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SEWRPC Community Assistance Planning Report No. __

CITY OF WAUKESHA COMPREHENSIVE PLAN, 2ND EDITION
VOLUME 1

Section 8

NATURAL RESOURCES INVENTORY

COMPONENTS OF THE NATURAL RESOURCE BASE

The natural resources element is one of the nine elements of a comprehensive plan required under Section 66.1001 (2) (e) of the *Wisconsin Statutes*. In accordance with State law, this element contains an inventory and descriptive analysis of natural resources in the City. This chapter includes information pertaining to climate and air quality alongside natural resources defined under State law, which include the following:

- Groundwater
- Woodlands
- Environmentally sensitive areas
- Threatened and endangered species
- Stream corridors
- Surface water
- Floodplains
- Metallic and nonmetallic mineral resources

Inventory data in this section has been collected through regional land use and natural area planning activities conducted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). Additional inventory data has been collected from and by the City, Waukesha County, and by State and Federal agencies, including the Wisconsin Department of Natural Resources (WDNR); the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP); the State Historical Society of Wisconsin; and the U.S. Department of Agriculture (USDA).

Call Out: Despite being one of Wisconsin's more urbanized areas, the City contains an abundance of high-quality natural resource amenities.

PHYSIOGRAPHY, GEOLOGY, AND SOILS

Southeastern Wisconsin's physiographic features, or surface landforms, were determined largely by repeated stages of glaciation, the last of which ended about 10.000 years ago. The resulting topography of the City, shown on Map 8.1, includes landforms like recessional moraines and drumlins. Glaciation also contributed to the City's geology. Geologic properties can influence how land is used as geologic conditions, including the depth to bedrock, may impact the cost and feasibility of building site development and provision of public facilities and infrastructure.

Call Out: The City is in proximity to one of the State's most dominant physiographic and topographic features: the Kettle Moraine. Extending through Washington, Waukesha, and Walworth Counties, the Kettle Moraine, or Interlobate Moraine, is a complex system of kames (crudely stratified conical hills), kettle holes (depressions), and eskers (long, narrow ridges of drift) that formed between the Green Bay and Lake Michigan Lobes of the continental glacier, which moved across southeastern Wisconsin in a general northeast-southwest direction from its origin in Canada..

Geologic features of the City include several layers of bedrock formations. Silurian dolomite (primarily Niagara dolomite) is a pervious layer located near the ground surface and under shallow, unconsolidated glacial deposits. Ordovician dolomite, sandstone, and shale can be found beneath the Silurian dolomite. This layer can include a relatively impervious layer of Maquoketa shale. Below these layers are Cambrian sandstone and, continuing downward, Precambrian crystalline rocks.

In portions of the City, bedrock is situated within 100 feet of the ground surface. Areas with such a shallow depth to bedrock may pose physical or economic limitations for most types of development. However, locations with high bedrock may also have potential for the extraction of nonmetallic minerals. Other portions of the City contain unconsolidated glacial deposits, alluvium, and marsh deposits, which have a combined thickness exceeding 100 feet in much of the County,

Nonmetallic Mineral Resources

The geologic attributes of an area can be of specific importance in the case of nonmetallic minerals, limited and irreplaceable resources that are of significant economic value to urban development. In Southeastern Wisconsin, marketable nonmetallic minerals include sand, gravel, and crushed limestone or dolomite, which

are used for structural concrete and road building; peat for gardening and horticulture; and dimension stone uses in buildings, landscaping, and monuments. The locations of mineral resource deposits within the Region were determined primarily by glacial geology.

According to the U.S. Geological Survey, development in the United States requires an annual per person average of 9.5 tons of construction aggregate, including sand, gravel, crushed stone, and recycled crushed concrete. One ton of aggregate, which is expensive to transport due to its weight and bulk, can more than double when hauled 25 miles or more.

Call Out: Wise management of nonmetallic mineral resources is important to ensure an adequate supply of such resources at a reasonable cost for new development and for future maintenance of existing development.

