successful in achieving its purpose. More generally, it is recommended that the countywide ordinance require the use of best management practices for water quality and provide a technical guidance manual describing their design, installation, and maintenance.

Recommendations for requiring protective buffers in the countywide ordinance are made in Section 4.2.1.3 above. Another area that the countywide ordinance should address concerns isolated wetlands that no longer receive federal protection under the Clean Water Act. As noted above, it is an objective of the County Plan to protect sensitive environmental areas including wetlands. Thus, a logical first step would have the Belvidere / Boone County Regional Planning Commission begin to assemble partners and funding to conduct an Advanced Identification of Wetlands (ADID) study. The purpose of an ADID study is to protect wetlands using a science-based approach to understanding their location, extent, and function within the landscape. The resultant information is designed to inform planning and other decision-making that so often involves land-use change. Such a study should not be limited to the Beaver Creek Watershed, but rather be county wide in scope. Kane County, for example, secured the participation of nine different federal, state, and county departments for its ADID study completed a few years ago

with funding from the U.S. EPA, Region 5.[37] As a complementary step, the emerging stormwater management plan should emulate the protection and mitigation of isolated wetlands that neighboring county stormwater management ordinances afford theirs. For example, Lake County outlines its permitting program for "Isolated Waters of Lake County" in the Lake County Watershed Development Ordinance published in 2006.[38]

A specialized stormwater management ordinance is not the only place in which natural resource protections are relevant. 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. A checklist of model development principles[39] is offered below in Table 4-1 for evaluating current development rules at both county and city/village levels of authority. This watershed plan recommends that these principles be addressed in either amended or new zoning and subdivision codes or alternately via site design requirements in a move towards implementing conservation design. Each municipality and the county would do this by holding a "site planning roundtable" in which officials from 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.

Table 4-1. Center for Watershed Protection (CWP) Checklist of Model Development Principles

Area	Development Feature / Code Element	CWP Guideline
1	Street width	18-22'
	Queuing allowed?[40]	Yes
2	Try to minimize street length?	Minimize
3	ROW width	<45'
	Placed utilities under paved part of ROW?	Yes
4	Cul-de-sac radii	<35', <45'
	Allow landscaped island in cul-de-sac?	Yes
	Allow alternative turn-arounds?	Yes
5	Curb and gutter required?	No
	Established swale criteria?	Yes
6	Parking ratio, professional office	<3
	Parking ratio, shopping center	≤4.5
	Parking ratio, single family detached	≤2
	Parking ratios given a max rather than min?	Yes
7	Promote shared parking?	Yes
	Provide model shared parking agreements?	Yes
	Reduce parking ratios w/ shared parking?	Yes
	Parking ratio reduced near transit?	Yes
8	Parking stall width	≤9'
	Stall length	≤18'
	Smaller dimensions for compact cars?	Yes
	Pervious area for spillover parking?	Yes

[37] http://www.co.kane.il.us/kcstorm/adid/index.htm
[38] Lake County Stormwater Management Commission, Watershed Development Ordinance. http://www.co.lake.il.us/elibrary/publications/smc/wdo2006_appcmod.pdf
[39] Center for Watershed Protection. 1998. Better Site Design: A Handbook for Changing Development Rules in Your Community.
[40] "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.

Area	Development Feature / Code Element	CWP Guideline
9	Incentives for structured parking?	Yes
10	Require minimum landscaping for parking lots?	Yes
	Bioretention islands allowed?	Yes
11	CD or open space design allowed?	Yes
	Land conservation or impervious cover a major goal of open space design ordinance?	Yes
	Additional submittal or review requirements for CD?	No
	Is CD by-right form of development?	Yes
	Have flexible site design criteria?	Yes
12	Irregular lot shapes allowed?	Yes
	Front setback for 0.5 ac residential lot	≤20'
	Rear setback for 0.5 ac residential lot	≤25'
	Minimum side setback for 0.5 ac residential lot	≤8'
	Frontage for 0.5 ac residential lot	≤80'
13	Minimum sidewalk width	≤4'
	Sidewalks required on both sides of street?	No
	Sidewalk sloped to drain to yard, not street?	Yes
	Can alternate pedestrian networks be substituted?	Yes
14	Minimum driveway width?	≤9'
	Can pervious materials be used on driveway?	Yes
	Use two-track design?	Yes
	Shared driveways permitted in residential developments?	Yes
15	Require association to manage open space?	Yes
	Require consolidation of open space?	Yes
	Keep percentage of open space in natural condition?	Yes
	Uses defined for open space?	Yes
	Can open space be managed by third party?	Yes
16	Discharge roof runoff to yard?	Yes
	Allow temporary ponding on yard or roof?	Yes
17	Have stream buffer ordinance?	Yes
	Requires min buffer width?	≥75'
	Include wetlands, steep slope, and floodplain?	Yes
18	Require native vegetation in buffer?	Yes
	Does ordinance describe allowable uses in buffer?	Yes
	Buffer ordinance specifies education and enforcement?	Yes
19	Encourage preservation of natural vegetation on residential lots?	Yes
	Require clearing trees from septic field?	No
20	Require tree conservation?	Yes
	Limits of disturbance on construction plans adequate to prevent clearing?	Yes
21	Incentives for conserving non-regulated land?	Yes
	Flexibility to meet regulatory requirements?	Yes
22	Require water quality treatment for stormwater?	Yes
	Effective design criteria for BMPs?	Yes
	Discharge stormwater directly into wetland without pretreatment?	No
	Restrict or prohibit development in 100 yr floodplain?	Yes

