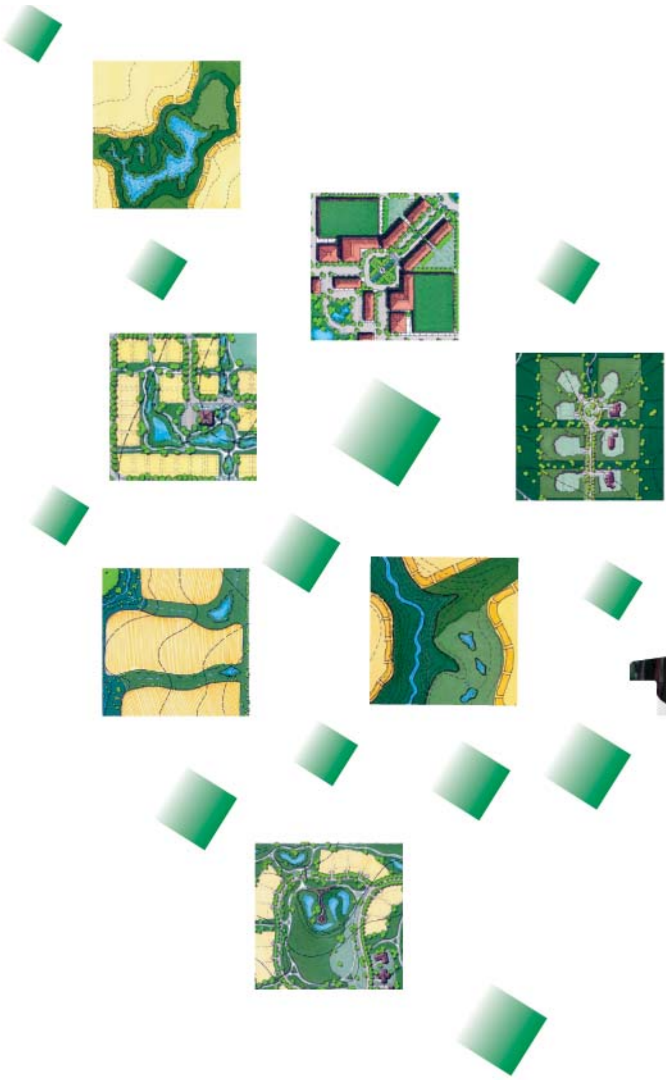

September 2003

Blackberry Creek Watershed
Alternative Futures Analysis

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was funded by a grant from the US Environmental Protection Agency
through the Illinois Department of Natural Resources, with a match
from the Kane County Department of Environmental Management.

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Project Team:

Conservation Design Forum:
Chingwen Cheng, Staff Designer
Sandra Kosek, Project Intern
Charles McGhee Hassrick, Project Manager
Tom Price, Director,
Water Resources Engineering

Illinois Department of Natural Resources:
Marvin Hubbell,
Wetland Biology
Bill White,
Realty and Environmental Planning

Kane County:
Ken Anderson, Project Manager,
Department of Environmental Management
Karen Kosky, Watershed Engineer,
Department of Environmental Management
Kane County

The Conservation Foundation:
Ksenia Rudensiuk, Watershed Manager

US Environmental Protection Agency:
Sue Elston,
Chicago, Illinois Office
Rich Sumner,
Corvallis, Oregon Office

Advisory Team:

Conservation Design Forum:
James Patchett, Founder and President
David Yocca, Director,
Landscape Architecture and Planning
Gerould Wilhelm, Ph.D., Director
Environmental Services

Illinois Department of Natural Resources:
James Langbein, Fisheries
Steve Pescitelli, Fisheries
Robert Rung, Fisheries

Kane County:
Sam Santell, Director,
Planning Department
Paul Schuch, Director,
Department of Water Resources

King County, Washington:
Klaus Richter,
Department of Natural Resources

Northern Illinois Planning Commission:
Dennis Dreher

RP Novitzki and Associates:
Richard Novitzki

(continued on the next page)

Advisory Team (continued):

The Natural Conservancy:
JoJo Gehl

University of Oregon:
Dave Hulse

US Environmental Protection Agency:
Tom Davenport,
Chicago, Illinois Office

US Fish and Wildlife Service:
John Rogner

US Geological Survey:
Audrey Ishii
David Soong

Village of Sugar Grove, Illinois:
Jane Tompkins

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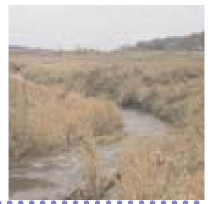

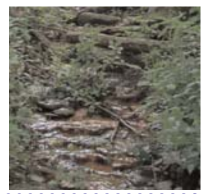

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Introduction and Purpose

In July 1996 a major rainfall event struck northeastern Illinois. One of the most heavily impacted areas was the Blackberry Creek Watershed. The flooding and associated damage prompted formation of the Blackberry Creek Watershed Resource Planning Committee. This committee, with the assistance of numerous municipal, county, regional, state, and federal agencies, as well as private consultants, developed the Blackberry Creek Watershed Management Plan. This plan was completed in 1999 and adopted by most of the municipalities and Kane and Kendall Counties. A significant focus of the Plan's recommendations was prevention of problems as the watershed develops. In addition to increased flooding, "stakeholders" were concerned about degradation of the overall health of Blackberry Creek and the watershed's wetlands. Water quality, biological integrity, and streambank erosion were specific areas of concern.

Due to the existence of the Watershed Management Plan as well as expected growth in central Kane County, USEPA and IDNR funded an alternative futures analysis for the Blackberry Creek Watershed. The purpose of this project was to identify alternative visions for the future of the watershed and to evaluate their implications. Armed with this information, the municipalities and counties will be able to make informed decisions related to site design practices and future land uses. Kane County will be considering this information as it develops its 2030 Land Resource Management Plan and as it coordinates with municipalities on the development of stormwater management strategies.

Project Components

During scoping of this project, it was recognized that protection of the watershed's aquatic resources from both direct and indirect impacts will be essential during its transition from a largely rural watershed to a mixed rural and urban watershed. To that end, there was both a land use focus to protect the streams and wetl from direct modifications, and a site design focus to prevent degradation of watershed hydrology and water quality upon which streams and wetlands depend. The primary components of the project were:

1) Develop model site design templates for a range of land uses (commercial, three densities of residential, agriculture, as well as streams and wetlands). The focus of the urban templates was to illustrate conservation based stormwater and site design principles to preserve natural hydrologic mechanisms, minimizing changes in hydrology and water quality caused by land development. In addition to the conservation version of each template, a "conventional" version was developed. The conventional version of each template was based on current practice for site design and stormwater management that collects, conveys, and detains stormwater rather than distributes, infiltrates and retains stormwater. The stream and wetland templates illustrate management of these resources in ways that protect and improve their natural capacity to mitigate the effects of intensive land use change.

2) Develop a conservation based watershed land use scenario that provides direct protection of stream and wetland resources from land disturbances. The conservation land use scenario is then contrasted with existing watershed land uses (existing conditions) and future watershed land uses based on current plans (current proposed land use plans). The conservation scenario does not significantly change the overall character of current land use plans, but demonstrates how the "green infrastructure" of streams, wetlands, floodplains, and natural drainage of the watershed can be integrated into those plans.

3) Evaluate hydrologic impact of the land use templates and watershed scenarios. Continuous simulation hydrologic modeling was used to determine the hydrologic response of each of the templates and to compare the response of the conventional and conservation versions of each of the templates. The value of the conservation-based templates was also evaluated at the watershed scale by comparing results at a number of

evaluation points in the watershed for each of the three scenarios. The hydrologic response was characterized using a number of evaluation metrics to assess the implications of the results in terms of biological health, protection of aquatic habitat, and impacts on flooding and streambank erosion.

Alternative Futures Evaluation

Evidence from other watersheds around the region and the Country has shown that as a watershed urbanizes, a number of changes in hydrology occur. In addition to an increase in the magnitude and frequency of flooding, a reduction in low flows between storm events also occurs. The reduced stability of hydrology associated with more frequent flood events can destroy streams and habitats through streambank erosion and deposition, and through shifts in vegetation resulting from greater water level fluctuation. The lower low flows stress aquatic insects and other organisms that live in the bottom of streams and serve as food for fish and other life on the food chain.

Site Scale Modeling Results: The hydrologic modeling performed for this project indicates that all hydrologic measures are improved under the conservation templates relative to the conventional templates of the same land use. The "flashiness" of the stream is decreased, low flows are less low, and the magnitude of floods is decreased. As expected, the modeling also indicates that the conventional versions of the urban templates generally have less stable hydrology than an assumed existing condition of cropland. However, the conservation version of all the templates, including commercial, should be able to improve many measures of hydrologic conditions relative to conventional agriculture.

Watershed Scale Modeling Results: The scenario results are similar to the template results. The results show that hydrologic, physical, and biological conditions in the streams and wetlands of Blackberry Creek are likely to degrade as the watershed urbanizes based on current plans and conventional templates. Conversely, under the conservation scenario with conservation templates, hydrologic, physical, and biologic conditions have the potential to improve as conservation plans and developments are implemented. However, the results indicate that the negative impacts of conventional development and the positive impacts of conservation development are less pronounced than at the site (template) scale. This appears to be due to the mix of existing conventional and proposed conservation land uses in the conservation scenario as well as due to the moderating influence of floodplains and protected natural areas that occur in both conventional and conservation scenarios. Flooding, as measured by the 100-year flood flow, is expected to remain the same or even decrease even under the current proposed land use scenario with conventional templates due to Kane County's detention release rate standards. Under the conservation scenario with conservation templates, flooding could be expected to actually decrease. Although not a direct focus of this study, the results suggest that implementation of the conservation templates may also improve deep groundwater recharge, potentially improving the water supply for a growing population.

Conclusions

The analysis outlined in the report suggests that with proper planning and site design, Blackberry Creek and wetlands can be protected from many of the negative impacts often associated with watershed urbanization. However, the evaluation results for the conservation templates and scenarios are conditioned upon full implementation of the stormwater management practices outlined in the conservation templates and not just the general land use plan. Although substitution of native prairie and wetland landscaping for turf will improve hydrology, that design modification alone will not achieve the benefits identified here. It is essential that a distributed stormwater management approach that utilizes created prairie and wetland systems to filter and retain stormwater runoff be implemented if the benefits outlined here are to be achieved.

Two future conditions watershed scenarios were evaluated as part of this project. However, there are many other possible scenarios that could be conceived for this watershed as the County and municipalities proceed with development of 2030 land use plans. The scenario models could readily be adapted to evaluate other potential scenarios and factor water resource implications into the land use decision-making process.

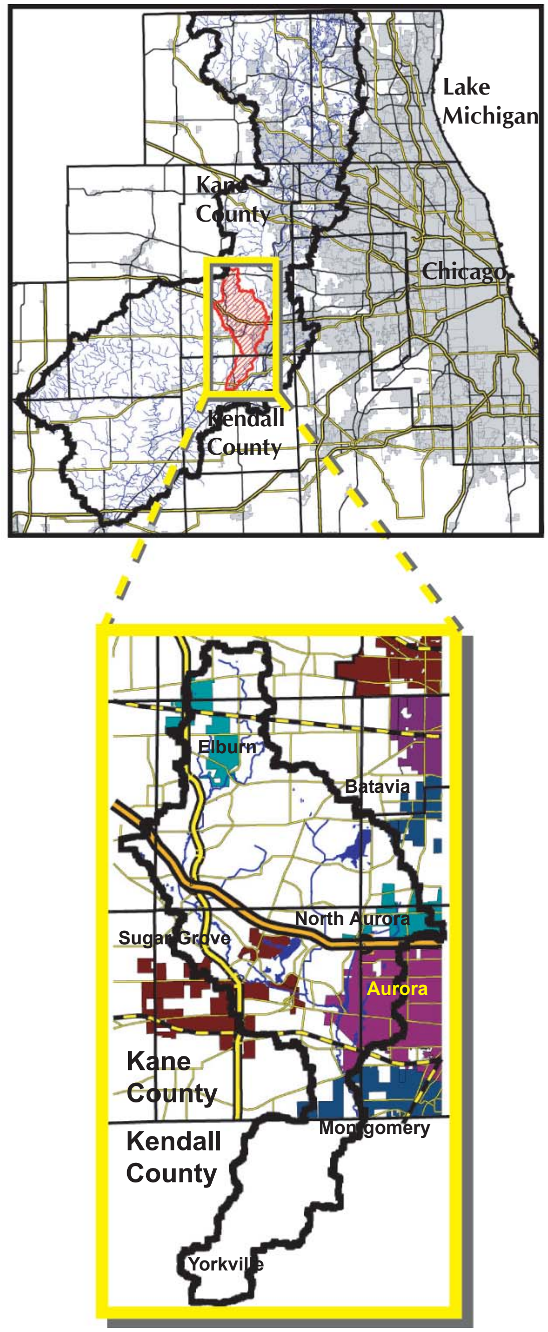
Introduction & Background

In July 1996, the Blackberry Creek Watershed experienced significant flooding as a result of record rainfalls. This flooding prompted formation of the Blackberry Creek Watershed Resource Planning Committee and preparation of the Blackberry Creek Watershed Management Plan. A significant focus of that plan was on prevention of further flooding and degradation of stream and wetland resources as the watershed urbanizes.

To assist watershed stakeholders and decision-makers in understanding the potential future of the watershed and the cumulative impacts of numerous land use and land development decisions, this study was undertaken to identify potential alternative futures and to evaluate the impact of those futures on aquatic habitat, streambank erosion, and flooding.

The alternative futures analysis was performed in three steps. The first step was to develop "conservation" and "conventional" versions of a number of single land use templates. These templates are not "place-specific" but instead are intended to be representative urban and agricultural land uses that could generally be located any where in the watershed. In the second step, the templates were arranged in various patterns around the watershed according to two different land use patterns generally based on the Kane County and municipal comprehensive plans. The third and final step was to evaluate the impacts of the templates and scenarios on watershed hydrology, biology, and flooding using computer hydrologic modeling.

All of this information is intended to aid in the implementation of conservation-based land planning initiatives taking place in the Blackberry Creek Watershed.



Blackberry Creek lies within the Fox River Watershed in Kane County, Illinois due west of Chicago, Illinois.

Project Location

The Blackberry Creek Watershed is located in south central Kane County and north central Kendall County within the Fox River Basin, and is approximately 73 square miles in size. It includes portions of seven municipalities, including Elburn, Batavia, Sugar Grove, North Aurora, Aurora, Montgomery, and Yorkville, from north to south. Due to data availability, analysis within the project area was limited to the Kane County portion of the watershed (58 square miles). Blackberry Creek discharges to the Fox River in Yorkville, Illinois.

Even though Kendall County data and plans were not used in this project, the soil types, ecological resources and many other critical aspects of the portion of the watershed in Kendall County are very similar to those in the northern portion of the watershed. Thus, the results of this project are relevant throughout the watershed and have implications in both Kane and Kendall Counties as well as throughout the region. This is particularly true at the template scale, and for the modeling and evaluation results that were generated at the county line.

Project Area Conditions

The Blackberry Creek Watershed contains a diverse and unique range of cultural and ecological resources with wetlands, stream corridors and other critical natural features interfacing with rural, small town, and suburban development. The watershed is dotted with hydric soils and wetlands and Blackberry Creek and its tributaries generally drain from north to south. Wetlands consist of both riparian wetlands well connected to Blackberry Creek and depressional wetlands scattered throughout the watershed. Wetland types include marshes, seeps, fens, and occasional wooded wetlands. Prior to European settlement, woodlands, prairies, wetlands, and limited agricultural fields were the primary land covers in the watershed. Around the turn of the last century, the towns of Elburn, Sugar Grove, and Yorkville began development, and subsequently, many acres of lands away from these town centers were converted to croplands. More recently, residential, industrial, office, and commercial land uses have been developed on the outskirts of these cities and villages as well as around the cities to the east along the Fox River, creating new types of pressures to the ecological and hydrological systems found in the watershed.

Streams in northern Illinois like Blackberry Creek were historically fed through slow groundwater seepage. Wetlands and other related natural features formed part of a network of hydrologically connected, and ecologically integrated systems. Much of the rainwater was used by the plants where it fell and was evaporated back into the air. The remaining water would percolate deeper to become active groundwater slowly draining to the streams and wetlands of the watershed. Surface runoff was rare except during spring snowmelt conditions when the ground tended to be saturated. The slow movement of water through the ground imparted a unique chemistry and relatively constant water temperature that created unique ecological niches where the groundwater surfaced.

As the watershed develops, less and less rainwater percolates into the ground as natural areas are converted to lawns and impervious roofs, roads and parking lots. In addition to creating additional surface runoff, water temperatures are increased and pollutants that accumulate on these surfaces are washed off and quickly conveyed to streams and wetlands. Stream and wetland ecosystems that previously received a majority of their water from ground seepage now receive it as surface drainage in large pulses, to which they are not naturally adapted.

The future of the Blackberry Creek Watershed is at a critical moment for determining the future impacts that existing and proposed development will have on the natural features of this region. As development and growth continue to expand into the watershed, potentially negative effects on the economic, cultural and ecological health of the community may follow. The community is considering alternative futures, which include conservation-oriented designs and planning approaches that provide for growth, but at the same time conserve, connect and protect ecological resources.

Project Descriptions

The primary purpose of the project was to illustrate and evaluate potential alternative futures for stream and wetland protection and restoration in the Blackberry Creek Watershed. Alternative futures were analyzed on two scales within the watershed. Hydrological impact was modeled at both the site and the watershed scales for various potential "futures". The intent was to look at what could occur if current development codes and land use plans, along with the current standard of practice for land development and management activities, were followed and compare it to what might occur using conservation-based site design and ecologically sensitive land use planning.

The alternative futures analysis includes several pairs of land development "Templates", which are generally 40-acre sites designed using either typical conventional development techniques or conservation design techniques. The templates are categorized by land use according to the Kane County 2020 Land Use Plan, and become the basis for modeling the scenarios, or watershed-scale impacts. In the "Scenarios", these templates were distributed across the watershed in different patterns following either current proposed land use plans, or alternatively, following "improved" conservation-based land use patterns. The templates and scenarios were then modeled for their comparative effects on hydrologic systems.

The terms "*conservation*" and "*conventional*" are used throughout this report in reference to the various alternative futures that were designed and evaluated. "*Conservation*" for this project refers to techniques and best management practices that are based on ecologically sensitive design and planning principles with a particular focus on stormwater management. Conservation templates and scenarios combine various sustainable design concepts with such names as "green design", "low-impact development", "sustainable development", "ecological design", "smart growth", and others. Generally conservation templates and scenarios use integrated, state of the art technologies, designs, and site planning to achieve stormwater, habitat, livability, restoration, and other ecological goals.

"*Conventional*" is the second design descriptor used in this project, and refers to practices that are typically being utilized in land development and building construction today in northern Illinois. Even though conservation and conventional designs are both allowed by code, conventional designs and techniques are seen most often, and thus represent the default designs and practices for a majority of communities and developers. Conventional developments rarely use innovative and alternative design and planning tools to achieve ecological health, beyond the baseline amount required in codes.

Project Focus

There are four major issues on which this project focuses, including the hydrologic impacts of urban development, the region's flooding concerns, population growth, and the inability for conventional stormwater management techniques to resolve hydrologic, ecological, cultural, and economic challenges comprehensively and adequately.

Hydrologic Impacts

Development within a watershed can dramatically change its hydrology. Changes include reductions in groundwater recharge and increases in volume and rate of surface runoff. Water supply issues can impact future growth and current quality of life issues, while increased surface runoff erodes stream channels and has negative impacts on bio-diversity and habitat quality. A more detailed description of the range and level of impacts development has on hydrological systems is contained in "Stormwater Impacts", the final section of this chapter.