Significant Geological Sites

The City contains one significant geological site as identified by a survey of scientifically and historically important geological sites.[1] The site, Carroll College Quarry, was the first quarry opened in the County and was visited by many prominent 19th-century geologists. Carroll College Quarry is classified as being of statewide or greater significance and is the source of large fossil collections, including those of major museums across the Nation. Waukesha Dolomite is the type section[2] of the site, which features covered rock exposures.

Soils

Soils have varying physical, chemical, and biological properties. These properties, attributable to the interaction of glacial deposits and topography, climate, plants, animals, and time, exhibit wide spatial variations. Detailed soil surveys map the geographic locations of various types of soils based on their physical, chemical and biological properties. As soil properties can exert a strong influence on how people

[1] Dr. Joanne Klussendorf, of the University of Illinois-Champaign-Urbana, and Dr. Donald G. Mikulic, of the Illinois State Geological Survey, conducted a survey of bedrock sites using published literature, library archives of manuscripts, letters and unpublished reports, and field notes and maps of earlier geologists and new field examinations to compile a list of significant geological sites known to have existed over the last 150 years. The survey identifies 30 significant geological sites located in Waukesha County, including nine sites of statewide or greater significance (GA-1), eight sites of countywide or regional significance (GA-2), and 13 sites of local significance (GA-3).

[2] A geologic type section defines a unit stratotype, a reference section of a geologic area that presents the most complete, representative profile of that geologic area's characteristics.

use land, soil surveys can be extremely useful for to support regional planning, engineering, agricultural, and resource conservation efforts in determining how certain soils may be best used or managed.[3] A soil survey containing information relative to the City[4] shows a large variety of different soil types in the Southeastern Wisconsin Region.

Call Out: The properties of soils affect their capabilities. Some soil types better support urban development than others whose properties may affect the feasibility and cost of building site development or the provision of public facilities. Soils not suitable for urban development include hydric soils, which are significant for their ability to support water management, as in areas with wetlands.[5]

There are four soil associations within the City of Waukesha.[6] Two of the four soil associations, which make up about 86 percent of the City's total land area, feature good to well-drained soils and can support urban development.[7] The other two associations, which account for the remaining 14 percent of the City's total area, feature hydric soils, i.e., soils that are saturated with water or have a water table at or near the surface. Such very poorly drained soils are generally unsuitable for development unless they are drained[8] or are best

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[3] *The Soil Conservation Service completed a soil survey of the Southeastern Wisconsin Region under contract to the Regional Planning Commission, the results of which are in SEWRPC Planning Report No. 8,* Soils of Southeastern Wisconsin, *and in five reports published by the Soil Conservation Service.*

[4] *a Soil Survey of Milwaukee and Waukesha Counties, published by the U. S. Department of Agriculture, Soil Conservation Service in 1971*

[5] *Other soils not ideal for development are soils that are well-suited for producing certain crops, including highly productive soils as determined by a classification system established by the Natural Resources Conservation Service (NRCS).*

[6] *A soil association is a landscape with a distinctive proportional pattern containing one or more major soil types and at least one minor soil type, as classified by the NRCS. Each association is named after the landscape's major soils.*

[7] *About 80 percent of the City's land area consists of the Hockheim-Theresa Association, silty clay loam and clay loam that hosts a mix of native prairie grasses and woodlots. About 6 percent of the City is relatively flat to slightly sloping topography featuring the Warsaw-Lorenzo Association, which also supports native prairie grasses and a few scattered oaks.*

[8] *About 3 percent of the City consists of marshy depressions along the Fox River and Pebble Creek that host native reeds and sedge and feature the Houghton-Palms-Adrian Association.*

undeveloped and left in open space, where they serve as important locations for wetland restoration, as wildlife habitat, and for stormwater detention.[9]

Water Resources

Groundwater

Groundwater, an extremely important component of the natural resource base, is present in reservoirs or aquifers within stratum[10] of varying depths. Three major aquifers underlie the City. From the land's surface downward, the first of these major aquifers is composed of sand and gravel deposits in glacial drift. The second is the shallow dolomite strata in the underlying bedrock. Due to their proximity to the land's surface and to their hydraulic connection, these two aquifers are commonly referred to as the shallow aquifer. The third aquifer from the land's surface downward is the Cambrian and Ordovician strata, which is composed of deeper sandstone, dolomite, and shale. This third aquifer is referred to as the deep aquifer. The shallow and deep aquifers are separated by a relatively impermeable layer of shale in the Maquoketa Formation.

