3

watershed inventory and analysis

3 watershed inventory and analysis

3.1 INTRODUCTION

An understanding of the unique features and natural processes associated with the watershed, as well as the current and potential future condition, is critical to developing an effective watershed plan. The watershed inventory and analysis organizes, summarizes, and presents watershed data in a manner that clearly communicates the issues and processes that are occurring in the watershed so that Dead River watershed stakeholders can make informed decisions about the watershed's future. The inventory and analysis helps to identify causes and sources of watershed impairment and provides the basis for recommending both programmatic and site specific actions intended to improve the watershed, which are found in Chapter 5.

As part of this effort, the project team collected and reviewed available watershed data and reports, investigated stream reaches, wetlands, natural areas, and other resources in the field, and gathered input from watershed stakeholders. Examples of information investigated includes water quality, streambank erosion, soils, wetlands, flood damage areas, the detention and drainage system, population, and current and future land use.

Geographic Information System (GIS) software was used to compile, analyze, and display this complex geographical information in graphical and map format so that stakeholders can easily understand the condition and location of watershed resources. The project team also investigated water quality by modeling the amount of different pollutants that are expected from various land uses.

This chapter presents the results of the inventory and analysis in a series of maps, tables, graphs, photographs, and narrative format. A summary of the watershed assessment is included at the end of the chapter.


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Bull Creek headwaters near Lewis Avenue (BL04).


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Lower reaches of Bull Creek (BL08) upstream of Illinois Beach State Park.


© Lake County Stormwater Management Commission

The Lake Michigan shoreline.

3 watershed inventory and analysis

3.2 WATERSHED SETTING

The 15.9 square mile (10,115 acres) Dead River watershed is located at the most northeastern corner of Lake County and Illinois, within the Lake Michigan watershed. The Dead River watershed drains from west to east, from the fairly f at headwaters reaches in the west, through a number of ravines, to the lake plains of Illinois Beach State Park before discharging to Lake Michigan. Stream reaches and tributaries f ow through the municipalities of Beach Park, Zion, and Waukegan.

The watershed includes a number of large wetlands, depressional areas, signif cant natural areas, 55 threatened and endangered species recognized by the State of Illinois and four threatened and endangered species recognized by the federal government. Illinois Beach State Park and the Nature Preserve are highly unique natural area containing assemblages of species found nowhere else on earth, and is one of the few remaining undeveloped shorelines in the State of Illinois, providing important migratory habitat for f ve distinct bird species groups. It also deserves special mention that the overall quality and connection of the Bull Creek, Glen Flora Tributary, and Dead River stream systems to Lake Michigan is highly important for the proper management and stewardship of this valuable aquatic resource.

3.3 WATER RESOURCES

The water resources within the Dead River watershed are composed primarily of 12.6 miles of stream and 1719 acres of wetlands. From north to south, the major stream channels are: an unnamed tributary to the north, Bull Creek, which f ows into the Dead River , and Glen Flora Tributary, which f ows into Lake Michigan. Bull Creek is made up of four tributaries, listed from north to south: the 27th Street Tributary, North Branch of Bull Creek, South Branch of Bull Creek, and the Wilson Avenue Tributary, as illustrated in Figure 3.1.

The Glen Flora Tributary, formerly known as the Little Dead River, used to discharge south of Midwest Generation into a ditch. Current alignment of the Glen Flora Trib is under the railroad tracks, north into Johns Manville lagoons, and then east through ponds and a pipe that discharges to the Lake.

The Dead River is intermittently hydrologically connected to Lake Michigan and at other times this connection is obstructed by a sand bar dam created by littoral drift, which is broken during high river f ows. Nonetheless, the Dead River watershed is one of the few remaining Illinois tributaries that drains to Lake Michigan. Thus, the importance of managing watershed resources to protect Lake Michigan water quality can not be overstated.

3.4 CLIMATE AND PRECIPITATION

The climate of the Dead River watershed, and of Northeastern Illinois, exhibits a wide range of temperatures over the calendar year. Mean high summer temperatures are in the low eighties; mean low winter temperatures are in the low teens. Although the temperatures f uctuate from season to season, the large thermal mass of Lake Michigan makes the f uctuation less extreme than is typical in Northwestern Illinois, for example. This attenuation of extreme high temperatures during the summer months and extreme low temperatures during the winter months results in a slightly milder microclimate along the Lake Michigan shoreline.

Precipitation and snowfall in the watershed average 34.09 and 37.9 inches per year, respectively. While Lake Michigan helps to moderate temperature, it contributes to the region's heavy winter snowfalls in the form of lake-ef fect snow . Precipitation is greatest during the late spring and summer and is typically associated with low-pressure weather systems. These systems result in the thunderstorms that are commonplace across the Midwest during the summer months. The ravines of the watershed have unique micro-climates and assemblages of plant species due to the moderating ef fect of Lake Michigan. Tables 3.1 and 3.2 present the 1971–2000 temperature and precipitation normals for the watershed.

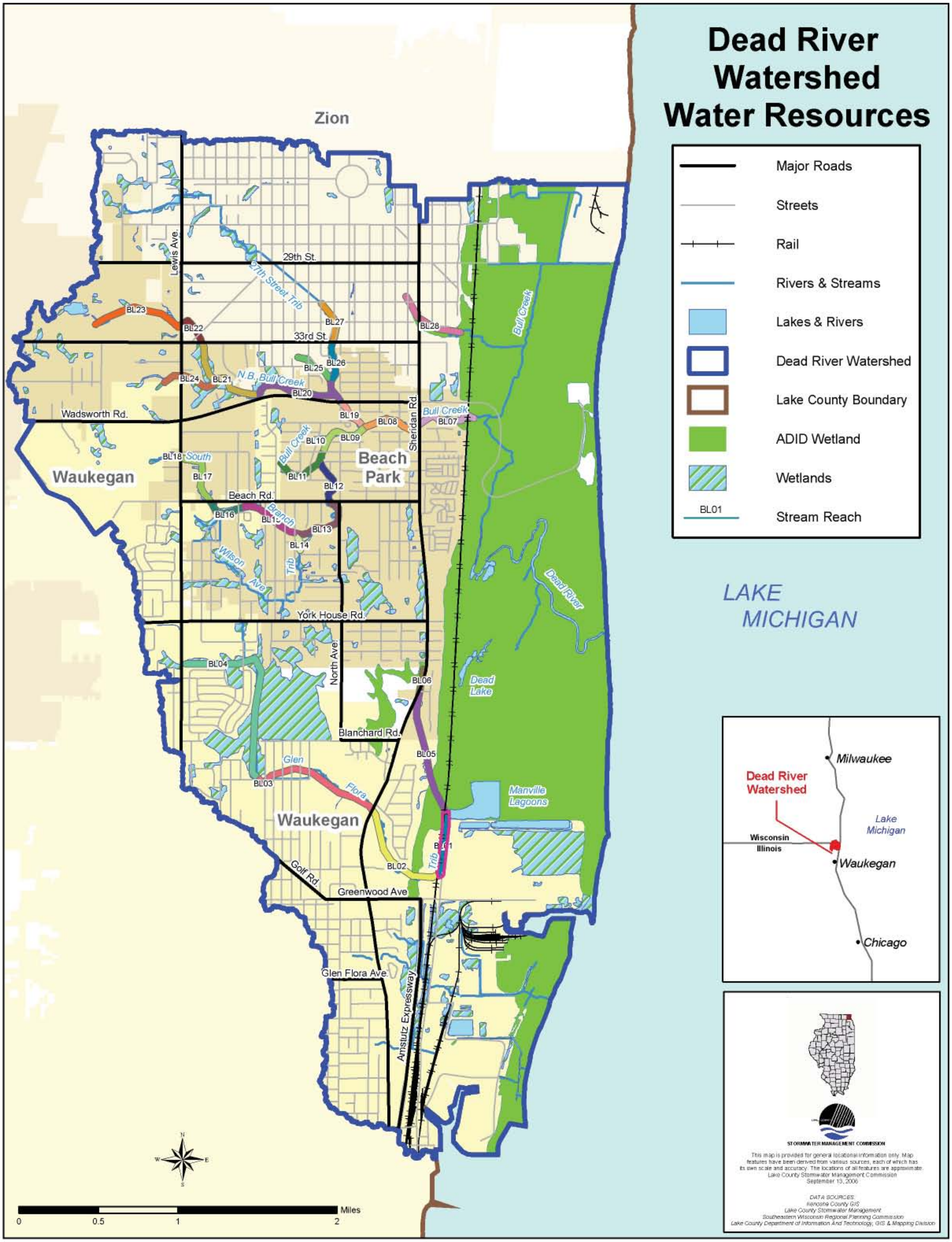


FIGURE 3.1: WATER RESOURCES

Table 3.1 1971-2000 Temperature data for Waukegan climate station

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Totals
High (deg. F)	28.5	32.9	43.0	54.6	66.7	77.1	81.7	80.1	73.1	61.6	47.3	33.9	
Low (deg F)	12.0	16.6	25.0	35.6	45.8	55.3	61.3	60.5	52.4	40.6	29.9	18.3	
Mean (deg. F)	20.3	24.8	34.5	41.5	56.3	66.2	71.5	70.3	62.8	51.3	38.6	26.1	
Days High=90 (num)	0.0	0.0	0.0	0.0	0.3	2.2	4.3	2.9	0.9	0.0	0.0	0.0	10.6
Days High=32 (num)	19.0	12.8	5.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	2.3	13.2	52.6
Days Low=32 (num)	29.5	25.2	23.8	10.3	0.9	0.0	0.0	0.0	0.3	5.0	18.3	27.9	142.2
Days Low=0 (num)	7.0	4.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.4	14.8

Table 3.2 1971-2000 Precipitation data Waukegan climate station

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Totals
Rainfall (inch.)	1.60	1.40	2.15	3.73	3.44	3.62	3.49	4.22	3.40	2.42	2.57	2.05	34.09
Days Total=0.01' (num)	7.9	7.1	8.7	10.4	10.6	9.7	9.1	9.4	8.6	8.3	9.3	9.1	108.4
Days Total=0.10' (num)	4.2	3.9	5.1	7.1	6.8	6.7	5.9	6.4	5.8	5.0	5.9	5.1	68.3
Days Total=0.50' (num)	1.0	0.7	1.3	2.7	2.5	2.4	2.5	3.3	2.5	1.5	1.8	1.4	24.1
Days Total=1.00' (num)	0.2	0.2	0.5	1.1	0.9	0.8	1.1	1.3	0.9	0.4	0.5	0.3	8.3
Snowfall (inches)	11.5	9.5	5.3	1.4	0.0	0.0	0.0	0.0	0.0	0.1	1.9	8.2	37.9
Days Total=0.1' (num)	4.8	4.8	2.8	0.5	0.0	0.0	0.0	0.0	0.0	0.1	1.4	4.8	20.0
Days Total=1.0' (num)	3.0	3.0	2.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.7	12.5
Days Total=2.0' (num)	2.0	2.0	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.6	7.5
Days Total=5.0' (num)	0.4	0.4	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.5

Source: Illinois State Climatologists Office, Illinois State Water Survey, http://www.sws.uiuc.edu/atmos/statecli/.

3.5 GEOLOGY AND TOPOGRAPHY

The Dead River watershed is located within the Wheaton Morainal Country subdivision of the physiographic division called the Great Lake Section of the Central Lowland Province. The Dead River watershed is in the area of northeastern Illinois whose character resulted from the most recent Wisconsin Episode of glaciation (approximately 14,000 years ago), which left drift (broken up rock and sediments) and moraines (piles and ridges of rocky debris left by retreating glaciers) more than 50 feet thick. The youngest moraine in Illinois, the Zion City Moraine, is comprised of three small ridges in and around Zion. The Zion City Moraine is one of five Lake Border moraines, all roughly parallel to the present-day shoreline of Lake Michigan. The western limit of the Dead River watershed, or the watershed divide, is created by the Highland Park Moraine, another Lake Border moraine. Green Bay Road (Illinois 131) generally follows the crest of this moraine through Lake County (see Figure 3.3.)

Illinois Beach State Park is part of a distinct and unique coastal landform called the Zion beach-ridge plain, an expanse of coastal land formed by deposition and migration of a succession of nearly parallel beach sand ridges. Sixty-six acres of the globally rare Panne ecosystem type is found here. Pannes are groundwater fed wetlands found within the depressions between sand ridges or dunes. Coastal processes, such as waves, nearshore currents and fluctuating lake levels, cause the erosion, movement and distribution of sand and sediment along the Lake Michigan shore, which present shoreline erosion and coastal management issues. The net direction of this sand movement is southward due to prevailing winds from the north and northeast that push wave action south along the shoreline.

The topography of the Dead River watershed is variable and slopes from a high point in the northwest to the east where it meets with the Lake Michigan water level elevation. It is generally flat or gently sloping in the eastern third (the beach plain), relatively flat in the western third with a few areas of greater (but still gentle) slopes, and the central third is generally flat but dissected with steep ravines formed by downcutting and other hydrologically-driven changes. (See Figure 3.4)

© Lake County

FIGURE 3.2 ILLINOIS BEACH STATE PARK DUNE AND SWALE SYSTEM

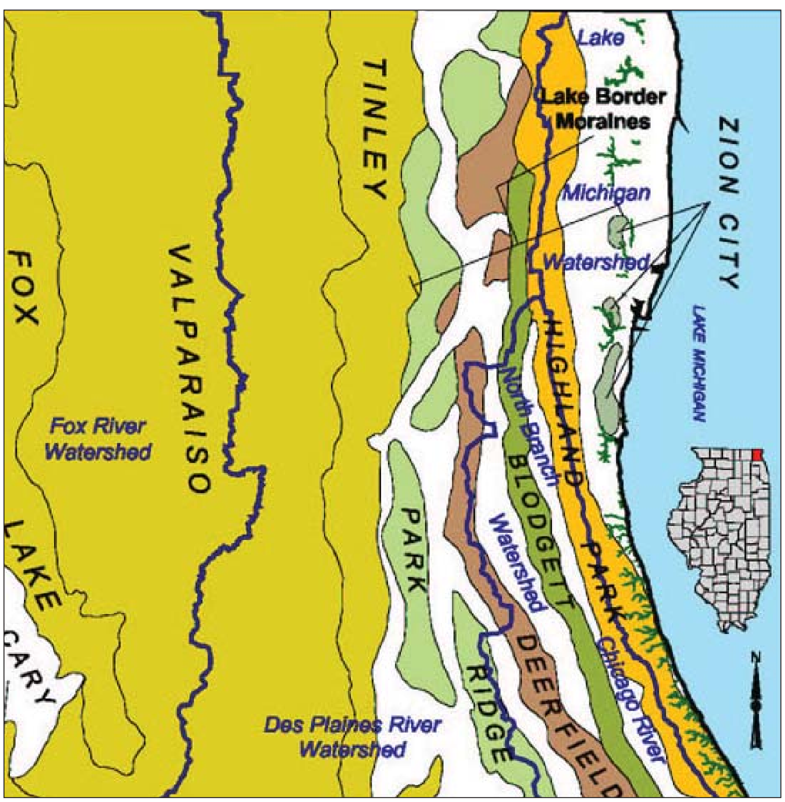


FIGURE 3.3 LAKE COUNTY LANDFORMS

(data source: Illinois State Geological Survey; Lake County Department of Information; and Technology, GIS and Mapping Division; Lake County Stormwater Management Commission.)

The stream headwaters begin at approximately 760 feet above sea level and enter the beach ridge plain at around 580 feet. Thus, the watershed elevation varies between approximately 760 feet and 575 feet at Lake Michigan. The elevation data for the watershed, depicted in Figure 3.4, was used in a number of the inventory and assessment steps of the watershed planning effort, including identifying watershed boundaries, flooding assessments, and defining smaller drainage areas within the watershed that are referred to as Subwatershed Management Units (SMU's), which is discussed in Section 3.13.2 below.

3.5.1 RAVINES

The bluff and ravine system associated with the Lake Michigan coastal plain and Bull Creek deserves special mention because it is a unique landform feature. These ravines formed prior to European settlement when water running off the western areas of the watershed towards Lake Michigan found the path of least resistance creating a small channel down the eastern slope of the moraine. As more water followed this same course, the channel deepended until the ravines were deeply cut through the moraine. the locations of the ravines are illustrated in Figure 3.4.

Over time, the ravines developed some interesting characteristics. The incision of the ravines into the underlying soils eventually intersected with the groundwater table in some locations, and water slowly seeped out through the steep ravine banks. This water caused wetland-like conditions to develop at the bottom of the slopes, creating unique, groundwater-fed growing conditions and plant assemblies called fens or seeps. These fens are rare in northeastern Illinois and deserve special consideration for preservation. These are described in further detail in Section 3.11.3.

Ravines also experience microclimates, small areas where the climatic conditions (such as temperature and humidity) are different from those of the surrounding landscape, sometimes due to air masses moving up and down the ravines from the Lake Michigan beach plain. These air masses have different characteristics than those outside of the ravines, whcih creates unique growing conditions and communities of plants and animals.

Due to development of the watershed, the increase in impervious cover, and stormwater collection and conveyance systems, a greater volume of runoff water reaches the stream and ravines more quickly today than in the past, subjecting the relatively fragile slopes to more destructive runoff energy than prior to development. This increased speed and volume of runoff entering ravines has led to destabilization and erosion of the stream and ravine banks and incision of the stream bed. Debris blockages, common in ravines, can trap sediment and cause water to back up behind the blockage and, in some cases, cause flooding. Blockages also divert water towards the streambanks, further exacerbating erosion problems. Development near or adjacent to ravine edges and bluffs has further compromised these systems. Removal of vegetation for development reduces the stability of the soil and can cause significant and catastrophic bank failure, threatening property and infrastructure. Roof and footing drains direct water into the ravines, adding to erosional forces. The sensitivity of these ravine systems, combined with the problems associated with development of the watershed, create special management challenges for watershed stakeholders.


Typical ravine

© Conservation Design Forum

Sources: Guide to the Geology of Illinois Beach State Park and the Zion Beach-Ridge Plain, Lake County, Illinois, Michael J. Chrzastowski and Wayne T. Frankie, Illinois State Geologic Survey, 2000.

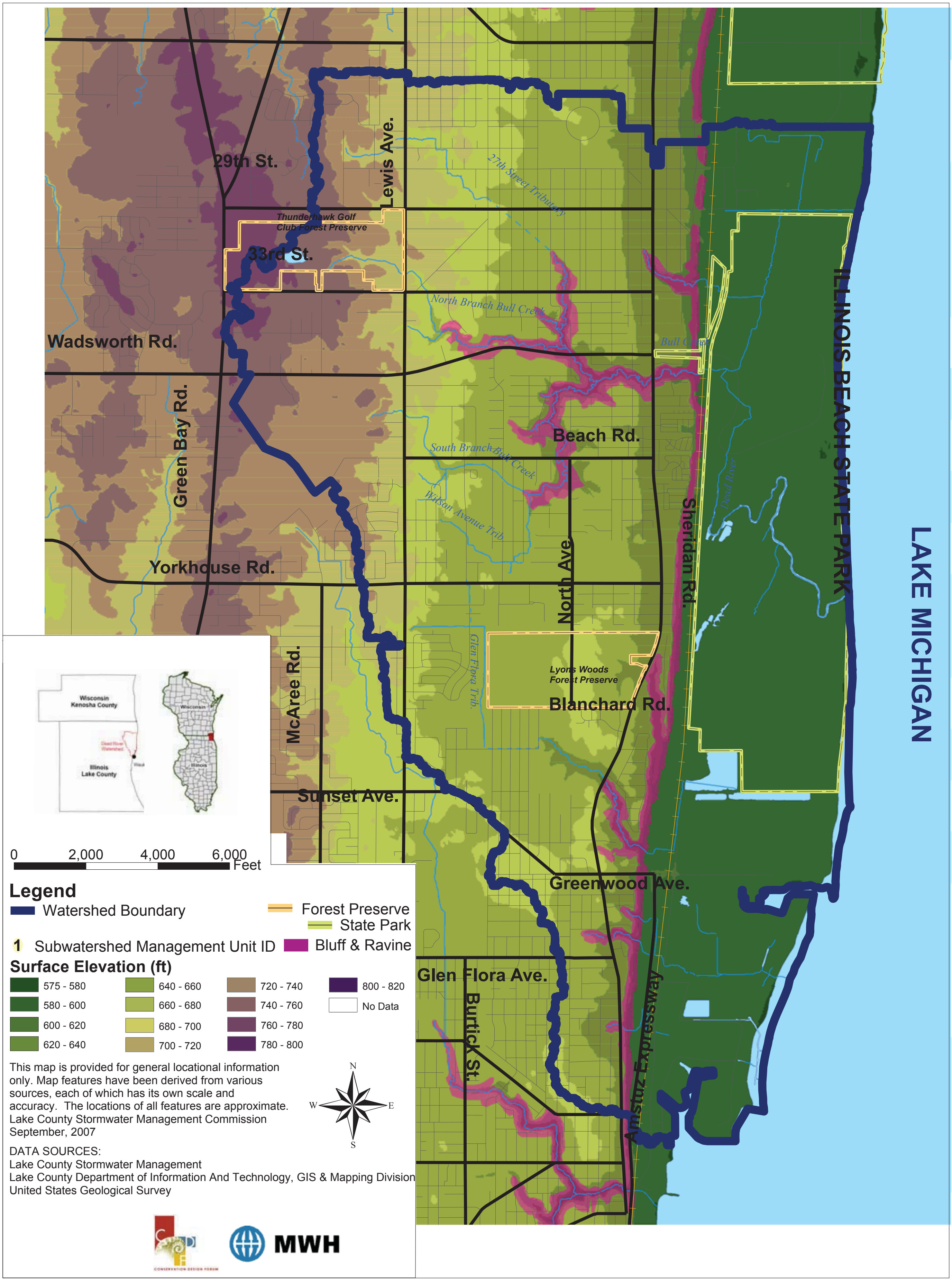


FIGURE 3.4 SURFACE ELEVATION

Chicago River/Lake Shore Area Assessment Volume 1: Geology , Critical Trends Assessment Program, Illinois Department of Natural Resources, 2001.

Ravine Systems in the Lake Michigan W atershed, Illinois. Illinois Coastal Management Program Issue Paper – TAG D. Illinois Department of Natural Resources, August 8, 2007.

Lake Michigan Action Plan DRAFT, June, 2006.

3.6 SOILS

Three categories of soil characteristics were investigated and mapped for this inventory . These were hydric soils, hydrologic soil group, and soil erodibility . Hydrologic and hydric soils help us determine which management practices are appropriate for dif ferent applications throughout the watershed. Understanding the extent and location of hydric soils helps to identify possible locations for restorinig former wetlands. Erodible soils indicate areas where development or improper management may cause erosion, and where maintaining vegetative cover can help hold soils in place.

3.6.1 HYDRIC SOILS

Hydric soils are those that have been saturated, f ooded, or ponded long enough during the growing season to develop anaerobic (oxygen-lacking) conditions in the upper part or soil layer. These conditions favor the growth and regeneration of hydrophytic (wetland) vegetation. Hydric soils have unique physical and chemical properties that can be detected in the f eld. Hydric soils that are drained will retain those chemical and physical properties.