Region's Flooding Concerns

On July 17, 1996, Blackberry Creek and Kane County experienced extreme flooding after a storm that dropped almost 17 inches of rain in the watershed over a 24 hour period, which flooded the City of Aurora and many areas of the watershed and region. Flooding in the watershed caused almost $14 million worth of damage to residences in the area. Kane County took the initiative after this event to attempt to address the causes for the flooding, including growth pressure and development.

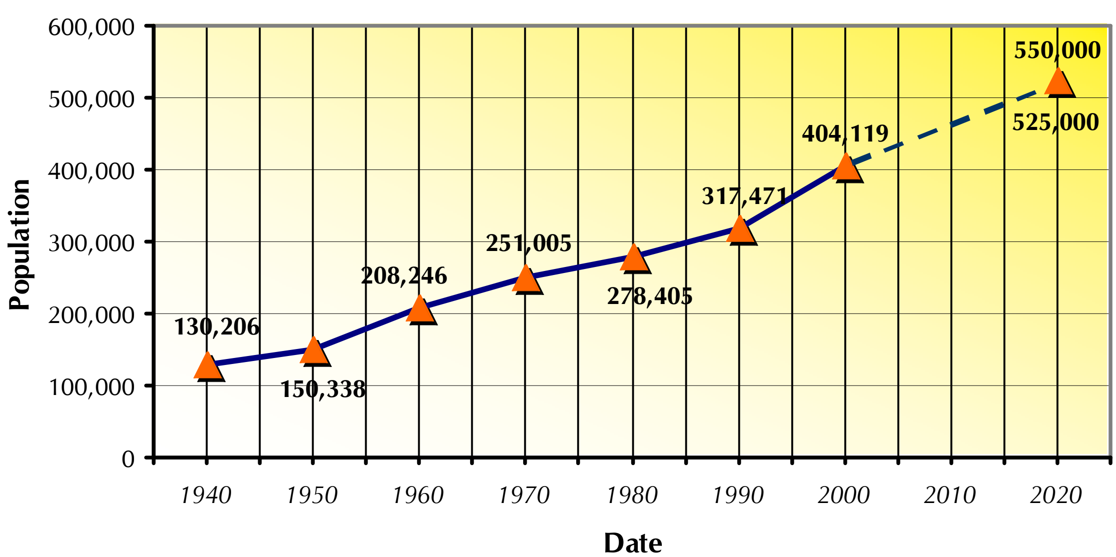
Recently, several communities and counties have taken the initiative to attempt to address their concerns over flooding. This project represents one such initiative. Over the last seven years, the communities and counties of the watershed have developed numerous other plans and studies, including a county-wide Stormwater Ordinance in Kane County, that look at policy, planning, design, engineering and other ways to make the watershed a more hydrologically and ecologically sound place, while at the same time improving the cultural and economic opportunities and resources of the region. Other initiatives that reflect the community's concern over flooding are discussed in more detail in a later portion of this chapter.

Population Growth

Kane and Kendall Counties have an attractive mix of rural, agricultural, natural and urban settings that continue to draw residents from the Chicago metropolitan area. The Blackberry Creek Watershed lies on Chicago's metropolitan urban edge, adjacent to the expanding cities along the Fox River and containing a number of rural communities blossoming into significant suburbs. The 2000 Census showed 27% growth in Kane County from 1990, with a total population slightly over 400,000 people. According to analyses done by the Northeastern Illinois Planning Commission and Illinois State University, the projected population of Kane County in the year 2020 will be between 525,000 and 550,000 people (see chart on page 4). This level of growth suggests even heavier potential impacts on the hydrologic systems of the Blackberry Creek Watershed, not to mention other natural and cultural resources.

Kane County Population - With NIPC 2020 Projection

(Data Sources: US Bureau of Census, Illinois State University, and the Northeastern Illinois Planning Commission)



Conventional Stormwater Management

Conventional methods of stormwater management commonly result in the degradation of hydrologically dependent ecosystems, such as streams and wetlands. Even with strict regulations restricting detention release rates, streambanks continue to be eroded, habitats continue to be degraded, groundwater recharge continues to decrease, and the costs associated with flooding continue to increase.

Conclusions

With the negative impacts of conventional stormwater systems on the environment and the population growth estimated for the region, alternative methods of stormwater management must be found and tested. This alternative futures project develops conservation-based alternatives that provide room for growth and development, while at the same time providing more ecologically, culturally and economically sensible ways of managing stormwater. This project also provides the watershed with the opportunity to continue to create conservation-based programs that meet the growth and conservation objectives of the county and municipal comprehensive plans, while stabilizing the impacts of development on the region's hydrologic systems.

Project Process

This project had four primary phases: *template design*, *scenario design*, *evaluation*, and *community outreach*. Each phase was conducted and produced by a Project Team that was consulted by an Advisory Team (see acknowledgements page for a list of Team members). The Project Team was composed of the granting agencies, the grant recipient, the design and technical consultant, and the outreach consultant. This team was responsible for administering the project and completing all project elements as documented within this report. An Advisory Team was also assembled to provide input and independent review. The Project Team prepared project materials and the Advisory Team provided input through several timely workshops. The first three phases of the project have been completed and are addressed in this report.

Template Design

During the design phase of the project, the Project and Advisory Teams met on a number of occasions to select the categories of templates and review the designs. Seven categories of templates were identified and two versions of each were prepared.

- ***Commercial/Industrial***
- ***Moderate Density Development***
- ***Rural Residential***
- ***Estate Residential***
- ***Agriculture***
- ***Stream Corridors***
- ***Depressional Wetlands***

All potential types of development typical to the watershed were covered, except for industrial parks, which are hydrologically similar to commercial developments and were therefore combined into that template. Each pair of templates includes a conventional version of the particular land use and a conservation-designed version. Both versions meet current county-wide stormwater, floodplain, wetland protection and development standards for Kane County.

Scenario Design

The Project Team also created three "scenarios" for the watershed within Kane County, or watershed-scale land use alternatives:

- ***Existing Conditions***
- ***Current Proposed Land Use Scenario (with Conventional Templates)***
- ***Conservation Land Use Scenario (with Conservation Templates)***

Evaluation

During the evaluation phase of the project, the 14 templates and the three alternative scenarios were modeled for hydrologic impact. For the scenario evaluation, associated templates from the design phase were distributed across the watershed according to either county and municipal land use plans or a modified version of the plan that uses conservation-based regional planning principles and the conservation design templates for all new developments.

Within this report, evaluation is presented as part of the template and scenario chapters. This was done to provide a complete picture of the template designs and their implications before proceeding to the scenario design and evaluation discussion.

Community Outreach

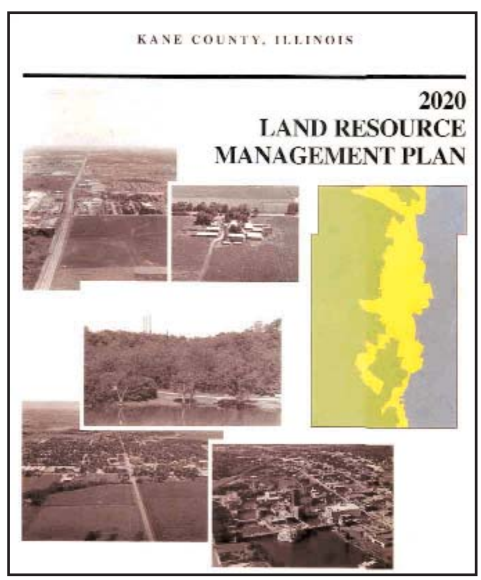
The final phase of this project includes an ongoing community education and outreach program that includes public meetings with municipalities, public officials, residents, landowners and other stakeholders throughout the watershed. The outreach program is described in detail in the final chapter of this report.

Other Watershed Initiatives

Several major planning and community initiatives have continued to support conservation-oriented programming in and around the Blackberry Creek Watershed, including:

Kane County 2020 Land Resource Management Plan

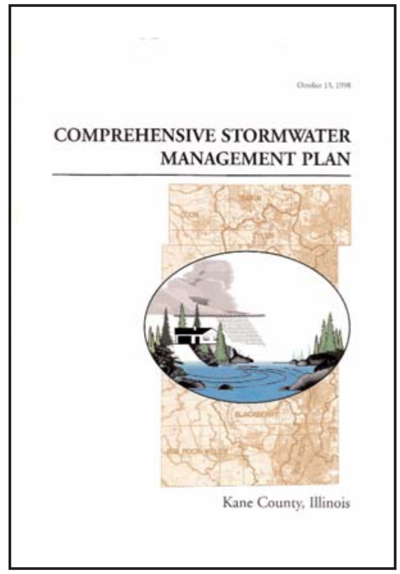
Adopted in June of 1996, the 2020 Plan contains two major components: a comprehensive planning piece and a resource management plan. One of the major differences between this plan and previous efforts is that the 2020 Plan has a focus on the retention of the County's historical land use patterns, including natural, agricultural and developed lands.



Three major geographic planning areas were identified in the 2020 Plan, including an urban corridor, a critical growth area, and an agricultural/village area. Blackberry Creek includes portions of the critical growth and agricultural/village zones. Currently, Kane County is continuing its comprehensive planning efforts through the initiation of a 2030 Land Resource Management Planning process, which will build upon and expand the goals, objectives and information established in the 2020 Plan and will make use of the findings of this report.

The Kane County Comprehensive Stormwater Management Plan and Stormwater Ordinance

Adopted in October of 1998, this Management Plan was a directive from the County 2020 Land Resource Management plan and a response to flooding that occurred in the summer of 1996. In addition to the goals of protecting public health and safety, improving water quality, and minimizing the negative impacts of and potential damage due to stormwater, several other important objectives were established by this plan, including:



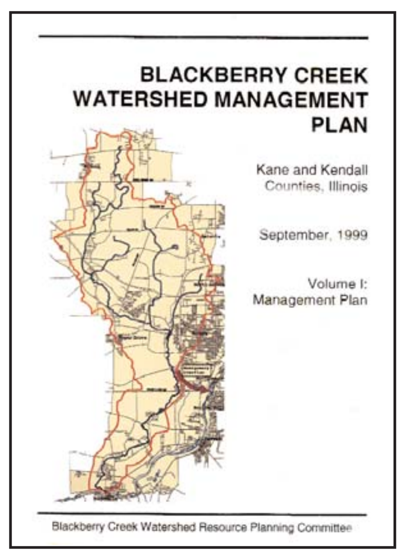
- Regulating and standardizing stormwater management throughout the County under a unified set of codes;
- Identifying, protecting and improving hydrologically sensitive and critical lands, including floodplains, recharge areas, lakes, ponds and wetlands;
- Increasing public awareness and understanding of stormwater issues;
- Identifying revenue sources to aid in the implementation of the plan; and
- Developing and maintaining a comprehensive database for watersheds in Kane County.

The county-wide stormwater management plan recommended county-wide programs, stormwater standards and codes, and other tools for managing stormwater in Kane County. It also emphasized a connection between stormwater management and the proper management, restoration and maintenance of natural areas. Public education, a critical component of effective stormwater management, was also given a high priority.

As a follow-up to the Management Plan, the County developed a comprehensive Stormwater Management Ordinance and Technical Guidance Manual to implement the standards recommended in the Management Plan. The Ordinance was adopted in October, revised in December 2001, and become effective in January, 2002.

Blackberry Creek Watershed Management Plan

Development of the Management Plan was conducted by the Blackberry Creek Watershed Resource Planning Committee. The Committee included representatives from Kane and Kendall Counties, most of the municipalities, local consultants, environmental organizations, the Farm Bureau and other stakeholders. The Committee was advised by a team of technical advisors from various local, regional, state, and federal agencies as well as by consultants. The plan was completed in September, 1999 and endorsed by each of the counties and municipalities.



Four major goals were adopted as part of this plan, including:

1. Reduce existing flooding problems,
2. Improve water quality and related stream and wetland resources,

3. Avoid negative impacts of development on flooding and watershed resources, and
4. Establish a watershed framework for implementing the objectives set out in this plan.

This watershed plan included 40 recommendations that serve as an action plan for the various watershed stakeholders. The plan makes recommendations in many areas including restoration, maintenance, conservation and development, and consolidates essential data for the watershed for researchers and planners.

Blackberry Creek Watershed Floodplain Remapping

The U.S. Geological Survey (USGS) is currently involved in a restudy of the Blackberry Creek floodplain, including development of revised hydrology and hydraulic models. Components of the USGS watershed hydrology model were used as part of the scenario analysis for this project. Remapping of the Blackberry Creek floodplain is scheduled to be complete in 2003.

Community-Scale Initiatives

Several community-scale initiatives are also continuing to endorse conservation design principles in and around the Blackberry Creek Watershed. Some of the more recent initiatives include:

City of Aurora - The City recently adopted a Countryside Vision Plan. This plan includes recommendations for conservation-based design for new development on Aurora's west side based on an image of "Neighborhoods in Nature."

Village of Elburn - The Village has enacted a stream and wetland protection ordinance that includes an overlay map of the Village's stream and wetland resources.

Village of Sugar Grove - The Village recently enacted a stream and wetland protection ordinance.

United City of Yorkville - The City of Yorkville recently rejected a proposal to place a sewer pipe along the Blackberry Creek riparian corridor and protected the stream from a potentially damaging project. The City is also in the process of adopting a stream and wetland protection ordinance and natural resources inventory.

Conservation Foundation - The Conservation Foundation is coordinating numerous advocacy, educational, and other projects within the Blackberry Creek Watershed through its full-time watershed manager who works with local municipalities, Kane and Kendall Counties, and other organizations and agencies to assist them in planning and monitoring this watershed.

Through the development, planning, adoption and implementation of these county-wide and local initiatives, the framework has been established for innovation in stormwater management through conservation-based planning and ecologically sensitive design. Kane County already has a successful track record for raising money to implement research-oriented and real-world planning projects that will make a strong case for good stormwater management through conservation development in the County. Some of the more recent projects are discussed in the final chapter of this report.

Environmental Framework

The following maps and descriptions outline the Blackberry Creek Watershed's natural and cultural features and systems, their importance to this project, and the originator of the data.

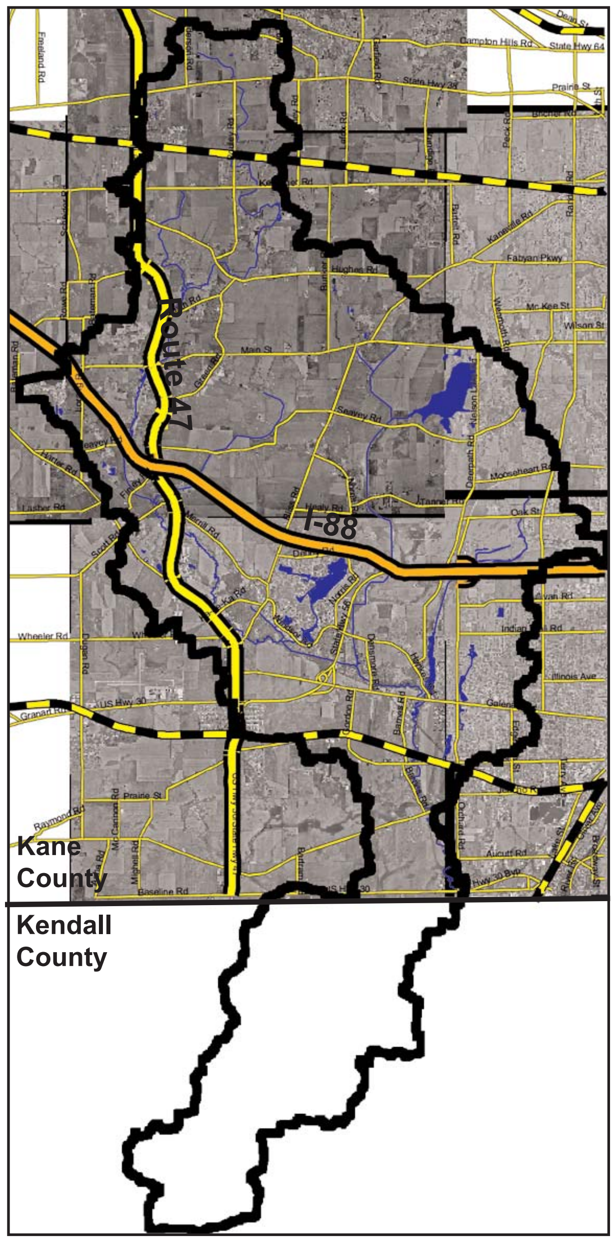
The Watershed

The Blackberry Creek Watershed is approximately 73 square miles in area. The project area includes approximately 58 square miles (80%) of the watershed and is the entire portion of the watershed that lies within Kane County.

The Blackberry Creek Watershed is bisected by one Interstate highway, a State highway, and several major and minor roads. The main east-west highway passing through the area is Interstate 88. The main road bisecting the watershed from north to south is Illinois State Route 47. These highways provide the major points of access to this watershed, and have become and will continue to serve as conduits for development.

Two major rail lines pass through the watershed as well. To the north lies the Union Pacific line, which runs through the Village of Elburn. To the south runs the Burlington Northern/Santa Fe rail through Aurora and Sugar Grove.

The watershed boundary data was provided by USGS. The data for roads, highways and rails was provided by Kane County.



Watershed Aerial Photo.

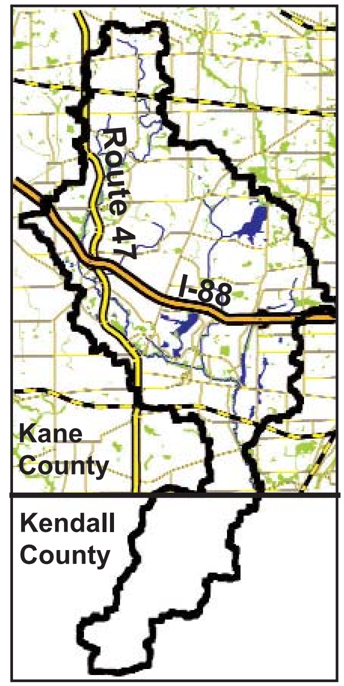
Streams and Wetlands

Blackberry Creek flows generally from north to south for approximately 32 miles, and has three main branches - the mainstem originating near Elburn, Lake Run originating in Nelson Lake and East Run originating in North Aurora. As reported in the Illinois Water Quality Report (Illinois EPA, 2002) the designated uses for Blackberry Creek are aquatic life and fish consumption for the entire creek.

Wetlands are shown in light green on the map on this page. Many of those wetlands are riparian wetlands located along the Blackberry Creek corridor but many others are depressional wetlands scattered throughout the watershed.

Streams and wetlands provide important aquatic habitat as well as functional benefits such as water quality improvement and flood attenuation. However, to the degree that wetlands are required to mitigate for the impacts of urban and agricultural development, the biodiversity of these features will diminish.

Kane County, the Northeastern Illinois Planning Commission and others have prepared a wetland inventory and are currently assessing stream and wetland quality under an Advanced Identification (ADID) Study funded by USEPA. Stream location was provided by Kane County and edited based on aerial photography.



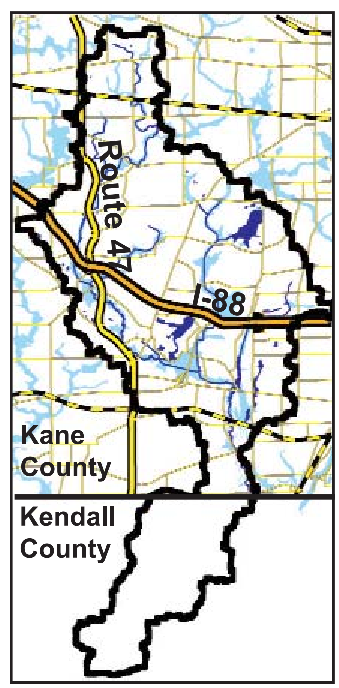
Streams and Wetlands.

