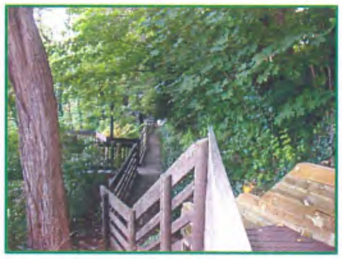
03-DG-11244225-427

Feasibility Study



The Urban Forest as a Biogenic Utility

City of Kent, Ohio

December, 2005

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Feasibility Study

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Reprinting of this handbook is encouraged with credit given to the above groups.

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Introduction

The importance of the urban forest in the City of Kent is more than the amenity value of the trees. While the trees provide important amenity values, such as shade, screening, and landscape ornamentation, they also perform the following beneficial functions that can be translated into economic value:

- Removal of air pollutants, including ozone (0_3), carbon monoxide (CO), sulfur dioxide (SO2), nitrogen dioxide (NO2), and particulate matter less than 10 microns (PM10)
- Decrease in energy costs *(e.g.*, shading and cooling effects of trees)
- Stormwater mitigation
- Carbon storage and sequestration
- Increase in property value
- Sociological and psychological values

City of Kent, Ohio
2005

Population: 27,906

Land Area: 9.22 square miles

City Parks: 300 acres

City Streets: 115 miles

Estimated Total of Street and Park Trees: 50,100

Estimated Total of Trees City-wide: 666,000

This project focused primarily on the environmental benefits of trees. The important sociological and psychological values, while documented in the literature, have not yet been modeled to accurately estimate economic value. Environmental functions of the urban forest can be estimated using field sampling techniques and mathematical models developed over the past two decades by United States Department of Agriculture (USDA) Forest Service research scientists. The science behind these models is sound and has been published in peer-reviewed journals. The challenge now is to apply the science to enhance the quality of life in our cities by improving the condition and extent of our urban forests.

The City of Kent is located in northeast Ohio in Portage County, approximately 40 miles southeast of Cleveland and 15 miles east of Akron.

This feasibility study explores the possibility of calculating the economic value of the beneficial functions trees perform and devising a funding mechanism to pay for these functions. The income generated would be used to manage and enhance the urban forest to meet goals of increased canopy cover within the City; thus, enhancing the quality of life of the residents. The rationale is that urban forests require planning, management, and oversight; they are not self-sustaining like natural forests.

Kent's public urban forest includes the trees located along the streets and trees in parks.

Urban forests require maintenance, such as pruning, plant health care, and removal of individuals that pose a threat to public health and safety. In addition, tree preservation and conservation efforts are essential tools for a community to ensure important trees and components of the urban forest are not destroyed without mitigation. Tree planting is also a critical component of long-term urban forestry management and requires careful planning and strategizing to maximize the benefits needed for a healthy city environment.

Another way to explain this notion is to view the urban forest as a *biogenic municipal utility* that provides important functions, such as removing air pollutants, mitigating stormwater runoff, and sequestering carbon dioxide, a key component of greenhouse gases causing global warming. As with other municipal utilities *(e.g.,* drinking water, wastewater, stormwater, and electricity), it can be argued that users need to support, or pay for, the functions of the urban forest in order to keep the system—the trees—sustainable and working properly. Enhancement and continual improvement of the urban canopy over time is not only desirable for aesthetic reasons, it is critical to long-term public health and well-being.

Viewing the urban forest in this new way requires a *paradigm shift—a* fundamental change in approach or assumptions. It changes the way we currently view trees in our cities and communities. Shifting from viewing urban trees as an amenity to viewing them as biogenic units that perform important biological and ecological functions will result in a cleaner and healthier environment for city residents and visitors.

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[1] *Webster's New Millennium™ Dictionary of English*, Preview Edition (v0.9.6) ©2003-2005 Lexico Publishing Group, LLC.