4.4.2 EXPECTED RESULTS

Table 4-2 reports the load reductions estimated for each of the identified opportunities from the perspective of the horizon year — that is, assuming a long time frame for the implementation of the plan — and compares them to the estimated load reduction needed. To estimate the effect of the recommended BMPs requirements in the countywide stormwater ordinance, two key assumptions were made: runoff from all areas planned for exurban residential development would be treated at least by grass swales and that all other development would be served by

wet detention, which generally shows higher water quality benefits that dry detention.[41] The NIPC model ordinances described in Section 2.3 state a preference for wet detention. For wastewater, it was assumed that the plants would meet the 1 mg/L total phosphorus standard and that they would also undertake biological nutrient removal for nitrogen.[42] To estimate the improvement resulting from agricultural BMPs, the water quality benefits of the recommendations in Section 5 were summed. The results indicate that the identified projects, policies, and anticipated changes in the watershed would likely result in meeting the load reduction target by a comfortable margin.

Table 4-2. Load reductions resulting from recommended policies and BMPs

	N (lb/y)	P (lb/y)	Sediment (t/y)
Total reduction needed	340,480	50,892	—
Reduction from identified opportunities or planned changes	433,581	72,026	6,758
Required BMPs in development (wet pond + swales)	28,409	3,109	1,365
Conversion from agricultural to urban use	155,184	21,685	—
Agricultural BMPs	169,777	30,779	5,393
Nutrient removal at WWTPs	80,211	16,454	—
Additional reduction needed	(93,101)	(21,134)	—

[41] Pollutant removal values were taken from the National Pollutant Removal Performance Database (Version 3) developed by the Center for Watershed Protection. See http://www.cwp.org/Resource_Library/Center_Docs/SW/bmpwriteup_092007_v3.pdf.
[42] Nutrient loading was not estimated for the Schlichting discharge.

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.

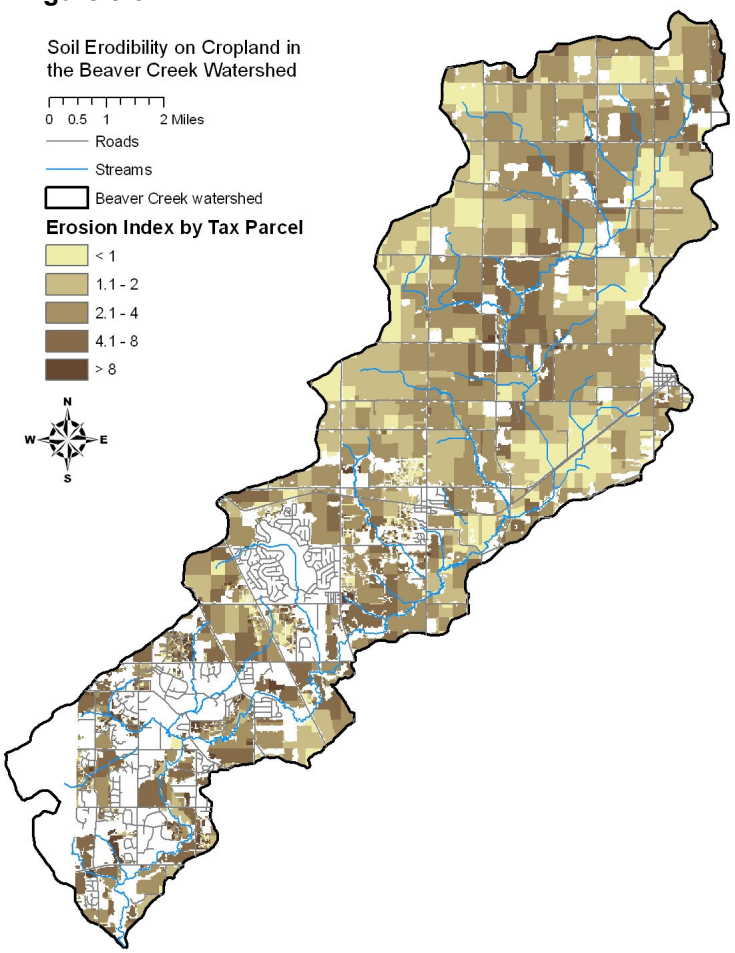
5.1 Agricultural Best Management Practices

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.

5.1.1 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 most applicable to lands with higher erosion potential. Increased use of conservation tillage would be beneficial in areas with erosion index values between 1.0 and 8.[43] It can be seen from Figure 5-1 that higher erosion areas run along a spine parallel to the stream, primarily in the Upper Beaver Creek watershed. There are 26,629 acres in of land with an erosion index value over 1 but less than 8, averaged by tax parcel, in agricultural production in the Boone County portion of the watershed (parcel information was not available for the small area in Winnebago).[44]

Figure 5-3.



[43] 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 in order to maintain eligibility for Farm Bill programs farmers are required to implement certain conservation measures if they farm highly erodible lands (erosion index > 8, with additional conditions). The map in Figure 5-1 averages the erosion index by tax parcel, so some areas in each parcel will have higher and lower index values.