Hydric soils occur throughout the Dead River W atershed, as shown in Figure 3.5. Approximately 2436 acres (24%) of 10,194 total acres are hydric soils. The hydric soils data is from the Lake County Soil Survey developed by the Natural Resources Conservation Service and was provided by Lake County. The greatest concentration is within Illinois Beach State Park, along some of the current or former stream channels, and associated with current or former large wetland complexes. These hydric soils in their natural state were often poorly drained soils, or well-drained soils that are saturated due to a high water table, typically associated with wet prairies, wetlands, and streams. See Figure 3.9 Presettlement V egetation, which illustrates the location of these wet landscape elements.

Knowledge of the location of hydric soils is important for a number of reasons. Hydric soils provide an indication of historic wetlands and locations for potential wetland restoration. Hydric soils also are areas that may be prone to f ooding or otherwise wet conditions if the infrastructure that drains the soil (tiles and ditches) is not maintained. Hydric soils occur along natural drainageways and therefore can be useful in identifying natural connections between isolated wetlands where no apparent connection exists, and where restoration can improve hydrology.

3.6.2 HYDROLOGIC SOIL GROUPS

Under a system devised by the U.S. Department of Agriculture, soils are classif ed into four hydrologic soil groups (HSG), A, B, C, and D, based on the degree to which certain soil types absorb and in f ltrate precipitation. Precipitation that is not absorbed or inf ltrated becomes runoff. Therefore, hydrologic soil groupings within a watershed are one determinant of how much rainfall will run of f as surface f ow to streams. In general, Group A (sandy soils) has the highest permeability and least runoff potential whereas Group D (predominantly clay soils) has the lowest permeability and highest runof f potential. Figure 3.5 shows the location of Hydrologic Soil Groups in the Dead River watershed. Note that there are two classif cations for open water: Open W ater (shown as blue) is based on the Lake County GIS system, and HSG Z (shown as white) is based on the county soil survey which classif es water as Z. Thus, both blue and white areas are considered as water features for this map.

For many hydric soils, the runof f potential depends on the drainage capacity of the soils. In their drained state, soils tend to have lower surface runof f potential since water can inf ltrate into the soil. In their natural undrained state, with the water table at or near the surface, hydric soils often have high surface runoff potential (HSG D) since the soil is already saturated and can not accept or inf ltrate more water. For the mapping, hydric soils that have modi f ers such as “ponded” or “undrained”, were mapped based on the undrained HSG. Hydric soils with no such modi f er were mapped based on the drained HSG. The percentages of each HSG in the watershed are shown in Table 3.3.

As indicated in Figure 3.5, the hydrologic soil groups change

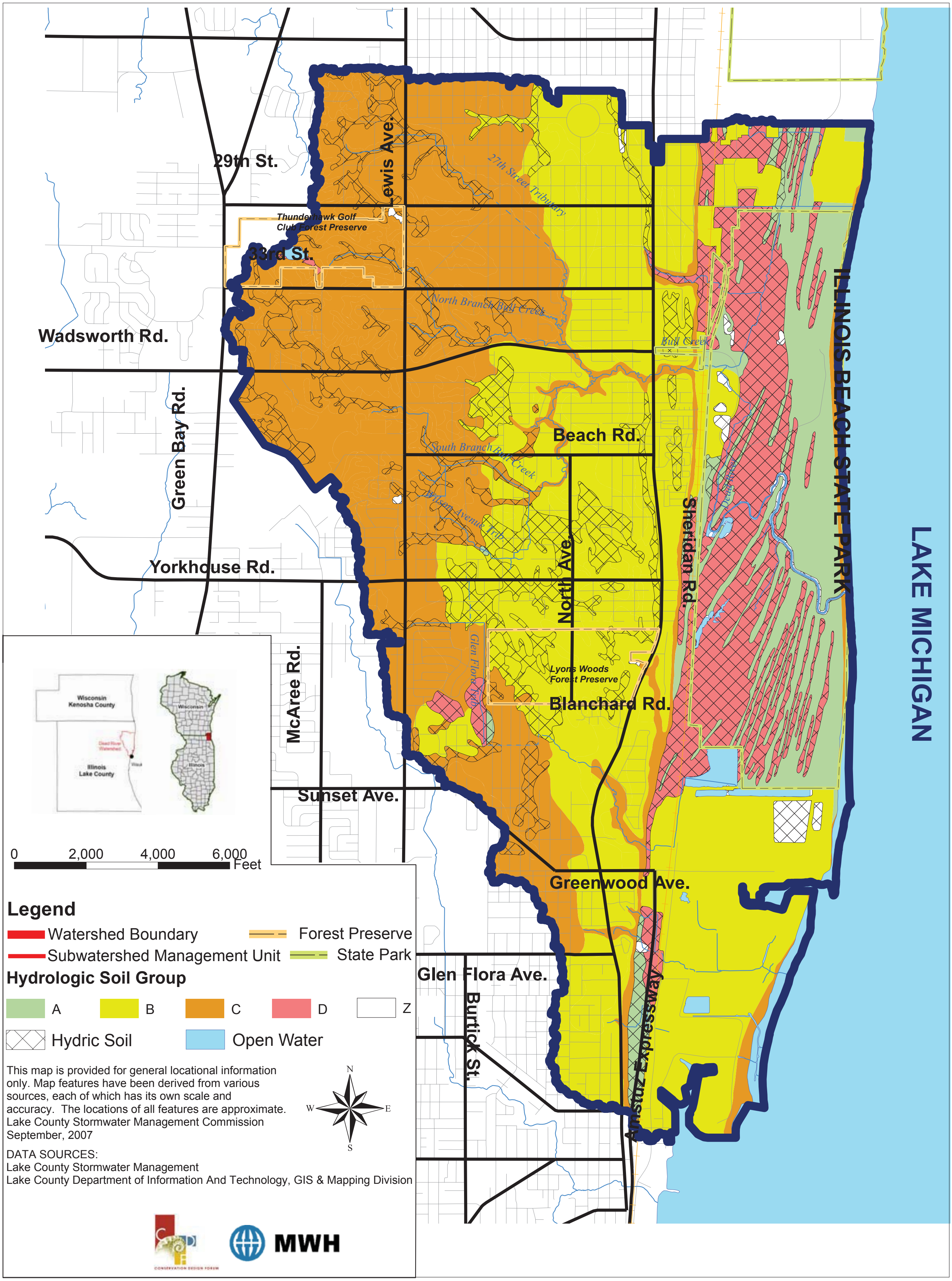


FIGURE 3.5 HYDROLOGIC SOIL GROUPS

from C to A moving from west to east along the topographic gradient with B and C soils generally occurring west of the bluff line and A soils occurring in the lake plain. Most D soils occur within the lake plain and along the drainageways. Nearly all occurrences of D soils in the Dead River watershed are hydric and classified as D due to poor drainage resulting from landscape position where there is a high water table rather than due to very low permeability. Some of the hydric D soils are muck soils that have very high organic content, with the greatest prevalence of muck soils occurring in the lake plain.

Hydrologic soil groups can influence the types of management measures that can be used. For example, stormwater infiltration practices designed to reduce stormwater runoff by allowing some of it to seep into the ground, will be more effective on A and B soils where permeability is higher than on C and D soils, where infiltration of water would be difficult. Likewise, attempting to restore wetlands on A soils, where water infiltrates easily, would not be very successful because water will not pond or sit near the ground surface, which is typical of most wetlands.

3.6.3 SOIL ERODIBILITY

Classification of a soil as highly erodible is dependent on both the erosion factor of the soil and the ground slope. Erosion factor, Kw, is a measure of a soil's susceptibility to detachment and transport by rainfall. Factor K is one of several factors used to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and permeability. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by runoff. Slope is also an important determinant of erosion potential. Erosion potential increases (for a given erosion factor) when slope increases.

In the Dead River Watershed, approximately 537 acres (5.3% of the watershed area) of soils are considered highly erodible. These results are illustrated on Figure 3.6 using Lake County GIS data. Much of the highly erodible soils are located within areas of steep slope, such as the ravines, and along the Lake Michigan bluff east of Sheridan Road, but they also occur in other areas of the watershed. The erodible soils should be preserved from development or alteration when possible, and should remain under vegetative cover to maintain soil stability.

Table 3.3 Hydrologic Soil Groups

Hydrologic Soil Group	Acres	Percentage
HSG A	1,005	9.9%
HSG B	4,296	42.1%
HSG C	3,542	34.7%
HSG D	1,197	11.7%
HSG Z	155	1.5%

Source: Lake County Soil Survey U.S. Department of Agriculture & National Resource Conservation Service, 2005.

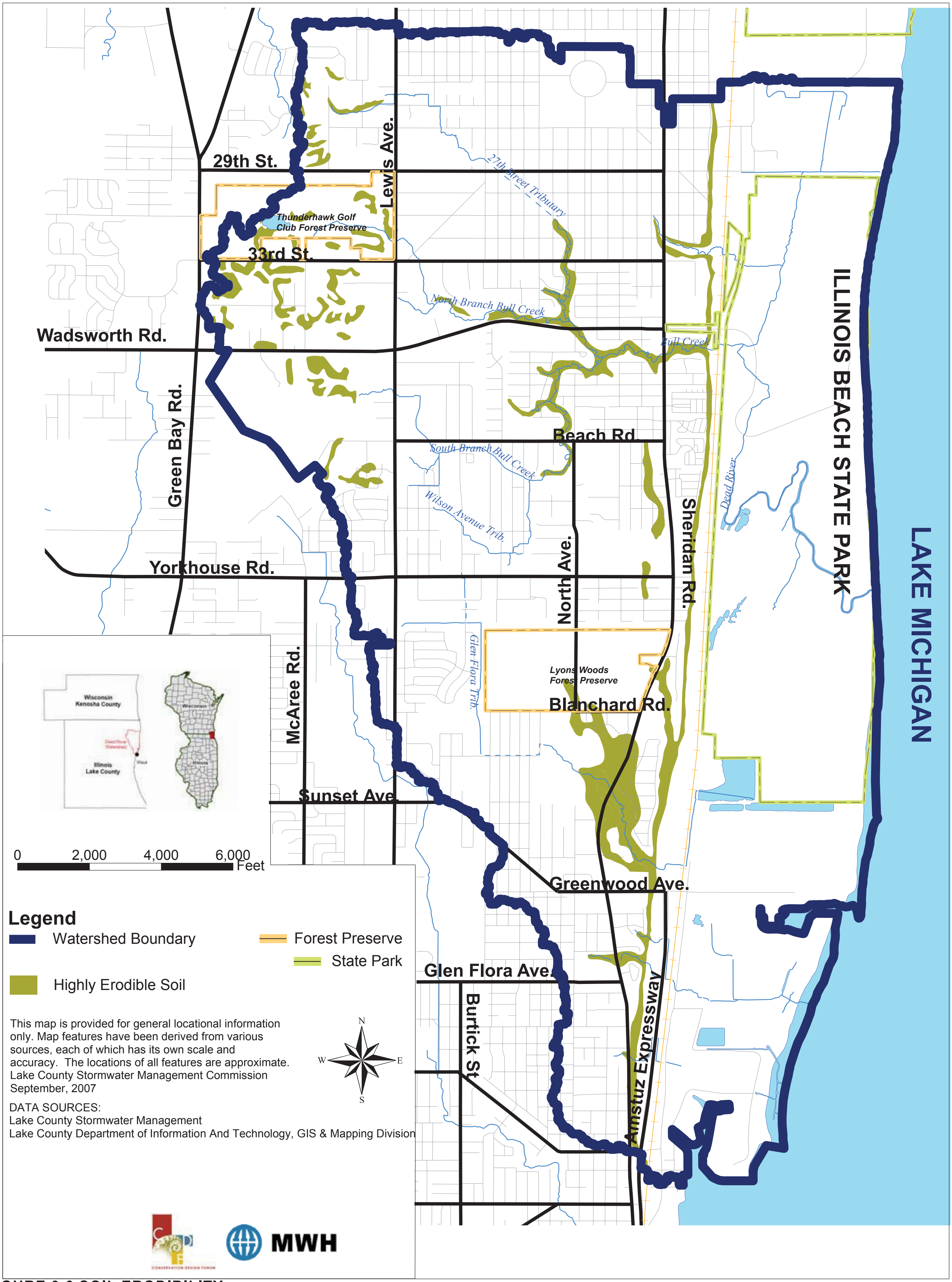


FIGURE 3.6 SOIL ERODIBILITY

3.7 WATERSHED JURISDICTIONS

The Dead River watershed includes parts of the municipalities of Zion, Beach Park, and Waukegan, which are responsible for most land use and development decisions, as well as stormwater management, within their boundaries. Zion and W aukegan Townships have limited jurisdictional authority within the watershed, limited primarily to some highways and roads. Lake County retains land use and development jurisdiction over unincorporated areas. The Lake County Forest Preserve District owns and manages natural areas, such as Thunderhawk Golf Course and L yon's Woods Forest Preserve. The State of Illinois Department of Natural Resources maintains and manages Illinois Beach State Park and the nature preserves within the park.

Elementary School Districts in the watershed include Zion District 6, Beach park Community Consolidated District 3, and W aukegan Community Unit 60. High School Districts include Zion Benton Township District 126 and Waukegan Unit 60. Zion and W aukegan Park Districts manage both natural and recreational / developed parklands within the watershed.

The North Shore / Beach Park and North Shore Sanitary Districts provide sanitary sewer service for the entire watershed. The Beach Park Drainage District maintains drainage ways within a boundary that covers portions of Beach Park and small portions of other communities as well; its boundary does not follow the municipal boundary because the drainage district pre-dates the incorporation of the village. The drainage district f rst tries to address drainage and f ooding problems that may cause damage to property and/or structures and then removes debris from stream channels as a secondary goal. The Waukegan Port District is responsible for W aukegan Harbor and the W aukegan Regional Airport.

The following political jurisdictions are covered by the Dead River watershed: County Board Members Randall E. Whitmore (2nd), Brent C. Paxton (4th), Robert Sabonjian (8th), Mary Ross Cunningham (9th), and Angelo D. Kyle (12th); State Representative Eddie Washington (60th) and JoAnn Osmond (61st); State Senators Terry Link (30th) and Michael Bond (31st); United States Representatives Melissa Bean (8th) and Mark Steven Kirk (10th); and United States Senators Barack Obama and Dick Durbin.

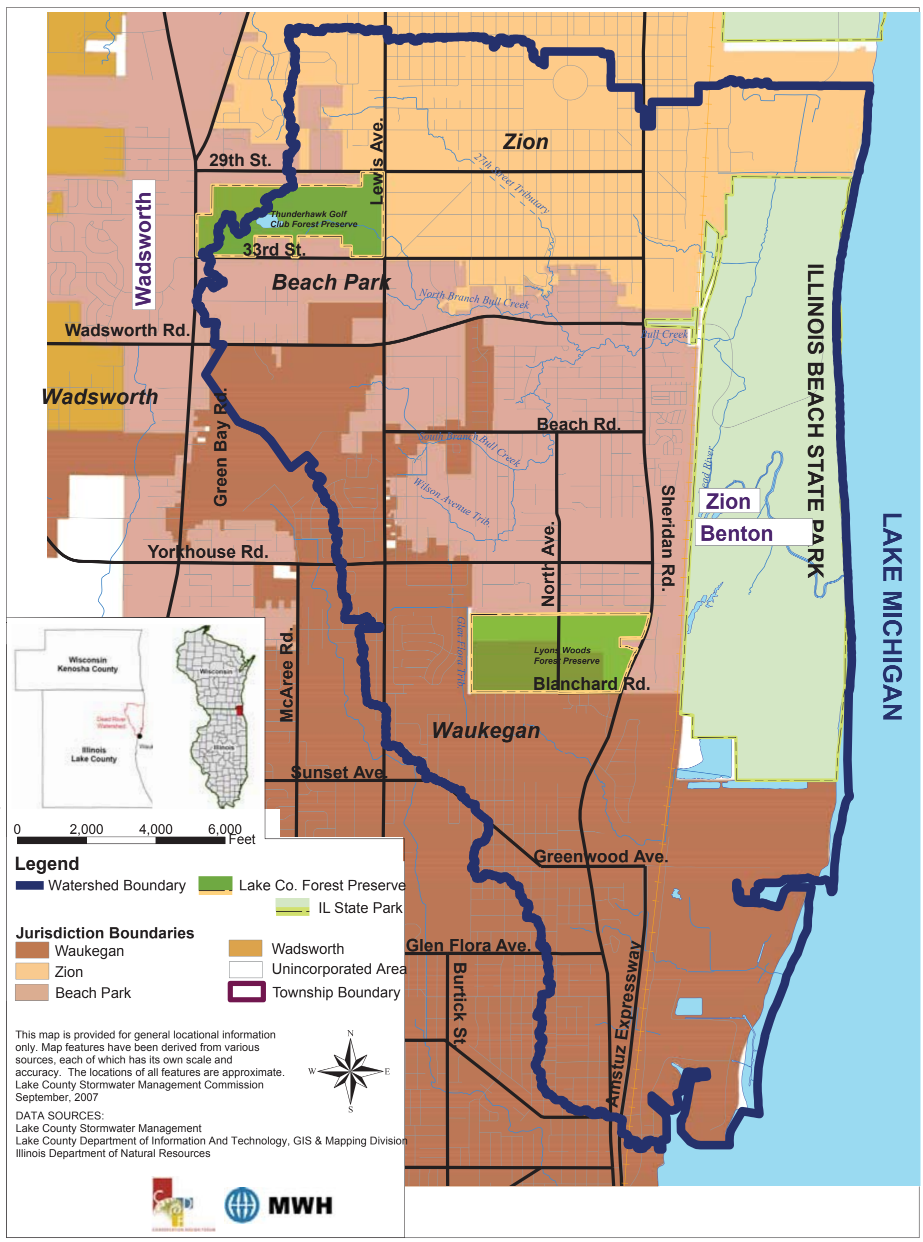
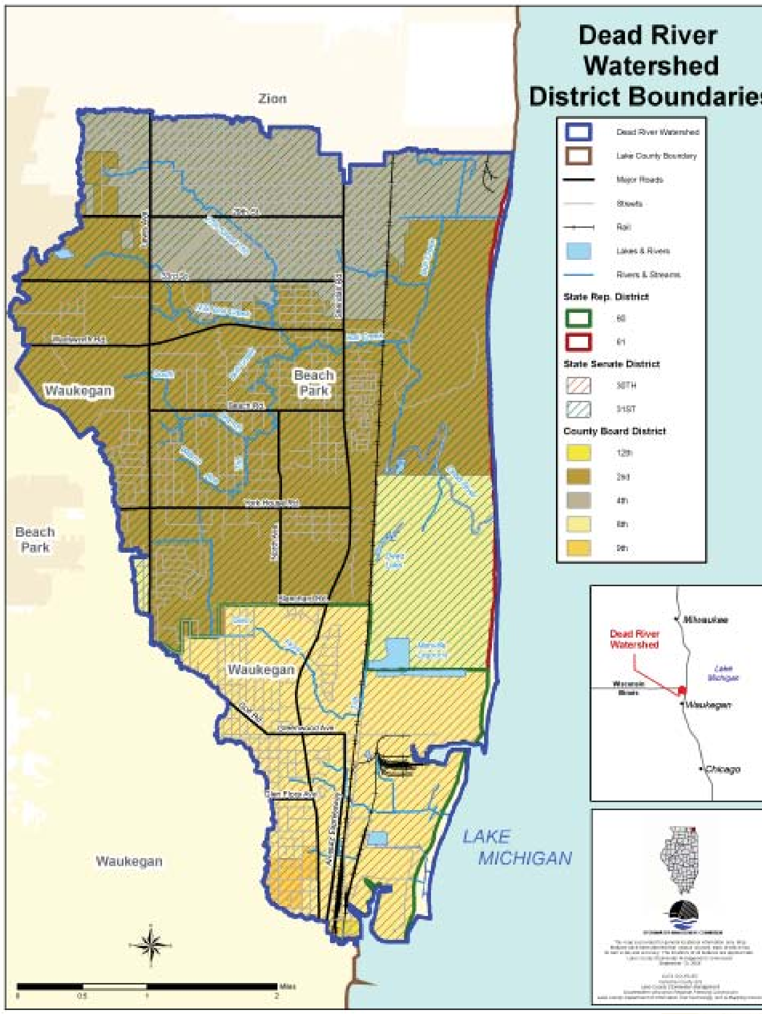


FIGURE 3.7 JURISDICTIONAL BOUNDARIES



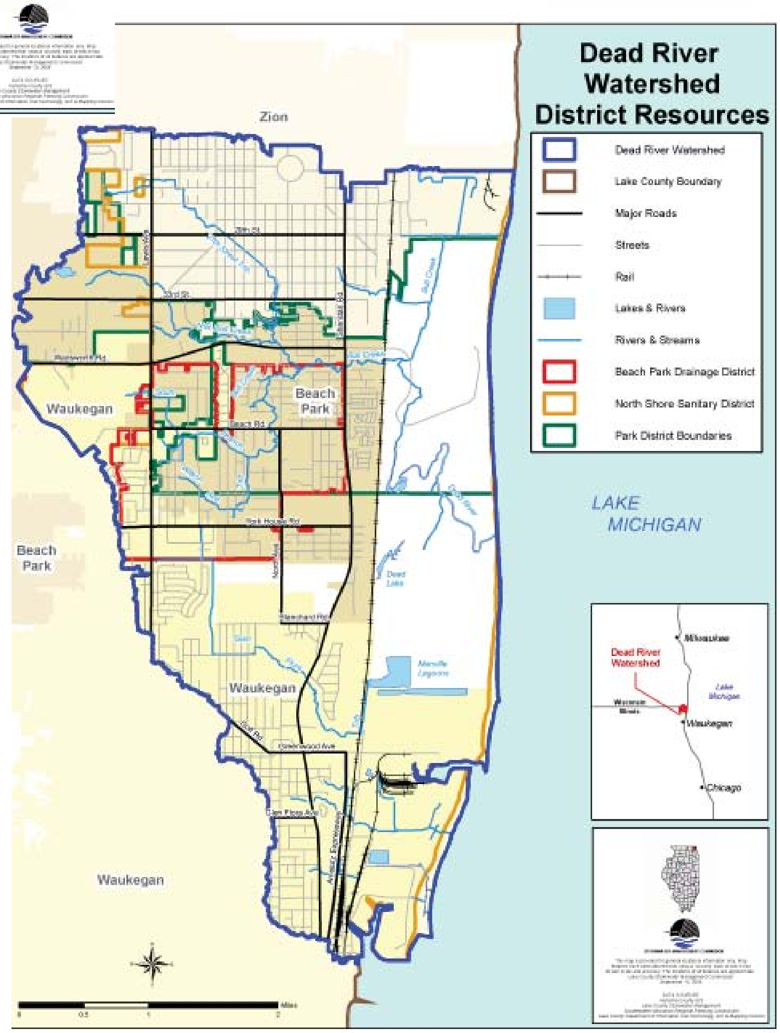


FIGURE 3.7 JURISDICTIONAL BOUNDARIES (CONTINUED)

This list of jurisdictional parties and responsibilities within the watershed, and the cross-jurisdictional nature of streams and other natural resources (i.e., they do not stop at jurisdictioinal boundaries), demonstrates the need for cooperation and coordination among jurisdictions to achieve watershed improvements. Jurisdictional boundaries are illustrated in Figure 3.7.