Methodology

This study used the following three tools to characterize the urban forest and natural areas within the city limits of Kent, Ohio:

- Environmental Health MatrixTM (EHM) developed by Davey Resource Group
- Urban Forests Effects Model (UFORE) developed by the USDA Forest Service Northeastern Research Station in Syracuse, New York
- Street Tree Resource Analysis Tool for Urban Forest Managers (STRATUM) developed by the USDA Forest Service Research Station in Davis, California

These tools were developed for specific uses and are not necessarily interchangeable. Each of the USDA Forest Service models —UFORE and STRATUM—was developed independently and uses different algorithms and assumptions. These models are currently in the process of being integrated into a suite of products referred to as iTree. For more information on these tools, please refer to www.itreetools.org.

Environmental Health Matrix

The EHM methodology was developed by Davey Resource Group to characterize areas of undeveloped land in a given jurisdiction in terms of ecological integrity and importance to maintaining public health and safety. It has been used primarily by local governments to minimize impacts of development pressure by prioritizing land acquisitions for preservation or conservation and justifying setback requirements to protect streams, wetlands, and other land use conditions.

To perform the EHM study for the City of Kent, each undeveloped area greater than 5 acres was defined as a polygon using a Geographic Information System (GIS) data layer. These polygons were then characterized based on vegetative type using aerial photographs. Representative segments of each vegetative type were examined in the field and characterized based on a set of criteria established to rate the ecological integrity of the area as well as the importance of the area in maintaining public health and safety. Each polygon or area was ranked for each criterion *(e.g.,* species diversity, importance to preventing erosion from stormwater run off, and degree of disturbance) and a total score was calculated. For a more detailed description of the methods used to perform the study, please refer to the complete EHM report included in Appendix A.

This tool will be useful to the City of Kent in planning for enhancement of total canopy cover because so much of the City's urban forest is on private land.

Urban Forests Effects Model

UFORE uses detailed, statistically based sampling and data collection protocols to estimate the structure and environmental effects and values of urban forests. This model is usually applied to all trees within a municipal or county boundary, but can be applied to a single tree or defined subsets of trees, such as street and park trees. This model was developed in the late 1990's by researchers at the USDA Forest Service's Northeastern Research Station in Syracuse, New York. Most of the results presented in this study for the City of Kent are from the UFORE analysis with the exception of stormwater runoff reduction estimates and associated economic value.

UFORE was used to examine the city-wide urban forest and two critical data subsets __the City's street trees and park trees. The city-wide study was based on data from 31 randomly selected 0.1-acre plots throughout the City. The park tree study was based on a 2 percent sample of park lands by acres using 0.1-acre plots. The street tree study was based on a 2 percent sample of all City blocksides.

The UFORE model performs the following analyses:

- Urban forest structure *(e.g.,* species composition, number of trees, diameter at breast height (DBH) distribution, tree health, leaf area, leaf and tree biomass, and species diversity)
- Pollution *(i.e., 0_3,* SO?, NO?, CO, and PM10) removed by the urban forest and associated percent of annual air quality improvement
- Urban forest volatile organic compound (VOC) emissions and the relative impact of tree species on net 0_3 and CO formation throughout the year
- Total carbon stored and net carbon annually sequestered by the urban forest
- Effects of trees on building energy use and consequent effects on carbon dioxide (CO?) emissions from power plants
- Compensatory, air pollution removal, and carbon storage and sequestration values of the urban forest

For more information on the UFORE field sampling procedures, please refer to http://www.ufore.org/UFORE_manual.doc. For detailed information on the methods used in the model to perform the UFORE analyses, please refer to www.ufore.org.

Street Tree Resource Analysis Tool for Urban Forest Management

STRATUM is a tool that quantifies the dollar value of annual environmental and aesthetic benefits of urban street trees. The model also determines if the accrued benefits of street trees outweigh their management costs. This model was developed by researchers at the Center for Urban Forest Research, University of California in Davis, California. In this study, STRATUM was used to estimate stormwater runoff reduction for street and park trees *(i.e.,* public trees) in the City of Kent.

For more information on the STRATUM field sampling protocols and methods used in the model to perform the analyses, please refer to www.cufr.ucdavis.edu/stratum.asp.

Table 1 summarizes how the above three tools were used for the City of Kent Feasibility Study.