[44] About 4,000 acres are under the tolerable soil loss rate (index < 1) and about 400 have erosion potentials eight times the tolerable rate.

Table 5-1. Conservation tillage targets

Erosion index	Acres	Number of owners	Number of parcels	Target year
< 1	3,933	307	796	—
1.1 – 2	9,326	384	1,419	4–5
2.1 – 4	12,254	595	2,328	2–4
4.1 – 6	3,955	400	2,814	1–2
6.1 – 8	1,095	151	3,067	1–2
> 8	413	195	310	—
Total	**30,976**	***1,959**	**10,734**	

* Individual owners may be represented in more than one erosion index category
Note: excludes Winnebago County

In Boone County, various forms of conservation tillage accounted for only about 22 percent of farm acres planted with corn in 2006 but 82 percent of soybean acres.[45] These two crops are planted on the vast majority of fields in the watershed. 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 (78 percent and 18 percent for corn and soybeans, respectively), then an additional 12,048 acres could be targeted for conservation tillage. Priorities could be set by working down from an index value of 8. In the first two years of plan implementation, it is recommended that resource agents and the agricultural BMP coordinator (Section 5.1.7) try to target reduced tillage adoption to the fields with erosion index values over 4 but less than 8. In the next two years, the fields with index values of 2 – 4 would be targeted. In the final year the remaining acreage would be targeted (Table 5-1). To get a better sense of the level of outreach effort required, the number of individual parcel owners was estimated as a measure of the number of people who would need to be contacted.[46] Erosion index values by parcel with associated ownership information are provided in Appendix B.

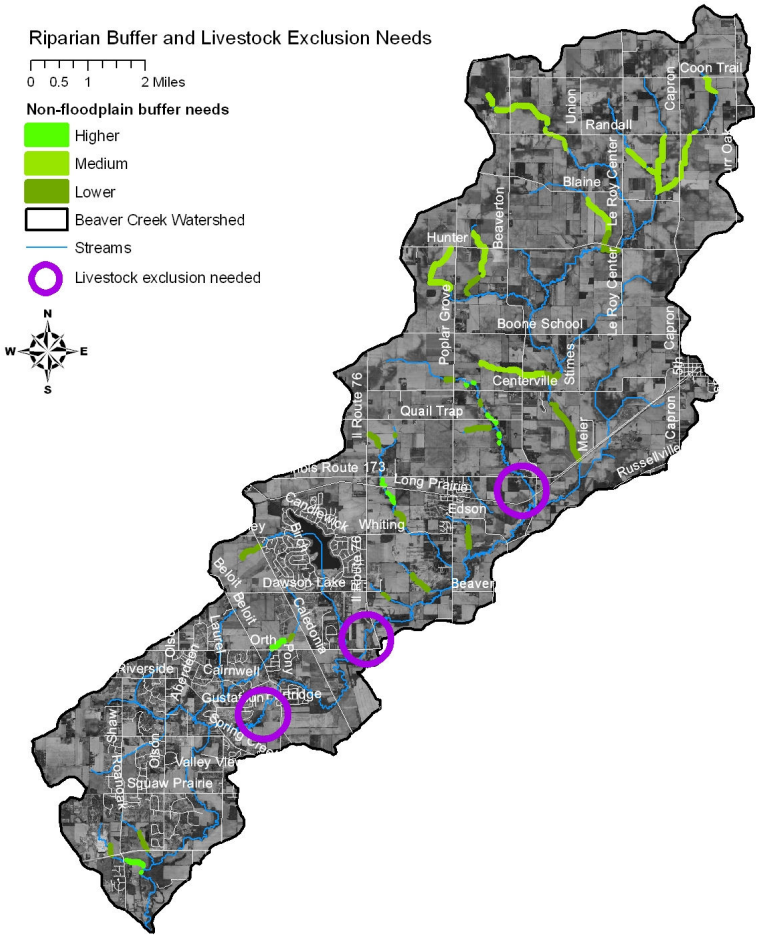
Figure 5-4. Strip-till on left; no-till on right

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 Boone 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. Some NRCS agents tend to promote the strip till form of conservation tillage — tilling strips where seeds will be planted and leaving area between rows untilled (Figure

[45] Illinois Department of Agriculture. 2006. *Illinois Soil Conservation Transect Survey*.
[46] This estimate is subject to several limitations. Among others, some properties are held by firms which clearly intend to develop them even if they are currently in agricultural use. Also, parcel databases often have misspellings of names, may alternate between last–first and first–last name sequences, and so forth. Finally, many producers farm on a cash rent basis.

5-2). No-till tends to keep the soil colder and wetter for longer into spring, which delays planting and can 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 5-3.



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. 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,[47] but the SWCD can assist by helping farmers understand the program and fill out the forms. As of July 1, 2008, no contracts had been signed in Boone 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.[48] 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.