Groundwater in any stratum is subject to a continuous process of natural and artificial forces. Groundwater in the shallow aquifer system generally moves from beneath topographic high areas, or higher elevations, to lower elevations, including nearby lakes and streams. Groundwater therefore sustains lake levels and wetlands and provides the perennial base flow of the streams. The primary means by which groundwater is naturally recharged is by precipitation that escapes evapotranspiration or runoff and percolates into the ground. Shallow aquifers are generally replenished by precipitation relatively easily.[11] The infiltration of precipitation to the deep aquifer, however, is impeded by the relatively impermeable Maquoketa Formation. Thus, the deep aquifer is recharged primarily by the slow downward leakage of water from the overlying, shallow aquifers through the Maquoketa Formation or by infiltration of precipitation in western portions of the County where the Maquoketa Formation does not separate the aquifers.

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[9] Approximately 11 percent of City land in proximity to the Fox River features the Montgomery-Martinton-Hebron-Saylesville Association, which contains soils that are often wet and host water-tolerant grasses and trees.

[10] Stratum are comprised of a layer or a series of layers of sediment or rock.

[11] Much of the groundwater in shallow aquifers originates from precipitation that has fallen and infiltrated the ground within a radius of 20 or more miles from where it is found. Approximately 80 percent of that precipitation is estimated to be lost to evapotranspiration and a small proportion flows into streams as stormwater runoff; the remainder infiltrates the ground and replenishes groundwater. Estimates approximate that an average of 10 to 15 percent of annual precipitation contributes to recharging groundwater in shallow aquifers.

The primary artificial force affecting groundwater relates to the use of groundwater as a water supply source. Man-made wells make groundwater accessible for residential, industrial, and municipal development. when, Withdrawals from wells create drawdown and reduce groundwater levels when more groundwater is extracted from aquifers than is replenished. As noted in the previous reports,[12] groundwater levels in aquifers underlying the City and County have declined due to artificial uses.[13] Artificial groundwater withdrawals also divert groundwater from surface waters, reducing baseflows. In the past, high-capacity wells that withdraw groundwater from the deep sandstone aquifer have allowed for the diversion of groundwater from surface waters to be more widely distributed. Wells that access groundwater from shallow aquifers can increase groundwater diversion from surface waters as shallow wells are more localized than deep aquifer wells.

In addition to groundwater loss, natural and artificial forces can contribute to groundwater degradation. Artificial causes of groundwater degradation from human activities can lead to contamination from bacteria, nitrate, pesticides, and volatile organic compounds (VOCs). While human activities could be adjusted to reduce or eliminate such artificial causes, groundwater degradation caused by natural factors may be more difficult or impossible to control. An example of one such water quality factor is water hardness. Water hardness is an effective, initial indicator of water quality.[14] While there are no national or state standards to quantify acceptable levels for water hardness, groundwater beneath the City is considered very hard.[15] It is worth noting that such hard water requires softening for most purposes and that water softening devices

[12] *Including SEWRPC Technical Report No. 47,* Groundwater Recharge in Southeastern Wisconsin Estimated by a GIS-Based Water-Balance Model*, (2008) and the City's 2009 comprehensive plan.*

[13] Groundwater levels are also susceptible to natural forces, including draughts.