Table 1. Summary of Tools Used in the City of Kent Feasibility Study

Tool	Study Area	Objectives
Environmental Health Matrix (EHM)	Undeveloped areas of the City greater than 5 acres	Ecological integrity Public health and safety assessment
Urban Forest Effects Model (UFORE)	City-wide urban forest Street trees Park trees	Air pollution mitigation Carbon storage and sequestration Energy savings Compensatory value
Street Tree Resource Analysis Tool for Urban Forest Management (STRATUM)	Street trees Park trees	Stormwater mitigation

Results

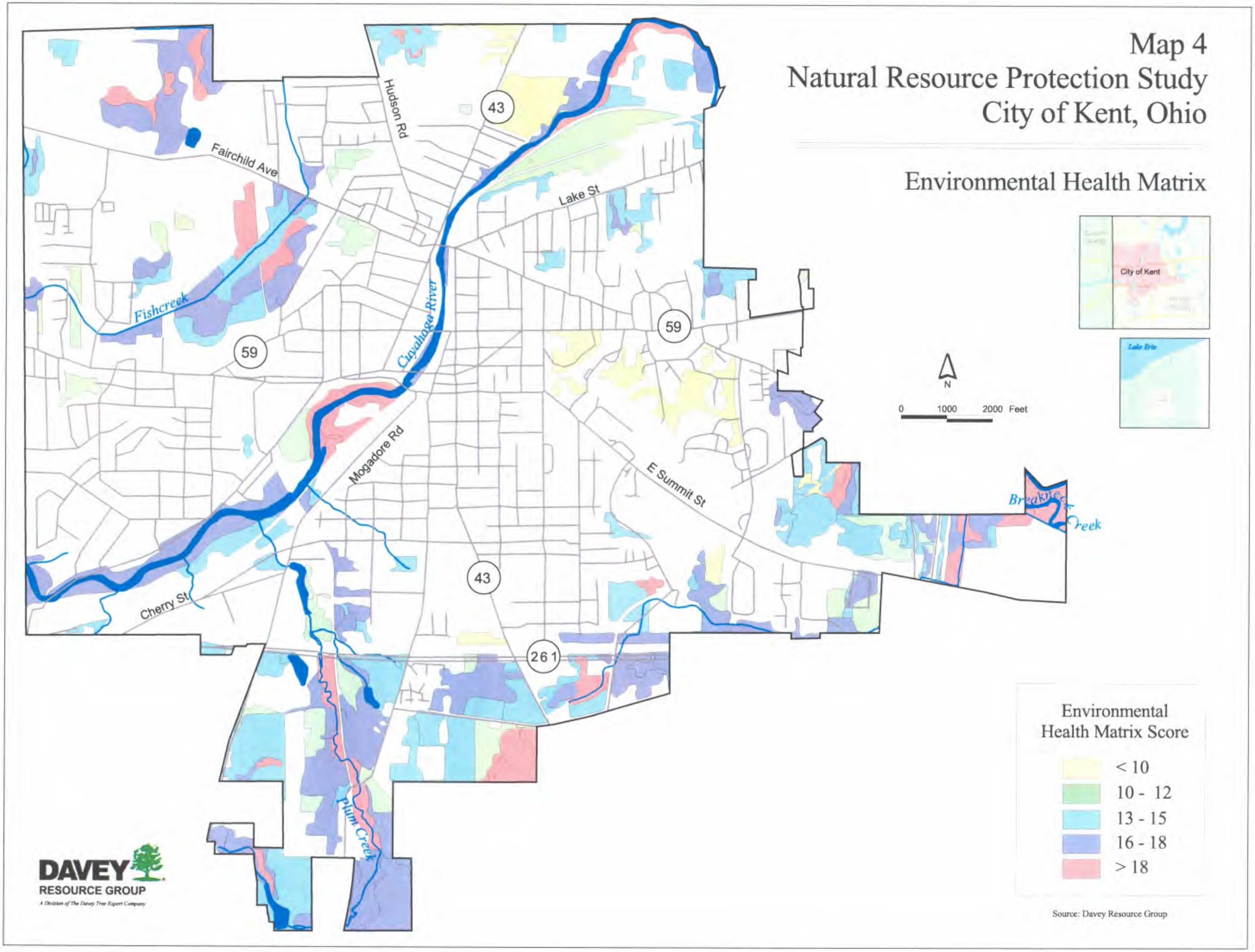
Environmental Health Matrix

Twenty-four percent of the land area in the City was mapped as open space and analyzed using the Environmental Health Matrix (EHM). Almost half (49 percent) of these areas received a high EHM score and 41 percent received a moderate score (Table 2). The high scoring areas were forests and/or wetlands. The lower scoring areas were parks and successional lands *(i.e.,* old fields and sapling/shrub thickets). The lower scoring areas indicate degraded natural areas such as areas in parks where management practices *(e.g.,* mowing) remove natural vegetation. The map indicating the composite scores and their locations is shown in Figure 1. For more detailed results of the EHM study, please refer to the complete report included in Appendix A.

The EHM can help the City prioritize the remaining natural areas for protection based on ecological health. Preservation efforts can be justified by the identified public health and safety functions these natural resources provide. This study can serve as a benchmark so that these urban ecosystems can be evaluated in the future to determine if policies have been effective in maintaining and improving the reaming natural areas.

Table 2. Summary of Results of the City of Kent EHM Analysis

EHM Score	Area of Vegetation Type (Acres)					Totals		
	Forests	Wetlands	Old Fields	Sapling/Shrub Thickets	Park	Area (Acres)	% of Study Area	% of City of Kent
Low (6-10)	3	0	15	6	118	142	10%	2%
Moderate (11-15)	292	58	151	95	11	607	41%	10%
High (16-21)	414	307	0	8	0	729	49%	12%
Totals	709	365	166	109	129	1,478	100%	24%



Map 4
Natural Resource Protection Study
City of Kent, Ohio
Environmental Health Matrix
City of Kent
Lake Erie
N
0
1000