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

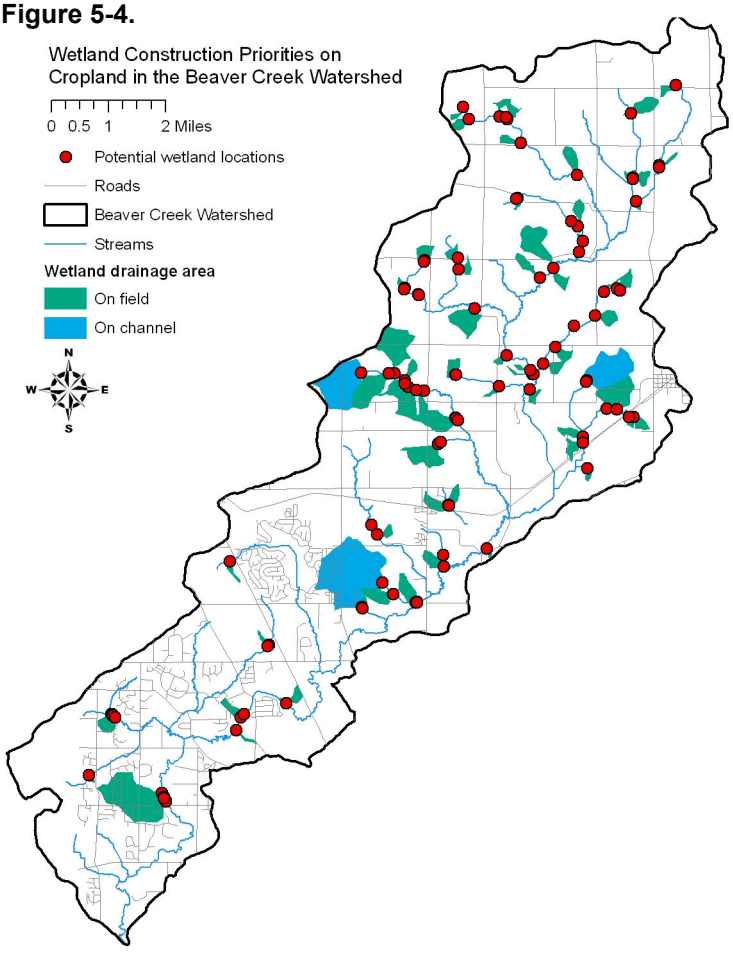
5.1.2 LIVESTOCK EXCLUSION

Livestock is not a major factor in Beaver Creek — livestock operations have been moving further west from Boone County over the past decades — but there are three locations where cattle are found near the stream and where livestock exclusion may be needed. This generally consists of fencing, streambank stabilization, and the provision of alternative watering. Stakeholders were asked to identify potential project locations along the stream, resulting in the recommendations in Figure 5-3. The approximate locations are just south and east of Route 173 and Beaverton Rd., the stretch between Route 176 and Orth Rd., and west of Town Hall Rd.

5.1.3 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. 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 5-3 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. About 162 total acres of filter strips are recommended for installation.

Figure 5-4.



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. Under most conditions, it can at least be shown (Section 5.1.8 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.

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.[49] The program is run through Boone County Soil and Water Conservation District. One problem with instituting agricultural BMPs is 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.

5.1.4 NUTRIENT MANAGEMENT

All cropland could potentially benefit from improved nutrient management. It will be somewhat more beneficial on lands with higher erosion potential because phosphate tends to bind to soil particles, although nitrate export is not a function of erosion potential since it tends to leach through soil and be removed through the tile drain system. Thus the priority areas for nutrient management can be considered similar to the priorities for conservation tillage. It is not known how many acres could benefit from improved nutrient management. Nutrient management will probably already have been implemented to a somewhat greater degree than conservation tillage because of the direct savings in fertilizer inputs. For purposes of planning it was assumed that about two-thirds of the cropland in the watershed (21,600 acres) could be targeted for additional nutrient management planning. 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.

Figure 5-5. Grass waterway

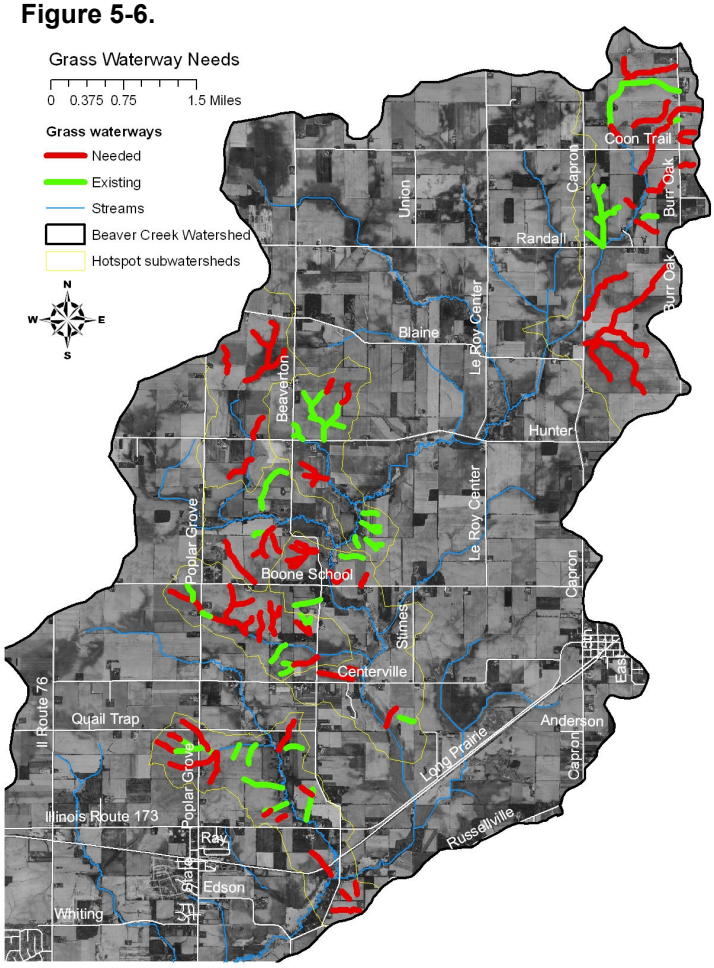
5.1.5 WETLAND CONSTRUCTION IN AGRICULTURAL AREAS