[14] Dissolved-solids concentration is also an effective initial indicator or water quality. According to SEWRPC Technical Report No. 37, Groundwater Resources of Southeastern Wisconsin *(June 2002), the dissolved-solids concentration of groundwater underlying the City did not exceed the recommended maximum dissolved-solids concentration for certain uses.*

[15] Water hardness, reported in terms of equivalent concentration of calcium carbonate in milligrams per liter (mg/l), under 100 mg/l is generally considered suitable for domestic uses. Groundwater within aquifers underlying the City has a concentration exceeding 180 mg/l.

discharge into the environment chlorides and sodium, which are extremely difficult and expensive to remove.[16]

Another indicator of groundwater quality is the concentration of minerals and other elements in groundwater. These naturally occurring elements dissolve from bedrock into groundwater as water moves through the aquifer. Measures of one such element in the aquifer underlying a portion of the Region, including the City, have trended upwards over years preceding publication of this report. In some instances, measures have exceeded federally accepted limits for certain groundwater uses.[17] As noted in a 2013 report, the deep aquifer underlying the City has had significant water quality issues and severe groundwater level drawdown. The shallow aquifer underlying the City, which feeds sensitive surface water resources, was also found to have had water quality issues.[18]

Lakes and Streams

Surface water resources, including lakes and streams and their associated wetlands, floodplains, and shorelands, and groundwater resources are interrelated components of a single hydrologic system. Like groundwater, surface waters are susceptible to degradation through improper land use development and management. Pollutant loads, including nutrient loads, which enter from malfunctioning and improperly located onsite waste treatment systems, from sanitary sewer overflows, from construction and other urban runoff, and from careless agricultural practices can degrade surface water quality. The water quality of lakes and streams may also be adversely affected by the excessive development of riparian areas and by the filling of peripheral wetlands, which remove valuable nutrient and sediment traps while adding nutrient and sediment sources.

The Wisconsin Department of Natural Resources (DNR) is responsible for assessing the quality of the State's water resources under the Clean Water Act. This process includes identifying water resources by type, identifying specific, selected uses for each water resource, and establishing water quality benchmarks. This process also includes monitoring the State's surface waters and comparing monitoring data to benchmarks.

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[16] *A SEWRPC study of the environmental impacts of the use of chloride on the surface water and groundwater resources of the Region was underway as this report was being prepared.*

[17] *Additional information is presented in Chapter 4 (Utilities and Community Facilities) of this report.*

[18] *CH2M HILL*, City of Waukesha Water Supply Service Area Plan *(October 2013).*

The DNR then uses this data to ascertain whether a water resource is healthy, impaired, or restored in accordance with requirements set forth by the Environmental Protection Agency (EPA). The DNR monitors three major streams within the City, including the Fox (Illinois) River, Frame Park Creek, and Pebble Creek.19

The Fox River may be the City's most historically significant natural resource feature. In the mid-1800s, the City's earliest development initiated along the Fox River in what is now the City's historic downtown. The City expanded from this central core along the Fox River. The river runs a total of 202 miles from its headwaters in southern Washington County and northern Waukesha County to its confluence with the Illinois River in Ottawa, Illinois. Through the City, one of the river's most urban extents, the Fox River hosts urban riverwalk trails and plazas and access to natural resource areas via a water trail, boardwalk, and other recreational trails.

The DNR recognizes the Fox River as an aquatic area of countywide or regional significance and has designated the river as a Rare Species Habitat (RSH), an aquatic area that supports endangered, threatened, or special concern species. While the river is identified as a Warm Water Sport Fish Community, the river is expected to support aquatic life. The river is considered appropriate for recreational activities like canoeing, kayaking, and fishing.

At the same time, the river is listed on the DNR's inventory of impaired waters, as is Frame Park Creek. This recognition is due to the water bodies' low dissolved oxygen, high levels of total phosphorous, and turbidity caused by higher levels of sediment in the water column.

The Fox River has had a specific restricted fish consumption advisory in effect for polychlorinated biphenyls (PCBs) since 1998. a statewide general fish consumption advisory that applies to all (non-Great Lakes) waters of the state based on statewide distribution of mercury in fish and species differences in mercury concentrations. The statewide

Frame Park Creek is a spring fed-stream one mile in length that is supported by surrounding wetlands. Located northeast of downtown adjacent to primarily industrial uses, a portion of the stream is underground. The stream is daylighted in Frame Park prior to draining into the Fox River. The DNR has designated the stream as a Limited Forage Fishery as it is capable of supporting a limited community of forage fish.