Floodplains

Floodplains are an important component of stream ecology and serve to moderate flow rates and stream energy during high flow runoff conditions. Many of the watershed's wetlands are located within mapped floodplains. Floodplain width is greatest north of Keslinger Road in Elburn, along Lake Run (the westernmost of the two eastern tributaries) and south of the confluence with East Run.

In many areas of the watershed, the Creek has been channelized and the floodplain narrows to a width not much greater than the width of the channel.

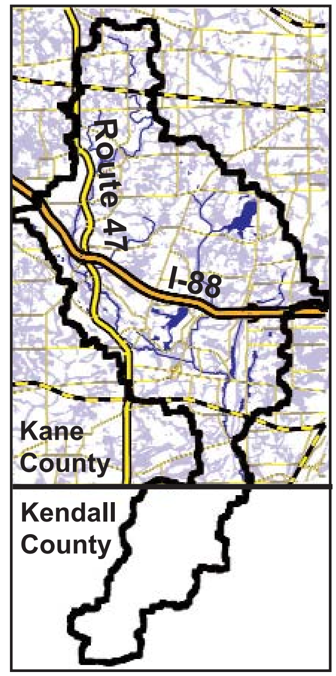
Floodplain data for the watershed were provided by the Federal Emergency Management Agency (FEMA) through Kane County.



Floodplains.

Hydric Soils

Hydric soils in their natural state are wet, poorly drained soils associated typically with wet prairies and wetlands. Knowledge of hydric soils is important from a number of standpoints. Hydric soils provide an indication of historic wetlands and locations for potential wetland restoration. By disrupting the tiles and drainage features that drain the hydric soils, wetlands can be restored potentially.



Hydric Soils.

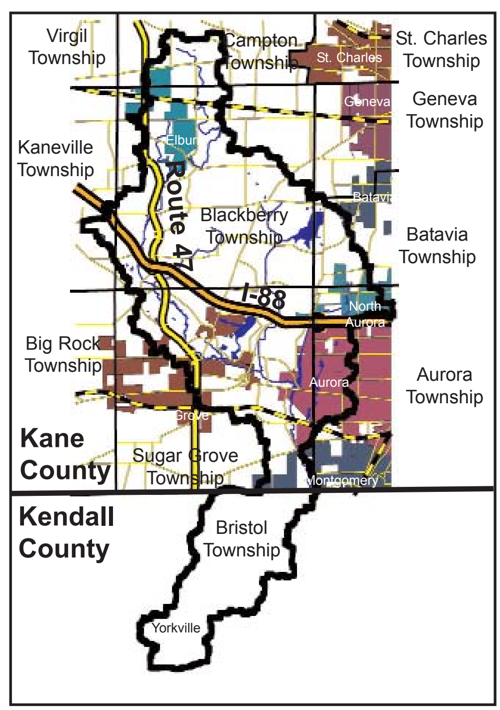
Conversely, hydric soils are areas that may be prone to flooding or otherwise wet conditions if the infrastructure that drains the soils (tiles and ditches) is not maintained.

Hydric soils occur along natural drainageways and therefore can be useful in identifying natural connections between isolated wetlands, streams, and floodplains to restore wetland complexes and functioning ecological and open space networks.

Hydric soils data for the watershed were originally adapted from the US Department of Agriculture's National Resource Conservation Service (USDA - NRCS) SSURGO data (Soil Survey Geographic Database). SSURGO soils were adjusted according to Kane County's listing of hydric soils. The result of this excerpted database is the hydric soils map shown here.

Municipalities

The Blackberry Creek Watershed is home to seven townships and seven municipalities. The municipalities from north to south include Elburn, Batavia, Sugar Grove, North Aurora, Aurora, Montgomery, and Yorkville. The Blackberry Creek Watershed is primarily contained within Blackberry, Sugar Grove, and Bristol Townships, with much smaller portions within Campton, Kaneville, Batavia, Aurora, and Geneva Townships. With land use and zoning power, municipalities and counties have the greatest power to determine the future of the Blackberry Creek watershed. Thus, it is imperative that they coordinate land use decisions and development standards and controls.



Municipalities and Townships.

The data for townships and municipal boundaries were provided by Kane County. Municipal boundary information was also provided by the various villages and cities, and used by Conservation Design Forum to update the original Kane County data.

Land Use/Land Cover

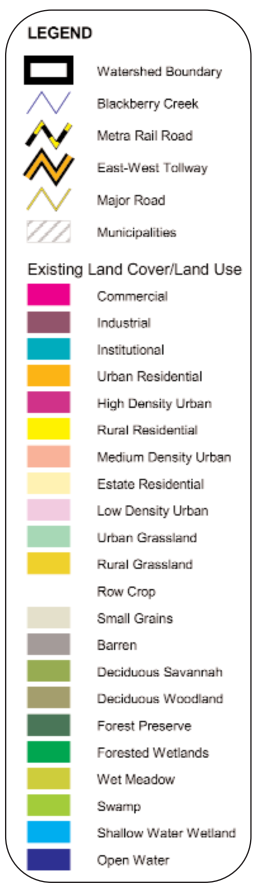
The land cover data shown here were used in the development of the existing conditions scenario, where the most recent data for actual rather than planned land uses were required for stormwater modeling purposes. The original 1990 land cover data provided by the USGS included 19 different land cover categories to describe built and natural areas. The USGS data was combined with Kane County land use categories to make hybrid set of land cover categories that provides the detail of the USGS data in the non-urban areas and the detail of the County data in the urban areas.

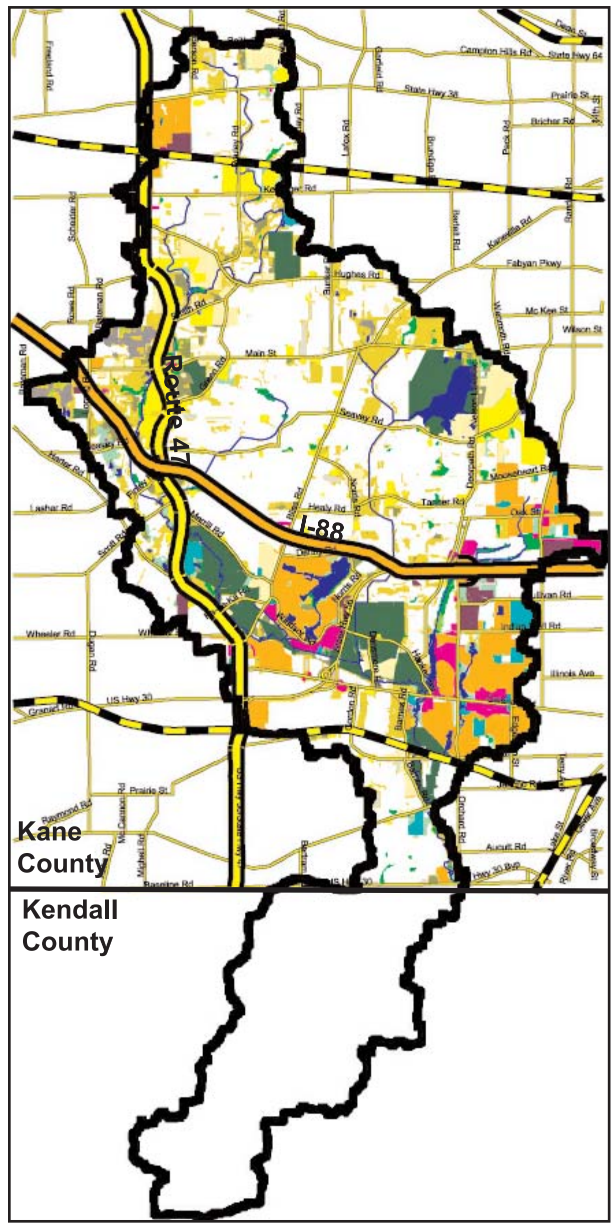
The 1990 land cover for the watershed based on this mapping is approximately:

- 66 % Agriculture
- 13 % Open Space
- 21 % Urban Land

With an expected population growth exceeding 120,000 over the next 17 years (see Introduction and Background section), there will be significant increases in urban land uses, and potential increases in associated ecological degradation and related flooding unless conventional development practices are replaced with conservation-based approaches as described in this report. Future land use is discussed further in the Scenario Design and Evaluation Chapter

Land use/land cover data for the Blackberry Creek Watershed were provided by USGS as adapted from the Illinois Department of Natural Resources land cover data.





1990Land Use/Land Cover

Potential Ecological Impacts

Ecological and hydrological analyses of the Watershed show a variety of sensitive natural features and an extensive network of hydric soils and wetlands. Each of these natural features plays an integral role in the functionality of the hydrologic and biologic systems. Each is also potentially impacted by development and other changes to the landscape. Some of those potential impacts are discussed below.


July 1996 Flood in Aurora Region

Stream Impacts

Development within watersheds can drastically change the hydrology of streams. The increased magnitude and frequency of post-development flow peaks causes stream channel erosion and increased flooding downstream. The most commonly observed effect of this change in hydrology on rivers and streams is the physical degradation of natural stream channels through adjustments in channel width, depth, slope, velocity, roughness and other variables. This inevitably results in changes to channel morphology due to erosion and deposition of sediment, which in turn affects the diversity and suitability of aquatic habitat. As a result, decrease in aquatic stream biota such as fish and macroinvertebrates are commonly observed.

Wetland Impacts

Changes in the hydrologic regime of wetlands, either flooding or draining, can result in a number of impacts to the plant and animal communities that occur within them. It has been found that these hydrologic disturbances result in decreases in both diversity and abundance of wetland plants and animals, including microbes, algae, vascular plants, invertebrates, fish, amphibians, reptiles, and birds that rely on wetland habitats. This project attempts to suggest and test ways in which these impacts can be minimized and/or eliminated.

Summary

The environmental framework analysis identified ecological considerations that informed the design and evaluation of both the templates and scenarios described in the following chapters. Floodplains, streams and wetlands provide important hydrologic and biologic functions affecting the ecology of Blackberry Creek and hydric soils provide an indication of potential wetland restoration areas and hydrologic connections. Existing and proposed land uses indicate existing and potential future stressors on hydrologic and biological systems. Finally, the counties and municipalities hold the power to make land use decisions and set development standards and therefore the power to determine the future of the Blackberry Creek Watershed.

Template Design & Evaluation

Template Design

Template Development Process

The templates included in this chapter represent alternative development concepts for various land uses that exist and are proposed throughout Blackberry Creek Watershed. Each template was designed on an imaginary 40 acre site. Forty-acre area was used as a base size for templates because that is a fairly common parcel size, and thus provided a convenient and moderately sized site that fulfilled size requirements for a variety of land uses. Agriculture, being the exception, rarely occurs on parcels as small as 40 acres, except for special farms. Thus, the agricultural template was evaluated as a 160 acre parcel.

Conventional Stream

Conservation Stream

There are a total of 14 templates for five land uses (based on Kane County's land use designations) and two different aquatic ecosystem types, including:

- ***Commercial/Industrial***
- ***Moderate Density Residential***
- ***Rural Residential***
- ***Estate Residential***
- ***Agriculture***
- ***Stream Corridors***
- ***Depressional Wetlands***

Each land use type or ecosystem type has two templates, a conventional template using current default or standard-of-practice site design and planning techniques, and a conservation template that uses environmental design principles and best management practices and designs for stormwater management appropriate for Blackberry Creek Watershed. Both templates in each land use category have identical numbers of units, commercial square footage, etc., but are arranged and organized in different ways over the site and use different stormwater management and landscaping techniques.

Conventional Residential

Conservation Residential

Although the site planning and stormwater management concepts illustrated in the conservation templates can be applied to many development sites, the templates should not be viewed as “stencils” to be “stamped” across the watershed. A significant element of conservation design is adapting the site and stormwater plan to the specific conditions of the site.

Commercial and industrial land uses were combined into one template since they have similar hydrologic characteristics. The Conservation Agriculture Template was divided into a variety of conservation vignettes, instead of providing a single 160 acre conservation-based farm template. The Advisory Team determined that a vignette format would best depict the many sustainable agricultural techniques that are available but unlikely to occur all on one parcel or farm.

From a design standpoint, the stream and wetland templates differ from the urban and agricultural land use templates. While the conservation urban templates illustrate site planning and stormwater management principals, the conservation stream and wetland templates illustrate how naturalized corridors, networks and systems can be integrated into a site and protected at the site scale.

Template Design Principles

General environmental design principles incorporated into the conservation templates include:

1. Development should avoid, to the extent possible, natural features, including streams, wetlands, remnant natural areas, and critical habitats (stream and wetland templates).
2. Natural features should be protected, buffered, linked into complexes, and enhanced/restored where possible (stream and wetland templates).
3. The site plan should respect site topography, utilizing natural drainage patterns to minimize site grading and the need for built infrastructure.
4. Clustering of built areas, a range of lot sizes, and other design techniques should be used to create views, privacy, and amenities for each home site. This also facilitates protection of site natural areas, efficient utilization of site topography, integration of naturalized stormwater management systems, provision of common open space, and linked habitat areas.
5. Created native landscapes should be integrated into the stormwater management system to utilize their natural filtration, infiltration, storage, and transpiration processes as well as their habitat and aesthetic benefits.
6. Where appropriate, engineered systems based on natural processes should be utilized as part of the stormwater management system for the purpose of enhancing groundwater recharge, stabilizing site and regional hydrology, and minimizing irrigation needs.
7. Stormwater should be managed as close to its source as feasible.

Conservation site planning and design techniques used in the templates are cost-effective, have been used and proven in existing developments in the Midwest, and generally do not conflict with the intent of most existing codes and ordinances (although they may conflict with the letter of the ordinances).

The focus of the principles above is on protection of aquatic habitat from the direct and indirect impacts of development and prevention of flooding and streambank erosion. However, it should be noted that there are many other "green" design and planning principles that are not directly addressed as part of this project as their link to watershed protection is less obvious. Green design techniques not addressed here include transit and pedestrian oriented development as well as energy and resource conservation measures.

Sample Stormwater Best Management Practices

The following narrative provides a brief description of a variety of planning/zoning, on-site, and landscaping stormwater best management practices (BMPs). Each of the stormwater and landscaping BMPs was used in the development and design of the templates for their potentially positive impact on hydrological systems. Common to many of the techniques is the use of native landscapes that function not only as effective stormwater management systems but also as common open space. Also included are several Planning/Zoning BMPs that can be used to facilitate many of the stormwater BMPs. More detailed descriptions of the BMPs can be found in **Appendix A** of this report.

Planning/Zoning BMPs

Conservation Development

Site planning and design approaches that preserve existing natural areas, enhance habitat, utilize naturalized drainage and detention measures for stormwater management, conserve energy, and improve transportation efficiency.

Impervious Area Reduction

Impervious area reduction can be achieved in a number of ways, including use of narrower streets, shorter streets in lower density residential neighborhoods, creative driveway design, shared parking facilities, and designing roads, walkways, and trails for multiple uses as an integrated system.

Open Space/Natural Greenway

Designation of linear open spaces and/or natural areas as greenways, in order to preserve and connect significant natural features and accommodate aesthetic, recreational and/or alternative transportation uses.

Stormwater BMPs

Bioswales

Filtration and infiltration systems planted with grasses and forbes, and designed to filter, retain and evapotranspire stormwater. Vegetation enhances filtration, cooling and cleansing of water to improve water quality and prevent sealing of subsoils. Bioswales typically include an infiltration trench below the vegetated swale to provide temporary storage to increase the volume of runoff water infiltrated.

Bioswale

Filter Strips/Level Spreaders

Filter strips are an area of dense, preferably native, vegetative cover used to filter and absorb runoff. Level spreaders are often used in conjunction with filter strips and laid on the contour to distribute runoff over filter strip areas. Filter strips/level spreaders can be used within stream and wetland buffers to de-concentrate stormwater prior to discharge to streams and wetlands.

Level Spreaders

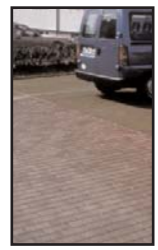
Green Roofs
Vegetated roof system designed to capture, temporarily store, and evapotranspire rainwater on the top of roofs. Green roofs are generally planted with drought and wind tolerant native vegetation. Green roofs can be designed as simple, lightweight systems primarily providing stormwater benefits or as more elaborate rooftop gardens providing outdoor space and stormwater benefits.


Green Roof

Naturalized Detention
Naturalized detention basins are used to temporarily store runoff and release it at a rate allowed by ordinances. Native wetland and prairie vegetation improves water quality and habitat benefits. Naturalized detention basins can be designed as either shallow marsh systems with little or no open water or as open water ponds with a wetland fringe and prairie side slopes.


Naturalized Detention

Porous Pavement
Permeable or perforated paving materials with spaces that allow for the infiltration of rainwater and the transmission of water through an aggregate base to the subsoils. Runoff is temporarily stored in the base for infiltration into the subsoils and/or slow release to a bioswale or stormwater system.


Porous Pavement

Rain Barrels/Cisterns
A vessel used to capture and temporarily store rainwater for various uses, including landscape irrigation, reuse for graywater purposes, etc..


Rainwater Garden

Rainwater Gardens
A landscaped garden designed to retain, detain, infiltrate, and evapotranspire stormwater runoff from individual lots and roofs.

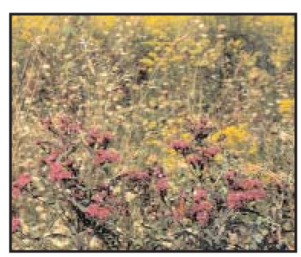

Rain Barrel

Vegetated Swales
Vegetated stormwater features that convey, retain, infiltrate and cleanse stormwater. Native vegetation enhances filtration and retention of stormwater.


Vegetated Swale

Landscaping BMPs

Native Landscaping
Native vegetation used in either large restoration or smaller gardening projects. Native vegetation refers to plants that were indigenous to a location prior to European settlement. Native landscaping can serve a variety of purposes including wildlife habitat and stormwater infiltration, filtering, and evapotranspiration.


Native Landscaping

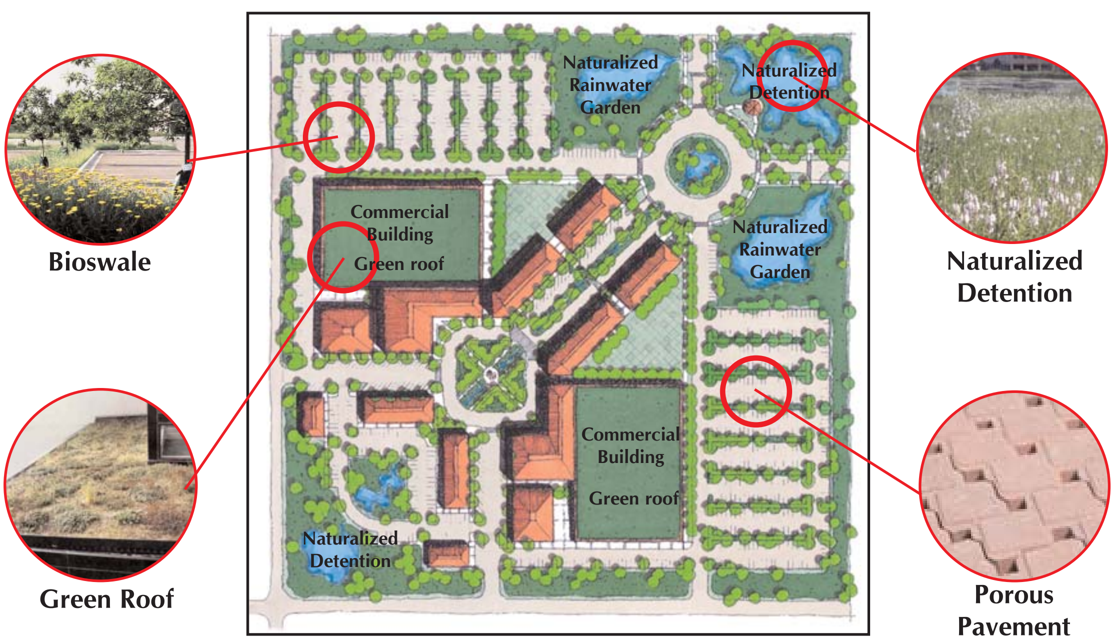
Template Alternatives

This section of the report provides brief descriptions of the template alternatives, including a definition of each template, some basic distinctive characteristics of both the conventional and conservation designs, and thumbnail illustrations. A much more detailed discussion is provided in **Appendix B** of this report.