Wetlands can be used to treat nutrient enriched runoff from cropland by constructing them down slope from fields and intercepting tile drain or grass waterway flow. This practice seems to have been used very little in Illinois, although Iowa has done so extensively through the Conservation Reserve Enhancement Program. Farm Service Agency research suggests that wetlands

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

are one of the most cost-effective means of reducing nitrogen loading.[50] 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. The 2001 National Land Cover Dataset was used to identify cropland, while the National Wetlands Inventory provided wetland locations.

Figure 5-6.



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 5-4). Most of the potential wetland construction locations were "on field," meaning that they would be constructed on farmland just off the stream and treat only the land immediately up slope. A few locations were on channel, meaning that they would receive water from a tributary upstream as well as from direct overland drainage; these were in the far headwaters of tributary subwatersheds. Using the rule of thumb that a 1:100 ratio of wetland area to drainage area[51] is required for effective treatment we estimate the resulting potential acreage of wetland construction at 42 acres, treating 4,156 acres of mostly cropland. Shapefiles describing the locations of potential agricultural BMP projects are in Appendix C.

5.1.6 GRASS WATERWAYS

Grass waterways help limit soil loss from farm fields by preventing the formation of gullies and by trapping sediment washed in from the field. Locations where grassed waterways are needed were identified by examining both aerial photography and flow accumulation — that is, where

[50] http://www.fsa.usda.gov/Internet/FSA_File/hyberg_iowa_wetlands.pdf

[51] This 1% value is chosen for planning purposes. For example, the Iowa Conservation Reserve Enhancement Program allows ratios between 0.5% and 2% (http://www.agriculture.state.ia.us/waterResources/pdf/LandownerGuide.pdf). The actual wetland size will be determined by site conditions.

concentrated flow would occur based on topography — in cropland and determining whether a grass waterway was already in place (Figure 5-6). The study was limited to the "hotspot" subwatersheds — those estimated to produce more nutrient and sediment loading per acre than the watershed average — in the core cropland area of the watershed in Upper Beaver Creek. Assuming an average waterway width of 35 feet, the results suggest that about 85 acres of waterways could be installed.

5.1.7 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 benefits. 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.

5.1.8 COSTS AND LOAD REDUCTIONS

Table 5-2. Estimated annual load reductions from agricultural BMPs

	Wetland Construction	Waterways	Nutrient Management	No/Strip Till	Livestock Exclusion	Filter Strips	**Total**
Acres installed	42	85	21,600	12,048	3 sites	162	—
Acres treated	4,165	NE	21,600	12,048	—	972	—
Nitrogen (lb/y)	14,698	NE	47,641	97,434	603	10,005	170,380
Phosphorus (lb/y)	3,917	NE	14,812	10,622	132	1,428	30,911
Sediment (t/y)	1,277	NE	0	3,847	73	269	5,466

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*
NE = not estimated

Table 5-3. Estimated costs for agricultural BMPs

Conservation Practice	Ac	Program	Avg cost / Ac[52]	Capital cost	Cost share	Soil rental /ac[53]	XSO /ac[54]	Total incentive payments to farmers	Total cost to farmers or (savings)
Filter strips[55]	162	CRP	$260	$42,120	90%	$95	$4.51	$35,399	($31,187)
Waterway – new	85	CRP	$2,250	$191,250	90%	$95		$18,190	$935
Wetland constr.[56]	42	CRP	$4,100	$172,200	90%	$95		$8,988	$8,232
Livestock excl.[57]	3 sites	EQP	$3,689	$11,067	90%			$0	$1,107
Strip till	12,048	CPP	$20	$240,960			$2.70	$273,490	($32,530)
Nutrient mgt	21,600	CPP	$20	$432,000				$432,000	$0
Total	33,940			$1.1 m				$768,066	($53,443)

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

5.2 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 and aquatic "bugs" and in some cases to improve stream buffering.