Source: Lake County Illinois Maps Online, http://gis2.co.lake.il.us/maps/.

3.8 WATERSHED DEMOGRAPHICS

The Chicago Metropolitan Agency for Planning (CMAP, formerly the Northeastern Illinois Planning Commission) is responsible for the northeastern Illinois region's of f cial forecasts of population, households, and employment. Updated every three years, these forecasts are intended to portray a most likely future given market forces and the impacts of expected public policy. Forecasts are based largely on expected changes in local land use patterns and municipal boundaries as presented by each of the region's 272 municipalities and 6 counties between the present and 2020, and between the present and 2030. The Chicago Metropolitan Agency for Planning uses the type of land use change and the area that will be af fected to determine the effect of those changes on population, employment, and housing. For example, a municipality planning to change land from a vacant manufacturing factory to single family housing can reasonably expect that change to reduce employment and increase population and households.

Table 3.4 and 3.5 list demographic data for the Dead River watershed and for Beach Park, W aukegan, and Zion individually. Table 3.4 shows f gures for the area of the three municipalities within the watershed boundary only. The f gures in Table 3.5, however, ref ect each municipality in its entirety. Population distribution is graphically represented in Figure 3.8. The data indicates slow growth, and occassional decline for some areas, in population, household, and employment f gures for the years 1970 to 2000. These f gures are based on actual census data. Projections from the Chicago Metropolitan Agency for Planning and Lake County indicate continued slow growth in population, households, and employment through 2020. However, individual municipalities are forecasted to grow signi f cantly

Table 3.4 Watershed Demographics

Dead River Watershed Demographics				
	Year	Population (%change)	Households (%change)	Employment (%change)
Existing	1970	44,907 (na)	No data	21,791 (na)
	1980	44,635 (1%)	15,737 (na)	19,420 (-11%)
	1990	43,757 (-2%)	15,814 (1%)	18,435 (-5%)
	2000	50,163 (15%)	16,720 (6%)	19,251 (4%)
Forecasted	2020	51,225 (2%)	19,444 (16%)	20,857 (8%)

Table 3.5 Watershed Demographics by Municipality

Dead River Watershed Demographics				
	Year	Population (%change)	Households (%change)	Employment (%change)
Beach Park	2000	10,072	3,636	565
	2030	16,729 (66%)	5,674 (56%)	1,012 (79%)
Waukegan	2000	87,901	27,787	37,146
	2030	92,714 (5%)	31,516 (13%)	44,702 (20%)
Zion	2000	22,866	0,552	6,076
	2030	32,585 (42%)	11,390 (51%)	10,032 (65%)

Source: Chicago Metropolitan Agency for Planning, endorsed 2030 forecasts, September 2006.

by the year 2030, most of which is assumed to occur outside of the watershed boundaries.

This type of data is useful for planning the types of improvments and best management practices that are most appropriate for the watershed. In a rapidly growing watershed, best management practices that prevent the degradation of watershed resources should be highlighted and recommended for those areas expected to be developed and built. In more stable watersheds, such as Dead River / Bull Creek, recommendations for watershed improvements can focus more directly on restoring watershed streams and natural resources and on installation of best management practices to reduce the impacts of the developed landscape

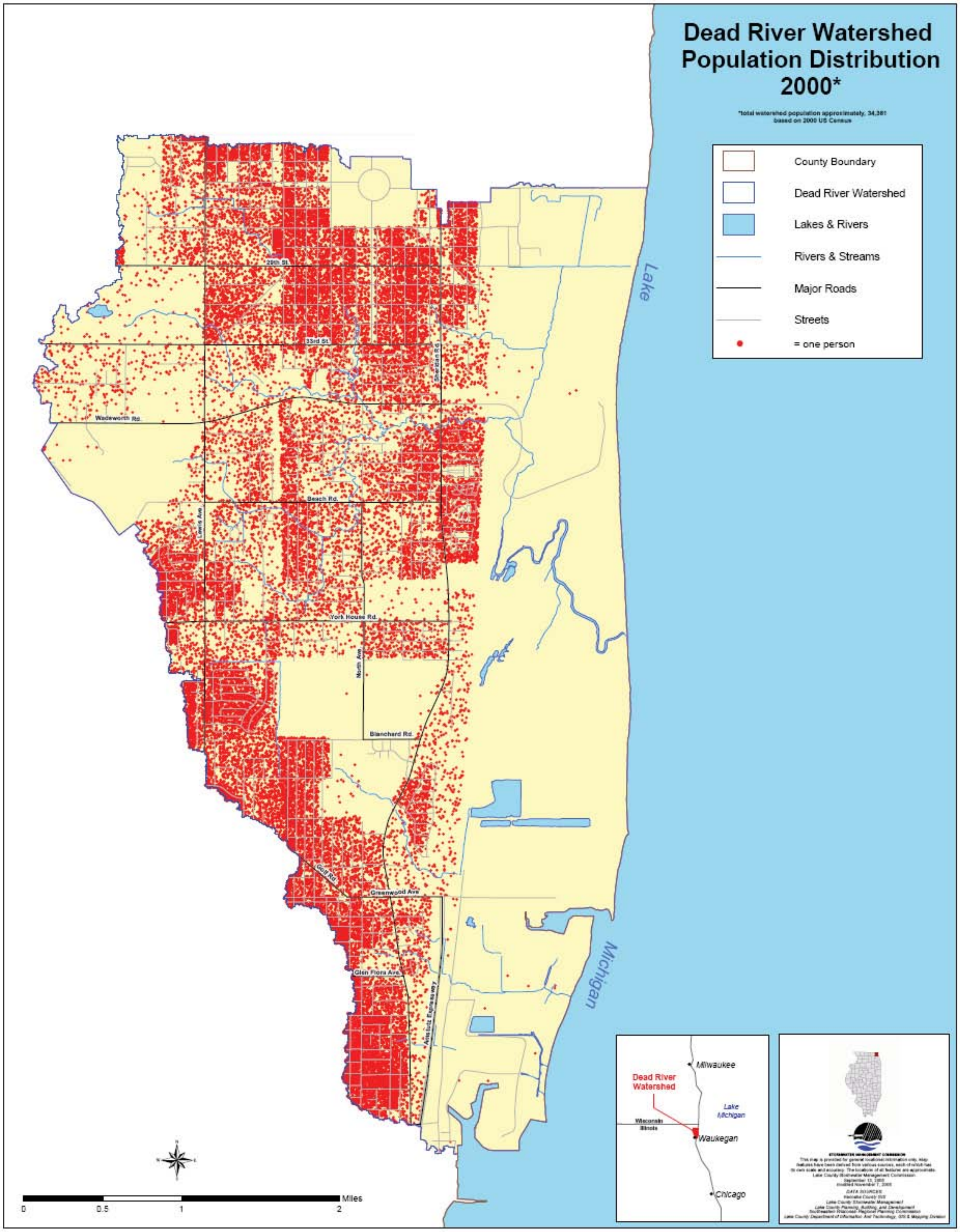


FIGURE 3.8 POPULATION DISTRIBUTION

on watershed resources.

Source: Chicago Metropolitan Agency for Planning, endorsed 2030 forecasts, September 2006.

3.9 LAND USE AND COVER

Land use and cover refer to the type of use assigned to a parcel, such as residential or commercial, and the type of surface coverage found on a parcel, such as forest and grassland, respectively . This information, as well as an understanding of the landscape characteristics prior to European settlement, provide a foundation for understanding the impact of current and future land use on watershed resources and the restoration potential.

3.9.1 PRESETTLEMENT VEGETATION

The pre-European settlement land cover map (Figure 3.9) for the Dead River watershed was derived from the US General Land Survey Of f ce surveyor's f eld notes. This historic information provides signi f cant clues to understanding and planning restoration activities within the watershed.

The map illustrates that in the early 1800s, savanna (a mix of scattered oak trees within prairies) covered the majority of the upland areas in the central and western thirds of the watearshed, and beach ridge (a ridge of sand running parallel to the shoreline) covered the eastern third along the Lake Michigan shoreline that is now Illinois Beach State Park. The beach ridge consisted of low dunes that were typically capped with stunted cedars, juniper berries and pine, oak and willow trees. A few large areas of oak woodlands (wooded areas dominated by oak species but also including other tree and shrub species) existed along the ridges and ravines that now line Sheridan Road, with a small line of upland forest extending up the Bull Creek ravine. A few small patches of wet meadow, wet prairie and marsh (types of wetlands, with wet meadow the driest and marsh the wettest of those listed) were scattered within the central area of the watershed.The savannah ecosystem type, which is now globally rare, occurred along the intersection of the great Eastern forests and the Midwestern open prairies. Its open, pleasant character and fertile soils resulted in mass conversion of these lands for agriculture and settlement. Oak woodland landscapes were more densely wooded than savanna, but would have been considered open by today' s standards, with an understory of grasses and forbs.

Except for the beach ridge and oak woodlands along the ravines, most of the presettlement vegetation cover types were converted to agriculture and urban land uses (including areas developed to provide living, working, learning, recreation, and other uses for people.) The beach ridge is the only large contiguous area where the existing land cover remains generally consistent with pre-settlement conditions.

3.9.2 CULTURAL RESOURCES

In the 1700s, the Lake Michigan dunes area originally which is now Illinois Beach State Park, was part of the "Three Fires" of the Algonquin Nation: the Potawatomi, Chippewa, and Ottawa. Prior to then the area had been occupied by the Miami. In the late 1600s French explorers f rst visited the area as part of their survey of what was then known as the Northwest Territory. By the time Illinois became a state in 1818, the area was full of transient hunters and trappers. In 1836, a treaty was made with the local Native Americans, who were moved westward, and the area became part of Lake County.

A number of historical structures, primarily homes and current and former businesses, are found within the watershed. With regard to archeological potential, however , the Illinois Historic Preservation Agency does not make known archaeological areas available to the public. Nonetheless, it is the professional opinion of the planning team that any remaining archeological resources would be found either within the beach ridge plain and Illinois Beach State Park,

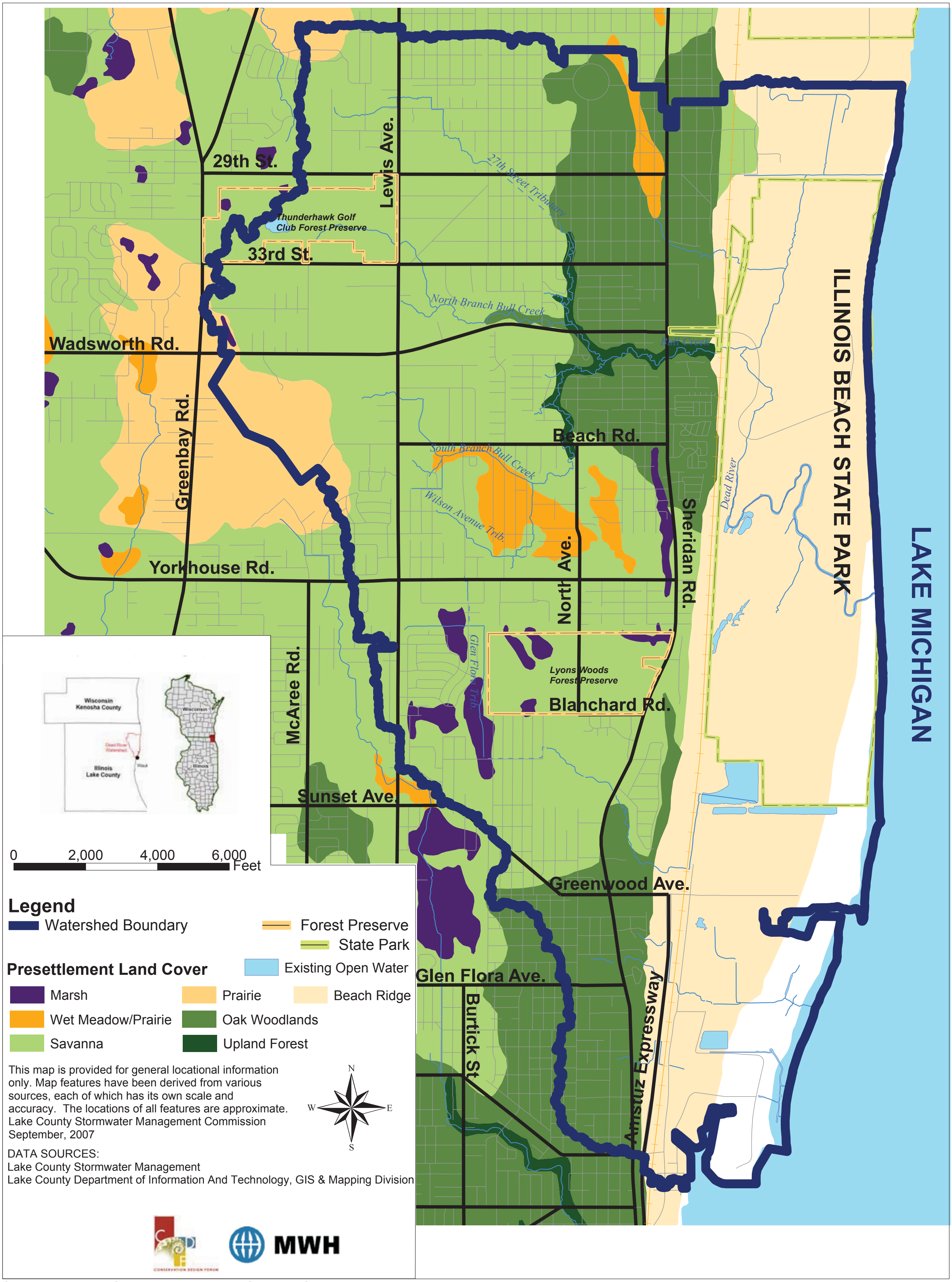


FIGURE 3.9 PRESETTLEMENT VEGETATION

along the coast of Lake Michigan, or along streams and within watershed ravines and surrounding areas.

Source: www.stateparks.com/illinois_beach.

3.9.3 EXISTING LAND USE

The composition of existing land use and cover for the Dead River watershed are shown in Table 3.6 and Figure 3.10. The watershed consists primarily of older developed neighborhoods, with some more recent development occurring in the western, headwaters of the watershed. In aggregate, natural and open lands, located largely in the coastal plain of the watershed, comprise more than a third of the land area in the watershed and single family residential a quarter. This information is used to understand the impacts of development on watershed resources and water quality , and will be used as part of the non-point source pollution loading modeling in Section 3.14.4.

Single and multi family residential development make up a little over one quarter (26.3%) of the watershed acreage.

Table 3.6 Existing Land Use and Cover

Land Use & Cover	Acres	Percentage
Agricultural	201	1.9%
Commercial	209	2.0%
Government and Institutional	268	2.6%
Industrial	164	1.6%
Multi Family	98	0.9%
Single Family	2,651	25.4%
Transportation, Utility and Waste Facilities	2,218	21.3%
Forest and Grassland	935	9.0%
Public and Private Open Space	2,791	26.8%
Wetlands	658	6.3%
Water	226	2.2%

Table 3.7 Land Use Categories

Land Use & Cover Category	Def nition
Agricultural	Cropland, pastureland, orchards, nurseries and greenhouse operations, and horse farms and stables.
Commercial	Shopping malls and parking, off ce and research parks, off ce buildings and hotels, retail (such as department stores, grocery stores, hardware stores), and cultural / entertainment (such as museums, historic sites, fairgrounds, recreation centers, yacht clubs, and marinas and harbors).
Forest and Grassland	Forested land or grassland that is vacant, which means undeveloped and unused land, forests not located within parks or forest preserves, and other land that has not been developed for any human purpose.
Government and Institutional	Government administration and services, medical and health facilities, educational facilities, correctional facilities, and religious facilities.
Industrial	Mining, mineral extraction, manufacturing and processing, warehousing and distribution centers, wholesale facilities, and industrial parks.
Multi Family	Apartment and retirement complexes.
Public and Private Open Space	Parks, golf courses, nature preserves, playgrounds and athletic f elds when associated with another open space activity, swimming beaches, camping and picnicking, and group or organized camps & retreats
Single Family	Single homes, duplex homes, townhomes, and farmhouses.
Transportation, Utility and Waste Facilities	Roads, railroads, airports, non-residential parking areas; communications (telephone, radio, and television facilities, towers, and dishes; utilities (power lines, gas, water, sewage, solid waste / landf lls, pipelines, treatment plants and power substations); and rights-of-way for these uses.
Water	Rivers, streams canals, lakes, ponds, reservoirs, lagoons, and Lake Michigan.
Wetlands	Wetlands over 0.25 acres in size.

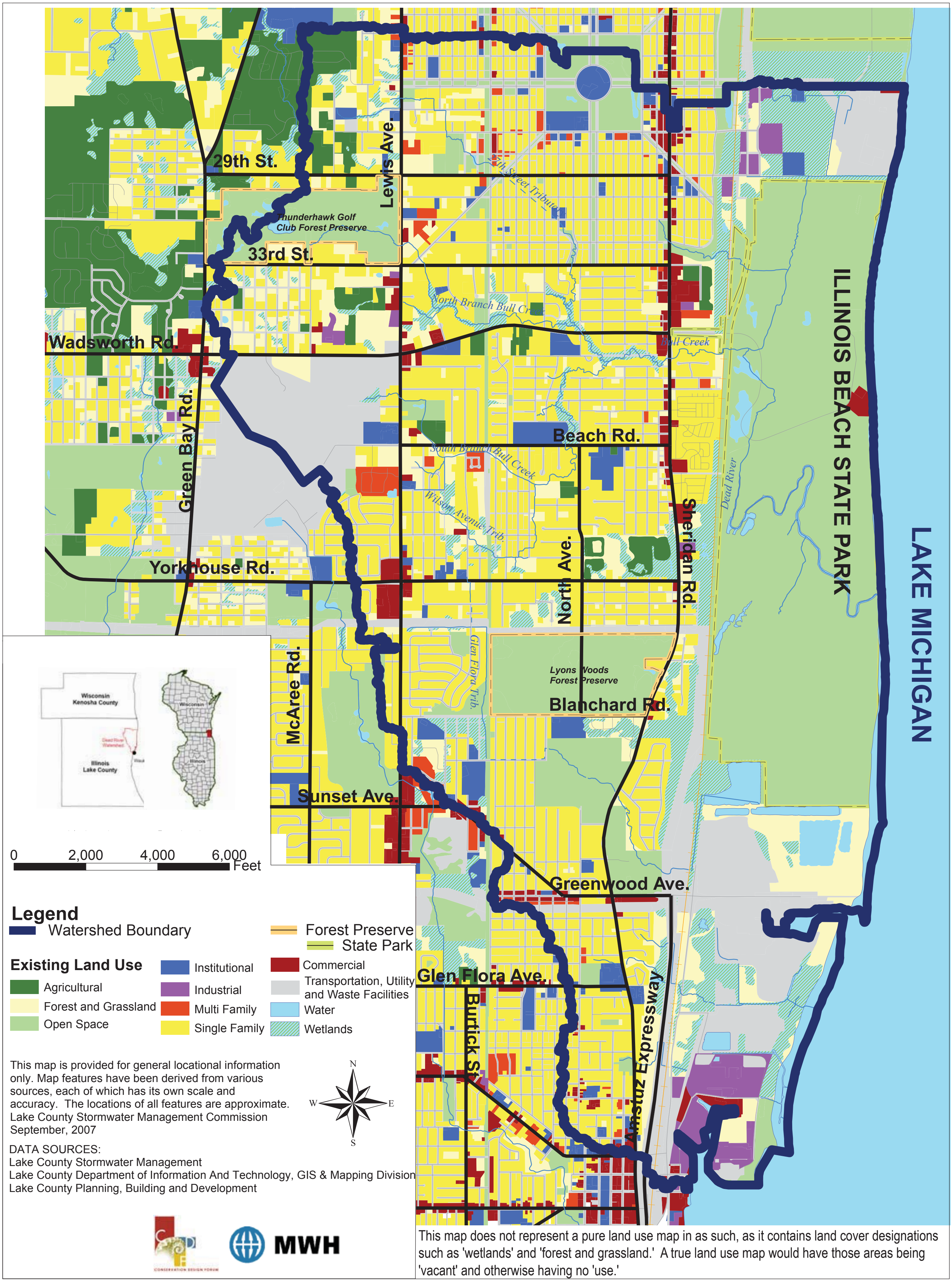


FIGURE 3.10 EXISTING LAND USE

Commercial, industrial, transportation, utility, and waste (landfill) facilities make up 24.9% of the watershed, and government and institutional only 2.6%. Combined, the urban land uses make up 53.8% of the watershed area.

Agricultural land, forest and grassland, open space (including recreational areas and some nature preserves), water, and wetlands make up 46.2% of the watershed - a large portion of which are the publicly held Illinois Beach State Park and Lyons Woods Forest Preserve and three golf courses. Open space is typically different from forest and grasslands in that it is usually associated with at least some sort of human use, from bird watching in a nature preserve to soccer fields. Review of Figure 3.10 shows significant open space along Lake Michigan except to the south where the lake plain is covered by industrial and utility land uses. Transportation / Utility (Waukegan airport) also covers a significant portion of the west central portion of the watershed. Commercial use is located primarily along Sheridan Road and Lewis Avenue. Single family residential is scattered throughout the watershed, intermixed with pockets of multi-family residential, institutional, and wetlands.

3.9.4 FUTURE LAND USE

Through land use decisions and development standards and controls, the municipalities and Lake County have the majority of the land use discretion to determine the future of the watershed. Without proper attention to development location and design, future impacts to watershed could include increased flooding and streambank erosion and the degradation of water quality, aquatic habitat, and floristic diversity. A note on land use tables and figures: the categories and acreage totals for the existing and future land uses are different due to differences in the way Lake County and the Chicago Metropolitan Agency for Planning categorize and calculate them. For example, it is unlikely that the watershed will lose 90 acres of due to conversion or other land use change, though this is how the data is currently reported.

Table 3.8 and Figure 3.11 show the distribution of future land use and cover for the Dead River watershed and is based on municipal comprehensive plans and data provided by the Lake County Department of Information and Technology. Much of the watershed is expected to be single family residential in 2020 (35%) with commercial and industrial uses clustered along Lewis Avenue, Sheridan Road, Wadsworth Road, and Yorkhouse Road, as well as along Green Bay Road. Conversion of 1200 acres of open lands to more urban uses is expected to occur, primarily to residential use, in the northwest and southwest quarters of the watershed. Interestingly, some existing development land uses are indicated as changing to a different land use. For example, the area around the State Highway 173 and Kenosha Road intersection is planned to become primarily industrial and commercial with some multifamily residential and mixed use development. Lewis Avenue is planned to become a commercial and industrial corridor rather than primarily residential and open space. The northern half of Sheridan Road will convert from residential and scattered commercial to mixed use development.