Commercial/Industrial Templates

Commercial/industrial developments include retail, light industrial and offices in various scales from large scale "big box" retail stores and light industrial and office park development, to smaller scale restaurants, shops, and individual offices. The Conventional Template is laid out as a typical strip mall, with two "big box" retail establishments, isolated outlet shops, and parking, landscaping and stormwater detention according to code. The Conservation Template also has two "big box" retail stores, but in the conservation design, they have green roofs and are designed as part of a "Main Street" retail setting with second floor mixed-use areas, a plaza and parking both on-street and in parking lots. Permeable paving systems are used in the parking lots along with stormwater infiltration bioswales as part of a naturalized and landscaped stormwater system.

Conventional Commercial/ Industrial Template



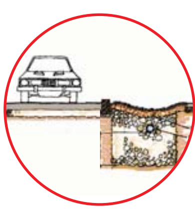
Conservation Commercial/ Industrial Template

Moderate Density Residential

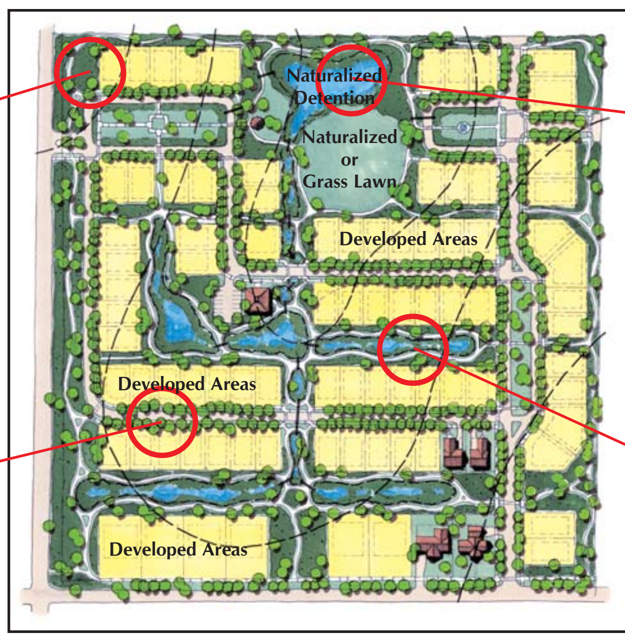
Moderate density residential development is defined for this project as having a gross density of approximately 2 units per acre with lot sizes ranging from 6,000 to 15,000 square feet with municipal water and sewer service. Typically, these developments are under municipal jurisdiction, but may occur in unincorporated areas as part of planned unit developments (PUD's). The Conventional Template includes wide roads, no public open space, and storm sewers discharging into turf and/or rip-rap lined detention basins, while the Conservation Template includes narrower streets and an integrated, naturalized stormwater system that hosts trails and public open space and allows every residence to back to open space.

Conventional Moderate Density Residential Template

Native Landscaping



Bioswale



Naturalized Detention

Vegetated Swale/ Rain Garden

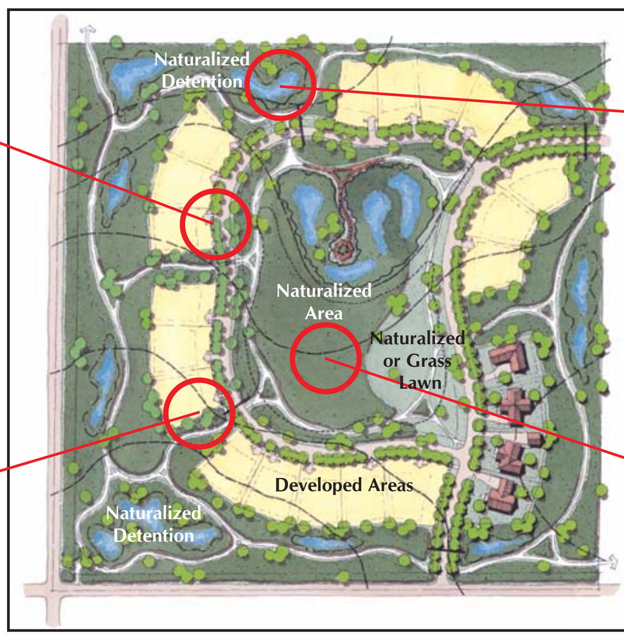
Conservation Moderate Density Residential Template

Rural Residential Templates

The Rural Residential Template is defined as having lots averaging approximately 1.25 acres, a gross density of 0.55 units per acre, served by private wells and septic systems. Typically, rural residential development is limited to unincorporated areas. However, more recently, many developments of this density have come under municipal jurisdiction, and would then often be served by municipal water and sewer. The Conventional Template includes a cul-de-sac drained with storm sewers discharging into detention basins, while the Conservation Template includes a narrow lane and a naturalized stormwater system that utilizes the landscape to filter, evapotranspire and absorb runoff as well as hosting walking/ biking trails.

Conventional Rural Residential Template

Vegetated Swale



Naturalized Detention

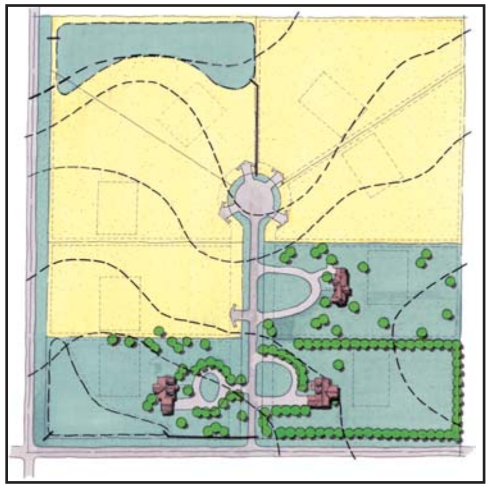
Rain Garden

Native Landscaping

Conservation Rural Residential Template

Estate Residential Templates

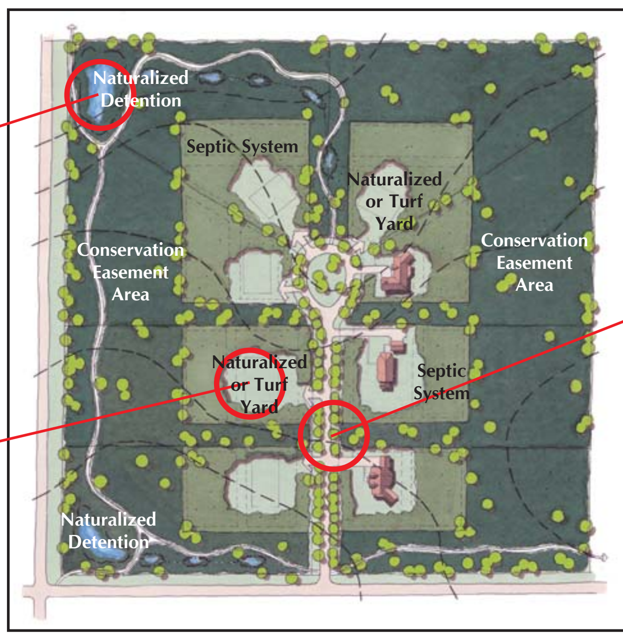
Estate residential development is defined as having lots averaging approximately 2.5 acres in size, a gross density of approximately 0.2 units per acre, served by private well and septic systems. Estate residential developments occur almost exclusively in unincorporated areas. The Conventional Template has longer driveways and is primarily landscaped with lawn, while the Conservation Template has shorter driveways and uses native plantings and a conservation easement.



Conventional Estate Residential Template

Naturalized Detention

Native Landscaping

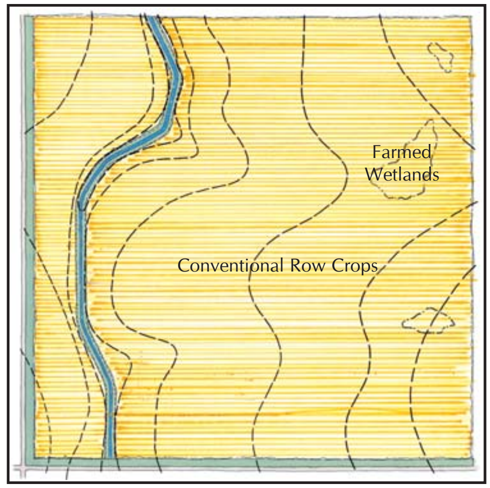


Vegetated Swales

Conservation Estate Residential Template

Agriculture Templates

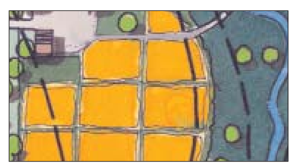
Agricultural lands are cultivated and manipulated for the production of food crops and/or livestock for sale beyond the immediate use of the farmer or landowner. The Conventional Template is typical row-crop agriculture, that includes the use of herbicides, pesticides, tillage of the soil, and mono-crop production. The Conservation Template includes a variety of techniques and environmentally sound agricultural practices that can improve the hydrology and water quality of the watershed. Those practices include contour plowing, native seed production, reduced or no-till techniques, organic farming, biodynamic or permaculture techniques, animal grazing on native grassland, and buffer zones.



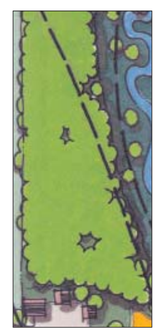
Conventional Agriculture Template

contour plowing, perennial crops, or grazing

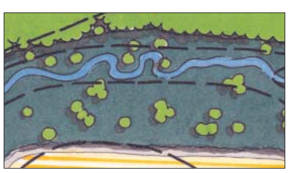
re-meandered stream



non-row crops

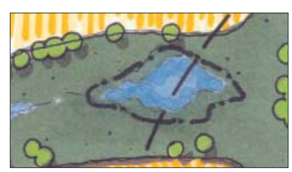


sustainable woodlot



floodplain buffer

conservation connector

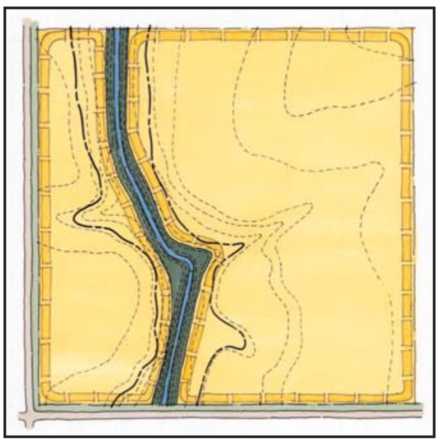


restored wetlands

Conservation Agriculture Templates

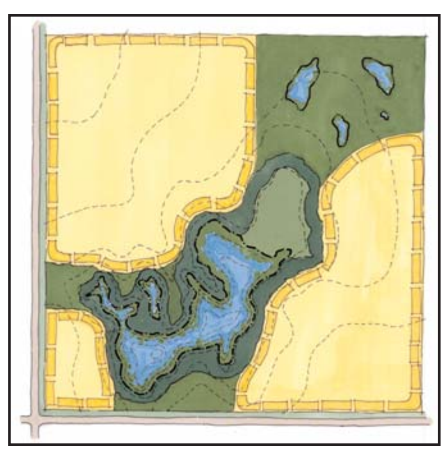
Stream Corridors Templates

Stream corridors are linear spaces along streams, creeks and rivers. The Conventional Template (left) represents a degraded stream corridor, which has been channelized, and is limited to a minimum buffer of 0 to 50 feet, depending on the drainage area and adjacent land use. The Conservation Template (right) refers to a healthy stream corridor with the freedom to meander naturally, and includes wetlands and floodplains adjacent to the stream. The areas in yellow represent land that may be developed in agricultural or urban land uses. Those yellow areas in the conservation version (right) will have little impact on the stream provided that the management practices outlined in the conservation versions of the urban and agricultural templates are used.



Depressional Wetlands Templates

Depressional wetlands are landscape features that are assumed to be distinct from flowing streams and have vegetation, hydrology and soils characteristics of wet conditions. Historically, depressional wetlands were located where the ground dropped below the water table and therefore served as discharge zones or flow-through zones. Where the hydrology has been manipulated through agricultural or urban development, many of these wetlands now receive a much greater amount of surface runoff and a reduction in groundwater discharge. As with the stream template, the areas in yellow represent areas for agricultural or urban land uses. In the Conservation Template (right), the yellow areas are developed using practices outlined in the conservation versions of the other described templates.



Template Modeling

Each of the templates was evaluated in terms of its expected performance in protecting the hydrology of Blackberry Creek and therefore the quality of Creek's aquatic resources. Hydrologic response of the templates, based on continuous simulation hydrologic modeling, was used as the predictor of expected performance. Thus, the evaluation involved developing hydrologic models of each of the templates and then comparing the runoff response of the conventional and conservation versions of the templates. The response of the urban templates was also compared to existing conditions, which was assumed to be conventional agriculture.

All hydrologic simulation was performed using Hydrologic Simulation Program - Fortran (HSPF) (Bicknell, 1993, see notes below). HSPF is a continuous simulation hydrologic model that produces a continuous time series of runoff from a continuous time series of precipitation and potential evapotranspiration. HSPF simulates surface runoff, interflow (shallow subsurface runoff, typically through the topsoil layer), active groundwater runoff (deeper, slower responding subsurface runoff that is responsible for baseflow in streams) and deep percolation. It also continuously accounts for moisture levels in various soil layers that are filled by infiltration from the surface and drained by evapotranspiration and gravity to lower layers or to a local waterway. HSPF was chosen because it allows examination of the influence of land cover on both high flows and low flows, and because it allows simulation of the impact of impervious runoff onto adjacent pervious areas.

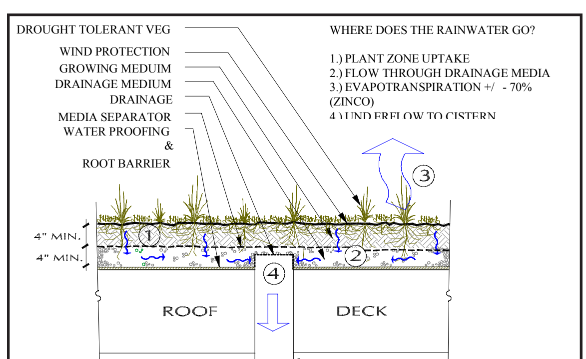
The modeling methods for individual conservation stormwater management practices used in the templates as well as the methods and assumptions for the templates as a whole are described below. Following the discussion of methods and assumptions, the modeling results are presented. The metrics used to characterize the runoff response are described under the results.

Hydrologic Modeling of Conservation Stormwater Practices

As described previously, the urban conservation templates utilized a number of conservation stormwater management practices. The techniques used to model these practices are described below.

Green Roofs

Green roofs were used in the conservation commercial template only. Green roofs were modeled as a shallow soil profile with a high infiltration capacity. As with actual green roof installations, no surface runoff occurs over the growing media layer. Initial rainfall rehydrates the growing media. As the saturation level increases, the water "breaks through" to the drainage media layer. The drainage layer is assumed to drain similarly to a very porous groundwater table with a recession constant determined from the hydraulic conductivity of the drainage media. The discharge from the drainage layer is to the site stormwater system.

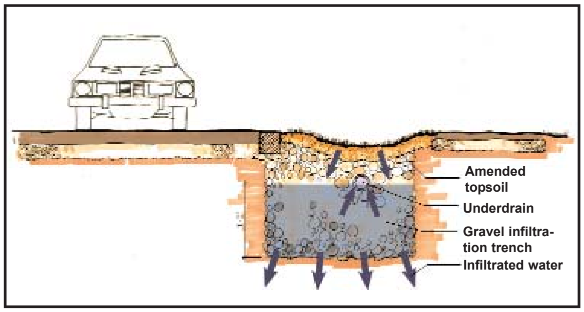


Green roof cross section.

Notes:
Bicknell, B.R., J.C. Imhoff, J.L. Kittle Jr., A.S. Donigian Jr., and R.C. Johanson, *Hydrologic Simulation Program - Fortran (HSPF): Users Manual for Release 10.0*. Aqua Terra Consultants and University of the Pacific, for Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Athens, Georgia, and Office of Surface Water, Water Resources Division, U.S. Geological Survey, Reston, Virginia, September 1993.

Bioswales

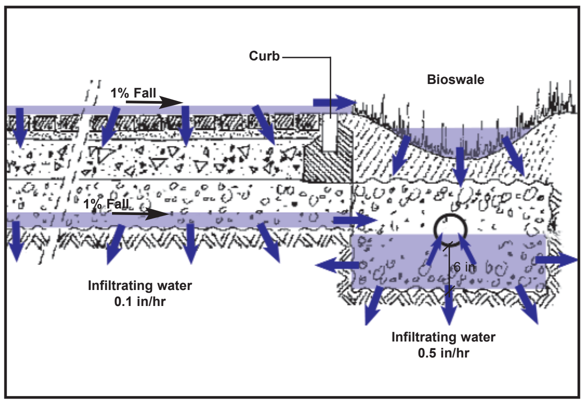
Bioswales were used along the roadways of the conservation moderate density residential template and within parking lots of the conservation commercial template (described as part of porous paving). Bioswales include a surface vegetated swale overlying an infiltration trench with an underdrain. Within the residential template, bioswales were assumed to occur on both sides of the road. Each bioswale receives runoff from half the road width and from the front half of the adjacent lot and its associate impervious surfaces. The percolation rate through the bottom of the bioswale infiltration trench was assumed to be 0.5 inches/hour and the depth of the trench below the underdrain was assumed to be 12 inches to ensure drainage in less than 12 hours (porosity = 0.4). Runoff rates exceeding the capacity of the bioswale were conveyed downstream through the underdrain or the surface swale.



Road side bioswale infiltration system.

Porous Pavement and Bioswales

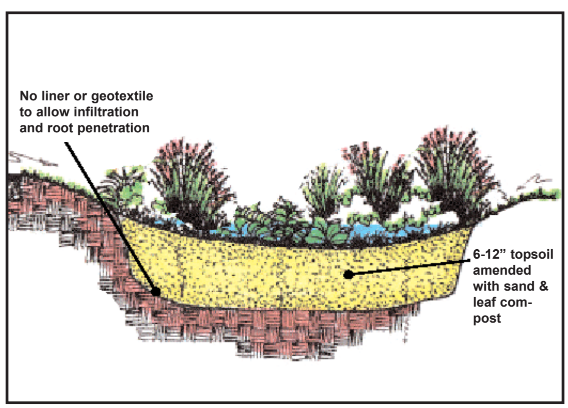
Porous pavement was only used in the conservation commercial template and was combined with bioswales. The porous pavement used here was assumed to be interlocking concrete pavers with openings to channel and allow water penetration through the pavement surface and into the aggregate base of the parking lot. Rainfall onto the surface either drains through the pavement openings or, during very intense rainfalls, drains to the surface of the bioswale. Water that percolates through the pavement surface either infiltrates into the underlying subsoils or moves laterally through the course aggregate base to the gravel trench under the bioswale. Water that drains into the gravel trench of the bioswale from either the vegetated swale above or from the adjacent pavement base either infiltrates into the subsoils or is conveyed downstream by the perforated pipe. The rate of infiltration through the pavement surface was determined by the material recommended for filling voids that was assumed to be in an unmaintained condition (gross infiltration rate through pavement = 2 inches/hour). The drainage capacity of the aggregate parking lot base was determined by the hydraulic conductivity of the base material and the slope of the subgrade.



Bioswale adjacent to porous pavement.