Stream Crossing Near the Intersection of Leroy Center Road and Randall Road (1) The stream crossing just west of the Leroy Center-Randall Road intersection is likely a source of large amounts of suspended sediments and nutrients to Beaver Creek. Currently runoff from the row crop field directly enters the stream channel. In addition tile flow enters the stream after flowing over bare ground. The substrate downstream of this area is silt covered and the water is turbid. Because this section of stream is in the headwaters, potential impacts could occur far down-stream. In addition, perched culverts are present where the stream passes under the road. A 100-foot wide riparian buffer or wetland should be installed adjacent to the stream channel to protect the stream from direct agricultural runoff. A grassy swale should be planted along the road to reduce the delivery of solids to the stream. The tile flow should also be directed into the grassy swale. The perched culverts should be replaced with a passable design geared towards fish species present in the watershed. Barriers to this project would be the cooperation of the local landowner and funding constraints. For budgeting purposes $6,000 should be allocated for

[52] 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
[53] Average soil rental rate for soils in Beaver Creek watershed
[54] 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
[55] Notes: the following incentives apply to filter strips, grass waterways, 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.
[56] Shallow water wetland estimated 5 acre area with 1 ft soil removed at $2.35/yard and 100 per acre seeding.
[57] Livestock exclusion estimated as 500 feet of electric fencing at $1.25 /ft, bank stabilization and planting of 2 acres at $433 /ac, and the installation of a watering trough (120 – 499 gal) at $633 each and pump at $1,565 each.

creation of 2 acres of stream buffer or wetland, $30,000 should be allocated to the creation of a grassy swale near the road, and $100,000 should be allocated to replace the culverts.

Figure 5-7. Stream Crossing near Intersection of Leroy Center Road and Randall Road.

Figure 5-8. Stream Crossing near Intersection of Leroy Center Road and Randall Road.

Farm Downstream of Tuttle Clarksen Natural Area on Hwy 173 (2) The farm just downstream of the Tuttle Clarkson Natural Area is characterized by a silty bottom and eroding banks likely caused by a combination of farm runoff, bank alterations, and cattle movement. It appears a section of the stream's floodplain may have been filled as a result of grading an agricultural field. The current stream configuration is removing large amounts of material. The obviously eroding portions of the bank should be planted with native vegetation or reinforced with riprap or other materials as necessary to prevent further soil loss. Cattle should also be excluded from the stream channel. The field located on the eastern bank should be graded to allow for additional storage during storm events to reduce the severity of erosion. Shrubs and trees should be planted along the stream corridor to improve wildlife habitat and provide shading of the stream channel. Instream restoration should include the installation of large woody debris to serve as fish habitat and encourage flow heterogeneity such as eddies and scour pools. Any instream or corridor improvement in this stream section would be especially valuable because of the close proximity to the Tuttle Clarkson Natural Area. Barriers to completing this project would be cooperation of the local landowner and funding. A total of $12,000 should be allocated to construct cattle exclosure fencing, $33,750 should be allocated for bank stabilization of approximately 450 lineal feet ($75/foot), approximately 6 acres of the floodplain should be re-graded at a cost of $118,900 (including design and permitting), 16 acres of stream buffer will require $48,000, and a series of five boulder clusters should be allocated $15,000.

Figure 5-9. HWY 173 Downstream of Tuttle/Clarkson Natural Area

Beaver Creek Stream Crossing at Hwy 173 (3) The bridge spanning Beaver Creek at Hwy 173 is currently being rebuilt. The upstream and downstream stream sections from this location are

channelized and/or highly entrenched nearly reaching Centerville Road upstream and Beaverton Road downstream. There is evidence of bank erosion visible from the road and the stream buffer is insufficient. The stream bottom in this section is variable, but shows signs of degradation primarily in the form of siltation. Investigations at the road crossings downstream indicate problems with siltation. It is recommended that this entire section of stream be relocated to its original bed requiring both a major excavation of the channel and its floodplain. Expansive in-stream habitat enhancements will be required such as the addition of bottom substrate appropriate to the local geological characteristics, addition of large woody debris or stream barbs to encourage habitat and hydrologic heterogeneity, and planting of native vegetation along restored floodplain areas including site appropriate prairie and wetland species. This is necessary because of the current degraded conditions of this stream section. Because of the current bank and channel configuration, there is very limited opportunity for improvement without a large-scale restoration effort. The overall benefits of a large-scale restoration would positively affect all aquatic, semi-aquatic, and terrestrial fauna including fishes, herptiles, birds, small mammals, and insects by creating connected aquatic and terrestrial habitats that are currently lacking. Barriers to this project would be cooperation of local landowners and funding a large-scale restoration project. A total of 1.2 miles of stream channel are in very poor condition. Cost estimates are very difficult to generate but would likely be in the range of $1,000,000-$2,000,000.

Figure 5-10. Beaver Creek Stream Crossing at HWY 173

Stream Crossings near the Intersection of Leroy Center and Blaine Roads (4) The stream crossings near the intersection of Leroy Center and Blaine Roads occurs along relatively high quality sections of stream. Upstream there are numerous naturalized old fields with a high degree of meandering in the stream channel. The immediate downstream section is characterized by coarse substrates, naturalized old fields, and dense riparian vegetation transitioning into a channelized section somewhat further downstream. The culverts at this location should be removed and replaced with passable structures. The high degree of separation between the culverts and the stream channel preclude any upstream movement of fish species. The benefit of replacing the culverts would be to create a relatively large section of connected, intact stream channel. Perched culverts generally prevent fish passage limiting access to seasonally important headwater areas in the watershed. They also limit the distribution of mussels by restricting the upstream movement of larval host fish species. Barriers to this project would be funding replacement of relatively new culverts. A total of $200,000 would be required to replace the existing culverts.

Figure 5-11. Near Intersection of Leroy Center Road and Blaine Road.

Figure 5-12. Near Intersection of Leroy Center Road and Blaine Road.