[19] *These surface waters are classified for planning purposes as major streams. Major streams are perennial streams that, at a minimum, maintain a small, contiguous flow throughout the year except under unusual drought conditions.*

Pebble Creek is classified as a Class 2 trout stream, which recognizes the stream's limited ability to support natural reproduction and the substantial survival of trout from one year to the next. Stocking is often used to maintain a Class 2 trout stream for desirable sport fishery. Brandy Brook which is a tributary to Pebble Creek which flows directly into the Fox River; both tributaries have the potential to support a cold-water community.

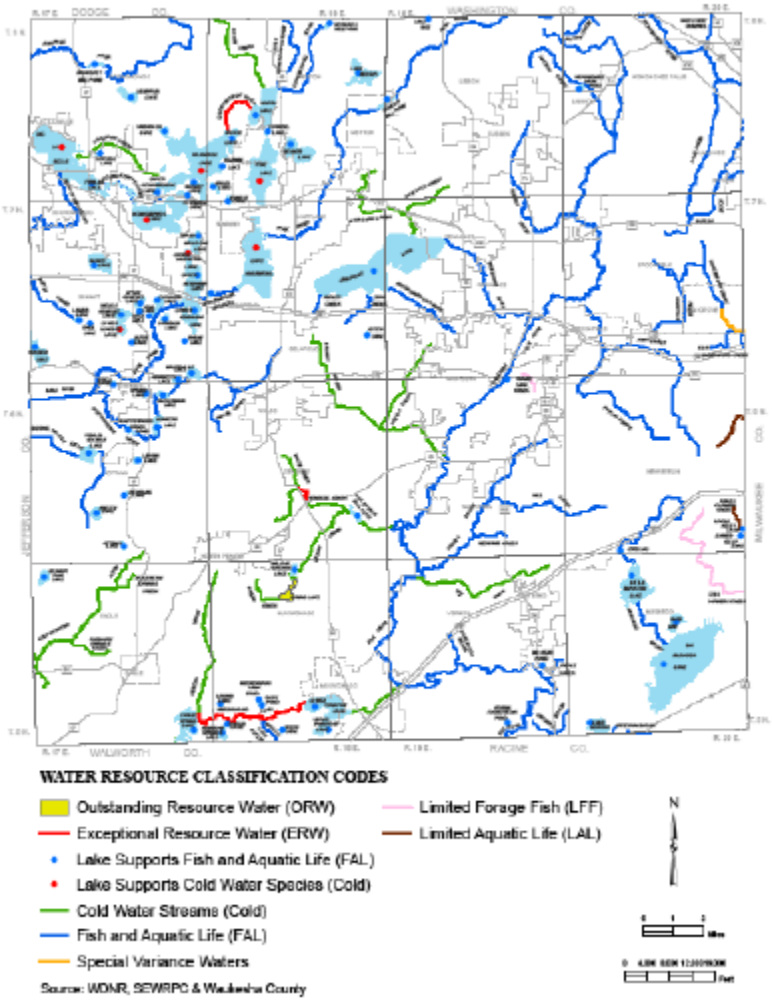
Watersheds

The City is located within the Fox (Illinois) River watershed, which is located west of southeastern Wisconsin's subcontinental divide and drains into the Mississippi River basin.[20] The Fox River watershed encompasses approximately 2,640 square miles: 920 square miles in Wisconsin, including the entire City, and 1,720 miles in northern Illinois. The watershed contains several sizeable lakes, including Pewaukee, Big Muskego, and Geneva Lakes in Waukesha and Walworth Counties.

The Fox River has several major tributaries, including the Mukwonago River, Sugar Creek, Honey Creek, and the White River. Some of these tributaries are used to subdivide the watershed for planning purposes. From upstream to downstream, the five major subwatersheds in the Fox River basin include the Upper Fox River, Mukwonago River, Middle Fox River, White River, and Lower Fox River subwatersheds. The City is located within the Middle and Upper Fox River subwatersheds.

[20] The subcontinental divide is the north-south boundary separating the Mississippi River and the Great Lakes - St. Lawrence River surface water drainage systems.