Table 3.8 Future Land Use and Cover (Illinois 2020)

Future Land Use	Area (Acres)	Percentage	Change from 2006 (Acres)
Agricultural	0	0.0%	-201
Commercial	407	4.0%	198
Institutional	125	1.2%	-143
Industrial	28	0.3%	-136
Multi Family	373	3.6%	275
Single Family	3,551	34.6%	900
Mixed Use	185	1.8%	185
Transportation, Utility and Waste Facilities	2,097	20.4%	-121
Open Space	3,371	32.8%	-1013
Water	136	1.3%	-90

According to this table, we can assume that the Dead River watershed will become more heavily residential and commercial by converting agricultural, institutional, industrial, and especially open spaces to residential and commercial use. Typically, conversion of industrial and institutional land to residential use results in less impervious cover and a lower impact on water runoff and quality than industrial and institutional. This is due largely to the reduction of parking lots and an increase in turf grass lawn coverage. However, this apparent gain will be more than offset by the water quality and runoff impacts that will result from convertion of open space and agricultural land to more urban uses, including residential, due to the increase in impervious cover.

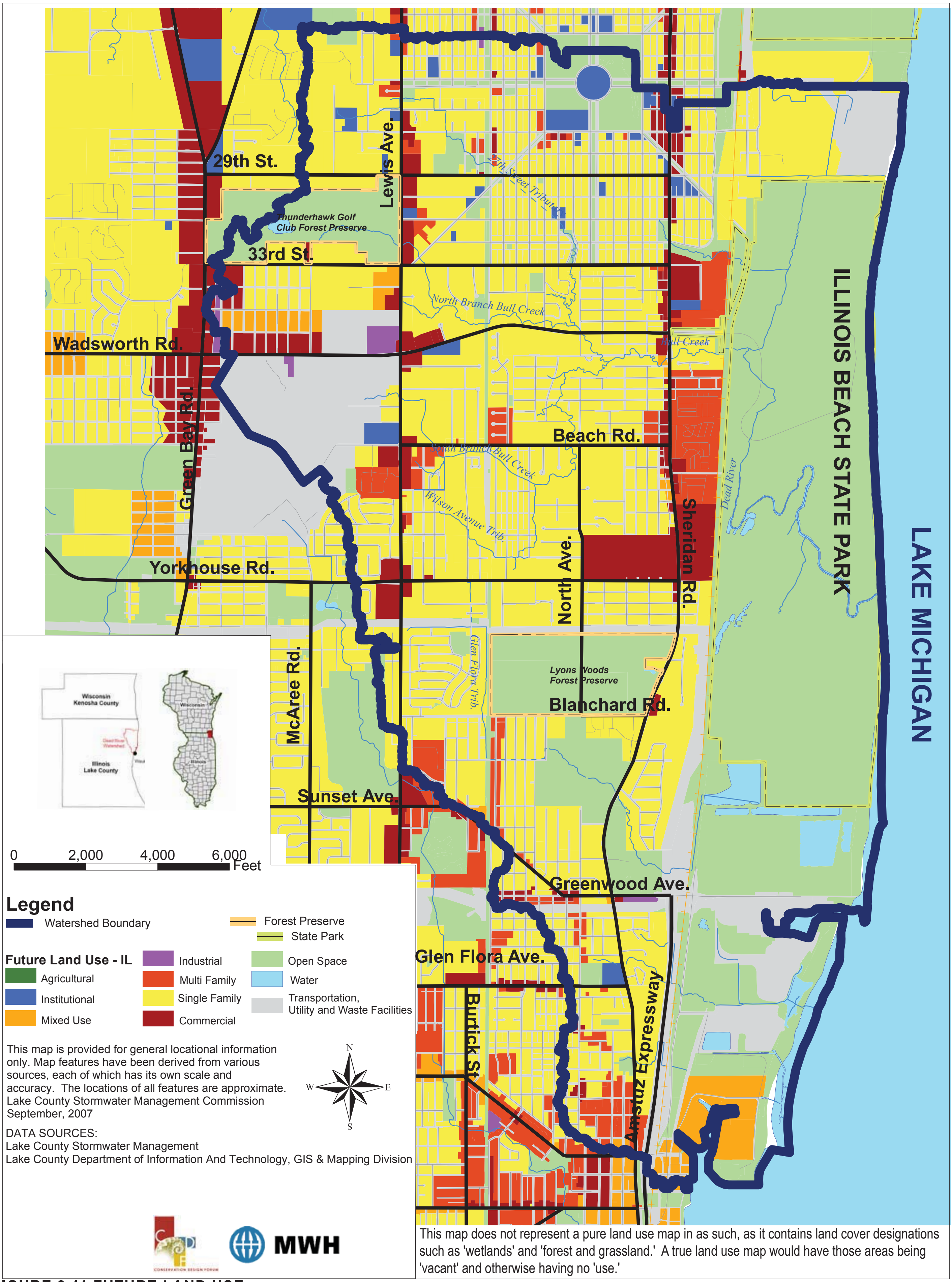


FIGURE 3.11 FUTURE LAND USE

Land use conversion from primarily open to a more urban land use will increase the impervious cover of the watershed, which will also have a signi f cant impact on f ooding, water quality, and other watershed resources. To help reduce the negative impact of additional impervious surfaces, best management practices should be integrated into development designs wherever possible. Conversely , the redevelopment that is projected for the watershed provides opportunities to provide stormwater BMPs for urban areas that currently have little or no stormwater controls. Conservation development, a practices that attempts to preserve the drainage and inf ltration capactiy of the developed landscape, is another very effective way to ameliorate the negative ef fects of land use conversion.

Discussions to expand the Waukegan Regional Airport to the north and east of its current footprint are currently underway. These discussions have resulted from the desire to improve safety and accommodate future demand by lengthening and/or relocating the airport's primary runway . A number of alternatives exist for the airport, some of which would include the acquisition and conversion of residential, open / recreational, and commercial land uses to transportation, utility, and waste facility land use category . Alternative expansion designs would likely convert between 128 to 290 acres of existing land uses for airport use. The impact on imperviousness in the area is unknown, since the areas of runway and turf grass of the airport expansion are unknown at this time. However , any change may result in additional discharges of airport-related engine and deicing chemicals into the Bull Creek stream system. However , when properly implemented, the airport's spill prevention plan can signif cantly reduct the risk of impact to water quality and watershed resources. This plan is discussed in Section 3.14.4 of this chapter.

3.9.5 W AUKEGAN LAKEFRONT REVITALIZATION

In December of 2003 the W aukegan City Council amended its Comprehensive Plan to incorporate *A 21st Century Vision for W aukegan's Downtown and Lakefront* Master Plan as part of the overall land use strategy. The Master Plan, which establishes the planning and actions necessary for a revitalized downtown and lakefront, includes recommendations for the area from W aukegan Harbor to Illinois Beach State Park. (See Figure 3.12.) These recommendations are likely to have a positive impact on the City of W aukegan, watershed resources, and Lake Michigan and its shoreline.

The plan recommends sensitive redevelopment of the North Harbor, which suffers from an industrial legacy (as detailed in the Water Quality section), and ecological and hydrological restoration of the valuable and rare North Lakefront, which will include wetlands, beach habitat, and public access and recreation. The North Lakefront will be reconnected to Illinois Beach State Park, Lake Michigan, and other local open space resources (ravines, the W aukegan River , and the Robert McClory bike trail), both recreationally and ecologically.

The W aukegan Moorlands, located generally along North Sand Street, east of the Union Paci f c tracks and west of Midwest Generation and bounded by East Greenwood Avenue to the north, will be an open space area containing restored wetlands, waterways, wildlife habitat, and recreation trails that will interface with future potential open space integrated into the current arrangement of public and private property. Partnerships with local landowners such as Midwest Generation and the North Shore Sanitary District will be essential to this ef fort. The Moorlands also may include the restoration of the former Little Dead River (see Figure 3.24) and the creation of treatment wetlands for North Shore Sanitary District overf ow.

The plan recognizes the global importance of the freshwater dune and swale system of the lakefront and recommends enhancing and expanding this ecosystem within the North Lakefront area and as an extension of Illinois Beach State Park. In spite of the industrial legacy of the area, remnant ecosystems remain including fore-dune wetlands adjacent to the beach and patches of plants and wetlands.

3.9.6 ZION NUCLEAR POWER STATION

The Zion Nuclear Power Station site, located on the Lake Michigan shoreline between the Illinois Beach State Park North and South Units at the southeastern corner of the watershed, was permanently shut down and retired in February, 1998 after 25 years of operation. In March 2008, plans were announced to decommission the plant over the next 10 years at a cost of approximately $978 million. The City of Zion plans the future land use of this area to be single family residential.

© City of Waukegan

FIGURE 3.12 WAUKEGAN LAKEFRONT MASTER PLAN

The proximity of this site to Lake Michigan and the valuable natural resources of Illinois Beach State Park suggest that signif cant care should be taken to ensure that appropriate land use and stormwater management measures are used for the decommissioning and eventual redevelopment or restoration of this site.

Sources: Lake County , Illinois, Department of Planning Building and Development.

A 21st Century V ision for W aukegan's Downtown and Lakefront, City of Waukegan, 2003.

3.10 TRANSPORTATION

According to state and local transportation authorities, no signif cant roadway construction projects are planned in the watershed except for two highway resurfacing projects planned by the Illinois Department of Transportation. One is on Illinois Route 137 (Sheridan Road) from Russell Road to Greenwood Avenue (7.9 miles). The other is on Illinois Route 173 (Rosecrans Road / Bethlehem Avenue) from IL-131 (Green Bay Road) to IL-137 (Sheridan Road) (3.06 miles.) Stakeholders, however , suggested that discussions have occurred regarding the widening of Green Bay Road and narrowing Sheridan Road in the future.

The impact of streets and highways on the watershed, particularly water quality , is signi f cant. Table 3.9 lists a number of water quality pollutants and their sources, all of which are associated with the transportation system. Rain water f owing over the surface of our streets can carry these pollutants into our wetlands, streams and Lake Michigan, where they can accumulate and impair the quality of these resources for aquatic life. Furthermore, Lake Michigan is the source of drinking water for millions of people, and removing these pollutants prior to consumption is an expensive process.

Source: Illinois Department of Transportation FY 2006-201 1 Proposed Highway Improvement Program, Highway District 1 Lake County. Watershed stakeholders, personal communication.

3.11 NATURAL RESOURCES

This section of the plan describes the natural areas within the Dead River watershed, including parks, preserves, plant and animal species concerns, ravines, wetlands, and recreational trails. These features make up some of the components of the watershed green infrastructure system, which is discussed in Section 3.12. The location of these resources are shown in Figures 3.13 and 3.17.

3.11.1 ILLINOIS BEACH ST ATE P ARK AND PRESERVE

llinois Beach State Park (and Spring Bluf Nature Preserve in the Kellogg Creek watershed, which is included here as part of the Illinois Beach State Park description) is a 3000-acre biologically rich area in Illinois, containing approximately 2000 acres of Illinois Nature Preserves (Illinois North Dunes Nature Preserve and Illinois Beach Nature Preserve), and a very high concentration and diversity of threatened and endangered species and rare plant communities. Illinois Beach Nature Preserve was the f rst dedicated Nature Preserve in Illinois and is a National Natural Landmark. Illinois Beach is visited by an average 2.8 million people annually for a variety of pastimes including birdwatching, hiking, photography, and botany.

Together these natural areas support 14 dif ferent natural community types (unique assemblages of plants and animals), including 66 acres of the globally signi f cant Lake Michigan panne, 1 11 acres of sand savanna (a regionally declining upland habitat with a sandy soil), sedge meadow (wetlands found along streams, f oodplains, and upland depressions in the landscape that occassionally hold water), wet prairie (a wetland type with a specif c set of plants), dune (sand ridge), and lakeshore . The palustrine (non-f owing or ponded) wetlands found here are considered nationally decreasing and of regional and local conservation concern. Over 500 species of plants and 300 species of animals are known to occur here, and the complex provides habitat for 160 migratory bird species. According to one report, Illinois Beach State Park is the highest quality natural area in the Lake Michigan watershed in Illinois. Studies also indicate that a dune remnant that is approximately one mile south of the Park contains amphibian species richness that exceeds two nearby nature preserves.

Over 6 miles of some of the last remaining undeveloped shoreline in the state exist here in a series of dry sand ridges, black oak sand savanna, dunes, and high quality wetland swales including sedge meadow , marsh, fen, and 66 acres of a globally-rare plant community called Lake Michigan panne. Pannes are shallow troughs of sand kept wet by the water table and/or springs within nearby dunes, which often

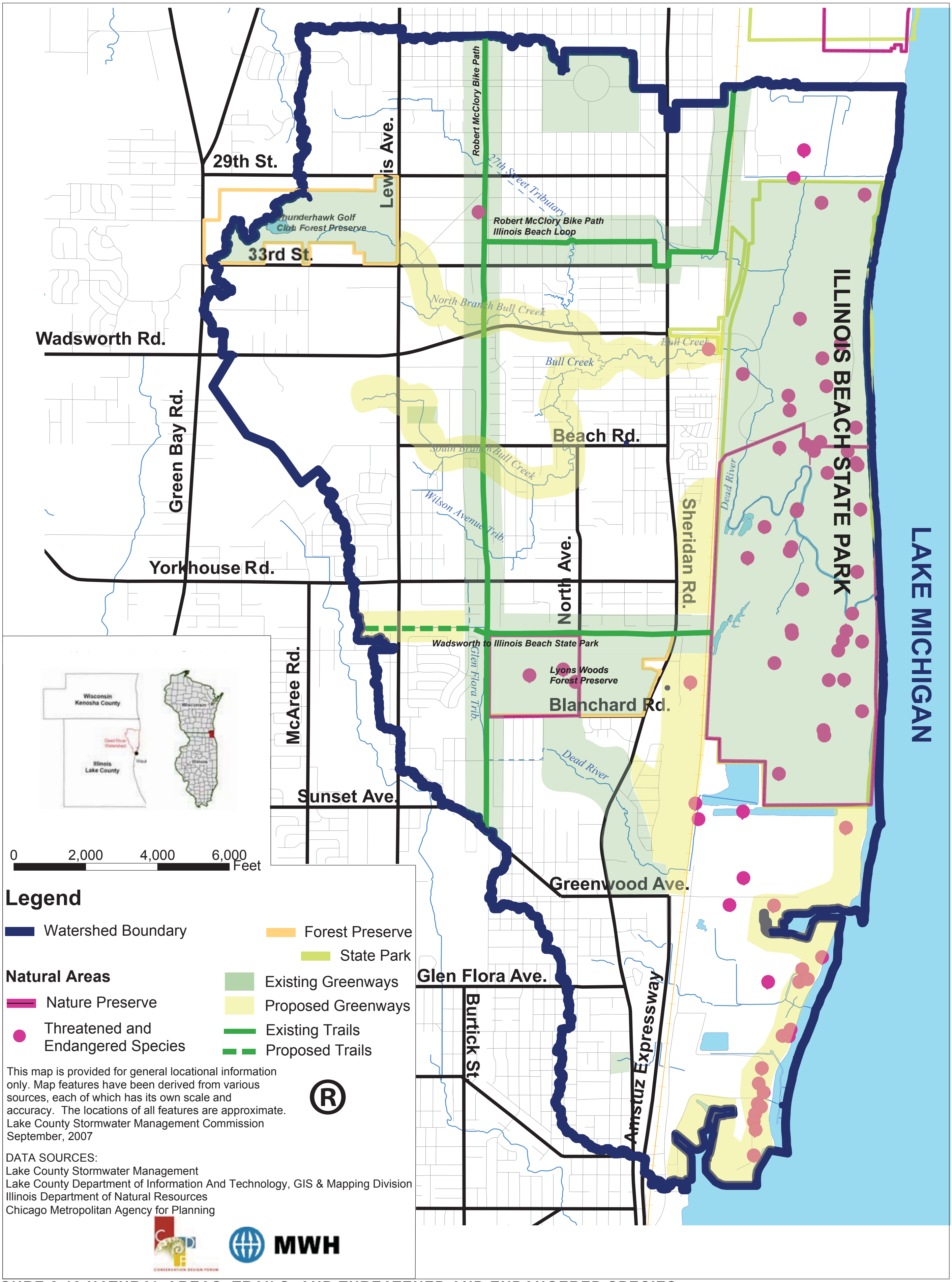


FIGURE 3.13 NATURAL AREAS, TRAILS, AND THREATENED AND ENDANGERED SPECIES

support uniques assemblages of plant species . Only a few hundred acres of this wetland community are believed to exist anywhere in the world.

These systems support a wide variety of species including a number of those listed in Appendix A, which are at risk of being lost forever. The Federally threatened Pitcher's (Dune) Thistle and Eastern Prairie Fringed Orchid are the subjects of a population recovery plan at Illinois Beach State Park, which is also being assessed for reintroduction of the Karner blue butterf y which feeds on the Wild lupine found there. Illinois Beach State Park provides both wetland and upland nesting habitats for the state endangered Blandings turtle, as well as a suite of wetland birds and rare insect species.

The water courses within the park provide important spawning and nursery habitat for yellow perch, northern pike, longnose sucker , blacknose shiner , and blackchin shiner. Restoration and creation of wetlands with a surface water linkage to the open waters of Lake Michigan, such as those in Illinois Beach State Park, may be critical shelter , spawning and feeding habitat necessary for the recovery of aquatic Great Lakes species. However , Dead River, one of the few remaining natural tributaries to Lake Michigan in Illinois, may be too small and shallow to function as substantial aquatic habitat for Great Lakes f sh species.

Much of the shoreline of the park has been designated critical habitat for the federally endangered piping plover and other migratory bird species including the Caspian tern, common tern, oldsquaw, black scoter, willet, whimbrel, and sanderling. Due to the regionally important resting and foraging areas for migrating shorebirds and raptors, and breeding habitat for grassland and wetland birds, Illinois Beach State Park has also been designated an Important Bird Area by the National Audubon Society (2004).

State and Federally Listed Species

Illinois Beach State Park contains suitable habitat for 4 federally threatened or endangered species as well as a number of state-listed endangered and threatened plant and animal species, as listed in Appendix A. According to expert knowledge of the insect diversity of the area, out of 31 insect species identif ed as state imperiled (found at only 1 or 2 sites statewide), 20 are found only at Illinois Beach. An endangered species is one that is in danger of extinction throughout all or a signi f cant portion of the area in which it lives. A threatened species is one that is likely to become

Table 3.9 Illinois Beach State Park Invasive and Exotic Species

Common Name	Scientif c Name
Common Reed	Phragmites australis
Reed Canary Grass	Phalaris arundinacea
Narrow-leaved and Hybrid Cattails	Typha angustifolia and T. x glauca
Purple Loosestrife	Lythrum salicarea
Crown vetch	Corollia varia
Multif ora Rose	Rosa multif ora
Black Locust	Robinea psuedoacacia
Bush Honeysuckles	Lonicera spp
Glossy Buckthorn	Franula alnus
Sheep's Fescue	Festuca obtuse
Kentucky Blue Grass	Poa pretense
Cottonwood Populus	deltoids
Box elder	Acer negundo
Willow	Salix interior and Salix nigra
Weeping Willow	Salix babylonica
Cypress spurge	Euphporbia cyparissias
Sweet Clover	Melilotus spp.
Canada Thistle	Cirsuim arvense
Lyme Grass	Elymus arenarius


© Illinois Department of Natural Resources

Illinois Beach State Park dune and swale system is classi f ed as ADID wetland #1650.

Prairie white-fringed orchid

Karner blue butterf y and pitcher's thistle

Woodland management

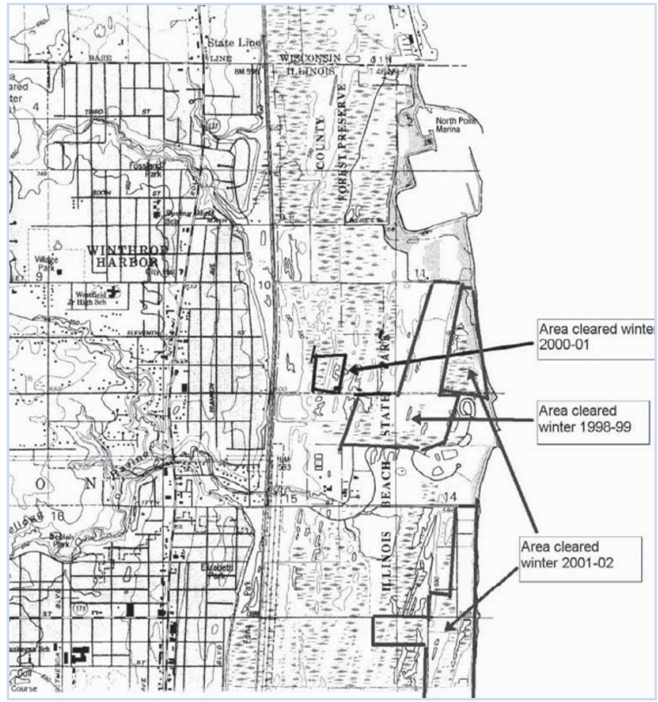


FIGURE 3.14 ILLINOIS BEACH ST ATE P ARK MAJOR RESTORATION AREAS

endangered in teh foreseeable future. The State of Illinois determines standards for listing species that live within the borders of the state regardless of how rare or common they are outside those borders. A Federally listed species must be threatened or endangered throughout all or a signi f cant portion of the geographic range in which it lives.

Management and Restoration

Management plans for the Illinois Beach State Park Nature Preserves have been developed that focus on exotic species and their negative impacts to native communities, with some mention of the movement of sediment, exotic species seeds (reed canary grass, phragmites), and other water-borne pollutants into the park through stormwater runof f from the Dead River watershed. However , these plans are neither comprehensive nor highly detailed, and updated restoration and management plans should be developed.

Stewards are actively managing 20 invasive plant species at Illinois Beach using an integrated approach that includes mowing, hand pulling, brush clearing, prescribed burns, and carefully timed and targeted herbicide application. However, increases in sediment and nutrient loads in surface water f ow from the entire watershed are associated with changes that favor invasive species and degrade the native plant community. Roads, culverts, ditching, f uctuating Lake Michigan levels, and beaver activity also have altered the hydrology in Illinois Beach State Park in complicated ways causing f ooding in some places and drying of wetlands in others. Invasive species tend to do will in these areas where the presettlement conditions have been altered and destabilized. Invasive plant species move by a variety of methods, the most common being seed dispersion by wind, water, and animals eating and excreting or otherwise carrying and depositing seeds. Some invasive plants spread via underground roots. The most aggressive and invasive plant species that are degrading conditions at Illinois Beach State Park are included in Table 3.9.

Nearly $200,000 in grant supported restoration and habitat enhancement funds have been applied to improving conditions at the park. In early 2007, it was announced that a $350,000 federal National Coastal W etland Conservation grant has been awarded to fund habitat restoration / invasive species removal projects on 240 acres at Illinois Beach State Park and Spring Bluf f Nature Preserve, the latter in the adjacent Kellogg Creek watershed. Ongoing volunteer opportunities to help manage and restore the park include monthly workdays to conduct invasive species control, seed collection, brush cleariing, and monitoring of conditions. Major restoration areas are shown in Figure 3.14.