Rainwater Gardens

Rainwater gardens are often recommended for use at the lot scale in residential developments. For this project, neighborhood scale rainwater gardens were integrated into the conservation moderate density template to create contiguous naturalized open space behind all of the home sites. Rainwater gardens were also used in the conservation commercial template. In this context of this project, rainwater gardens were assumed to be nearly flat, created prairie



Rainwater garden (adapted from LID Center) landscapes that receive runoff from adjacent lawns and impervious areas. Excess runoff that cannot be absorbed by the rain garden drains by gravity across the surface. Rainwater gardens were modeled in HSPF by adding the runoff from adjacent areas to the rainfall directly onto the rainwater garden and were modeled as nearly flat areas vegetated with deep rooted native species planted in topsoil amended to a depth of 6 -12 inches to reverse the compaction effects of grading. In the conservation agricultural template, filter strips within the cropped fields and buffer strips at the edges of fields were modeled the same as rainwater gardens.

Vegetated Swale

Vegetated swales planted in native vegetation are similar to bioswales except that they do not include a gravel infiltration trench. For this project, prairie swales were used in the conservation version of the rural and estate residential templates along the roadways to provide water retention as well as conveyance during larger storm events. These were modeled in the same manner as the rain gardens described above where the runoff from the street and adjacent front yards was distributed over the area of the swale. Within the conventional version of the rural and estate residential templates, turf swales along the roadways and backyard lines were modeled in the same manner as the vegetated swales except using runoff parameters for turf rather than created prairie.

Template Modeling Assumptions

This section outlines the modeling assumptions and methods for the individual templates. In general, the conventional versions of the templates utilized standard stormwater management components, including storm sewers in the commercial and moderate density residential templates, turf swales in the rural and estate residential templates, and detention throughout. In contrast, the conservation templates minimize use of storm sewers and attempt to manage stormwater as close to the source as possible utilizing naturalized drainage systems as outlined in the BMP sections of this report.

General Assumptions

The following assumptions were common to all the templates and illustrate the attempts made to ensure comparability between the conservation and conventional versions of the templates.

1. The total site area for the urban templates was 40 acres and includes land to the centerline of two exterior roads (assumed to be county or township roads.)

2. The house footprint was assumed to be the same for like density residential templates. However, the driveways did not necessarily have the same area.

3. The same runoff parameters were used for like land covers. In particular, turf was assumed to have the same runoff response whether it was part of a conventional or part of a conservation template. Porous pavement and green roofs that change the runoff characteristics of traditionally impervious surfaces were used only in the conservation commercial template.

4. The potential impact of septic systems or irrigation on runoff response was not considered in the modeling.

5. For all residential templates, the portion of the yard between the roof ridge and the street was assumed to drain toward the street and the rear portion of the yard was assumed to drain to the rear.

6. All urban templates utilize detention designed to meet the Kane County allowable release rate of 0.1 cfs/acre of site.

Template Specific Assumptions

Commercial/Industrial

Conservation Commercial Template

Conventional: The conventional commercial template was assumed to be served by storm sewer drainage. The parking areas and pitched roof buildings were assumed to have an initial abstraction of 0.1 inches. The primary building on the site was assumed to have a flat roof and therefore to have a greater initial abstraction (retention storage constant in HSPF) of 0.4 inches.

Conservation: Parking areas were assumed to be paved with interlocking porous concrete pavers and include bioswales as illustrated in the template graphic. The porous pavement and bioswales were modeled as previously described. The two largest buildings were assumed to have green roofs (modeling also described previously). A bioswale (with a 6-inch deep, 30-foot wide infiltration trench) running down the center of the "main-street" area of the template was assumed to treat runoff from the roofs, walks, and roads adjacent to it. Rain gardens in a number of locations were used to filter and absorb runoff from adjacent impervious areas. The runoff from the impervious patio areas behind the main-street buildings was assumed to drain to the large rain gardens on either side of the traffic circle.

Moderate Density Residential

Conservation Moderate Density Residential Template

Common Assumptions: Roof areas were assumed to be 3,000 square feet per lot and the entire roof area was modeled as impervious.

Conventional: The entire development was assumed to be served by curb, gutter, and storm sewer drainage.

Conservation: The streets were assumed to be drained by shallow bioswales with an 11 foot wide infiltration trench beneath (trench extends under the sidewalk). The depth of the infiltration trench was assumed to be 12 inches below the underdrain. The surface runoff from the bioswales was added to the runoff from the backyards (including roof area) and distributed over the area of the "vegetated swale/rain garden" in the backs of the lots. Only the area between the trails (average of 35 feet wide) was assumed to be available for absorption of runoff.

Rural Residential

Common Assumptions: Open swale drainage systems were used in both versions of the rural residential template. The runoff response of the street, drive, and front yard areas was modeled by distributing the runoff from these features over the area of the swale and adding the rainfall directly onto the swale. Roof areas were assumed to be 3,500 square feet per lot.

Conventional: Both the interior and exterior roads were assumed to be drained by turf swales approximately 10 feet wide. Within the front yard, both the roof and driveway impervious cover were assumed to be sufficiently significant to be modeled as impervious surface. Within the back yard, the roof area was assumed to be insignificant and its area was combined with the turf area and simply modeled as urban grass or turf.

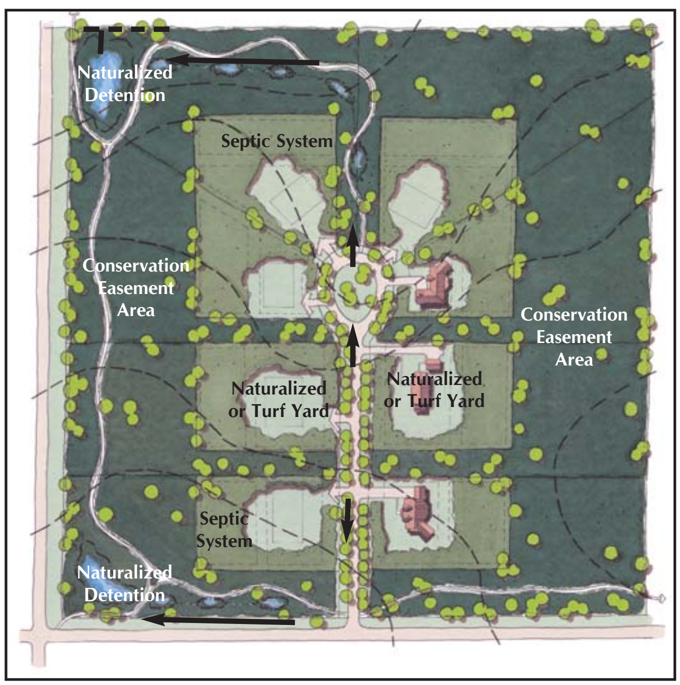
Conservation Rural Residential Template

Conservation: Because the lots are smaller than the conventional version of this template, the entire roof area was modeled as impervious cover. Both the interior and exterior roads were assumed to be drained by prairie vegetated swales. The interior road was assumed to be pitched toward the center of the development and its runoff was distributed over a 35 foot wide prairie vegetated swale. The front yard was assumed to drain to a 15 foot wide prairie vegetated swale. The runoff from the front yard swale and the back yard were distributed over the prairie area between the back yards and the trail illustrated in the plan. All but one acre of the central green space was assumed to be vegetated in prairie. The one acre was assumed to be vegetated in turf.

Estate Residential

Common Assumptions: Open swale drainage systems were used in both versions of the Estate Residential Template. The runoff response of the street, drive, and front yard areas was modeled by distributing the runoff from these features over the area of the swale and adding the rainfall directly onto the swale. Roof areas were assumed to be 5,000 square feet per lot.

Conventional: Both the interior and exterior roads were assumed to be drained by turf swales approximately 10 feet wide. Within



Conservation Estate Residential Template the lot, only the driveway impervious cover was assumed to be sufficiently significant to be modeled as impervious surface. The runoff from the roof area was combined with the turf area and simply modeled as urban grass or turf.

Conservation: Both the interior and exterior roads were assumed to be drained by prairie-vegetated swales. The assumption for interior street swale was 20 feet wide whereas the exterior road swale was 30 feet wide. The vegetated swales drain to the wide prairie areas between the road and detention areas. In the model, the discharge from the swales was distributed over the prairie area. Because the front yard is somewhat smaller in the conservation template than in the conventional one, the runoff from the front half of the roof was assumed to contribute directly and was modeled as impervious. One quarter of the non-impervious front yard was assumed to be planted in prairie vegetation and the remainder was assumed to be turf. Three quarters of the back yard was assumed to be prairie. In the model, runoff from the back yard was distributed over the prairie area behind the lot portions of the yard.

Agriculture

A portion of the difference between the conventional and conservation agriculture templates was represented at the scenario level. In the conservation scenario, existing rural grasslands as depicted on the existing conditions land cover map were assumed to be retained whereas in the conventional scenario they were assumed to be cropped. Although the template graphic depicts a number of vignettes of conservation agriculture options, the only modeling difference was related to the assumed presence of filter strips and vegetated waterways.

Conventional: Within the conventional template, the entire area was assumed to be used for row crop agriculture.

Conservation: Within the conventional template, 30 foot filter strips were assumed to occur every 300 feet of slope length. This resulted in 10% of the agricultural area being vegetated in prairie vegetation. For modeling purposes, cropland runoff was distributed over the area of the prairie filter and added to the rainfall directly onto the filter to determine the runoff response of the template.

Stream Corridor and Depressional Wetland Templates

Both the stream and wetland templates are different than the other templates in that they are not a single land use (i.e., residential or commercial) but rather a collection of land uses. The land covers in the template include the stream or wetland itself, the corridor or buffer, and the surrounding land uses (shown in yellow in the template graphics).

Because the area of the stream and wetland template outside the boundary of the stream or wetland and its buffer is a land use already represented in other templates, the template models for streams and wetlands represent the runoff from the area of the stream and wetland only. Finally, because the runoff response of high quality and degraded streams and wetlands is not expected to be significantly different, separate models were not developed for conservation versus conventional wetlands and streams and therefore no template modeling results are presented for the stream and wetland templates.

Template Evaluation

Template Evaluation Measures

A number of statistical measures or metrics were used to evaluate the hydrologic performance of the various templates. The intent of the metrics was to provide indicators of those aspects of template hydrology that are important to the goals of the Blackberry Creek Watershed. Generally, the watershed goals outlined in the 1999 Management Plan are to avoid degradation of stream and wetland resources as the watershed urbanizes and to prevent increases in streambank erosion and flooding.

TQmean

TQmean is defined as the proportion of time that the flow rate is above the mean rate. It is a measure of the "stability" of the streamflow and was developed by researchers at the University of Washington. The higher the TQmean value, the more stable and less flashy the streamflow. Typically, a stream becomes flashier as its watershed urbanizes. The University of Washington found a strong relationship between TQmean and their Benthic Index of Biotic Integrity (B-IBI). No correlation analysis has been performed for Northern Illinois. However, TQmean values for a number of gaged streams and rivers were computed and found to range from 0.19 to 0.41. Although there are exceptions, the more rural streams typically have higher TQmean values than the urban streams. TQmean values were computed based on daily average flows. To reduce the influence of annual variability, an average TQmean was computed from annual values for 1990 through 1995. Differences in TQmean values less than 0.02 are generally not statistically significant.

1.1-year and 2-year discharge rates

These are the peak flow rates that occur, on average, every 1.1 and 2 years, respectively. These values are determined by performing frequency analysis on annual maximum peak flows over the 47 year modeling period. The 1.1- to 2-year flow rates are generally considered "channel forming" flows since strong relationships have been found between flows with this frequency and stream channel geometry. As a watershed urbanizes, the flow rates associated with these frequencies increase and as a result, channel size must increase, causing streambank erosion and subsequent sedimentation.

The analysis was performed on the detention discharge rates since both the conventional and conservation urban templates were assumed to have detention that meets Kane County's release rate standard. Because all urban templates must meet the detention standard, they all have 100-year discharge rates that are approximately 4 cfs (0.1 cfs/acre for the 40 acre template size).

Required Detention

This shows the amount of detention that was required to meet the County 100-year release rate requirement of 0.1 cfs/acre. Since continuous hydrologic modeling was used, the event of record (the event that requires the most detention to prevent exceeding the 4 cfs maximum allowable discharge rate) was selected as the design storm for detention sizing. It was interesting to note that the event of record varied from template to template. For most of the conventional templates, the August 1987 event was the event of record. For most of the conservation templates, the July 1957 event was the event of record. The rainfall associated with the July 1957 event was less than the rainfall during the August 1987 event. However, it was much drier before the 1987 event than before the 1957 event.

Hydrographs

The plotted hydrographs are not a metric but provide a visual indicator of the difference in runoff response between the conventional and conservation templates. The conventional agriculture is plotted along with the hydrographs of the conventional and conservation urban templates as a surrogate for existing conditions. The plotted hydrographs show daily average detention discharge rates for January 1, 1990 through December 31, 1990. The year 1990 was chosen since it was a relatively wet year that had some larger events. The rainfall associated with the August event (day 230) was equivalent to approximately a 2-year rainfall. Because the hydrographs show daily average flow, they provide a good visual indicator of event runoff volumes as well as low flows between events.

It should be noted that HSPF simulates both surface and subsurface runoff (groundwater driven baseflow) and that both the subsurface and surface runoff is represented in the plotted hydrographs. In many cases, the subsurface baseflow does not drain to detention basins and instead drains directly to a stream or wetland. However, at these small drainage areas, it is difficult to predict whether or not this will occur. Thus, both the surface runoff and baseflow were routed through the detention basins for this analysis.

Template Evaluation Results

The overall template evaluation results are summarized in the table below and the results for the various urban land uses and agricultural templates are described in the following paragraphs.

Commercial

The conventional commercial template is approximately 85% impervious surface, which results in the most flashy conditions of all the templates as evidenced by examination of the hydrographs as well as the TQmean values. The high imperviousness of the commercial template causes the discharge to

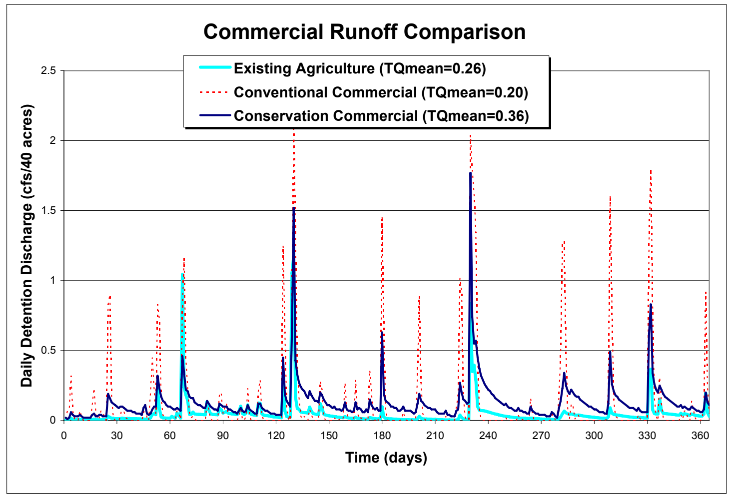
	Agriculture	Estate Residential	Rural Residential	Moderate Density Residential	Commercial
TQmean					
Conventional	0.26	0.24	0.25	0.19	0.20
Conservation	0.32	0.32	0.32	0.37	0.36
1.1-Year Discharge (cfs)					
Conventional	0.8	0.8	0.9	1.5	1.8
Conservation	0.2	0.2	0.3	0.4	0.9
2-Year Discharge (cfs)					
Conventional	5.0	1.7	1.6	1.9	2.3
Conservation	1.8	0.8	0.9	1.2	1.6
Required Detention (ac-ft)					
Conventional	-	7.5	8.5	13.8	21.7
Conservation	-	0.9	2.5	6.1	12.2

- TQmean is the proportion of time that the flow rate is above the average flow based on simulated runoff for 1990 through 1995. Differences in TQmean of 0.02 to 0.03 are generally not significan t.
- The 1.1- and 2-year discharge rates are flow rates in ft^3/s for the 40 acre templates.
- The required detention volumes in acre -feet are the volumes required to meet the County 100 -year discharge standard of 0.1 cfs/acre.

drop to zero between essentially every event.

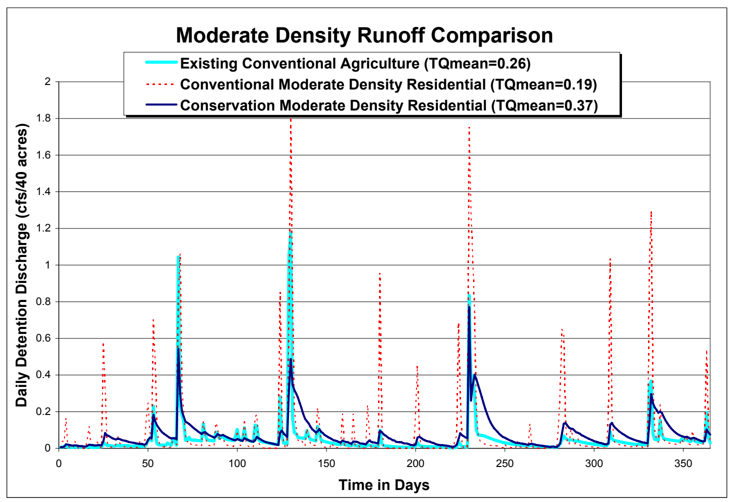
The conservation commercial hydrograph actually exhibits higher baseflow than existing conditions (assumed to be conventional agriculture) but peaks that are sometimes lower and sometimes higher.

Although the conservation version of the commercial template has higher 1.1-year and 2-year discharge rates than the other conservation templates, it should be noted that these rates are as low or lower than the rates for all the conventional templates, including estate residential.

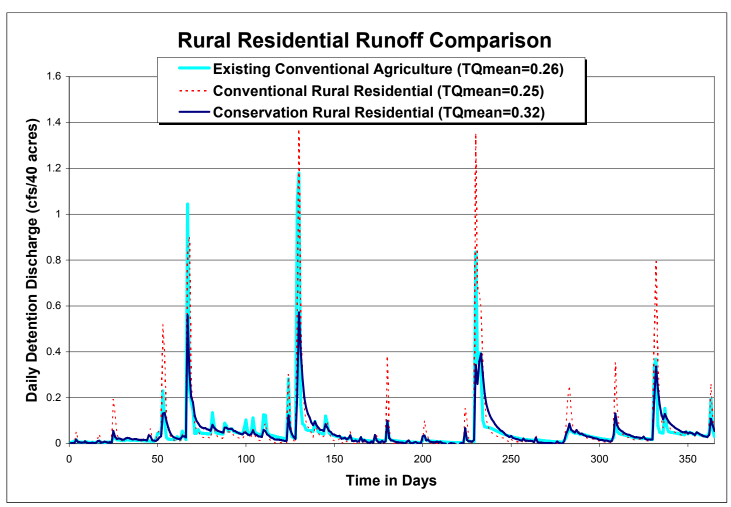


Moderate Density Residential

Examination of the hydrographs, TQmean values, and the 1.1-year discharge rates shows that the conventional moderate density residential template is much more "flashy" than the two lower density residential templates. This is due to the greater percentage of impervious surface and the more connected nature of the impervious cover (curb and gutter drainage vs. open swales).



Due to the greater impervious cover, the detention volumes for the moderate density residential development are significantly greater than for the lower density development. This is true for both the conservation and conventional versions of the templates. However, it should be noted that the conservation version of the moderate density residential template requires less detention than even the estate residential conventional template.