Stream Section Downstream of the Crossing at Beaverton Road (5) The stream section downstream of the crossing at Beaverton Road is located at the base of a small valley. The valley appears to be used for cattle grazing as the stream banks show evidence of trampling. The banks are also eroding on the cutting edge of the stream with some visible slumping. There are two perched culverts at the road crossing causing the formation of a small backwater area upstream. The stream bottom is not easily visible from the road, but the land management and eroding banks suggest at least some silt is present.

Table 5-4. Estimated costs and potential funding sources for habitat restoration projects

Site	Project Description	Quantity	Unit	Cost
1a	stream buffer creation	2	acres	$6,000
1b	grassy swale creation	4.5	acres	$30,000
1c	culvert replacement	1	unit	$100,000
2a	cattle exclosure fencing	600	linear feet	$12,000
2b	bank stabilization	450	linear feet	$33,750
2c	floodplain grading/creation	6	acres	$118,900
2d	stream buffer creation	16	acres	$48,000
2e	boulder clusters installation	5	units	$15,000
3	complete channel restoration	1.2	miles	$1-2 million
4	perched culvert replacement	2	units	$200,000
5a	cattle exclosure	3,000	linear feet	$60,000
5b	bank stabilization	1,000	linear feet	$75,000
5c	stream buffer creation	14	acres	$42,000
5d	stream barb installation	3	units	$22,500
5e	culvert replacement	1	unit	$75,000
6a	stream buffer creation	17	acres	$51,000
6b	stream barb installation	4	units	$28,000
7	wetland creation	30	acres	$90,000

Cattle should be excluded from the stream channel to prevent further trampling damage to the stream banks. Bank stabilization such as riprap or vegetated riprap should be installed in highly eroding areas while areas with limited bank erosion should be planted with native vegetation. Native vegetation should be planted along the stream corridor to create a 100-foot wide stream buffer. The perched culverts should be replaced with passable structures to facilitate movement of fish and other aquatic species. Further investigation of the stream channel is required to de-

termine additional instream habitat improvements, but it is likely that the steam would benefit from the installation of anchored large woody debris or stream barbs in alternating patterns to create backwater eddy areas and/or parallel installations to constrict flow and create scour pools. The benefit to this project would be to create more instream habitat heterogeneity, reduce bank erosion limiting addition of silt, and limit runoff. The cattle exclosure will require $60,000, bank stabilization of approximately 1,000 linear feet will cost $75,000, stream buffer creation for 14 acres will require $42,000, and stream barb installations at three locations will cost $22,500. Culvert replacement in this location is estimated at $75,000.

Figure 5-13. Downstream of the Crossing at Beaverton Road.

Figure 5-14. Downstream of the Crossing at Beaverton Road.

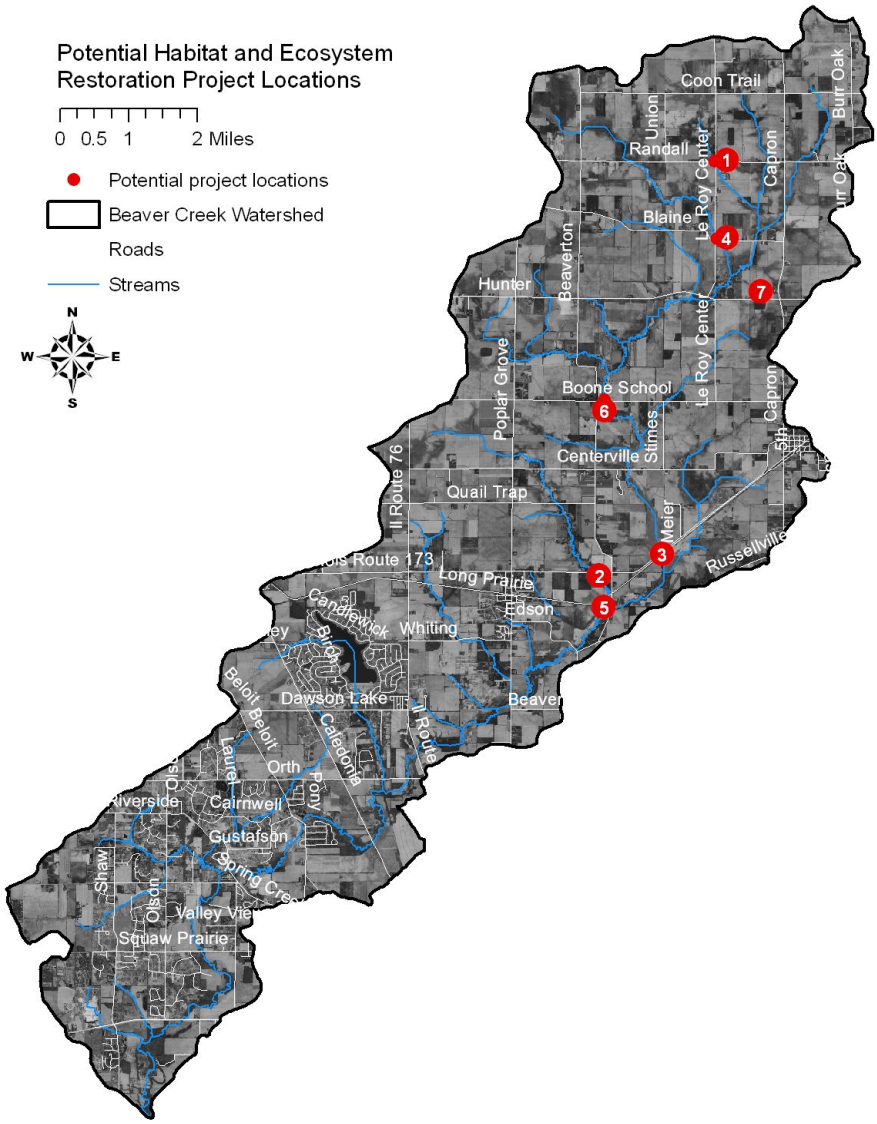
Stream Section Just East of Intersection of Beaverton Road and North Boone School Road (6)
The stream upstream of the road crossing is entrenched with a narrow riparian zone composed of reed canary grass on the west bank. The stream bottom is generally composed of coarse substrates with some siltation. The downstream section of stream is a sand/silt mixture with a mowed lawn within 15-feet of the stream channel. Both of these stream sections are low gradient and lack instream habitat. The upstream section should have an expanded riparian buffer planted out to 100-feet from the stream channel. Large woody debris or stream barbs should be installed in both the upstream and downstream sections to encourage habitat heterogeneity either in alternating or parallel orientation. Stream buffer creation for 17 acres will cost approximately $51,000, while stream barbs installed at 4 locations will cost $28,000.