Shoreline Erosion

Sand movement along the Lake Michigan shoreline (also called littoral transport, see Figure 3.16) is a natural process driven by wind and currents that serves to regenerate and maintain the natural shoreline and the communities that depend on it. Some of the threatened and endangered species found in the park depend on this sand movement to maintain their habitat, such as the piping plover and Pitcher's thistle. However , beach erosion, driven by wind, water currents, and shoreline structures, is a major management issue for Illinois Beach State Park and has already caused the loss of a number of acres of beach and dune plant communities, including the unique Lake Michigan panne ecosystem type and habitat for threatened and endangered species. The area most af fected by beach erosion extends generally from the marina south to the Zion Nuclear Power Station, but other areas may be more mildly af fected. If this loss of beach continues, these species and the rare habitat that supports them, could be lost forever. Figure 3.15 shows the extent of erosion between 1967 and 2006.

Management measures have been attempted, such as pea gravel stabilization, sand replenishment, and armoring, yet these and other solutions are expensive and have not proved to be very successful.These and other solutions, such as the construction of structures to slow erosion, also can cause other problems such as the loss of aesthetic, recreational, and biological values. According to one stakeholder , sand replenishment from sources in the vicinity of W aukegan Harbor, which is known to be contaminated with a variety of substances, may pose the additional complications of moving contaminated materials into uncontaminated areas. The continued movement and loss of the Lake Michigan shoreline is an ongoing management issue that is complicated by the competing needs and desires of those who use the lakefront.

Potential Contamination Issue

Asbestos containing materials (ACM) and asbestos particles and f bers are also known to be present in Illinois Beach State Park. The degree of human health risk associated with asbestos, however, continues to be in dispute by the various public and private interests involved in the issue. Additional information can be found at the US Department of Health and

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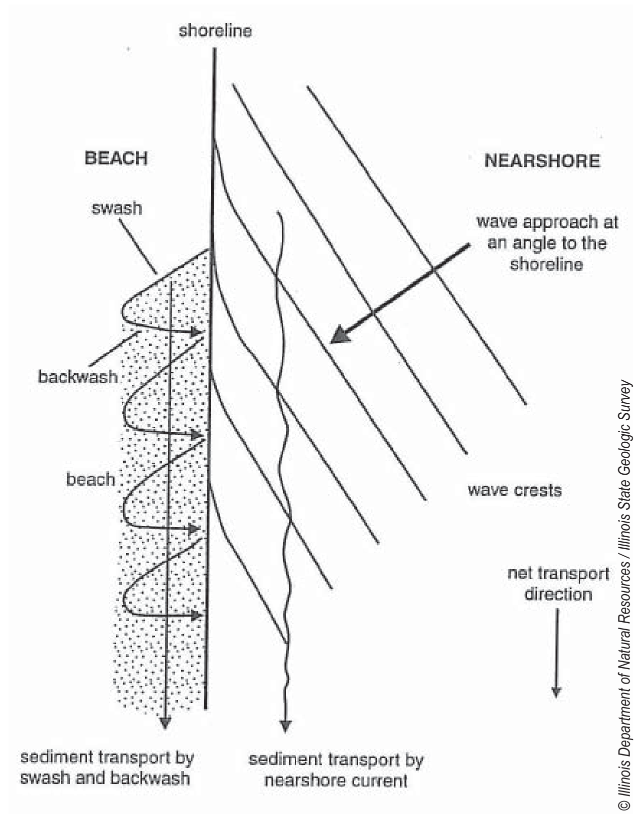
FIGURE 3.15 ILLINOIS BEACH STATE PARK SHORELINE EROSION



© Illinois Department of Natural Resources / Illinois State Geologic Survey

FIGURE 3.16 LITTORAL (SAND) TRANSPORT
Natural processes that contribute to the movement of sand and sediment along the lakeshore. Sediment can move in either direction depending on the direction of the wave approach, but the net direction predominates.

© Illinois Department of Natural Resources

Beach erosion has exposed this buried pipe from 11 feet in 2003 to over 20 feet in 2005, Illinois Beach State Park

Human Services Agency for Toxic Substances and Disease Registry (http://www .atsdr.cdc.gov/HAC/pha/illinoisbeach/ibp_toc.html) and the Illinois Dunesland Preservation Society (www.illinoisdunesland.org).

3.11.2 LYONS WOODS NATURE PRESERVE

The 264-acre L yon's Woods preserve was assembled and acquired as a Forest Preserve due to its history and natural quality between 1976 and 1986 and lies within the Zion City Moraine geologic formation. It is a dedicated Nature Preserve and 'uses' are listed as threatened and endangered species preservation, wildlife habitat, wildlife viewing, and recreational trails. The diverse range of natural communities include an old pine nursery (planted by hand), wet prairie, oak savanna (savanna with dispersed oak trees), fen (a groundwater fed wetland), and oak woods containing white, bur , and black oaks, as well as a variety of bird species including the bluebird. Over 260 plant species and several threatened and endangered plant and animal species are found here, and a Floristic Quality Index of 76 indicates a good diversity of plant species and a high quality resource area. The Floristic Quality Index is a tool for measuring habitat quality based on a survey of existing vegetation. Areas with an FQI greater than 50 is extremely rare and found in less thean 5% of the land area in the Chicago region.

Former land use activities that have destroyed or degraded the presettlement condition of the preserve, such as clearing, farming, grazing, the pine plantation, invasive species, loss of savanna habitat, and possibly wetland drainage, have made management and restoration a challenge for preserve staff. Although a detailed management and restoration plan has not been developed for L yons W oods, management activities are underway . The primary goal is to restore a landscape-scale savanna ecosystem with wet prairie and open woodland as secondary communities where present and appropriate. The following are the most pertinent restoration and management issues that have or need to be addressed.

- Continue ecological restoration to maintain and improve the native plant communities and unique natural diversity of L yons W oods. This encompasses the savanna, open woodland, black oak savanna, and wet prairie that dominated the majority of the preserve.
- Investigate any potential artficial or disturbed hydrologic conditions that may be negatively impacting L yons Woods. This may include removing drain tiles and working with watershed stakeholders to reduce erosion and increase stormwater infltration within the Dead River watershed to help reduce sedimentation and surface water inputs into Lyons Woods.
- Continue to implement prescribed fre to restore and maintain wet prairie, savanna, and woodland communities and reduce densities of invasive species.
- Continue control of invasive species such as reed canary grass and buckthorn.
- Continue monitoring plant and wildlife populations to assess any changes in quality , diversity and habitat use over time and adapt management and restoration activities based on responses of plant and wildlife communities.

In 2005, 565 trees and shrubs were planted to help restore savanna habitat. In 2006 and 2007, invasive woody plant species were cleared on 136 of the preserve 264 acres.

3.11.3 RA VINES

Lake Michigan ravines have been found to contain unique assemblages of plant and animal communities, including some species that are locally rare. Due to their proximity to Lake Michigan, ravines may exhibit a cooler climate regime than the surrounding lands and natural communities that are normally found further north can be found within the ravines. Species that may be found there include paper birch (Betula papyrifera), white pine (Pinus strobus), arbor vitae (Thuja occidentalis), Canadian buf falo-berry (Shephardia Canadensis) and star fower (T rientalis borealis). In some locations, ravines intersect the groundwater table, causing percolation of groundwater to the surface and the formation of a 'seep' or 'fen' . This unique environment supports plants not found elsewhere, and a few of these have been found along Bull Creek. Unfortunately , due to changes in the watershed and its runof f characteristics, these unique systems are in danger of being lost if they are not preserved and managed.

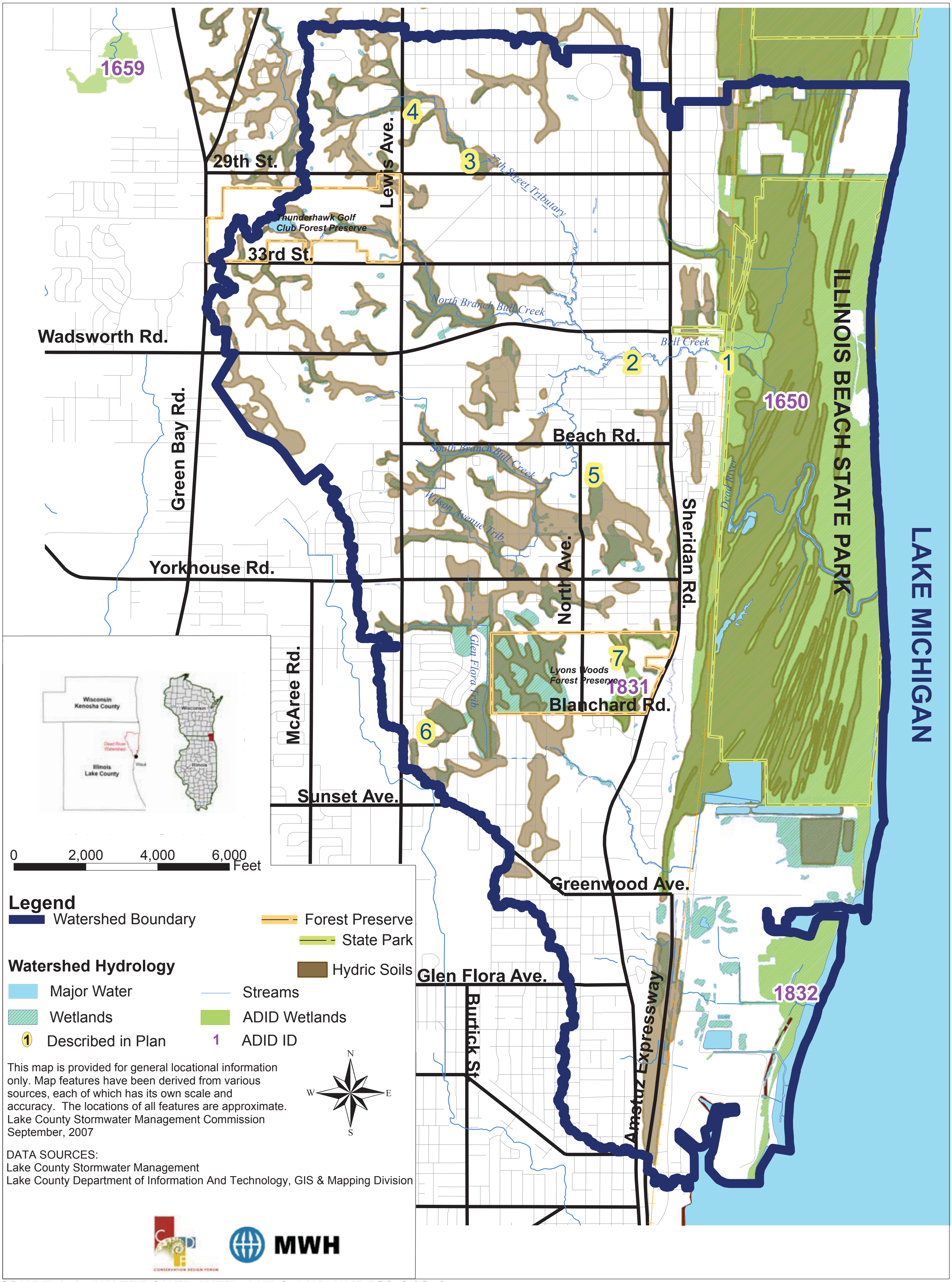


FIGURE 3.17 WATERSHED WETLANDS AND HYDRIC SOILS

3.11.4 WETLANDS

Wetlands, once prevalent within northeastern Illinois, have continued to decline in area and quality. Wetlands are of interest to watershed studies of this sort due to the benefits they provide. These benefits include absorbing and moderating the flow of runoff from the landscape, reducing the risk and damage of flooding by providing space for excess water to go, filtration and cleansing pollutants from runoff, and as important habitat for watershed wildlife.

Currently, approximately 3106 acres (31% of the entire watershed area) of wetlands exist within the Dead River watershed, including 1831 acres of wetlands (59% of the total wetland acreage) within Illinois Beach State Park. This 3106 acres is 946 acres less than an estimated original 4052 acres of wetlands, a loss of approximately 23% of the original wetland acreage, indicating that 946 acres of wetlands are potentially restorable. The number of acres of wetland lost was estimated by calculating the area of hydric soil not classified as wetland, assuming that these areas were once wetlands and have since been drained and/ or developed. The majority of these losses have occurred in SMUs 3B, 3C, and 5. Wetlands and hydris soils are shown in Figure 3.17. Potential wetland restoration sites are shown in Figure 3.18

During a rapid watershed assessment in 2006, Conservation Design Forum observed seven wetlands within the Dead River watershed using a rapid assessment of wetland vegetation. Due to time and resource constraints, the site reconnaissance of these wetlands was very limited and several of the areas were only assessed from the road. Thus, the information presented here should not be considered representative of the watershed as a whole, but only as observations. As a result, this information is not used in the Action Plan to make specific recommendations about specific management measures for wetlands, but to make more general statements about the need for wetland restoration. Nonetheless, those wetlands that were observed were of marginal vegetative quality, however, it is probable that they can continue to provide some water quality benefits for the watershed.

Locations of the seven wetlands observed are provided in Figure 3.17. A summary of the observed wetlands, as well as the reported conditions of Advanced Identification of Aquatic Resources (or ADID) Wetland 1650 and 1831, follows. ADID is a cooperative effort between federal, state, and local agencies to inventory, evaluate, and map high quality wetland and stream resources. Overall, these wetlands demonstrated the following characteristics:

- Limited vegetative wetland quality and invasive species of Cattails, Reed Canary Grass, and Phragmites are present in some combination at almost all the wetland areas assessed by CDF.
- Open water areas and cattail marshes may still provide some water quality improvement and runoff retention.
- Larger wetland complexes and shrub thickets may provide some wildlife habitat opportunities.
- Some wetland seeps were noted along Bull Creek.

Map Location 1
Small, backwater wetland within Bull Creek probably formed due to fallen trees within creek. Vegetation consisted of sedges and Green Ash saplings. Due to the wetland's size, limited functions would be provided.

Map Location 2
Wetland seep area. Skunk Cabbage was noted along the north slope of Bull Creek. Otherwise the ground plain was mostly devoid of vegetation within this immediate area. Mature trees of Sugar Maple dominate the area. Occasional seeps were noted along the N. B. Bull Creek.

Map Location 3
Wetland associated with the 27th Street Tributary is dominated by Reed Canary Grass and consists of a shrubby area that is predominantly Multi-flora Rose and Gray Dogwood. Other invasive species of buckthorn and honeysuckle are present along the upland edge. This area provides some habitat and water quality functions.

Map Location 4
Wetland associated with tributary located east and west of Lewis Avenue. Wetland is a cattail marsh that is dominated by Hybrid x cattail and Reed Canary Grass. Other vegetation noted included Green Bulrush, Redtop, Grass-leaved Goldenrod, bidens, and willow. The marsh on the west side of Lewis Avenue is surrounded by thicket. This wetland provides some wildlife and water quality functions.

Map Location 5
Mapped wetland habitat is not present. Given the size of the existing trees, it does not appear that this area had been filled within the past several years.

Map Location 6
A large portion of the wetland habitat is cattail marsh; this area was inundated during the November site visit. Reed Canary Grass is also prevalent amongst the cattails. Phragmites dominates an extensive portion of the wetland area surrounding the cattail marsh. It appears that Phragmites has been there for a while since no other plant species except for occasional Field Thistle plants were present within that portion of the Phragmites colony that was traversed. Given the size of this wetland system and its placement within the watershed, this area provides water quality bene fts and stormwater retention.

Map Location 7 / ADID Wetland 1831
This mapped ADID wetland near Blanchard Road in Lyons Woods is characterized as a 42-acre wetland that has functional value of habitat and water quality Site characteristics include the presence of threatened/ endangered species, stormwater retention, and shoreline/bank stabilization.

ADID Wetland 1650
This complex within Illinois Beach State Park consists of approximately 4,073 acres most of which are Illinois Beach State Park. Based on the ADID Wetland Report data sheet, this wetland complex provides functional value of habitat and water quality It is characterized as a high quality plant community with threatened/endangered species. The wetland system also provides water quality bene fts of sediment/ toxicant retention and nutrient removal/ transformation. Illinois Beach State Park is a listed Illinois Natural Area site.

Wetland restoration and management recommendations, including existing wetlands and restoration of former wetlands (areas of hydric soils that are no longer wetlands), are identi fed within the Action Plan included in Chapter 5. It is possible

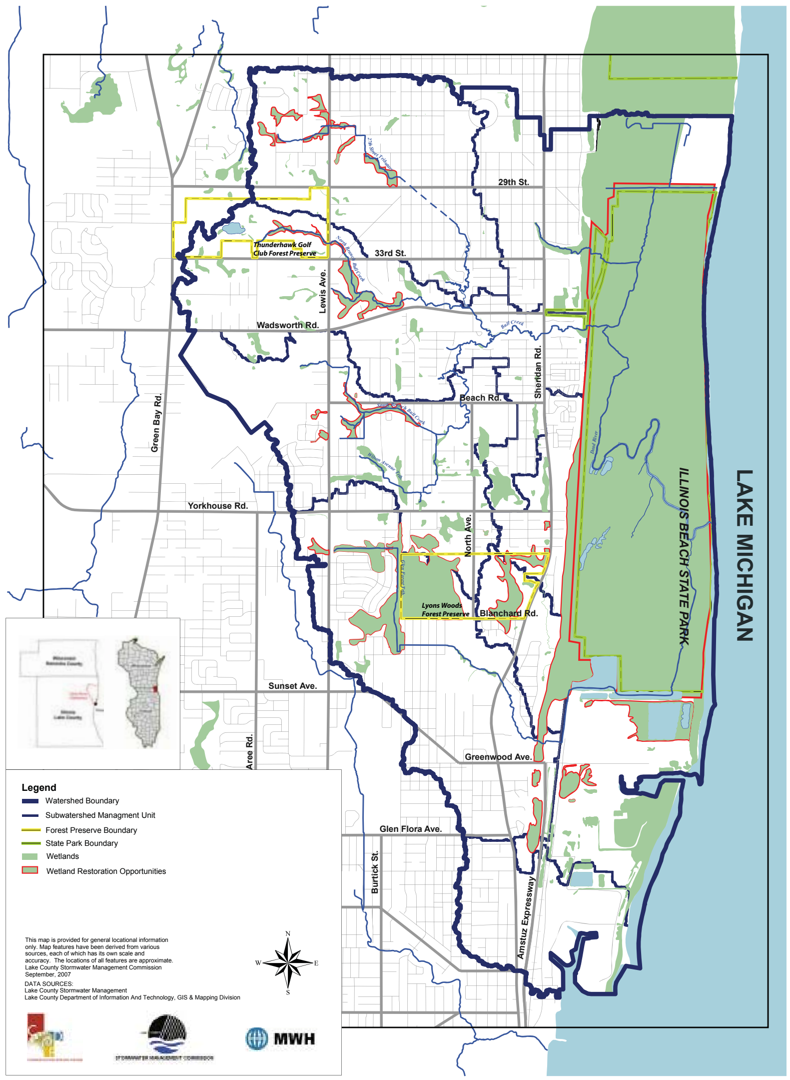


FIGURE 3.18 POTENTIAL WETLAND RESTORATION SITES

that former wetland areas that are undeveloped can be restored. (By 'undeveloped' we refer to those that remain in an agricultural, forest and grassland, vacant, or open space land use category.) However, this is typically a more diff cult task than managing and restoring existing wetlands, and resources may be best spent on improving the remaining wetlands.

It is the opinion of the consultant team that all wetlands within the watershed are in need of some sort of restoration and management. Without a proper wetland assessment, it is diff cult to determine the causes and sources of wetland degradation and the specif c management needs. However, it is highly likely that without stabilizing the hydrology of areas upstream of each wetland, by controling the quantity and quality of stormwater runof f entering these wetlands, restoration of these wetlands will prove to be a signi f cantly diff cult uphill battle due to the negative impacts of hydrology and water quality on wetland quality.

Table 3.10 Green Infrastructure Parcel Ownership Categories

Public Owners	Private Owners
Department of Natural Resources	Bank
Department of Conservation	Homeowner / Business Association
Department of Transportation	Landf ll
Federal	Private
Forest Preserve	Private Club
Lake County	Religious Institution
Municipality	Trust / Trustee
Park District	Utility
Sanitary District	
School District	
State	
Waukegan Port District	

3.11.5 GREENW AYS AND RECREATION

Some recreational elements in the watershed are found within Illinois Beach State Park and along the Lake Michigan shoreline, where there are hiking trails and water-based recreational opportunities such as swimming, f shing, camping, and boating. More passive recreational pursuits include bird watching, botany, and wildlife observation. Other recreational opportunities, such as golf, soccer, softball, and similar sporting activities, are found distributed throughout the watershed.

The Robert McClory Bike Path follows a former north-south railroad grade paralleling and east of Lewis Avenue. Hiking paths are also present within Shiloh Park (Zion), Hermon Park, and Lyons Woods Forest Preserve. Figure 3.13 depicts the trails within the watershed, though some of those shown, such as that following the east-west utility corridor just north of Lyons Woods between Green Bay Road and Illinois Beach State Park, are proposed and are not currently trails.

Sources: Conservation Design Forum Stream Inventory (2006).

Debbie Maurer , Lake County Forest Preserve District, Deb Nelson, Illinois Department of Natural Resources, and Don Wilson, personal communication.

Ravine Systems in the Lake Michigan W atershed, Illinois. Illinois Coastal Management Program Issue Paper – TAG D. Illinois Department of Natural Resources, August 8, 2007.

Community Enhancement of Illinois' Northeastern Coastal Natural Areas, proposal to the US Fish and Wildlife Service for the National Coastal Wetland Conservation Grant Program, 2006, IDNR.

Lake Michigan Lakewide Management Plan

Lake Michigan Action Plan DRAFT, June, 2006.

3.12 GREEN INFRASTRUCTURE INVENTORY

One of the primary goals of the watershed planning process is to identify green infrastructure that is important and should be preserved as a functional part of the natural drainage system, contributes to maintaining watershed hydrology and may be a good location for local best management practices. The inventory is designed to assess, prioritize, and plan the watershed green infrastructure, the system of open space, greenways, streams, forest preserves, wetlands, and natural areas that form an interconnected support system for natural functions and processes, particularly natural hydrologic functions and the aquatic environment. Some de f nitions of green infrastructure, such as that of the US Environmental Protection Agency, include stormwater management as a component or bene f t.Green infrastructure, as it is used in this plan, is def ned as follows and illustrated in Figures 3.19 through 3.21.