Rural Residential

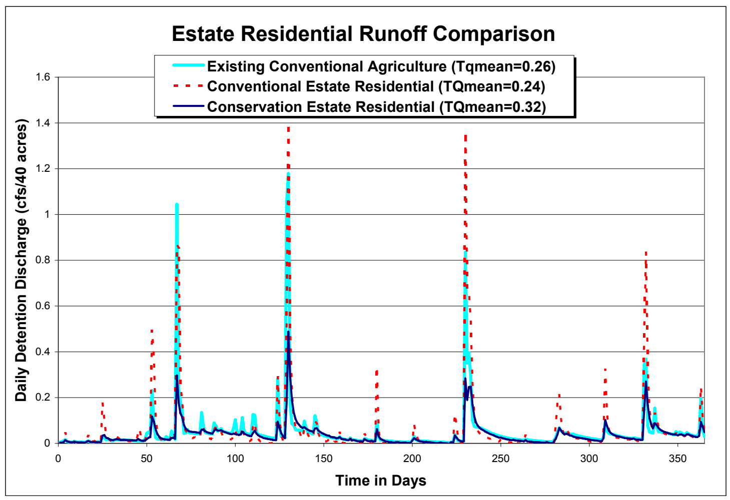
At this low density and due to the relatively disconnected nature of the impervious area (due to swale drainage), the influence of turf appears to be affecting the runoff response to a greater degree than impervious.

The relatively low imperviousness of even the conventional rural residential template resulted in similar a TQmean value and 1.1- year discharge rate as the cropland template. The small differences in TQmean and 1.1- year discharge values between the rural residential and agriculture templates were not found to be statistically significant. However, examination of the hydrographs shows a distinct difference in runoff response between the conventional rural residential and agricultural templates, particularly for the smaller summertime events. As with the other land uses, the difference between the conventional and conservation versions of the template is quite significant as can be seen in both the statistics and the hydrographs.

The runoff response for rural residential is very similar to estate residential for both the conventional and conservation templates. The difference in TQmean between the conservation estate and rural residential land uses is not significant.

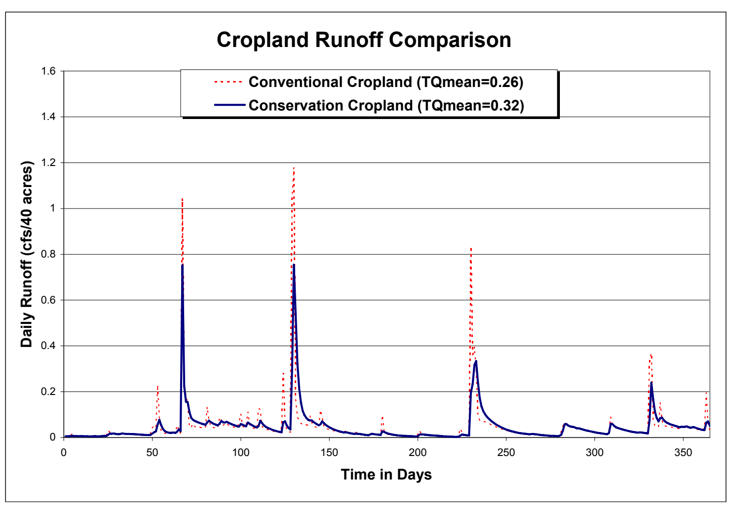
Estate Residential

As discussed under the rural residential template, the runoff response for estate residential is very similar to rural residential for both the conventional and conservation templates. As expected, estate residential has the lowest detention requirements of the urban land uses and the conservation estate residential land uses require very little detention to meet the County release rate requirement.



Agriculture

Cropland generally produces less total runoff than urban land uses since there is no impervious surface. This is particularly evident when comparing the conventional cropland hydrographs to those of the urban land uses and when comparing the 1.1-year discharge rates. For the 2-year discharge rates, the lack of detention for the agriculture land use becomes more important, resulting in agriculture having the highest 2-year discharge rates of all the land uses.



The hydrographs, TQmean, and discharge rates show a significant difference in runoff response between the conventional and conservation versions of the cropland template. Both runoff volumes and runoff rates are significantly reduced and there is more uniformity to the streamflow (lower high flows and higher low flows) as evidenced by the significantly higher TQmean value for the conservation cropland template.

Conclusions

In summary, for all the templates, the event runoff volumes are substantially lower under the conservation version of the land use than under the conventional as evidenced by review of the hydrograph plots. As a result, the amount of detention required to meet the County release rate is significantly reduced under the conservation templates. The conservation versions of the templates require approximately half or less detention than the conventional versions.

Peak flow rates are also substantially reduced under the conservation templates relative to the conventional. In fact, the modeling indicates that even the commercial and moderate density residential conservation templates have 1.1-year and 2-year peak flows as low or lower than the lowest density conventional templates. Because agricultural land uses have no detention requirements, the 2-year peak flow rates in the table are significantly higher for the agricultural land use than for the urban land uses. However, in comparing the hydrographs, it can be seen that the daily runoff volumes are significantly lower for the agriculture land use than for the conventional urban land uses.

A correlation analysis between MBI and TQmean has not been completed for Illinois. Although there is a clear statistical significance to the increase in TQmean from the conventional to the conservation versions of the templates, it is difficult to judge the biological significance of the increases. The percent increase in TQmean from the conventional to the conservation versions of the templates varies from almost 30% to nearly 100% with the greatest difference occurring for the higher impervious moderate density and commercial land uses. It is also important to note that there is a clear significance to the difference between all the conservation urban templates and an assumed existing condition of conventional agriculture (with the conservation urban templates having higher TQmean values).

The modeling, as evidenced by the difference in baseflows between the conservation and conventional versions of the templates shows that there is an increase in infiltration and groundwater runoff under the conservation templates relative to the conventional templates. This is beneficial to the receiving stream reaches and wetlands. It also suggests that there may be an increase in deep groundwater recharge that is important for municipal and private water supplies. Although the importance of an area to deep groundwater recharge varies around the watershed, it appears that implementation of the conservation templates has the potential to generally preserve the groundwater recharge characteristics of the site.

The conservation versions of the moderate density residential and commercial templates actually have the highest baseflows as can be seen in the hydrographs. This is true even though the conservation version of the estate residential template is mostly naturalized open space. This appears to be the result of the infiltration storage that is included in the moderate density residential (road side infiltration trenches) and commercial templates (porous paving and infiltration bioswales). These features temporarily hold water, providing additional time for infiltration. At the same time, these features reduce transpiration, resulting in a net increase in the amount of water that infiltrates relative to what would ordinarily occur in the landscape. In many cases greater infiltration will be beneficial since it can at least partially compensate for reduced infiltration in other areas of the watershed. However, in certain circumstances, such as within the recharge area of a high quality fen, the increase in infiltration volume could be detrimental if it results in a change in the overall hydrologic balance or chemistry of the sensitive feature.

In general, the conservation versions of the templates out-perform the conventional versions and have the potential to substantially reduce the impacts of urbanization in the watershed.

Scenario Design & Evaluation

Scenario Design

General Assumptions

For this project, scenarios were defined as alternative, watershed-scale, land use and template allocations. Each scenario represents a unique distribution of the various template land uses throughout the watershed following three distinct land use plans. Continuous simulation hydrologic modeling was used to evaluate the implications of the various alternative land use futures in terms of changes in high flow and low flow hydrology and distribution of high and low flows and using similar metrics as used to evaluate the templates.

The three scenarios developed as part of this project were existing conditions and two future conditions, one using conventional templates and the other using conservation templates. Several assumptions common to both future land use scenarios were:

1. Each future scenario uses a combination of the Kane County 2020 Land Use Plan and local municipal land use plans as its foundation. However, there were two exceptions to this rule:

    - Existing residential areas located within the agricultural land use of the County plan were retained as residential in both scenarios.

    - Stream and wetland land covers were assumed to take precedence over the planned land uses in both scenarios (in other words the streams and wetlands were assumed to be retained rather than converted to an urban land use).

    Since many of the residences in agricultural areas are associated with agricultural production and since the 2020 Plan calls for preservation of stream and wetland resources, these exceptions are consistent with the intent of the 2020 Plan. Specific identification of these exceptions was required as part of the hydrologic modeling of the scenarios.

2. Municipal land use plans within municipal boundaries were not changed.

3. Land use categories for all municipalities were modified to match the Kane County 2020 land use designations. This was required to provide consistency in land use designations throughout the watershed. The County designations were chosen since the majority of the watershed area is currently not incorporated into any municipality.

4. Existing built areas were assumed to remain in their current land use (no redevelopment and rezoning from one urban land use to another).

In summary, the assumption of the both future condition scenarios was that the current Kane County 2020 plan and the various municipal comprehensive plans would be followed. The primary difference in land use between the conservation and conventional scenarios related to the assumptions in those areas where the County and municipal plans overlap. Since Illinois municipalities are allowed to plan up to 1.5 miles beyond their boundaries, the scenarios had to address the overlap between the County and municipal plans. In some places, this overlap showed a conflict between the two plans. As discussed in the descriptions of the scenarios that follow, the assumptions for resolving this conflict varied from the Conventional to the Conservation Scenario.

Mapped to Modeled Land Use / Land Cover Conversion Table

Model Land Use	USGS Land Use/ Land Cover	Existing Condition Land Use/ Land Cover	Current Proposed Scenario Land Use	Conservation Scenario	
				New Land Use	Existing Land Use (conventional)
Commercial/Industrial	**Commercial** **Industrial**	**Commercial** **Industrial** **Transportation**	**Commercial** **Industrial** **Office/Research** **Transportation**	**Commercial** **Industrial** **Office/Research** **Transportation**	**Commercial** **Industrial** **Transportation**
Institutional (50% Commercial + 50% Urban Grassland)	**Institutional**	**Institutional**	**Institutional**	**Institutional**	**Institutional**
Moderate Density Residential	**Medium Density/ High Density Urban**	**Urban Residential**	**Urban Residential**	**Urban Residential**	**Urban Residential**
Rural Residential	**Low Density Urban**	**Rural Residential**	**Rural Residential**	**Rural Residential**	**Rural Residential**
Estate Residential	**Estate Residential**	**Estate Residential**	**Estate Residential**	**Estate Residential**	**Estate Residential**
Agriculture	**Row Crop** **Small Grains** **Barren**	**Agriculture** **Barren**	**Agriculture**	**Agriculture**	**Agriculture**
Urban Grassland	**Urban Grassland**	**Urban Grassland**	**Urban Grassland** **Proposed Open Space** within municipalities and not adjacent to wetlands/ water	**Urban Grassland**	
Naturalized Open Space	**Rural Grassland** **Forest Preserve** **Deciduous Savannah** **Deciduous Woodland**	**Rural Grassland** **Forest Preserve** **Woodland**	**Forest Preserve** **Proposed Open Space** outside municipalities and adjacent to wetlands/water	**Forest Preserve** **Proposed Open Space** **Agriculture Resource Buffer** **Additional Open Space**	
Wetland	**Forested Wetland** **Swamp** **Wet Meadow** **Shallow Water Wetland**	**Wetland**	**Wetland**	**Wetland**	
Water	**Open Water**	**Water**	**Water**	**Water**	

NOTES:

The first column shows all of the modeled land cover/land uses and the columns to the right indicate which USGS and County land cover/land uses were assumed to be included in the model categories.

The Existing Condition Land Use/Land Cover in the third column represents the recategorization of the USGS land covers in the second column.

It should be noted that several of the Model Land Uses listed in the first column are not templates previously discussed. Although not discussed as templates, urban grassland, naturalized open space, and water are land covers that occur in the watershed and therefore must be modeled. Urban grassland was modeled as turf grass, which is a cover that was a component of many of the templates. Naturalized open space was modeled as prairie, which is also a component of many of the templates (mostly within the conservation templates). Water and wetland were modeled as wetland.

Existing Conditions Scenario

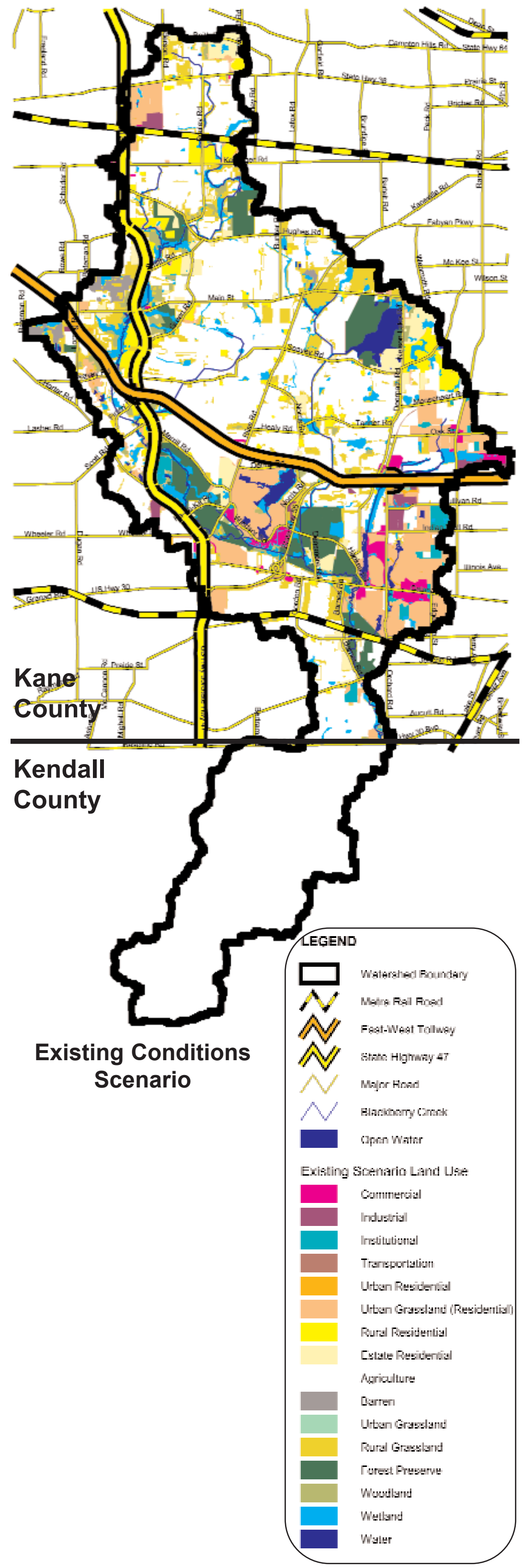
The Existing Conditions Scenario was intended to represent watershed conditions as they exist today and was the basis of comparison for the two future conditions scenarios. The source of the land use/land cover for this scenario was the land cover map provided by the USGS used for their watershed modeling of Blackberry Creek for floodplain mapping. To produce the Existing Conditions Scenario, the land cover/land uses in the USGS map presented in the Environmental Framework section of this report were recategorized primarily using the land use designations in the Kane County 2020 Plan as presented in the table on the previous page. Few additional categories such as woodland and barren lands were planned as proposed open space, agricultural, or other land uses in future scenarios.

Hydrologic Modeling

To perform the hydrologic modeling of this scenario, a number of the Kane County 2020 Plan land use categories in the map to the right were collapsed into the template categories being modeled for this project. The table to the left identifies the translation of the Kane County categories to the modeled templates.

The watershed was divided into 43 sub-watersheds by the USGS for their floodplain mapping study. Hydrological modeling for this project inserted the template models developed here into the USGS sub-watersheds to determine the hydrologic response at the watershed scale.

The map on the following page shows the sub-watershed map with the template model land uses applied according to the land use conversion table to the left.



Future Conditions - Current Proposed Land Use Scenario (Conventional Scenario)

As described previously, the beginning point for the Conventional Scenario was the County and Municipal Land Use Plans. In addition, the following assumptions were applied:

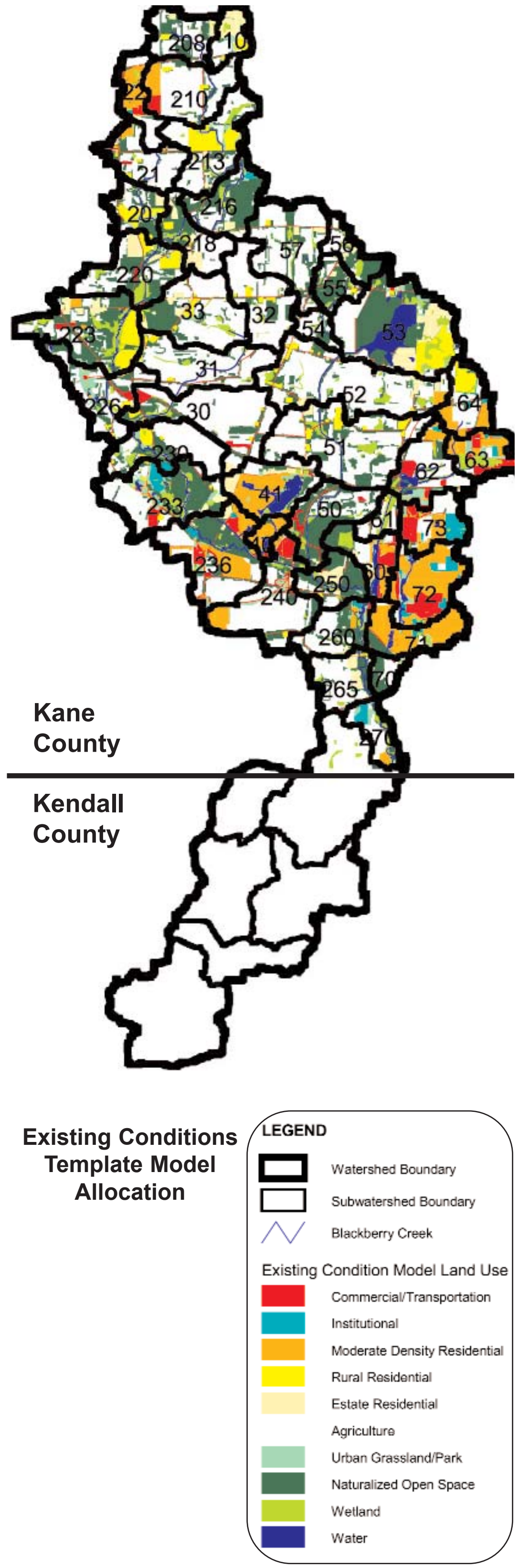
1. The municipal land use plans take precedence over the County Plan in areas of conflict within the 1.5 mile municipal planning jurisdiction.
2. Existing urban uses, where different than shown

on the County/municipal plans, were assumed to be retained. This primarily applied to the agricultural use areas where there are a number of existing residences.

3. Streams and wetlands were assumed to be retained since these areas are protected by County, State, and/or Federal programs.
4. The conventional versions of each of the templates were used throughout the watershed.
5. Stream and wetland buffers do not extend beyond what is indicated in the County and municipal comprehensive plan maps.
6. The Resource Management Areas in the Kane County 2020 Land Resource Management Plan have a planned density roughly equivalent to the rural residential templates, thus “rural residential” was substituted for this category.
7. No open space was added to that which has already been designated in the County and municipal plans.

Hydrologic Modeling

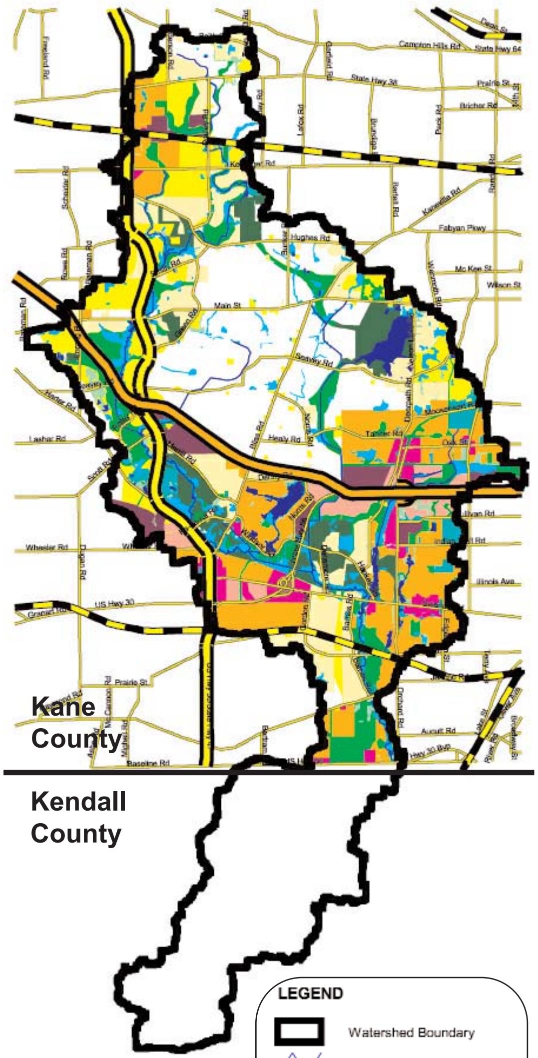
The "existing open space" and "proposed open space" land uses in the Conventional Scenario were modeled as "natural open space" outside the municipalities. Within the municipalities, these uses were modeled as "urban grassland". All "urban residential" lands were modeled as "moderate density residential". Within the agricultural of the Scenario, there are numerous individual residential parcels that are not shown on the County Plan. These were taken from the USGS existing conditions Map and modeled as "rural residential". The conventional versions of each of the modeled land use/land cover were used for this scenario.