Map III-6
Surface Water Resources of Waukesha County



Floodplains

Floodplains are the wide, gently sloping areas contiguous to, and usually lying on both sides of, a surface water body, such as a stream or river channel. Floodplain areas often contain important natural resources, such as high-value riparian woodlands, wetlands, and refuges for wildlife. Given their significant environmental value, floodplains may often be compatible with passive, nature-based recreational uses, such as hiking, bird watching, and nature study.[21]

For planning and regulatory purposes, floodplains are normally defined as the areas adjacent to rivers, streams, and lakes that are subject to inundation during the 1-percent-annual-probability (100-year

[21] *Floodplain areas are generally not well suited to urban development, not only because of the flood hazard, but also because of the presence of high water tables and, generally, of soils poorly suited to urban uses.*

recurrence interval) flood event. While perennial rivers and streams typically occupy their channels, even minor flood events can cause stream discharges to exceed a stream channel's capacity.

Wetlands

Wetlands are areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support—and that under normal circumstances do support—a prevalence of vegetation typically adapted for life in saturated soil conditions.[22] Wetlands generally occur in depressions and near the bottom of slopes, particularly along lakeshores and stream banks, and on large land areas that are poorly drained. Wetlands may, however, under certain conditions, occur on slopes and even on hilltops. Wetlands in the City, shown on Map 6.X, covered about __ acres, or about __ percent of the City, in 2020.[23]

Wetlands perform an important set of natural functions that include supporting a wide variety of desirable, and sometimes unique, plant and animal life forms. An integral component of the hydrologic system, wetlands support groundwater recharge, promote water quality by filtering pollutants and storing sediments and contribute to stabilizing lake levels and the base flow of streams. Wetlands also reduce stormwater runoff by providing areas for floodwater impoundment and storage and protect shorelines from erosion.

Wetlands are generally unsuited or poorly suited for most agricultural or urban development purposes. Wetlands, however, have important recreational and ecological values. Wetlands contribute to flood control and water quality enhancement, since such areas naturally serve to store excess runoff temporarily, thereby tending to reduce peak flows and to trap sediments, nutrients, and other water pollutants. Additional important natural functions of wetlands which make them particularly valuable resources include the provision of breeding, nesting, resting, and feeding grounds and predator escape cover for many forms of

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[22] This definition of wetlands is that of the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, and the Southeastern Wisconsin Regional Planning Commission. This definition differs somewhat from the definition used by the Wisconsin Department of Natural Resources (WDNR), which defines wetlands as areas where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions. Application of either definition has been found to produce relatively consistent wetland identification and delineations in most situations in Southeastern Wisconsin.

[23] Tamarack swamps and other lowland wooded areas are classified as wetlands, rather than woodlands, because the water table is located at, near, or above the land surface and such areas are generally characterized by hydric soils that support hydrophytic (water-loving) trees and shrubs.

wildlife. In view of the important natural functions of wetland areas, continued efforts should be made to protect these areas by discouraging wetland draining, filling, and urbanization, which can be costly in both monetary and environmental terms.

As described in the previous edition of this report, SEWRPC published a plan delineating wetlands within and adjacent to the City of Waukesha, identifying wetlands regulated by state and federal agencies; presenting information on the types, functions, and values of wetlands; established recommendations for preserving specific wetlands through protective zoning or through public ownership; and presented implementation measures, including model wetland zoning provisions. wetlands shown on Map 3.__ differ from those in the aforementioned report as result of changes in land uses since completion of that plan and the most recent wetland inventory. As wetland boundaries may be expected to change further over time, wetland boundaries should always be verified by field inspection and survey before proceeding with any site-specific planning and development.

Woodlands

Woodlands are a significant component of the natural and urban environment. For planning purposes, woodlands are defined as upland areas one acre or more in size with minimum number of deciduous trees of a certain size per acre with 50 percent or more tree canopy coverage.[24] As shown on Map 6.X, woodlands occur in scattered locations throughout the City. Woodlands provide immeasurable scenic beauty and can host a variety of recreational opportunities. Woodlands also contribute to sustaining a diversity of plant and animal life by providing flora and fauna habitat. Under good management, woodlands can serve a variety of beneficial functions, including reducing heat islands and improving air and water quality. While woodlands may require a century or more to develop, they can be destroyed through mismanagement within a comparatively short time. Their destruction can cause extensive environmental damage and have significant economic repercussions. The deforestation of hillsides contributes to the destruction of wildlife habitat as well as to rapid stormwater runoff and the siltation of lakes and streams.