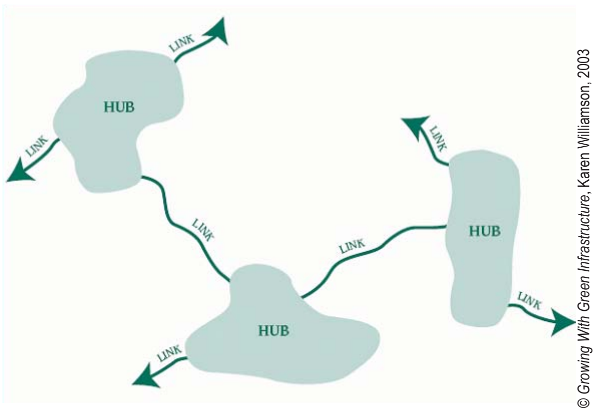


FIGURE 3.19 CONCEPTUAL GREEN INFRASTRUCTURE HUBS AND CONNECTING LINKS

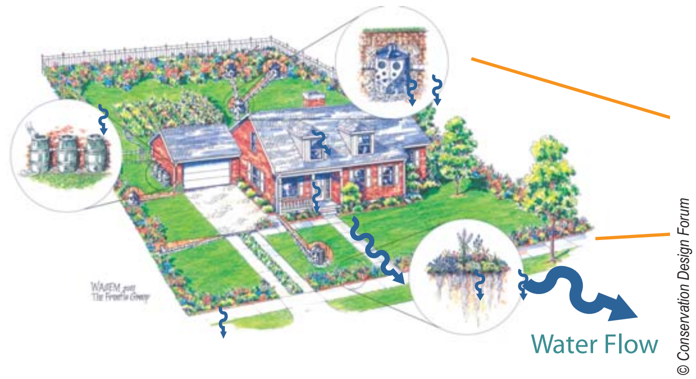


FIGURE 3.20 LOCAL GREEN INFRASTRUCTURE AT THE SITE SCALE

FIGURE 3.21 GREEN INFRASTRUCTURE HUBS (FOSSLAND PARK AND ILLINOIS BEACH STATE PARK) AND LINK (DEAD DOG CREEK)(KELLOGG CREEK WATESHED)

Green infrastructure represents a new approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure techniques utilize natural systems, or engineered systems that mimic natural landscapes, to capture, cleanse and reduce stormwater runoff using plants, soils and microbes.

On the regional scale, green infrastructure consists of the interconnected network of open spaces and natural areas (such as forested areas, floodplains and wetlands) that improve water quality while providing recreational opportunities and wildlife habitat.

On the local scale, green infrastructure consists of site-specific management practices (such as rain gardens, porous pavements, and green roofs) that are designed to maintain natural hydrologic functions by absorbing and infiltrating precipitation where it falls.

Appropriate preservation and management of a green infrastructure system can help allow movement of runoff through the watershed in a manner that enhances the aquatic ecology of the watershed, and at the same time provides natural conveyance, floodwater storage, water quality benefits, streambank stabilization and restoration, natural resource preservation, wetlands, and habitat. Green infrastructure network elements typically include hubs (large, intact blocks of natural areas that support a diversity of habitats and wildlife and provide space for recreation and stormwater management) and links (natural corridors and greenways that link larger natural areas). Hubs and links may be composed of:

- Lakes, ponds, and wetlands.
- Stream corridors and waterways.
- Parks, recreational areas, greenways, and trails.
- Public and private conservation lands.
- Other nature preserves, natural areas, and wildlife habitat (woodlands, savannas, and prairies).
- "Open space" and vacant lands.
- "Working lands" such as forests, farms, and ranches.

3.12.1 INVENTORY METHODOLOGY AND RESULTS

As part of the effort to connect and expand existing green infrastructure elements, such as creek corridors or forest preserve districts, the green infrastructure inventory identified parcels of land with the potential to contribute to the watershed green infrastructure system. Using Lake County parcel data, the inventory first identified open and partially open parcels. Open parcels are those listed in the Lake County parcel data as "unimproved" meaning they do not have built structures, utilities, or other man made improvements. Partially open parcels are improved parcels (having structures or improvements), but also contain significant unimproved acreage. For example, a 5 acre parcel with a single family home is considered by this analysis as partially open. Figure 3.22 shows the location of these parcels in various shades of green (open parcels) and blue (partially open parcels.) This figure shows not only the location of these parcels, but the location of publicly- and privately-owned green infrastructure parcels, as defined by Lake County and shown in Table 3.10, and the prioritization of these parcels, as described below. Table 3.12 shows summary results of the analysis of open and partially open parcels.

Some of the publicly-owned green infrastructure parcels are protected status, meaning that there is very low risk that they could be converted to other land uses. Protected status parcels include those owned by the IDNR, Forest Preserves, Park Districts, and Land Conservatory of Lake County. Some publicly-owned parcels are not protected and, along with privately-owned parcels, are considered available for development or conversion to a different land use.

3.12.2 GREEN INFRASTRUCTURE PRIORITIZATION

In order to help identify and plan the green infrastructure system for Dead River, the watershed planning committee developed a methodology and prioritization process to help sort the open and partially open parcels into their relative importance for the green infrastructure system. The prioritized parcels are shown in Figure 3.22.

The green infrastructure inventory and prioritization process is comprised of five steps:

1. Identify open (unimproved) and partially open (improved with significant undeveloped acreage) parcels using GIS (described above).

Table 3.11 Green Infrastructure Parcel Prioritization Criteria and Impairment Categories Addressed

Criteria	Flooding, Floodplains, & Hydrology	Water Quality	Stream & Streambank Restoration / Stabilization	Natural Resources & Habitat
1. Parcels that intersect 100-year f oodplain	X	X	X	X
2. Parcels within .5-miles of the headwaters	X	X		X
3. Parcels that intersect with a wetland	X	X		X
4. Parcels that are adjacent to or include at least 2.5 acres of drained hydric soils	X	X		X
5. Parcels with highly erodible soils		X	X	
6. Parcels in a SMU where less than 10% of the SMU is existing wetland	X	X		X
7. Parcels within .5-mile radius of Lake County Stormwater Management Commission Flood Problem Area Inventory site	X			
8. Parcels that are within 100 feet of a watercourse	X	X	X	X
9. Parcels intersecting with non-point source pollutant (NPSP) hotspot Subwatershed Management Unit.		X		
10. Parcels intersecting with or adjacent to a NPDES permitted point source		X		
11. Parcels adjacent to or including forest preserves, land trust holdings (for conservation), and privately and publicly preserved open space	X	X		X
12. Parcels adjacent to or including Illinois Natural Areas Inventory (INAI), nature preserve (NP), high quality natural areas, high quality wetlands (ADID), or T&E sites	X	X		X
13. Parcels that connect existing open space areas				X
14. Parcels that contain a depressional area.	X			

Table 3.12 Green Infrastructure Inventory Results

		parcels	acres	% of open / partially open parcels	% of watershed area
Total Watershed Area			10,115	-	-
Public	ownership		4,472	-	44%
	Illinois Beach State Park		1,284	-	13%
	Private ownership		5,644	-	56%
Open parcels	# of parcels	1,397		-	-
Area			3,443	-	34%
	Parcel size (maximum / average)		321 / 2.5	-	-
	Public ownership		2,369	68%	23%
	Private ownership		1,094	32%	11%
	Protected status		2,151	62%	21%
	Unprotected status		1,311	38%	13%
Partially open parcels	# of parcels	80		-	-
Area			843	-	8%
	Parcel size (maximum / average)		65.8 / 10.5	-	-
	Public ownership (area)		484	59%	5%
	Private ownership (area)		340	41%	3%
	Protected status (area)		289	35%	3%
	Unprotected status (area)		535	65%	5%

2. Establish prioritization criteria for ranking the relative importance of each parcel to the green infrastructure network.
3. Apply the prioritization criteria to the parcels identified in step 1 giving each parcel one point for each criteria met.
4. Give each parcel a total score; parcels with the highest scores meet the most criteria, and, are the highest-priority for consideration in the green infrastructure network.
5. Propose a green infrastructure network that connects priority open spaces.

As a starting point, prioritization criteria used in other watershed planning processes were considered for the Dead River/Bull Creek watershed. Watershed stakeholders reviewed, modified, and agreed on the following criteria that they viewed as appropriate for this watershed. Table 3.11 shows the relationship between the 14 criteria used to prioritize green infrastructure and the watershed issues identified by stakeholders. A brief rationale for including these criteria is included in parentheses.

1. Parcels that intersect with the 100-year floodplain. (These areas at risk of flooding are part of the natural drainage system for storing and conveying floodwaters. They function as stream buffers protecting water quality and channel stability, and also provide riparian habitat.)
2. Parcels within 0.5-miles of the headwaters (the upper reaches of the watershed; the source and upstream waters of a stream). (Headwater streams are often more sensitive to disturbance from urban and agricultural activities than reaches with larger drainage areas. They help absorb rainwater and protect the stream from the impacts of heavy stormwater runoff and its associated pollutants. Headwater areas often provide a broad range of habitat as they progress from upland, to wetland, to stream.)
3. Parcels that intersect with a wetland. (Wetlands provide habitat and help clean, filter, and retain stormwater.)
4. Parcels that are adjacent to or include at least 2.5 acres of hydric soils. (These areas, which were once wetland before being drained, are identified as potential wetland restoration sites and thus have the potential to provide similar benefits as wetlands.)

Table 3.13 Green Infrastructure Parcel Prioritization Results

Priority Score (14 possible)	Category	# of Parcels	Total Area (acres)
0	3	82	27
1	3	157	88
2	3	377	150
3	2	240	304
4	2	227	566
5	2	195	839
6	2	114	973
7	1	64	752
8	1	39	221
9	1	5	29
10	1	2	15
11	-	0	0
12	-	0	0
13	-	0	0
14	-	0	0

5. Parcels with highly erodible soils. (Areas of highly erodible soils are less stable and have the potential to produce proportionately large sediment loads when disturbed. In this watershed, many of these areas are steep bluff ravines that may be unsuitable for development.)
6. Parcels in a Subwatershed Management Unit (SMU) where less than 10% of the SMU is existing wetland. (Previous studies have found that stream systems are more impaired when the percentage of wetland in the watershed is below 10%. Where formerly wetlands provided benefits, open and partially open parcels may be used to replace those wetland benefits.)
7. Parcels within 0.5-mile radius of a Lake County Stormwater Management Commission Flood Problem Area Inventory site. (Potential locations for best management practices to address the flooding problem.)
8. Parcels that are within 100 feet of a watercourse. (A good riparian corridor to buffer the waterway can mitigate some of the water quality, flooding and stream stability impacts associated with impervious cover in the watershed in addition to providing habitat.)
9. Parcels intersecting with a subbasin identified as a non-point source pollution hotspot. (Potential locations for best management practices to mitigate (reduce or filter) heavy pollutant loads.)

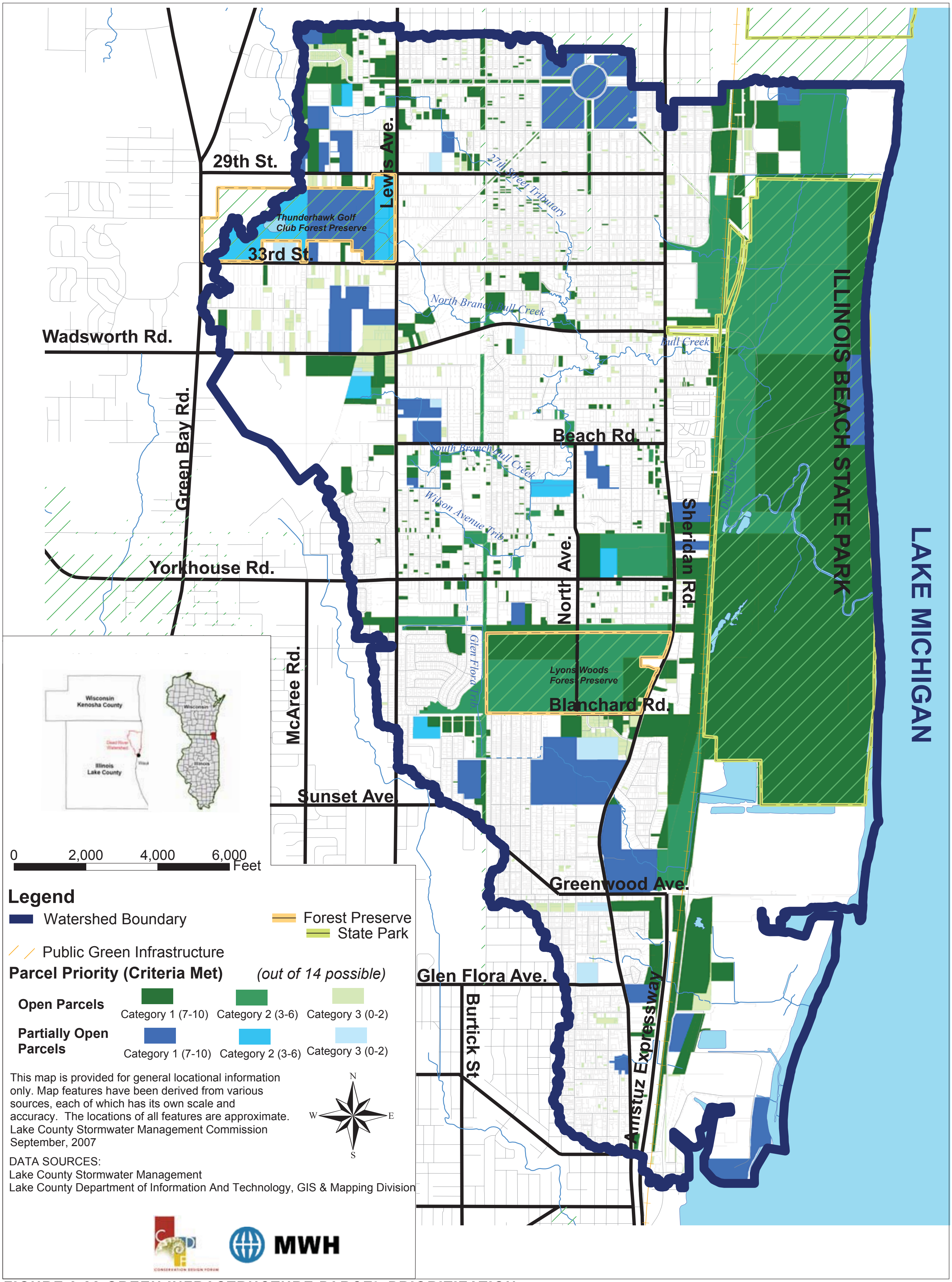


FIGURE 3.22 GREEN INFRASTRUCTURE PARCEL PRIORITIZATION

10. Parcels intersecting with or adjacent to a permitted point source discharge location. (These locations may present opportunities to install best management practices to help control the pollution these points are permitted to discharge.)
11. Parcels adjacent to or including forest preserves, land trust holdings (for conservation), and privately and publicly preserved open space. (Opportunities to expand existing protected open space areas and creating larger "hubs" that help absorb stormwater.)
12. Parcels adjacent to or including Illinois Natural Areas Inventory and Illinois Nature Preserve sites (high quality natural communities that qualify for formal protection by the State of Illinois), high quality natural areas, high quality or high function wetlands, or sites known to harbor or support state or federal threatened and endangered species. (Opportunities to expand existing open space areas and creating larger "hubs," and opportunities to provide greater buffers for sensitive natural areas.)
13. Parcels that connect existing open space areas. (Opportunities to expand and protect the greenway links that connect natural resource hubs and serve as corridors creating "links".)
14. Parcels that contain a depressional area. (Potential runoff storage area that could be used for regional detention or water quality management.)

The results of the Green Infrastructure prioritization process are summarized in Table 3.13 and Figure 3.22. The prioritization allowed watershed stakeholders and planners to develop a Green Infrastructure Plan, which is based on the prioritization of parcels as well as the best judgement of the watershed planning team. In summary, while some opportunities to expand and connect the hubs and links of the watershed's Green Infrastructure system remain, many of the stream channels, which would form logical connections between hubs, are no longer an option for preservation. In fact, few options remain for creating an integrated Green Infrastructure system. Nonetheless, action recommendations for implementing the Green Infrastructure Plan, and the location of the prioritized parcels, have been incorporated into the Action Plan in Chapter 5.

3.13 NATURAL DRAINAGE SYSTEM

This section describes the conditions and characteristics of the natural drainage system of the Dead River watershed. Results of the hydrology and hydraulic modeling and floodplain mapping study completed in 2007 are found in Section 3.15 Flooding.

3.13.1 GENERAL WATERSHED DRAINAGE

The Dead River watershed contains approximately 12.6 total stream miles and 1719 acres of wetlands, which is approximately 17 percent of the toal watershed area. Most of these wetlands are within the coastal plain and Illinois Beach State Park. The Dead River Watershed contains three main tributaries: an unnamed tributary to the north, the Dead River / Bull Creek system, and the Glen Flora Tributary and its unnamed tributary. The Dead River is located entirely in Illinois Beach State Park and discharges to Lake Michigan. Bull Creek flow splits north and south after entering Illinois Beach State Park. The north flow path is a virtually indistinguishable channel, while the south flows through a series of constructed ponds before entering the Dead River. Upstream of Illinois Beach State Park, Bull Creek is composed of three tributaries: the South Branch, the North Branch, and the 27th Street tributary, which are shown in Figure 3.23 and described below. Approximately 5.3 stream miles are within Zion's jurisdiction, 8.3 within Beach Park, 7.3 miles in Waukegan, 5.8 miles within unincorporated Lake County. These figures are approximate.

Historically, the Dead River and Glen Flora Tributary followed somewhat different flow paths than they do today. As shown in Figure 3.24, the Little Dead River, which included part of the downstream end of the Glen Flora Tributary, used to flow into Lake Michigan (1907). Over the years, this channel has been gradually filled and no longer exists.

According to local knowledge, there are some interesting characteristics with regard to hydrology in and around Illinois Beach State Park.

- a small drainage channel positioned between the Dead River and the Johns Manville lagoons exhibits some uncertainties with regard to direction of flow. Anecdotal evidence suggests that during rain events the channel, which normally flows in a southerly direction, may reverse flow due to the minor gradient, and back up to the north, possibly

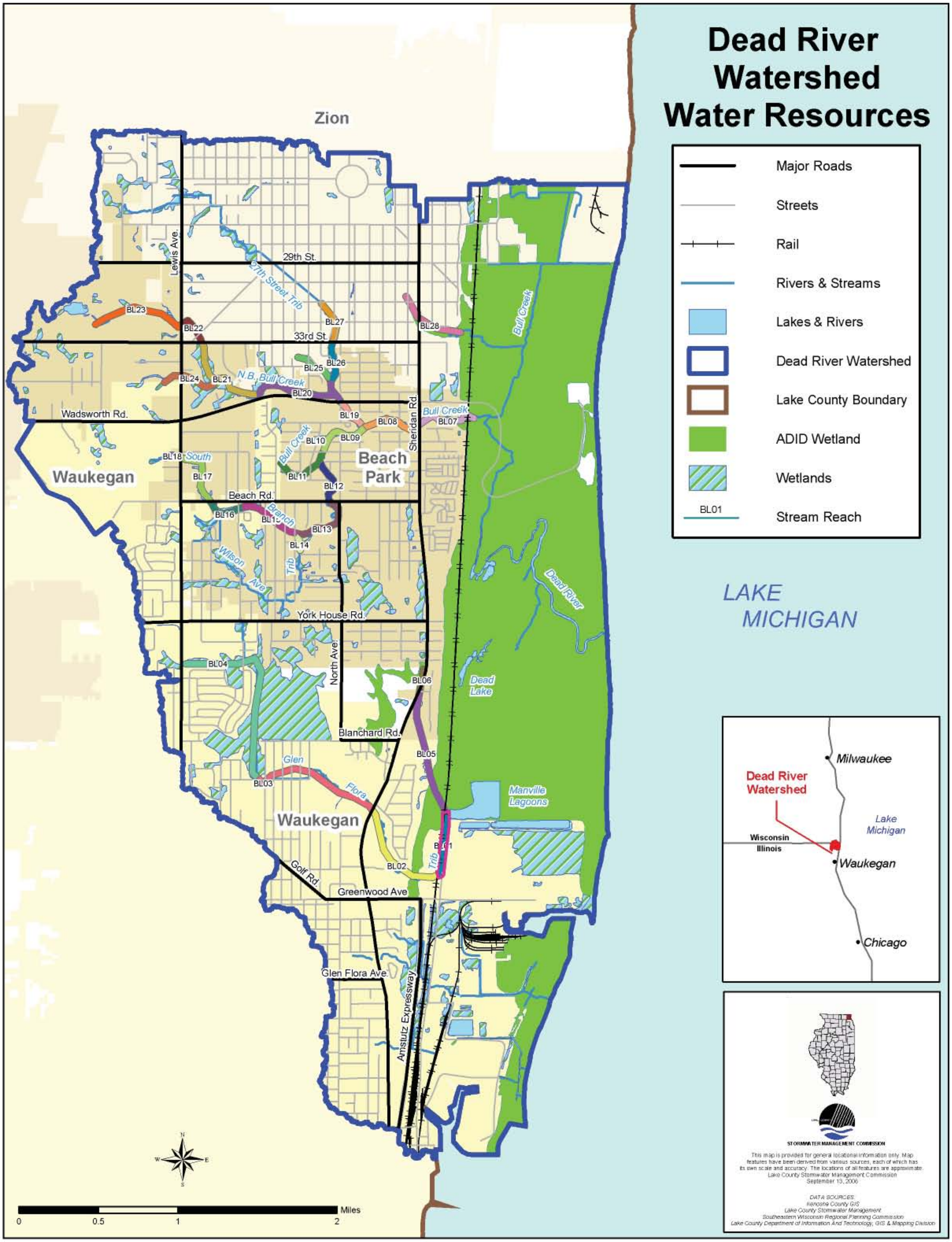


FIGURE 3.23 WATER RESOURCES

carrying asbestos-laden material from Johns Manville into Illinois Beach State Park.

- The downstream segment of the Glen Flora Tributary, formerly known as the Little Dead River, used to discharge south of Midwest Generation into a ditch. Current alignment of the Glen Flora Trib is under the rail tracks, north into ponds and then east through ponds, into a pipe which then discharges east to the Lake.

- Dead River is intermittently hydrologically connected to Lake Michigan and at other times this connection is obstructed by a sand bar dam created by littoral drift, which is broken during high river flows. This situation complicates the hydrologic picture as well as the habitat connection between Dead River / Bull Creek and Lake Michigan.

The Dead River watershed is one of the few remaining Illinois tributaries that drain to Lake Michigan. The importance of its hydrologic connection to the lake, whether intermittent or constant, is important not only for implications of spawning and feeding habitat for Lake Michigan fish species, but also for its contribution to water quality impairments in the coastal wetlands and the lake itself. Former and current land uses along the lakefront, such as Johns Manville and Outboard Marine Corporation, are likely greater contributors to water quality impairment in Lake Michigan itself.

In general, fluctuations in groundwater levels correspond to precipitation, evapotranspiration, infiltration, and Lake Michigan water level changes. Lake Michigan levels, which were at near-record lows in 1999 and 2000, directly impact groundwater levels in the park coastal wetlands, which were historically fed by groundwater discharge. Today, the wetlands receive a much different flow regime, with increased discharge volume and degraded quality of surface runoff from the upstream watershed area. As a further consideration, groundwater pumpage near the Lake Michigan shore and inland areas could interfere with natural groundwater flow and discharge into Lake Michigan.

This watershed assessment does not examine Lake Michigan water quality impairment, but it does review Lake Michigan beach closure data. The number of closures in a year for Waukegan South and North beaches is strongly correlated with the ranking of number of closures by year (year with most, second most, etc.) being the same for both beaches. Thus, these closures may very well have been

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FIGURE 3.24 LITTLE DEAD RIVER

The Little Dead River, shown in these graphics, has gradually been filled in over the years.