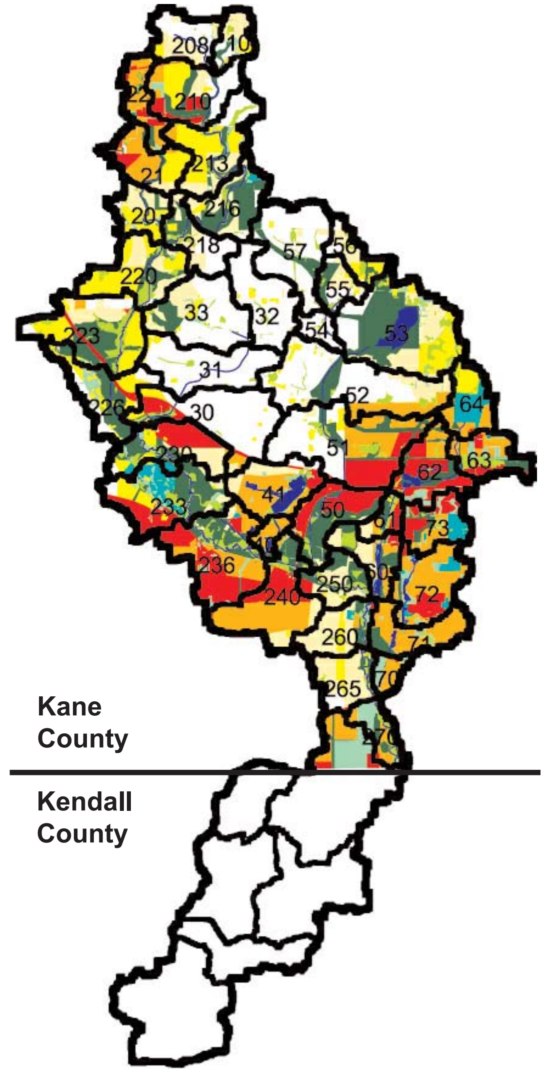
Existing Conditions Template Model Allocation

Future Conditions - Conservation Land Use Scenario (Conservation Scenario)

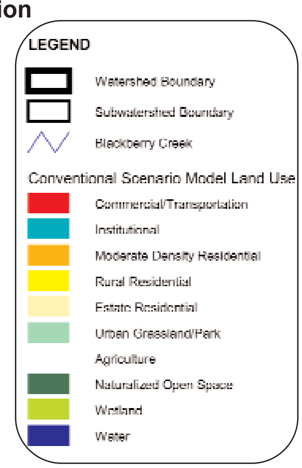
The objective of the Conservation Scenario was to first identify the most appropriate locations for natural resource protection and open space and then to apply urban and agricultural land uses according to the County and municipal plans. The purpose of this land use planning strategy is protect and enhance the hydrology and natural features of the watershed, while allowing for planned residential and commercial development. To accomplish this, the data identified under the Environmental Framework section of the Introduction and Background Chapter was used to identify the open space areas to be protected.



Current Proposed Land Use Scenario (Conventional Scenario)



Current Proposed Land Use Template (Conventional Template) Model Allocation



The identified open space to be protected under the Conservation Scenario was in addition to open space already identified in the County and municipal plans. To help distinguish between the "Conservation" and "Conventional" scenarios, two new categories of open space were created: "agriculture resource buffer" and "additional open space". The agriculture resource buffer represents lands within agricultural areas that have open space and aquatic resource protection value that are not part of the Conventional Scenario. The additional open space category signifies open space in urban areas that are part of the Conservation Scenario but not part of the Conventional Scenario. Both the agricultural resource buffer and the additional open space could remain in private ownership provided that they were managed in a manner consistent with the conservation stream corridor and depressional wetland templates.

A summary of the land use/land cover allocation process is shown in the box of the following page and a more detailed description of the rules used for delineating land uses for the Conservation Scenario follows. The term "Green Infrastructure Plan" was applied to the resulting hydrologically and ecologically based open space plan. A theme for identifying the open space of the green infrastructure portion of the Conservation Scenario was "Pearls on a String". The pearls are sensitive open space areas such as wetlands, high quality natural areas, and Blackberry Creek. The strings are the hydric soils and natural drainageways used to connect the pearls together into a ecologically functioning network of open space.

1. ID Priority Open Space (the "pearls")

The first step in developing the Conservation Scenario was to locate priority open space areas. These areas include existing protected open space areas, other significant open space areas identified in various documents and the Blackberry Creek corridor itself. Significant open space areas were identified using the following:

- The Chicago Wilderness Fox River Watershed Biodiversity Inventory,
- Blackberry Creek Watershed Management Plan, Figures 3 (INAI), 4 (NRCS Natural Storage Areas) and 9 (Wetlands for Acquisition) (pages 18, 20, & 67),
- Kane County Forest Preserves,
- Waubonsee Community College institutional open space, and
- Wetlands (from draft Kane County ADID wetland study).
- Blackberry Creek Floodplain

The Blackberry Creek stream corridors were delineated using the stream channel, floodplain, and draft ADID wetlands data layers. At a minimum, corridors contained the regulated floodplain or a minimum 50' riparian buffer, whichever was greater. If riparian wetlands were present, those areas were added to the stream corridor along with their own 50' buffer on all sides. In some cases, buffers could not be extended the full distance due to the presence of existing development within 50'. Where hydric soils existed in the buffer zone, these were used to define the edges of the buffer.

Depressional wetlands not associated with the stream corridors were then identified and assigned a minimum 50' riparian buffer. In many of these cases, existing development occurs within this buffer distance. If an existing vegetated area beyond the boundary of the wetland was observed on the aerial photo, it was included up to the size of the 50' buffer. However, if such a vegetated buffer zone did not exist, for example if there was only lawn or buildings, a buffer zone was not delineated. It was assumed that while the establishment of a buffer could be encouraged in developed areas, it would not be mandated. Typically this condition occurs where a detention basin or pond is surrounded by homes or commercial development. Wetlands were as defined in the draft ADID wetlands coverage.

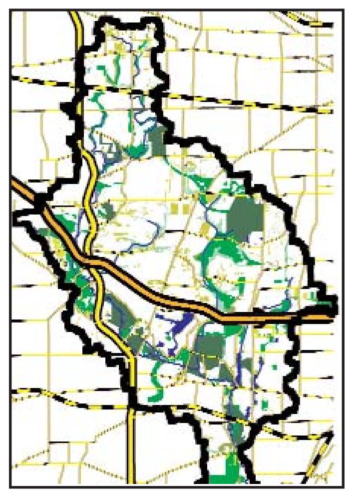
Future Conditions - Conservation Scenario Process

Step1: Map Natural Features

Natural features such as streams, wetlands, floodplains and hydric soils are critical elements to determine the location of areas designated as open space, i.e. the green infrastructure.

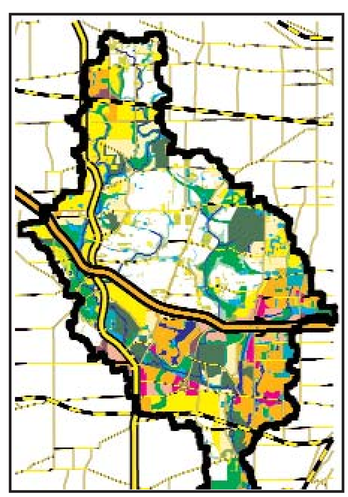
Step 2: Designate Open Space

Open Space includes "Proposed Open Space" in the Kane County 2020 Plan, "Additional Open Space" that protects natural features within proposed development areas and "Agriculture Resources Buffer" that protects natural features within areas designated as agriculture in the Kane County 2020 plan.



Step 3: Allocate Planned Land Uses

After mapping natural features and open space, the last step is to allocate planned land uses. Based on the Kane County 2020 Plan and municipal comprehensive plans, proposed land uses are designated in the remaining areas.



2. Protect/create ecological open space links (the "strings")

The "priority" areas identified in step 1 were then linked with each other, to provide a connected mosaic of open space that will enable ecological processes such as wildlife movement and hydrologic connections between patches of habitat. Where there were potential connections between stream corridors, depressional wetlands, floodplains, and existing or proposed open space (e.g., Forest Preserve land), these connections were created using a 100' wide strip (a double 50' buffer width) that followed hydric soils, existing significant vegetation visible on the aerial photo, such as a hedgerow, an existing drainage corridor visible on the aerial photo, or any combination of these. Due to constraints in locating additional open space in existing developed areas, and the fact that open space in the Kane County 2020 plan already has high connectivity, most of the identified connections that were not already present in the County and municipal plans fell into the "agriculture resource buffer" category. Examples of these corridors can be seen in each of the significant agricultural areas in the watershed, most particularly in the agricultural area in the southern part of the watershed and in the agricultural area in the center.

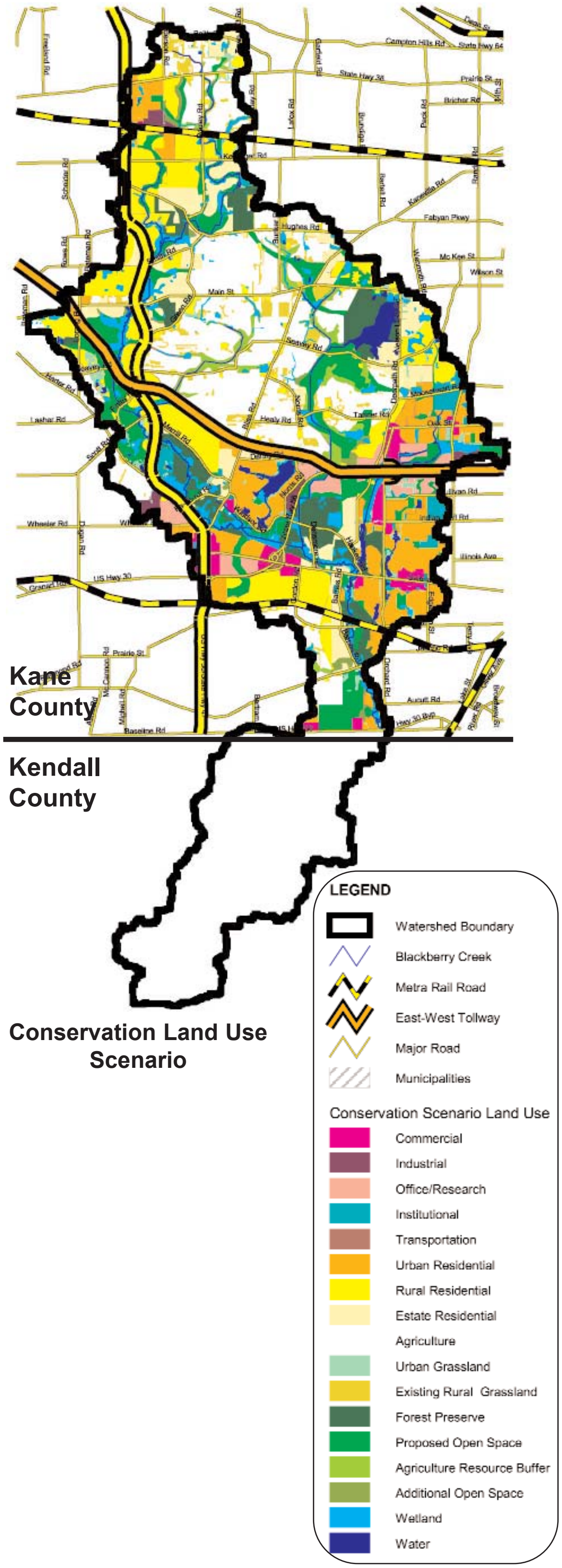
3. Allocate future urban and agricultural areas

Areas not designated as open space based on steps 1 and 2, were allocated to urban, agricultural, and open space uses according to the County and municipal comprehensive plans. In some cases, the open space designated in these plans was in addition to open space identified under steps 1 and 2.

As a cross-over between the scenarios and templates, an exception to the agricultural land use allocation was identified. There are a number of areas within the agricultural land use designation in the County and municipal plans that were not identified under steps 1 and 2 but also have not been used for agricultural production. These areas were generally identified as “rural grassland” in the land cover mapping provided by USGS. Under the Conservation Scenario, it was assumed that these rural grassland areas would be preserved and were designated as “existing rural grassland” in the Conservation Scenario mapping.

Hydrologic Modeling

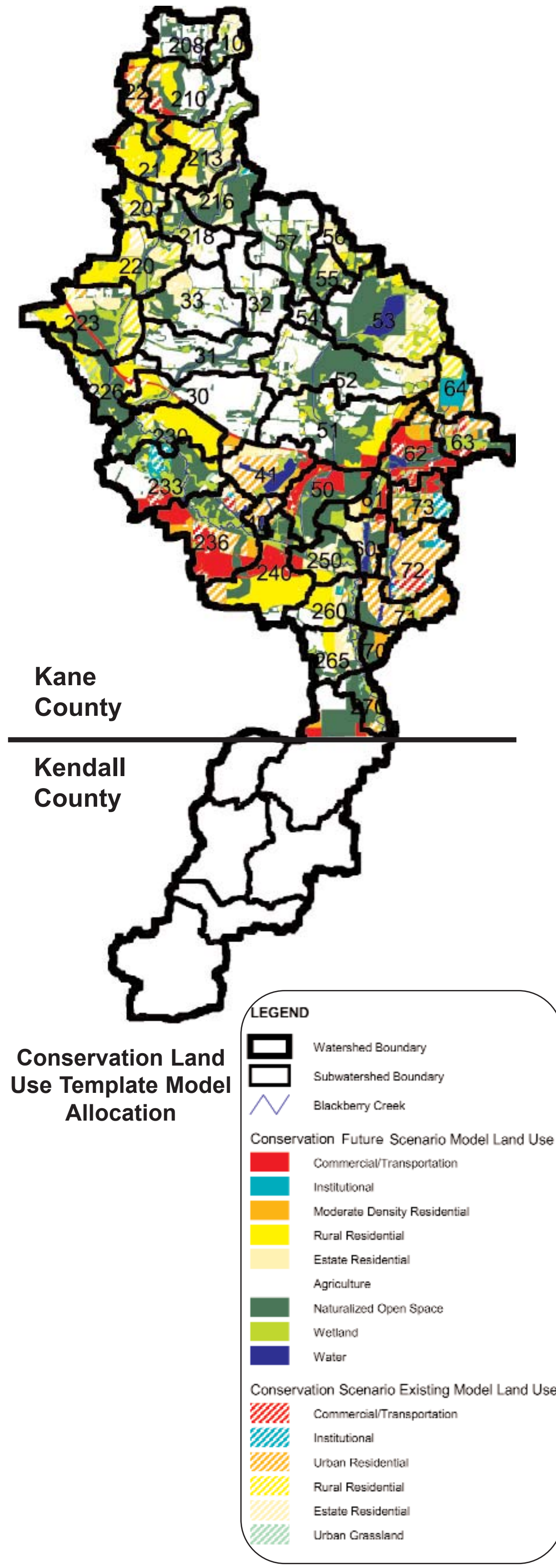
As with the Conventional Scenario, within the agricultural areas, the rural residences from the USGS Existing Conditions Map were added to Conservation Scenario map.



Conservation Land Use Scenario

The Conservation Scenario assumed use of the conservation versions of the templates for all new development but does not assume that existing development would be converted to conservation development. Thus, the urban land uses were subdivided into existing and conservation land uses as shown in the Conservation Land Use Template Model Allocation to the right. The existing urban land uses were modeled assuming the conventional versions of the appropriate templates. The future urban land uses and agricultural land uses were modeled assuming the conservation version of the appropriate templates.

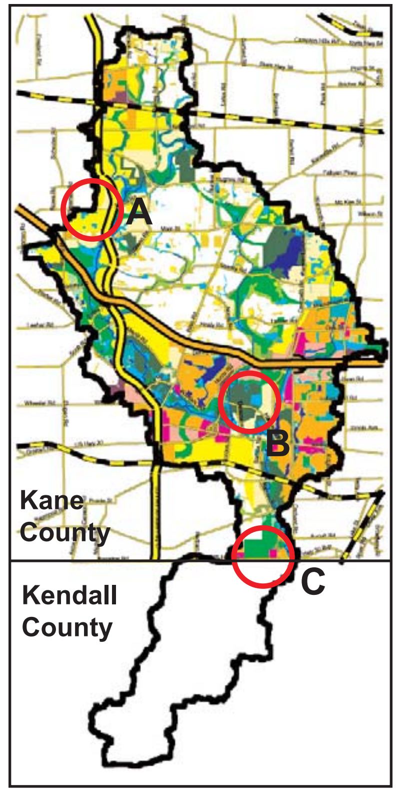
The "existing open space" and "proposed open space" covers on the 2020 Land Use Plan map were modeled as "natural open space" outside the municipalities. Within the municipalities, these covers were modeled as "urban grassland" if they were isolated from streams or wetlands (and therefore assumed to be urban parks). Open space within municipalities that is adjacent to streams and wetlands (and therefore assumed to be naturalized buffers) was modeled as "natural open space". The "agriculture resource area" cover were also modeled as "natural open space".



Conservation Land Use Template Model Allocation

Scenario Evaluation

Similar statistics as used for the template evaluation were used for the Scenario evaluation as described below. The statistics were calculated at a number of evaluation points or locations within the watershed. Hydrographs were also plotted at these points. The selected evaluation points are listed below (location map on the right):



A. Blackberry Creek at Smith Road, south of Elburn
This reach is in the upper watershed and is adjacent to a wetland recommended for acquisition in the Blackberry Creek Watershed Management Plan (Wetland A).

B. East Run at Blackberry Creek
This is the downstream-most reach of East Run. The East Run portion of the watershed is an area experiencing some of the highest rates of development.

C. Blackberry Creek at Baseline Road (County line)
This is the downstream-most reach of Blackberry Creek that was modeled and provides a good indication of the results for Kendall County.

The modeling was performed in a manner such that additional watershed locations can readily be evaluated to provide a useful tool for County and municipal officials during future land use and development planning.

Scenario Evaluation Measures

TQmean
As was discussed under the template evaluation, TQmean is defined as the proportion of time that the flow rate is above the mean rate and is a measure of the stability of the streamflow.

Frequency Discharge Rates
As with the template evaluation, predicted flow rates at various frequencies were computed. Flow rates were estimated for the 1.1-, 2-, and 100-year frequencies. The 100-year frequency was added to the evaluation since the effectiveness of detention often diminishes with increasing watershed size and since the amount of detention is not the same for all three scenarios (detention is only applied to the urban land uses).

Low Flow Frequencies
Q7-10 and Q7-2 are the predicted 7-day low flow rates with return periods of ten years and two years, respectively.These statistics are based on frequency analysis of the annual minimum flow rates. This provides an indication of the change in baseflows under the various scenarios. Typically baseflows and low flows would be expected to decrease with increasing urbanization and impervious cover.