Grasslands and Shrublands

Grasslands and shrublands are open, treeless, or generally treeless areas dominated by native grasses that have important ecological and scientific value. There are four basic types of grasslands and shrublands: low

[24] Woodlands contain a minimum of 17 deciduous trees per acre each measuring at least four inches in diameter at breast height with 50 percent or more tree canopy coverage. Regional planning efforts also classify coniferous tree plantations and reforestation projects as woodlands while lowland wooded areas, such as tamarack swamps, are classified as wetlands.

prairie; mesic or moderately moist prairie; dry prairie; and oak openings, or savannahs.[25] Grasslands and shrublands once covered large portions of the City. Agricultural practices, urbanization, and the suppression of wildfires, which had served to restrain the advancing shrubs and trees that shade out prairie plants, have resulted in the near total loss of grasslands and shrublands in the City, and County. Eight small remnant grassland and shrubland sites exist along the Glacial Drumlin State Trail,[26] a 52-mile trail extending from the southwestern portion of the City to Cottage Grove, much of which is within a relatively undisturbed former railroad right-of-way. Though these remnant grasslands and shrublands are located outside of the City, this plan supports regional planning recommendations to protect these sites to ensure City residents can continue to enjoy the aesthetic, cultural, historic, educational, ecological, and scientific value of such sites.

Natural Areas and Critical Species Habitat Areas

[To be completed]

Environmental Corridors and Isolated Natural Resource Areas

One of the most important tasks under the regional planning program is identifying and delineating areas in which concentrations of the best remaining elements of the natural resource base occur. The resulting delineated areas are distinguished as environmental corridors and isolated natural resource areas based on several criteria. Important, high-value natural resources within environmental corridors and natural areas include rivers, streams, lakes and associated riparian buffers and floodplains; wetlands; woodlands; grasslands and shrublands; wildlife habitat areas; wet, poorly drained, and organic soils; and rugged terrain and high relief topography. Cultural, recreational, and natural resource-related features, including park and open space sites, natural areas, historic sites, and scenic viewpoints, are also considered in identifying and delineating environmental corridors and isolated natural resource areas.

Environmental corridors and isolated natural resource areas serve many beneficial purposes. These areas—and the resources that they contain—are of great importance both to the Region's environmental quality and to the Region's quality of life. Environmental corridors and isolated natural resource areas provide

[25] Low prairie typically occupies ancient glacial lake beds. Mesic/moderately moist prairie tends to occur on glacial outwash plains, the glacial till of recessional moraines, and the loessial, windblown depositional soils that cover dolomitic bedrock. Dry prairie occurs on well-drained soils, usually on steep hillsides. Oak openings or savannahs are dominated by dry prairie grasses, with one to 17 oak trees—usually bur oaks—per acre.

[26] Remnant grassland and shrubland sites are less than 5 acres each in size.

wildlife habitat; protect plant and animal diversity, including rare and endangered species; and provide dispersal corridors for the movement of wildlife and for the movement and dispersal of seeds for a variety of plant species. These areas can also promote water quality as they reduce soil erosion, filter runoff before it enters surface waters, attenuate flood flows and stages by storing flood waters away from developed areas, help maintain base flows of streams and watercourses, and facilitate the recharge and discharge of groundwater. Environmental corridors and isolated natural resource areas also abate air and noise pollution; provide outdoor settings that support opportunities for resource-oriented recreational, educational, and scientific pursuits; and maintain the Region's scenic beauty and natural heritage.