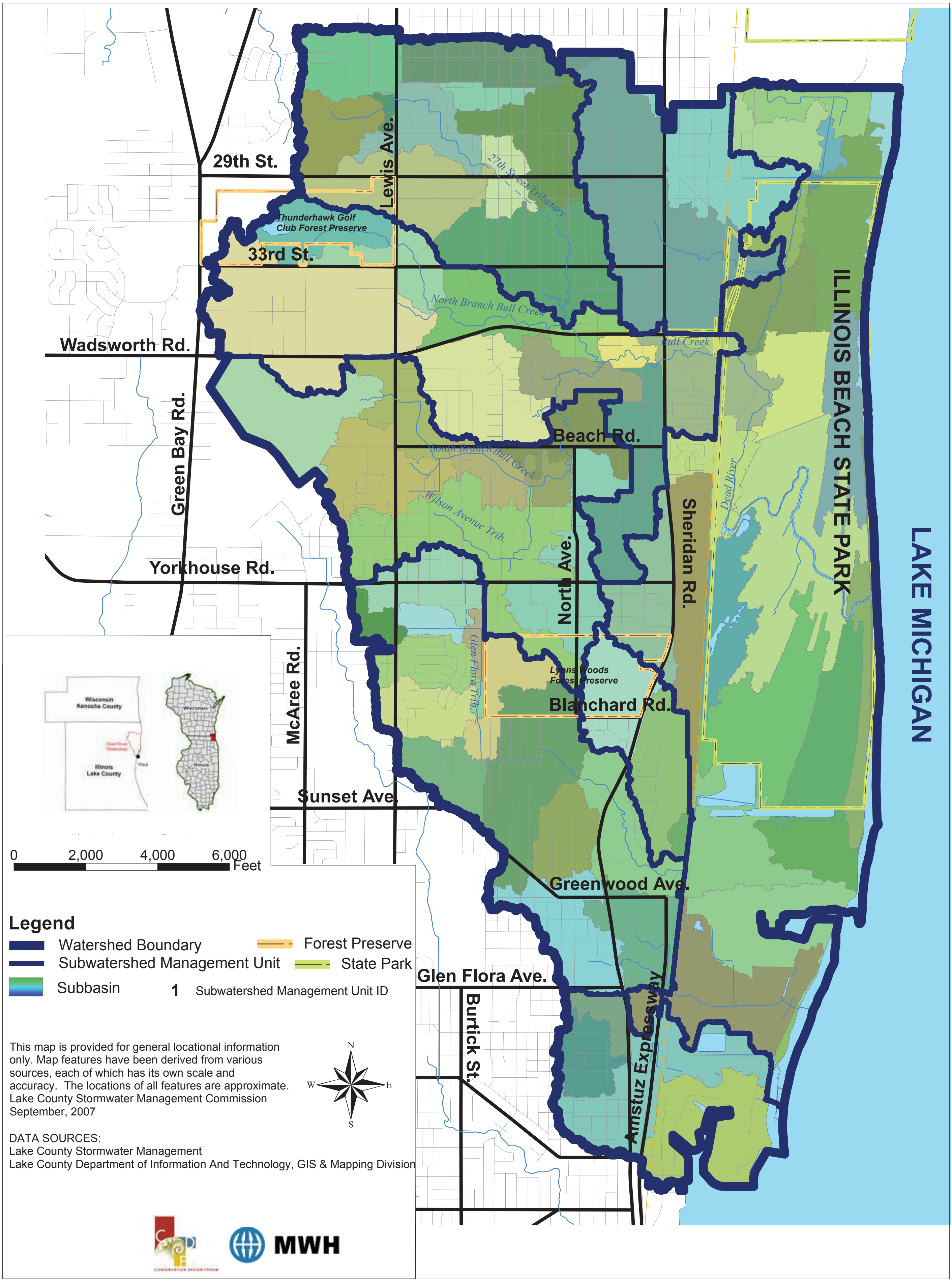

FIGURE 3.25 SUBWATERSHED MANAGEMENT UNITS

related to storm events or wave action.

Streamflow

Streams in this area exhibit a rapid rise and fall of water level, flow and velocity (termed "flashiness") as a result of rain events. In 2006, Bull Creek exhibited a median flow of 6.65 ft3/second and a maximum flow of 124.73 ft3/second, and median velocity of 0.58 ft/second and maximum of 3.16 ft/second. In 2007, Bull Creek exhibited a median flow of 11.29 ft3/second and a maximum flow of 688.08 ft3/second, and median velocity of 0.70 ft/second and maximum of 4.06 ft/second. The higher median and maximum flows in 2007 were the results of greater frequency and volume of precipitation that year.

3.13.2 DELINEATING SUBWATERSHED MANAGEMENT UNITS

The Dead River watershed has been subdivided into 77 subbasins and eight Subwatershed Management Units (SMU) based on major stream tributaries, as shown in Table 3.14 and Figure 3.25. This organizational structure allows the planning effort to examine the watershed at a variety of scales. For instance, the non-point source pollution loading assessment, discussed in Section 3.14.4, uses the 77 subbasins to model pollutant loading and locate hotspots. SMUs are groups of subbasins that all drain to a single point, the most downstream point in the SMU.These eight SMU's form the management units within which the action recommendations are organized, which simplifies the management structure of the plan.

SMU 1 includes the watershed area east of Sheridan Road, including Illinois Beach State Park. SMU 1 also includes a portion of the watershed west of Sheridan Road near York House Road.

SMU 2 includes the unnamed tributary at the northern boundary of the watershed.

SMU 3 is the Bull Creek drainage system. SMU3 is subdivided into SMU 3a, the 27th Street Tributary, SMU3b, the South Branch of Bull Creek and the Wilson Avenue Tributary, and SMU 3c, the North Branch of Bull Creek.

SMU 4 is a watershed area tributary to Glen Flora Tributary.

SMU 5 is the Glen Flora Tributary.

SMU 6 is an unnamed drainage area and includes the industrial area north of Waukegan Harbor.

Table 3.14 Subwatershed Management Units

Subwatershed Management Unit	# of Subbasins	Acres
1	24	3236
2	3	773
3a	10	1251
3b	8	1246
3c	11	1573
4	3	295
5	14	1414
6	4	612

3.13.3 DEAD RIVER / BULL CREEK STREAM INVENTORY

Bull Creek, the Glen Flora Tributary, and the unnamed tributaries were comprehensively inventoried by Lake County SMC in 2001 and rapidly assessed by Conservation Design Forum staff over two days in 2006. During the SMC effort, the stream system was divided into 28 reaches (a segment of a river or stream) with reach lengths varying between 1770 and 4000 feet (see Figure 3.23). Each reach was characterized using standard Lake County SMC methodology that is reflected in the stream data forms that are included in Appendix P. Since the coastal plain was not inventoried, all stream reach information refers only to areas upstream of Illinois Beach State Park. Measurements, photos, locations, and qualitative characteristics were recorded. The major stream characteristics inventoried included physical channel condition, discharge points (pipes or open channels that discharge flow to the stream), hydraulic structures (bridges, culverts, or other structures that contain or convey the stream), riparian corridor (strip of land bordering streams, lakes, rivers, and other watercourses) characteristics, and aquatic habitat conditions (whether there are characteristics of the stream that support fish and other animals living in the stream). Results of these inventories follow.

3.13.4 GENERAL DESCRIPTION / FLOW

© Lake County Stormwater Management Commission

A channelized reach of the Glen Flora Tributary within Illinois Beach State Park

© Conservation Design Forum

Streambanks in Hermon Park (Zion) with turf grass edges east of 27th Street and Lewis Avenue along a reach upstream of BL28 that was not visited during the 2001 stream inventory. These turf grass edges should be converted to native plants to improve water quality and riparian habitat.

3 watershed inventory and analysis

PATHWAYS

Unnamed Tributary (BL28)
North of the intersection of Sheridan Road and 33rd Street, a small, unnamed tributary flows from underground pipes under the residential area to the northwest, through Ophir Park and Carmel Park, and finally discharges to Illinois Beach State Park. The reach within Ophir Park is fairly channelized and surrounded by turf grass to the stream banks, which are eroding. Within Carmel Park, the stream meanders through fairly dense forest and appears to have fairly healthy channel substrates, such as sand and gravels, and moderate erosion of the streambanks.

Dead River / Bull Creek within Illinois Beach State Park
Within Illinois Beach State Park, the Dead River and Bull Creek are very low gradient. Dead River meanders through the dune and swale morphology of the Park. Although the banks are relatively steep in many locations, they are not high and are generally stable. The channel bottom is believed to be sand and, in some locations, mucky with low stability substrates. It is likely that this condition is caused by sediments eroded from upstream portions of the watershed settling out or collecting here in the low gradient Illinois Beach State Park. The overbank area is generally open with some trees and shrubs.

Bull Creek (BL07-BL08)
West of Illinois Beach State Park, the stream channels are generally located within wooded ravine-type valleys, many of which are wide enough to allow the stream to meander. Where the stream runs adjacent to the ravine slopes, erosion of the bluff can be quite severe. This erosion is also causing the failure of some stormwater outfalls. When these break or fail, the discharge point moves closer to the stream bank and continues to cause erosion and loss of the ravine slopes, which should be a major concern to those living on the ravine edges. These failures are identified in Section XX of this report. On the positive side, there are a number of seep areas within this reach with skunk cabbage and marsh marigolds growing along the stream corridor, which are indicators of potentially rare natural communities.

Natural Areas Ecosystem Management conducted two studies of channel conditions on this reach Bull Creek upstream of the Union Pacific Railroad in XXXX. Their findings conclude that erosion was a significant problem along Bull Creek. There were 46 major erosion sites totaling approximately 6900 feet of streambank requiring bioengineering solutions such as grade stabilization using artificial riffles, coir fiber rolls and/or mattresses and A-Jacks structures with vegetated geogrids to stabilize the banks and ravine walls. The problems generally revolve around accelerated stream channel downcutting and widening resulting in undercut banks. Further, the report suggests the creation of new floodplain on the inside bends of the stream channel and the softening of slopes on the outside bends of the stream channel can benefit the stream. The inside bend floodplain terrace allows the flow to spill out of the channel and reduce the erosive velocity of the water on the outside bends. Creating gentler slopes on the outside bends allows for long term plant stabilization of the banks.

Within this reach, the Lake County Stormwater Management Commission, U.S. Army Corps of Engineers, and Bull Creek Stakeholders Association collaborated on a streambank stabilization project. The project used bioengineering stabilization measures, such artificial riffles, floodplain terraces, coir fiber rolls, rock toe stabilization, vegetated geogrid lifts, and the creation of a riparian buffer using native shrubs, grasses, and wildflowers. However, the project located near the railroad east of Sheridan Road has experienced some loss of plantings on the low side of the channel.

In 2004, the North Shore Sanitary District and the United States Corps of Engineers implemented an emergency sanitary line stabilization project in reach BL08, where sanitary sewer manholes and sanitary sewers had been exposed by channel and bank erosion. This project was viewed by CDF staff during its inventory (2006) and found to be holding up well. Four additional NSSD projects have been installed in the Dead River / Bull Creek watershed to stabilize streambanks and help protect sanitary sewers. Those viewed by CDF staff appeared to be holding up well, though one was found to be causing erosion on the opposite bank from where the stabilization measure was installed.

A number of seeps also occurred along reach BL08, with one location appearing to support vegetation (skunk cabbage) typical of seeps. Evidence of beaver activity also was apparent on some of the trees in the area. Sump pump / footing / roof drains were seen leading from residential properties, which may be aggravating erosion processes where they occur on steep slopes or on lawn areas adjacent to high, steep slopes. Yard waste dumping was also seen.

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Relatively stable streambanks resulting from the Bull Creek stabilization project. (BL07)

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Exposed sanitary sewer manhole exposed by eroding streambank and streambed (BL08).

© Conservation Design Forum

Soil lifts stabilizing the streamank, Bull Creek restoration project (BL07)

© Conservation Design Forum

Structural, hard-edge protection for sewer infrastructure (BL08) protects the sewer but does not provide a natural stream habitat condition.

© Lake County Stormwater Management Commission

Artif cial riff e installed in the downstream reach of Bull Creek to provide grade stabilization (BL07).

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Erosion of the streambank opposite the sewer stabilization project (BL08).

Some stream channel substrates appeared fairly good quality, with sand and cobbles and stones in more than a few occurrences.

27th Street Tributary (BL25-BL27)
The 27th Street Tributary (approximately 1.6 stream miles broken into 4 reaches) exhibited varying degrees of eroded banks, debris jams, and instances of rock walls and other improvised erosion control measures, turf grass to the edge of the streambank, and fencing along residential lots. Some reaches have fairly generous natural vegetation buffers along the stream edge. At 31st Street the stream flows for approximately 2700 feet through an underground culvert and emerges west of the McClory Bike Path north of 29th in Hermon Park and its pond. Upstream of this park the stream exhibits low flow and a flat channel with very shallow stream banks. Just east of Lewis there is a manmade levee, apparently to protect the property at Lewis and 26th from flooding. Black colored water was seen in this tributary as well, which should be investigated further. Another sanitary sewer stabilization project installed along this tributary appears to be holding up well and is not exhibiting the erosional problems of the downstream project. A stormsewer and manhole near 33rd, which has not been stabilized, appears to be at risk of failure and should be addressed.

North Branch of Bull Creek (BL19-BL24)
The North Branch of Bull Creek is approximately 3 stream miles broken into 6 reaches. Just upstream of its confluence with the 27th Street Tributary the stream corridor (BL20) exhibits mown turf grass to the streambank edge. Some yard waste dumping and concrete lined or otherwise hard-armored channels were also seen along this reach. Yard waste dumping within the stream channel adds pollutants (such as pesticides and fertilizers) to the water and can smother vegetation along the streambanks that is helping to stabilize the bank soils and prevent erosion.

Upstream of the McClory Bike Trail (BL21), the stream exhibits a fairly shallow wooded channel with a few locations of eroded banks and stormsewer blowouts. However, it is not terribly encroached by residences and there appears to be sufficient room for natural stream meandering to occur. At Lewis Avenue the North Branch flows from Thunderhawk Golf Course, which demonstrated overall healthy stream channel and riparian corridor conditions.

On the day the rapid assessment was conducted by Conservation Design Forum, reach BL19 approximately 0.5 miles upstream of Sheridan Road exhibited water that appeared black in color, and although the cause could not be determined, it was assumed the black water was coming from the 27th Street Tributary (BL26-BL27) since black water was not observed in BL25.

South Branch of Bull Creek (BL09-BL18)
The South Branch of Bull Creek upstream of the North Branch confluence (BL09) meanders fairly sharply through a forested valley, though not too dense in canopy. In fact, this ravine is fairly open in character and clean stream substrates were observed suggesting limited hillside erosion. At least one side ravine was filled with yard debris (leaves) and a number of residential runoff discharge drains have been snaked to

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Severely impacted stream channel and armoring where reach BL15 crosses Wilson Street near Howard Street.

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Armoring such as this wood retaining wall helps stabilize the streambanks but reduces the quality of the stream habitat for aquatic plants and animals (BL11).


© Lake County Stormwater Management Commission

Severe streambank armoring and channelization improves f ow but has signi f cant detrimental ef fects on channel health and habitat quality (convergence of BL13, BL14, and BL15)


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Cement-lined stream channel armoring is often used to stabilize and erodiing channel and improve drainage, but it destroys the natural channel and is not supportive of a healthy stream condition. (BL15)


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Streambank armoring helps stabilize the streambank but reduces the natural structure and function of the stream (BL26)


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The bare dirt in this photo appears to have been recently deposited on the slope of this ravine, and the plastic residential drain installed so that it discharges runoff onto the slope, which causes erosion, rather than into the bottom of the ravine, which is the preferred discharge location for these types of drains (BL12).


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This new home on Hart Road north of the Pineview Cemetery is built very close to the ravine edge (BL12).

the bottom of the ravine. Stream bank armoring was present in a number of locations, some of wood and others of broken concrete, and some silt fence has been installed across the slope in some locations. A few bare banks were seen. As is fairly typical for this watershed, stormsewer blowouts, culvert erosion, and debris jams were found. There is some new development occurring very near the stream channel around Hart Road north of the Pineview Cemetery (BL12), and some dirt fill on the opposite (east) streambank, both of which may be in violation of local regulations that prohibit dumping dirt or other fill material within the floodplain and floodway. A concrete dam at this location has failed and water flows around and through it.

Just upstream of Beach Road (BL13), the reach is fairly natural in character except for one location where it appears that excess concrete from the adjacent land use has been disposed of along the stream channel. A little further upstream is where a number of stormsewers and two streams, the South Branch of Bull Creek (BL15) and the Wilson Avenue Tributary (BL14), come together to create the South Branch of Bull Creek (BL13). At the time of the investigation, this open concrete stormwater channel (BL15) was failing in some places and appears to be used for yard waste and leaf burning. Beneath the concrete channel there is a second, deeper CMP culvert, which is partially blocked by sediment and/or debris and partially filled with water. Upstream of this spot, along BL15, the South Branch of Bull Creek reportedly flows through old railroad tank cars that were installed by a developer to create more developable land.

Reach BL15 is day lit again near Manor and continues through a residential area and a partially collapsed culvert under the McClory Bike Trail. Below Beach Road, the stream flows through a channelized, eroding reach surrounded by turf grass. The Beach Road culvert is experiencing erosion behind and around the headwall and flow is bypassing the culvert altogether and undermining the structure. It appears that at times there is significant flow volume in this reach, presumably runoff from Waukegan Airport, where the stream originates.

Wilson Avenue Tributary (BL14)

The Wilson Avenue Tributary, which according to stream maps joins Bull Creek just downstream of the tank car culvert, was very difficult to locate and track. It apparently originates somewhere east of Lewis Avenue near Edgewood, flows in and out of culverts with a few daylit areas, and shows little or no flow in some locations. There were two large storm vaults along Wilson Avenue, and it was suggested that a number of flow paths converge here.

Unnamed Tributary to Glen Flora Tributary (BL05-BL06)

An unnamed tributary to Glen Flora Tributary flows from near Lyons Woods Forest Preserve into Illinois Beach State Park from the north and joins Bull Creek to create the Dead River. This tributary flows out of Ophir Park where it is small and mildly incised and surrounded by turf grass. Below Sheridan Road the stream exhibits fairly good substrate conditions, though oil slicks were detected, likely from a Sheridan Road discharge.

Glen Flora Tributary (BL01-BL04)

The downstream end of the Glen Flora Tributary (approximately 3 stream miles broken into 4 reaches), before crossing under the rail tracks and into the Johns Manville property lagoons, flows through the steep and deep ravines of Bowen Park. Within this park, a number of interesting things were seen, including a long, mud packed beaver dam that created a large long pool at the bottom of the valley. Incised gullies drain into Glen Flora Tributary from the upland areas, some filled with debris. Moving upstream, the stream flows along and through some residential properties, where armoring and other improvised erosion control projects have been installed. Some yard debris dumping was observed, areas of turf grass to the channel edge, and fences criss-cross the stream channel in a couple of locations. The Sheridan Road outfall is directed at the streambank, which has been attempted to be stabilized with concrete armoring. Good rock and cobble substrates were found in some locations.

Upstream of Sheridan Road, the stream flows for approximately 3000 feet through the Glen Flora Country Club and three ponds, which are created by dams across the stream. The stream and pond edges are armored with rip-rap in some locations and planted to the edge with turf grass in other locations. While the rip rap may help reduce erosion of the stream and pond edges, rip rap and turf grass do little to improve water quality in the stream or improve the stream habitat for aquatic plants and animals. Upstream of the Glen Flora County Club, the Glen Flora Tributary enters a culvert at Poplar and emerges west of the McClory Bike Path where it has been channelized for the rest of its upstream reaches until it disappears into an undefined channel near Lewis Avenue.

3.13.5 CHANNEL CONDITIONS

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Yard waste dumping into ravine (BL02) contributes nutrients to the stream and smothers ground vegetation that helps hold the slope in place. Yard waste should be composted, applied as mulch, or disposed of in yard waste collection facilities.

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Severe streambank erosion causes sedimentation in the stream and loss of property (BL19).

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The turf grass and rock stream edges in Glen Flora Country Club should be converted to native plant edges to help hold the banks in place andf lter runoff from the golf course, thereby improving water quality (BL03).

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Streambank erosion and bank slumping (BL16) illustrates the effects of stormwater runoff.

© Lake County Stormwater Management Commission

Stormwater outfall stabilized with rock rip rap (BL04).

© Lake County Stormwater Management Commission

Dense vegetation naturally stabilize the streambanks due to the deep root systems that hold soil in place (BL04).

Urban development in the watershed is reducing the amount of land available for the natural infiltration of precipitation into the ground, where it can be intercepted and absorbed by vegetation or stored in depressional wetlands and floodplains of the watershed. With increasing amounts of impervious surface and an extensive network of stormsewers that convey the increased volume of runoff to the stream channel faster, a stream channel experiences what is called "flashy" hydrology. A "flashy" hydrology means that the water level in the stream rises very quickly during a storm and falls quickly afterward. Since less water is infiltrating into the ground and constantly seeping out and creating a steady base flow within the stream, low flows are considerably lower. Likewise, because less water is absorbed by the ground and more water is flowing into the streams, high flows are considerably higher. High flows can result in damage to property of watershed residents, erosion, flooding, and pollution. Decreased or low flows degrade aquatic habitat because low flows have low levels of dissolved oxygen necessary for aquatic animals and because, in extreme cases, the stream can dry up completely for periods of time.

A number of factors were inventoried to better describe the condition of the Dead River/Bull Creek Watershed. Channelization, sinuosity, pool/riffle development, bank erosion, sediment accumulation and debris loads (defined at right and explained more fully below) are all measures of the health and condition of a river or stream. (A pool is a location in an active stream channel usually located on the outside bend of a meander, where the water is deepest and has reduced current velocities. A riffle is a shallow rapid, usually located at the crossover in the meander of an active channel. See Figure 3.26.) Physical measurements such as bank height, channel width, bank slope, and water depth reflect the shape of the channel and the amount of water that is or can be conveyed by the stream under both high and low flow conditions. Streambank vegetation and canopy coverage (the amount of tree shading) affect the stability of streambanks and the quality of habitat.

Channelization

Channelization alters the natural flow of streams and rivers that have a tendency to meander. The natural meander geometry of a stream will dissipate the energy of water as it flows through bends in the channel, and creates pool/riffle complexes in the streambed that provide habitat for aquatic plants and animals. Channelization tends to eliminate pools, riffles and meanders. Instead, a large volume of water is directed into a straight, confined channel, which increases the energy of the flow. The increase in energy flow results in the erosion of the streambed and/or streambanks. As the streambed erodes over time, the channel deepens becoming more entrenched. This process is referred to as downcutting. If the streambed is composed of materials that are more resistant to erosion such as gravel or stone, then the flow will tend to widen the channel by eroding the streambanks, rather than deepening it. This process is generally the result of the channel reshaping itself to accommodate new geometry or increased flows until it finds a new equilibrium.