	A. Smith Road	B. East Run	C. County Line
TQmean			
Existing	0.26	0.34	0.29
Conventional	0.25	0.33	0.26
Conservation	0.30	0.38	0.33
1.1-Year Discharge			
Existing	79	14	250
Conventional	110	20	360
Conservation	52	12	170
2-Year Discharge			
Existing	220	38	670
Conventional	220	47	780
Conservation	131	30	440
100-Year Discharge			
Existing	970	231	3500
Conventional	710	212	3200
Conservation	640	179	2500
Q7-10			
Existing	0.000	0.012	0.10
Conventional	0.000	0.012	0.13
Conservation	0.009	0.105	0.43
Q7-2			
Existing	0.012	0.063	0.51
Conventional	0.009	0.064	0.57
Conservation	0.055	0.290	4.90

Scenario Evaluation Results

The overall scenario evaluation results are summarized in the table on the previous page and the results at the three evaluation points are described in the paragraphs below. Only a portion of the watershed is expected to change land use from existing conditions to future conditions. Further, existing developed areas were modeled using the conventional templates in both future condition scenarios. Thus, the results at the evaluation points are an integration of the hydrology resulting from existing uses, the future land use changes, the conservation template assumptions, and floodplain and wetland storage conditions upstream of the evaluation point. Floodplain, wetland, and other watershed storage were assumed to be unchanged from existing to future conditions and between future condition scenarios.

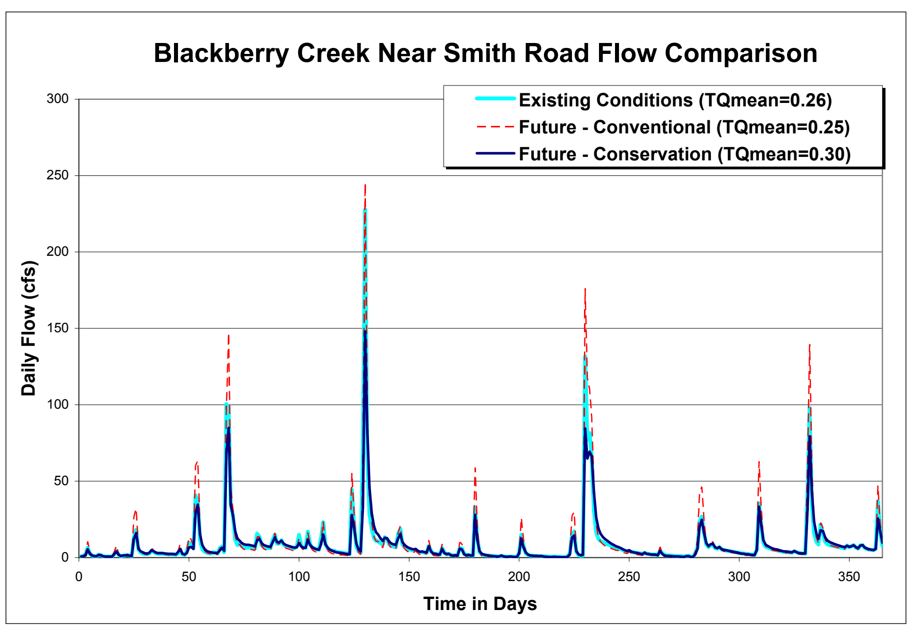
Blackberry Creek at Smith Road, South of Elburn

This reach is located south of Elburn near the confluence of the mainstem of Blackberry Creek and a small tributary that comes in from the west. Examination of TQmean indicates that the value is not expected to significantly decrease as the watershed urbanizes under the Conventional Scenario. However, the value could increase, indicating improved biological conditions if the Conservation Scenario is implemented.

The 1.1- to 2-year discharge rates are expected to increase as the watershed develops under the Conventional Scenario, indicating the potential for increased streambank erosion and habitat degradation. Under the Conservation Scenario, the 1.1- to 2-year discharge rates would be expected to decrease, providing a level of relief to streambank erosion pressure.

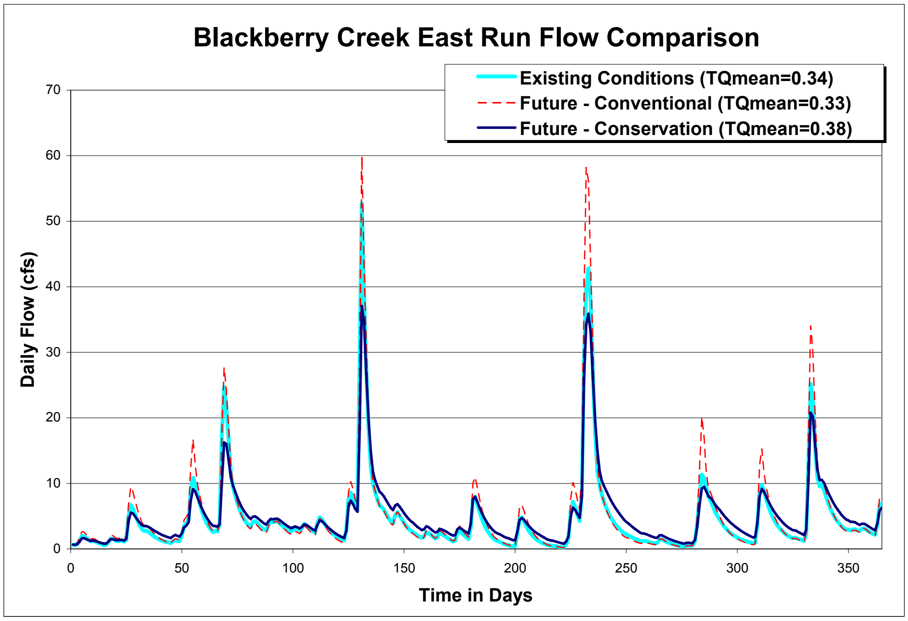
The 100-year discharge rate results are different than those of the more frequent events. At Smith Road, as well as at the other two locations, the Conventional Scenario 100-year discharge rates are at least slightly lower than the existing conditions. This suggests that the detention standards in the Kane County ordinance should be sufficient to prevent increases in 100-year discharge rates even under conventional stormwater techniques. The 100-year discharge rates could decrease even further if the Conservation Scenario is implemented.

Consistent with what typically occurs as a watershed urbanizes, the baseflows are expected to decrease somewhat from existing conditions to future conditions under the Conventional Scenario. However, baseflows have the potential to increase significantly if the Conservation Scenario is implemented. This could significantly improve aquatic conditions in this stream segment. The increase in infiltration, expressed as



an increase in baseflows suggests that deep groundwater recharge should also increase under the Conservation Scenario.

East Run at Blackberry Creek



The watershed of East Run is projected to experience some of the highest rates of urbanization in the watershed and is already quite urbanized. Despite the relatively high degree of urbanization, both existing and expected, the TQmean values for East Run are relatively high. This is likely attributable to the relatively large amount of floodplain storage and wetlands within this reach that are moderating flows. It will be important to maintain this floodplain and wetland storage to prevent decreases in TQmean and degradation of aquatic conditions. Based on the composition of urban land uses and the TQmean values for those land uses, TQmean would be expected to decrease sharply, to less than 0.2, if the watershed storage were lost or significantly altered under the Conventional Scenario. Implementation of the conservation templates could increase TQmean relative to existing conditions, provided that watershed storage is preserved.

Although TQmean is predicted to remain essentially the same under existing and Conventional Scenario future conditions, 1.1- to 2-year discharge rates could increase 25 to 40%, increasing erosion pressure. Implementation of the Conservation Scenario could decrease erosion pressure as indicated by the expected decrease in 1.1- to 2-year discharge rates.

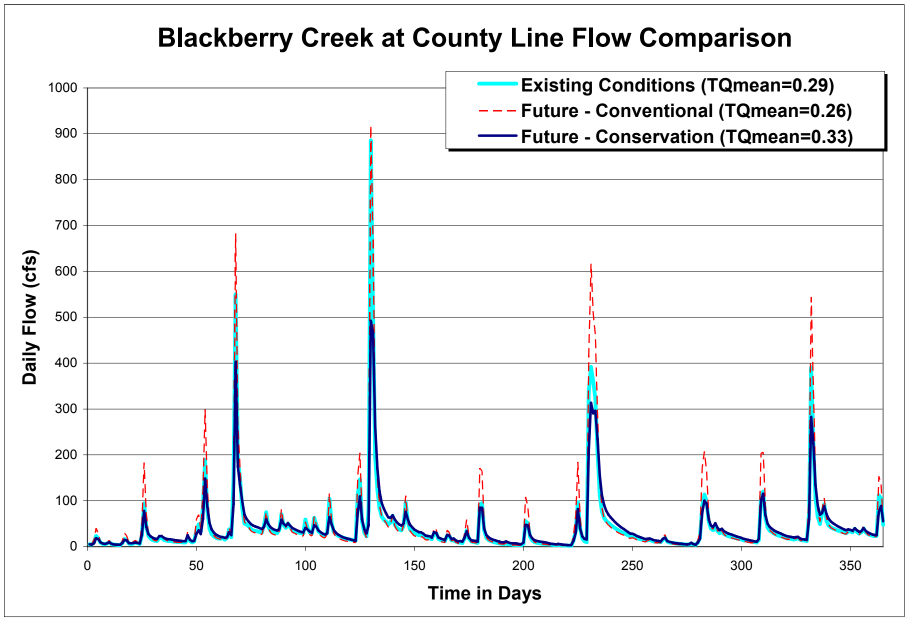
The modeling indicates that low flows may not decrease significantly if the Conventional Scenario is implemented. However, they could significantly increase if the Conservation Scenario is implemented. The increase in baseflows under the Conservation Scenario can be seen in the hydrograph plots as well the low flow statistics.

Blackberry Creek at Baseline Road (County Line)

TQmean values behave the most predictably at this point in the watershed. TQmean is expected to decrease under the Conventional Scenario and increase under the Conservation Scenario.

Consistent with the other evaluation points, 1.1- and 2-year discharge rates would be expected to increase under the Conventional Scenario but decrease under the Conservation Scenario. Also, similar to the other evaluation points, the 100-year discharge rate would be expected to decrease even under the Conventional Scenario due to the Kane County release rate standards. However, the percentage decrease is not nearly as great as at Smith Road where the drainage area is much smaller. Under the Conservation Scenario, the 100-year discharge rate could decrease significantly.

Somewhat unexpectedly, the low flow statistics indicate that baseflows could actually increase slightly at the County line even under the Conventional Scenario. The primary reason for this is that under both the Conventional and Conservation Scenarios, some existing agricultural land is converted to naturalized open space, which produces higher baseflows than cropland.



Conclusions

Modeling of the templates and scenarios indicates that use of the conservation templates can have a significant benefit at the watershed scale as well as at the template scale. Preservation of natural open space appears to provide a benefit at the watershed scale as well. Finally, it appears that the Kane County detention release rate standards should be effective in preventing increases in 100-year flood flows throughout at least the Kane County portion of the watershed. However, the modeling indicates that detention alone will not be effective in preventing increase in streambank erosion pressure resulting from increases in 1.1-year to 2-year discharge rates. Also, detention alone will not prevent decreases in TQmean at the downstream end of the watershed.

In general, if the watershed urbanizes according to the current planned land uses, using conventional development techniques (Conventional Scenario), the quality of aquatic habitat can be expected to degrade and streambank erosion to increase. However, if the watershed urbanizes according to the conservation land use plan using conservation development techniques (Conservation Scenario), the modeling indicates that aquatic conditions could actually improve and streambank erosion decrease.

Although deep groundwater recharge was not specifically modeled, the increases in baseflow resulting from increases in infiltration under the Conservation Scenario suggests that deep recharge is also likely to increase.

In summary, the conclusions above suggest that the growth envisioned in the County and municipal comprehensive plans can be accommodated and at the same time the quality of the Blackberry Creek and its wetlands can be improved. However, this is conditioned upon: 1) implementing the conservation site design and stormwater management measures illustrated in the conservation templates; and 2) implementing the green infrastructure and land use plan as depicted in the Conservation Scenario.

Outreach & Next Steps

Outreach Plan

Completion of the design and evaluation portions of this project are being followed by an outreach program intended to educate and engage residents and public leaders in and around the watershed. In reality, outreach began early in the project with release of draft information as the templates and scenarios were being developed. Outreach continued during the evaluation phase of the project with input from local and county officials and broad review of the products as they were developed. Continuing with this participatory educational effort, the Project and Advisory Teams established three priorities for post-design and modeling outreach.

Identify the Audience

The primary audience for outreach will be local officials-planning commissioners, village board members and village/city staff. Since these people are the designated decision makers for the communities, and thus for land use and planning decisions for the watershed, they have been identified as the primary audience for outreach.

In addition to the municipal and county leaders, there are four other groups that are critical recipients of this outreach program. First, the Project and Advisory Teams made up of present and past workshop participants will continue to be included. Second, the general public is always a critical component to any public venture. Within this group lies a subgroup, namely community "opinion leaders", or those residents who, although not officially representing their community's interest, have strong influence on public policy in their communities, including, but not limited to major landowners, developers and stakeholders. Third, it will be essential to include regional, state and federal officials in the outreach program, especially those who have access to resources and funding for future project implementation. And fourth, this outreach program will include the educational community. Targeted in the field of education will be those educators and students interested in taking part in future analyses and research pertinent to the objectives of this project.

Outreach Venue

The selected venues for this outreach program will vary from community to community and from audience to audience. In a sense, the varied locations where this outreach will take place represents a "circuit-rider" approach to education. This approach will allow the Project Team members responsible for outreach to connect with the variety of critical players in their own setting.

Additional and Associated Projects

The Blackberry Creek Watershed Alternative Futures Analysis has been the impetus for several other recently funded projects also intended to help the County to fulfill its goals and objectives with respect to stormwater management. Two of the projects compare the costs of conventional development to the costs of ecologically sensitive and hydrologically functional development. The third project analyzes current municipal and county zoning and subdivision ordinances that have direct and indirect impacts on stormwater, and recommends model language and best management practices for adoption into those codes. Each of these projects is described below.

Blackberry Creek Watershed Economic Analysis

This economic analysis occurs on two scales. One compares the future costs associated with conservation-based communities to those of conventional developments, while the other looks at larger scale conservation and conventional development growth scenarios and their associated costs. The focus of this analysis is on the costs of associated future public infrastructure, including schools, police and fire service, drinking water, and waste water. The first analysis will use the templates created in the Blackberry Creek Watershed Alternative Futures Analysis, while the second cost comparison will use Kane County's land use alternatives. Roger Dahlstrom and his team at Northern Illinois University's Center for Governmental Studies are managing this project, and should be finished with it by the end of the summer, 2003.

Cost Analysis of Conservation versus Conventional Development in Northeastern Illinois and Northern Indiana

Chicago Wilderness funded a separate, three-part cost analysis and study that centers on the templates designed for the Blackberry Creek Watershed Alternative Futures project. In this study, the staff at Conservation Research Institute and Conservation Design Forum, Inc. are conducting a cost analysis of conservation development in the Midwest. The first portion of the study includes a literature review of published comparisons of conservation and conventional development. At the same time, the developed templates (Estate Residential, Rural Residential, Moderate Density Residential, and Commercial/Industrial) are being run through a thorough, but generalized costing matrix to determine construction costs of various stormwater-related elements of the designs. Using the information gained from these first two steps, the team will also research and gather cost information on conservation-designed developments that have already been built, concentrating, but not limiting their review to built projects in the Midwest. All three of these products will enable conservation design, including infiltration-oriented stormwater management designs, to be convincingly marketed in the Midwest.

Blackberry Creek Watershed Model Ordinance Language Development and Zoning Code Analysis

With the futures analysis complete, the next logical step beyond the economic analyses discussed above, is to assist local communities in revising their zoning and subdivision ordinances so that conservation design is not only allowed, but in many cases, strongly encouraged and perhaps even mandated. The objective of this project is not to recreate the County's stormwater ordinance, but rather to create model codes, standards and best management practices for the many areas of development that are not controlled under a stormwater ordinance, but at the same time have direct and indirect impacts on stormwater and other hydrologic systems. The first step in this project is to gather and evaluate model ordinances and standards from around the country, including guides and handbooks on low-impact development and best management practices. Then, zoning and subdivision codes from around the Blackberry Creek Watershed will be gathered and analyzed. The project team will summarize the policies and standards that are related either directly or indirectly to stormwater, and propose changes to them wherever they conflict with the model standards.

Monitoring Conservation Design Performance

1. The Village of Villa Park is constructing a new police station on a 0.7 acre site on the location of a former parking lot in the center of the Village. The new police station is being constructed with a green roof, interlocking concrete porous pavers, and bioswales.

2. Conservation Design Forum is retrofitting a green roof on its office building in Elmhurst, Illinois. To better understand the influence of growing medium thickness and drainage layer type, a variety of systems are being installed.

3. The Peggy Notebaert Nature Museum in Lincoln Park in Chicago installed an award winning rooftop garden on the Museum.

Hydrologic monitoring will be performed for all three of these projects. Although separate from the Blackberry Creek Watershed Alternative Futures project, this monitoring will help calibrate and verify the HSPF models developed as part of this project. The data will also aid in developing simpler models that can be more readily used by the development and regulatory community as these practices become more commonplace.

Scoping for Follow-Up Projects

A number of followed-up projects have already been initiated as described in the previous section. However, there are other activities that could further build on the momentum of this project, the Watershed Management Plan, and the activities of the counties and municipalities. Some projects that have been suggested include:

Additional Scenario Modeling

- Provide scenario modeling results at additional evaluation points. In particular, provide results at key wetland locations that may be subject to significant development pressures. For example, evaluation of modeling results are currently being prepared for a large wetland NW of Lake San Souci (South of Denny Road in the central portion of the watershed, east of Route 47.) Those results will be completed in October of this year. The wetland was identified as a significant resource area under the Kane County ADID. Other wetlands, that may be subject to significant development pressures, could be similarly evaluated.
- Run additional scenarios to better understand the relative influence of the templates and the land use plan on the scenario results. Some additional scenarios include:
    - Conservation scenario land use plan with conventional templates. This would indicate the benefit of the additional open space alone.
    - A full build out conventional scenario that does not include any agricultural land and instead spreads primarily rural residential and estate residential across the watershed.
    - A full build out conservation scenario that includes the same number of residential units as the build out scenario above but concentrates those units into mostly mod-

erate density residential. The remaining land could be allocated as all agriculture, all naturalized open space or a combination in between.

- Utilize the scenario models to test various options as they are being developed under the Kane County 2030 Land Resource Management Plan.
- Utilize the scenario models to test comprehensive plans as they are being updated by the municipalities.

Monitoring

- Perform hydrologic monitoring of conservation residential developments that include rainwater gardens, vegetated prairie swales, and other measures to supplement the data being collected on green roofs and porous paving (as described above) and to better calibrate the conservation residential models.
- Monitor the level of implementation of the conservation planning and development practices outlined in this report.
- Monitor the biological health of streams and wetlands in the Blackberry Creek and other watersheds to evaluate the effectiveness of conservation planning and development and other unforeseen factors in preserving and/or improving the health of the Blackberry Creek and other watersheds.
- Perform correlation analysis between hydrologic metrics such as TQmean and biologic metrics such as IBI, MBI, and/or other measures of macroinvertebrate communities. This information could then be used, along with hydrologic modeling, to objectively evaluate the expected performance of watershed and development plans in meeting watershed goals.

Technical Assistance and Demonstrations

- Many of the conservation design techniques described and evaluated in this project are uncommon in northeastern Illinois and there are few practitioners familiar with their design and implementation. Thus, it will be essential that technical assistance be provided, particularly on early projects.
- Demonstration projects should be identified and constructed to provide developers and communities with on-the-ground examples of conservation design projects. A few projects already exist or will be completed in the near future but additional examples are needed.

Funding

- Watershed stakeholders should work cooperatively to identify sources and apply for funding to implement the additional activities described above.