In considering the importance of preserving environmental corridors and isolated natural resource areas, it is worth acknowledging that, because of the many interacting relationships between living organisms and their environment, the destruction and deterioration of any one element of the natural resource base may lead to a chain reaction of destruction and deterioration. For example, destroying woodland cover may result in soil erosion and stream siltation, more rapid stormwater runoff and attendant increased flood flows and stages, as well as destruction of wildlife habitat. Although the effects of any single environmental change may not be overwhelming, the combined effects will eventually create serious environmental and developmental problems. Conversely, preserving environmental corridors and isolated natural resource areas can help avoid serious and costly developmental problems as such areas can contain wet, poorly drained soils, rugged terrain, and high relief topography and are generally poorly suited for urban development.

While this plan acknowledges the need to protect environmental corridors and isolated natural resource areas, it also recognizes that types of development can be accommodated while maintaining the overall integrity of the existing resources. Thus, this plan contains guidelines for development considered compatible with environmental corridors and isolated natural resource areas in Table 6.X. While guidelines in the table indicate that certain areas should be preserved, the guidelines do not indicate what measures may be used to assure preservation. Examples of preservation measures include public interest ownership, conservation easements, or land use regulations.

Primary Environmental Corridors

Primary environmental corridors are defined as areas containing concentrations of important, high-value natural resource elements within a linear pattern of relatively narrow, elongated areas that are at least 400 acres in size, two miles in length, and 200 feet in width. As they contain a composite of some of the Southeastern Wisconsin Region's best remaining woodlands, wetlands, and wildlife habitat areas, primary

environmental corridors have immeasurable environmental and recreational value. Thus, it is a principal objective of this plan to protect primary environmental corridors from intrusion by incompatible rural and urban uses, and thereby from degradation and even destruction.

Primary environmental corridors within the City as of 2020, shown on Map 6.X, encompass about ___ acres, or about __ percent of the City. As shown on the map, primary environmental corridors in the City are generally located along major or perennial streams, including the Fox River, Mill Creek, Pebble Creek, and Pebble Brook. The City's primary environmental corridors in the City also include the large wetland complexes associated with these and other, smaller, streams. Preservation of these primary corridors in an essentially open, natural state, including park and open space uses, will serve to maintain a high level of environmental quality, protect the City's natural beauty, and provide valuable recreational opportunities. Preserving primary environmental corridors will also avoid the creation of serious and costly environmental and developmental problems, such as flood damage, poor drainage, wet basements, failing pavements and structures, excessive infiltration of clear waters into sanitary sewers, and water pollution.

Secondary Environmental Corridors and Isolated Natural Resource Areas

Secondary environmental corridors are concentrations of significant natural resources at least 100 acres in area and at least one mile in length. Secondary environmental corridors generally connect with the primary environmental corridors and contain a variety of resource elements, often including remnant resources from primary environmental corridors that were developed for intensive urban or agricultural purposes. Secondary environmental corridors facilitate surface-water drainage, maintain pockets of natural resource features, and provide corridors for the movement of wildlife, as well as for the movement and dispersal of seeds for a variety of plant species.

Secondary environmental corridors in the City, shown on Map 6.X, are generally located along intermittent streams. In 2020, a total of about ___ acres, or about __ percent of the City, were encompassed within secondary environmental corridors. Such corridors should be preserved in essentially open, natural uses as urban development proceeds within the City, particularly when the opportunity is presented to incorporate such corridors into urban stormwater detention areas, associated drainageways, and neighbor-hood parks and open space.

The City also contains other important areas with smaller concentrations of natural resource base elements, such as pockets of wetlands, woodlands, surface water, or wildlife habitat. Separated from the environmental corridor network by urban development or agricultural uses and measuring at least five acres

in size, these areas are defined as isolated natural resource areas. Isolated natural resource areas have significant value. They may provide the only available wildlife habitat in an area, offer good locations for local parks and nature areas, and lend aesthetic character and natural diversity to an area. Important isolated natural resource areas within the City include a geographically well-distributed variety of wetlands, woodlands, and wildlife habitat. These isolated natural resource areas should be protected and preserved in a natural state whenever possible. Isolated natural areas are shown on Map 6.X. In 2020, isolated natural resource areas within the City encompassed a total of about ___ acres, or about __ percent of the City.

Climate

[To be completed]

Air Quality

[To be completed]

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