In the Dead River/Bull Creek Watershed, channelization was

Table 3.15 Useful Definitions

Term	Definition
channelization	straightening or ditching of a stream channel
sinuosity	degree of stream channel turns and bends
pool and riffle	alternating series of deep pools and shallow rapids
bank erosion	the loss of streambanks due to scouring by water flow
sediment accumulation	build-up of soil, sand, and gravel in the streambed
debris load	natural and man-made debris including leaves, sticks, logs, lumber, and trash

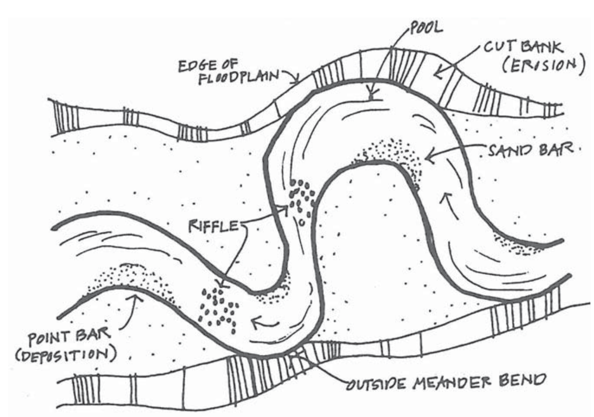

FIGURE 3.26 PLAN (OVERHEAD) VIEW OF NATURAL STREAM MORPHOLOGY

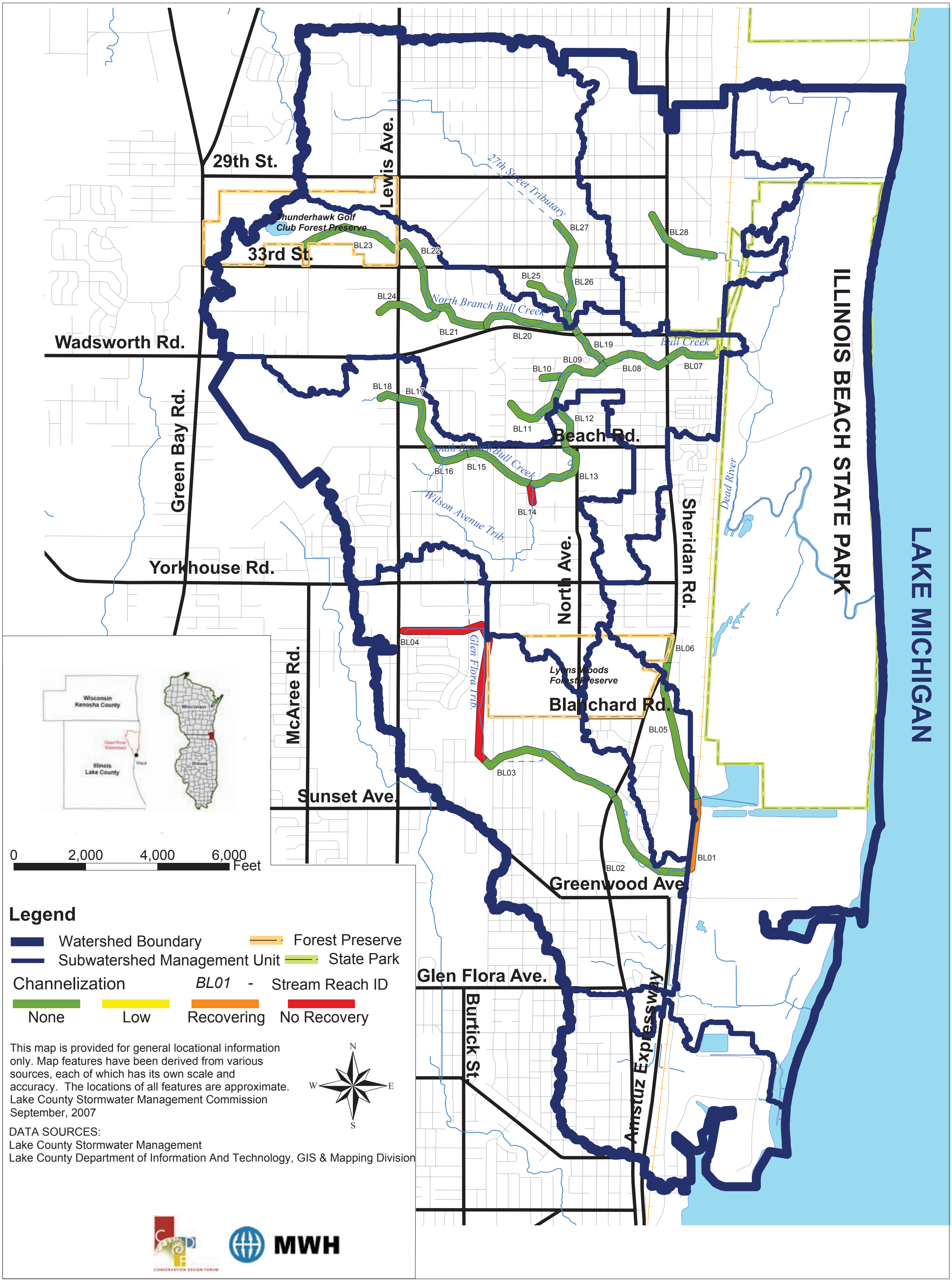

FIGURE 3.27 CHANNELIZATION

found in only 3 of 28 reaches (11%), with BL04 and BL14 exhibiting channelization with no recovery occurring, and BL01 in recovery, as shown in Figure 3.27. "Recovery from channelization" means that a channel is beginning to regain natural characteristics such as pools, riffles and meanders. Channelization is not considered to be a significant problem in this watershed.

Pool/Riffle Development

A pool is a location in an active stream channel usually located on the outside bend of a meander, where the water is deepest and has reduced current velocities. A riffle is a shallow rapid, usually located at the crossover in the meander of an active channel. The development of a pool/riffle complex is associated with the natural meandering of stream channels. The pool/riffle sequences benefit fish and macroinvertebrates by aerating the water during low flow conditions and providing more diverse bottom conditions. Pool/riffle complexes also offer streambank erosion relief by directing stream flow through the center of the channel and away from the banks. The characteristics of pool/riffle development are usually lost when a stream is channelized, though flashy runoff may also destroy natural pools and riffles.

Seventy-one percent of the reaches in the Dead River/Bull Creek Watershed had low or no pools and riffles, as shown in Figure 3.28. The North Branch of Bull Creek had the lowest percentage of reaches with moderate to high pool/riffle development (16%), while 83% of its reaches were characterized by low or no pool/riffle development. Bull Creek had a total of six reaches (27%) having moderate levels of pool/riffle complexes. Pool and riffle installation, as well as other habitat improvements, should be considered for most stream reaches in the Dead River watershed, as reflected in the Action Plan in Chapter 5.

A number of man-made riffles were noted in the inventory. Two were installed by the US Army Corps of Engineers, and 13 others were installed by the Lake County Stormwater Management Commission and its partners. The Corps of Engineers original plan was to install gabions (rocks contained within wire baskets) to protect exposed sanitary lines, but agreed to install riffles based on the work that LCSMC and its partners were doing in this reach.

Streambank Erosion

Erosion of the streambed or streambanks results in heavier loads of sediment being transported and settling out of the water column and into the channel, which reduces the capacity of the channel to convey water and makes the streambed less habitable for aquatic plants and animals.

© Lake County Stormwater Management Commission

Rock riffle installed over exposed sanitary line to protect it.

Streambank erosion in the Dead River/Bull Creek Watershed appears to be limited to specific problem areas, though some degree of erosion was present along most stream reaches and bank height in upper reaches was low. The most significant problem areas are those along the bluffs of the ravine that threatened buildings and infrastructure. Other erosion problems are found around point discharges and hydraulic structures that are either poorly constructed or maintained, and along the meandered reaches within ravines. Erosion problems near point discharges and hydraulic structures are important, but generally not as costly or difficult to remedy as bluff and ravine erosion. In most cases, streambank erosion was not threatening property damage except where the bank was coincident with the ravine wall. Erosion can also be caused by bank slumping in areas where water seeps laterally out of the sides of the slope. Some of the channel banks have a severe slope ranging from .25/1 to 1/1, which does not allow vegetation to root close to the channel, which would provide a more stable streambank. In reaches where the channels flow through developed areas, the streambank was sometimes armored with rock, concrete, or wood, and in other locations the bank was stabilized by installing a vegetated buffer strip, with deep plant roots to help hold the soil in place.

The streambank erosion map shown in Figure 3.30 reflects

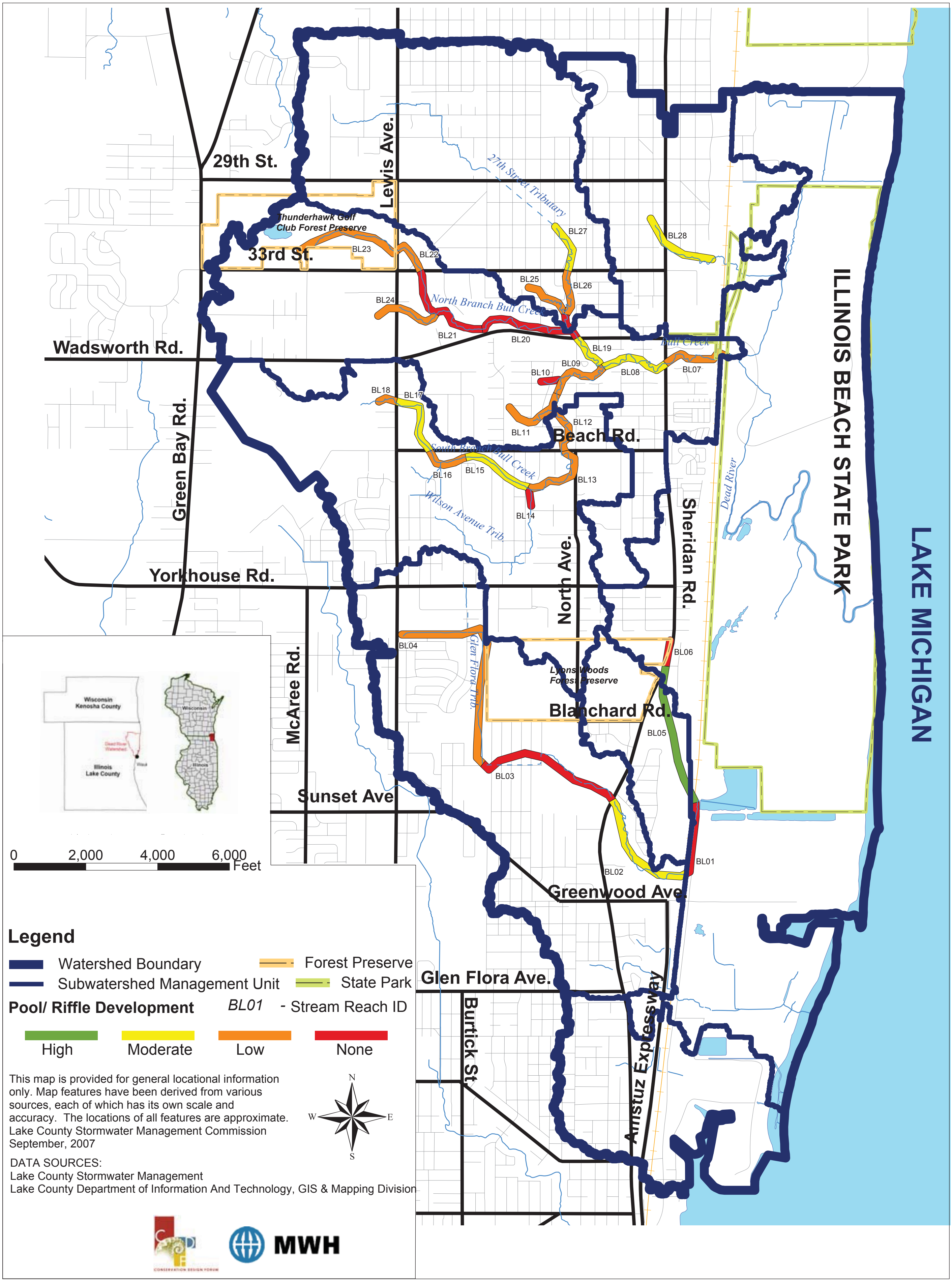

FIGURE 3.28 POOL AND RIFFLE DEVELOPMENT

the prevalence of erosion – the proportion of the reach length exhibiting signif cant streambank erosion. Erosion is characterized as follows:

None: Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems; less than 5% of bank affected.

Low: Moderately stable; infrequent, small areas of erosion mostly healed over; 5-33% bank has areas of erosion.

Moderate: Moderately unstable; 33-66% of bank has areas of erosion; high erosion potential during high runoff events.

Severe: Unstable; many eroded areas; “raw” areas frequent along straight sections and bends; obvious bank sloughing; 66-100% of bank with erosional scars.

In the Dead River/Bull Creek Watershed, 9 of the 28 reaches (32% or 25,300 feet) were characterized as having low or no streambank erosion problems. However, 10 of the 28 reaches (36% or 25,300 feet) fall into the moderate range. Nine (32% or 19,300 feet) of the Bull Creek stream reaches exhibited high streambank erosion. The most severe cases of erosion occurred in Bull Creek along the main stem and the South Branch. This is likely due to the presence of ravine-like banks that are not stabilized by ground level vegetation and the high incidence of stormwater discharge points along these reaches. More stormwater discharge points mean greater discharge of stormwater runoff and more frequency and severity of erosion. In some cases, sediment had accumulated at the bottom of the ravine, creating a lower bank near the stream. But the ravine walls showed high levels of erosion that could be problematic. Other severe cases of erosion were noted on the 27th Street Tributary and North Branch. These areas also had ravine-like banks and high numbers of discharge points and/or debris that indicate a "f ashy" hydrology, which would cause erosion. Figure 3.29 is provided to illustrate the correspondence between the location of ravines and the location of erosion.

Streambank armoring was present in a few areas, some protecting sanitary manholes and other signi f cant infrastructure, and others appear to be do-it-yourself approaches to slow or stop erosion of the channel or stream

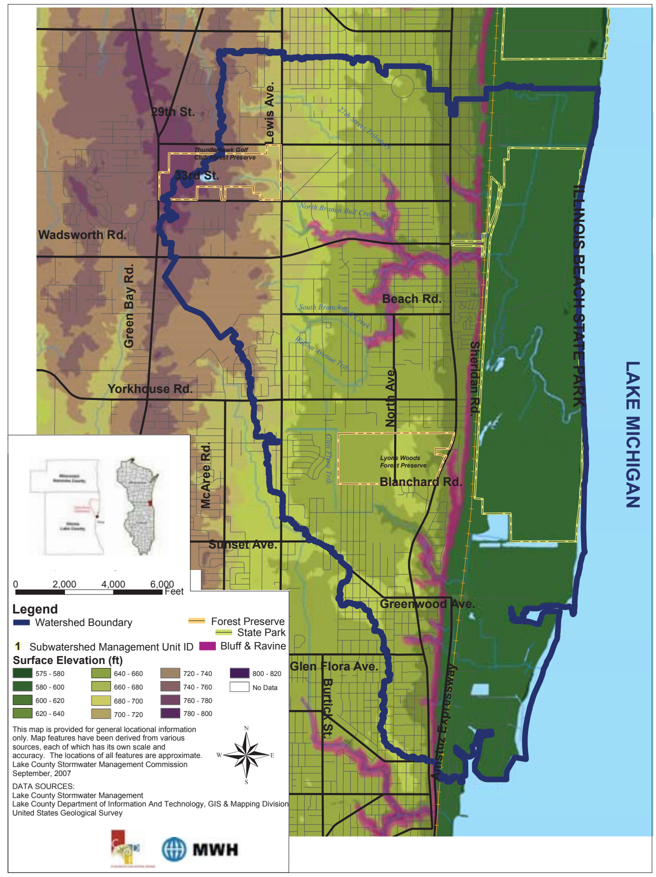

FIGURE 3.29 TOPOGRAPHY

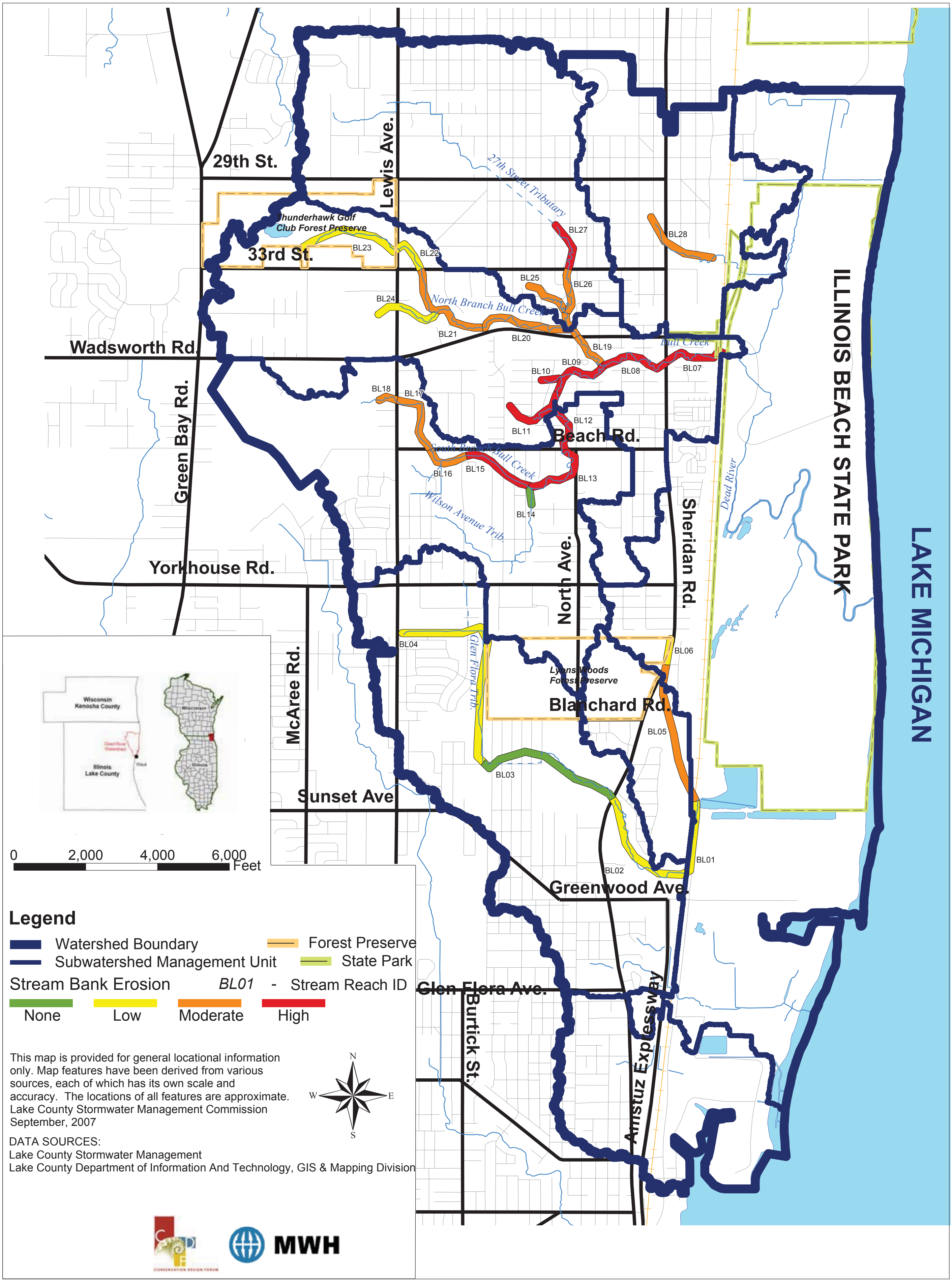

FIGURE 3.30 STREAMBANK EROSION

banks. Armoring included poured concrete, broken concrete slab, rock and brick walls, rip rap, gabion baskets filled with rock, cinder blocks strung over rebar, railroad ties, and wood retaining walls. It is unclear what proportion of the armoring projects are stable and how many are failing. However, it is important to recognize that armoring, when improperly designed and installed, can fail and cause problems to worsen.

As indicated, streambank erosion is a significant problem on a number of stream reaches, causing loss of property, water quality problems, and sedimentation downstream. Erosion deserves prioritized attention by watershed stakeholders.

Stream Bed Erosion
As a complicating factor that can hasten stream bank erosion, stream beds also are being eroded by high stormwater runoff flows, a process called downcutting. Heavy volumes of water moving quickly through a stream channel can scour the bottom of the channel and transport the substrate materials downstream, which also leads to sedimentation of downstream reaches (see below). This process deepens the stream channel and thereby exposes more of the stream bank to the erosive forces of water flow. Until a very stable rock or clay substrate is exposed, this process deepens and widens stream channels, erodes away natural pools and riffles, and transports many tons of sediment downstream. As documented in Bull Creek, sanitary sewer lines that were installed 2.5 feet underground were exposed by 12-18 inches above ground before the stabilization work done by the North Shore Sanitary District and US Army Corps of Engineers in 2003 and 2004. Stream bed erosion is an ongoing problem needing attention in the Dead River watershed.

Sediment Accumulation
The accumulation of sediment in a streambed is directly related to the degree of streambank and stream bed erosion that occurs within a channel and to the stream gradient. Ordinarily, sediments that are generated in the channel are conveyed through the steeper gradient reaches and deposited in areas where the stream velocity is decreased due to shallower stream gradient or by debris blockages or impoundments. Bull Creek has a low to moderate accumulation of sediment in spite of its moderate to high erosion problems in the watershed because of the ravine stream banks and steeper gradient. It is likely that sediment is being deposited in the low-gradient reaches of Illinois Beach State Park. The wide streambed area in these ravines is typically large enough where the sediment settles at the bottom of the ravine, leaving enough room for the stream to meander around it. Sediment tends to accumulate on the inside of a bend in the stream, where water is flowing slower, and pools tend to develop on the outside of a bend, where water is flowing faster. Sediment can also become lodged or trapped around and inside of culverts and other hydraulic structures, resulting in obstruction of water flow where sediment accumulation is very high or takes place over a long period of time.

As reported following the 2001 SMC Stream Inventory, the Dead River/Bull Creek Watershed had a total of 13 out of 28 reaches (46%) with low sediment accumulation. Moderate or high sediment accumulation was found in eleven reaches (39%), with nine of these reaches falling into the moderate range and two reaches in the high range. Bull Creek had only one reach (4%) with high accumulation and six reaches (27%) with moderate accumulations of sediment, as opposed to the Glen Flora and the unnamed tributary to the north, in which the reaches with moderate accumulations of sediment made up 50% of the streams. Sedimentation is a moderate problem within upper and middle stream reaches, but is likely a more significant problem in lower reaches where the gradient is shallow and sediment settles out. Figure 3.31 illustrates the location of areas with sedimentation.

The Lake County Health Department monitoring of Bull Creek, however, indicates that sedimentation, at least at

© Lake County Stormwater Management Commission

Relatively stable reach of Bull Creek (BL07) channel shows gravel and sediment that have been transported from upstream by water flow and deposited here where the stream gradient is fairly flat.