Figure 5-15. East of Beaverton Road and North Boone School Road Intersection.

Figure 5-16. East of Beaverton Road and North Boone School Road Intersection.

Wetland Restoration West of Capron Road and North of Hunter Road (7) There is a large low lying area just west of the Capron Road suitable for a wetland restoration. The field is currently in production, but large areas of standing water are indicative of water holding potential. There is a ditch section where water flows during wet periods down to the stream channel. This area is not currently identified as a drainage way in available GIS shapefiles, but is visible in aerial photographs. Restoration of a wetland at this location would create valuable habitat for herptiles and birds as well as provide water quality benefits and additional storm and floodwater storage. This site should be further investigated to determine the extent of hydric soils and to determine if subsurface drain tiles are present that might be disabled in order to restore pre-agricultural hydrology. The approximate size of restored wetland is 30 acres for a cost of $90,000.

Figure 5-17.



5.4 Schedule for Implementation

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

Table 5-5. Schedule for implementing recommended actions

Year	Action	Party	Section
2008	Begin monitoring nitrogen and phosphorus in wastewater	WWTPs	6.1.2
2009	Submit applications for funding for agricultural BMP coordinator	KREP/SWCDs	5.1.7
	Begin physical-chemical monitoring program	IEPA/ISWS	6.1.1
	Submit applications for priority 1 restoration practice	Landowner/KREP	5.2
	Draft conservation design ordinance language and seek passage	County and municipalities	4.2.1.2, 4.2.2
	Apply for funding for Candlewick Lake watershed plan	Candlewick Lake Assoc and KREP	4.1.4
2010	Agricultural conservation coordinator hired and begins work	KREP/SWCDs	
	Hold site planning roundtable to review ordinances for water quality effects and recommend amendments	County and municipalities	4.4.1
	Submit applications for priority 2 restoration practice	Landowner/KREP	5.2
2011	Submit applications for priority 3 restoration practice	Landowner/KREP	5.2
2012	Begin water quality model calibration and validation	ISWS	6.1.1
	Submit applications for priority 4 restoration practice	Landowner/KREP	5.3
2013	Begin plan update	IEPA/KREP/CMAP	—

CMAP = Chicago Metropolitan Agency for Planning, IEPA = Illinois Environmental Protection Agency, ISWS = Illinois State Water Survey

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 Beaver Creek Watershed Action Plan.

Additionally, an agricultural BMP coordinator is proposed in Section 5.1.7. 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 wa-

tershed 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 Beaver Creek 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 and potentially other parties commit funds 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 (if at all) and determine more precisely the reduction in loading (if any) necessary to meet the criteria.[58] Additional biological monitoring beyond the Intensive Basin Survey, while useful, is not being recommended in Beaver Creek.

Approximately 18 ~ 24 samples per year for about four years are recommended for nutrients and sediment at the site of Illinois EPA station PQD 07 (US Hwy 20 bridge). 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.[59] Because sedimentation may be impairing the creek as well, 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. 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 Beaver Creek 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

[58] 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.

[59] 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 2, the wastewater treatment plants do not monitor total nitrogen or total phosphorus. It is recommended that Illinois EPA require all wastewater treatment plants to monitor and report total nitrogen and total phosphorus as well.

6.2 Milestones for Plan Implementation

The interim measurable milestones for determining whether plan recommendations are being implemented are described in section 5.4, Table 5.5: Schedule for implementing recommended actions. It is further recommended that KREP track progress with implementation via an annual review (or more frequent if preferred) where all parties that are listed as having a lead role with implementation provide a report on the status of their activities. CMAP staff will participate in these annual reviews and lend assistance where appropriate.

6.3 Ensuring Load Reductions Are Being Achieved

Two 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, should IEPA choose to accept the plan recommendation made above to require the municipal wastewater treatments plants to monitor and report total nitrogen concentrations in effluent, these data will significantly improve the ability to determine the effectiveness of planned nitrogen removal technologies and loads over time from these point source dischargers.

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