2000 Feet
Environmental
Health Matrix Score
< 10
10 - 12
13 - 15
16 - 18
> 18
Source: Davey Resource Group
Hudson Rd
Fairchild Ave
Lake St
43
59
Fishcreek
Cuyahoga River
Mogadore Rd
E Summit St
Cherry St
261
Plum Creek
Breakneck Creek
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UFORE

Species Distribution

The species composition of trees in the City of Kent's urban forest—both public and private trees—is shown in Table 3.

Table 3. Species Composition of Kent's Urban Forest Based on UFORE

Urban Forest Component	Dominant Species	Other Species Present	
City-wide Urban Forest **Estimated 666,000 trees**	black cherry (28%) boxelder (9%) sassafras (9%)	chokecherry red maple white ash Norway maple	eastern white pine American elm eastern cottonwood 22 other species were noted
Street Trees **Estimated 8,800 trees**	crabapple (20%) honeylocust (15%) callery pear (15%)	eastern hophornbeam red maple	sugar maple 17 other species were noted
Park Trees **Estimated 41,300 trees**	black cherry (28% red maple (26%) gray birch (11%)	sassafras northern red oak white ash tree of heaven	boxelder American elm green ash 32 other species were noted

There are an estimated 666,000 trees in the entire City—including private trees. The dominant species throughout the City is black cherry *(Prunus serotina)* followed by boxelder *(Acer negundo)* and sassafras *(Sassafras albidum)*.

The estimated number of park trees is 41,300.The dominant park tree species is also black cherry followed by red maple *(Acer rubrum)* and gray birch *(Betula populifolia)*.

On the city streets, there are an estimated 8,800 trees. The dominant species are crabapple *(Malta* spp.), honeylocust *(Gleditsia tricanthos),* and callery pear *(Pyres calleryana)*.

Size Class Distribution

Tree size is the diameter of the trunk measured at 4.5 feet from the ground—referred to as diameter at breast height (DBH). The size class distributions and corresponding percentage of leaf area of the two data sets are shown in Figures 2 and 3. As trees become larger and have more branches and leaves, the leaf area increases. The leaf surfaces are where most of the biogenic activity occurs so leaf area is an important factor. Because leaf area is so important, especially in air pollution uptake, large trees play a dominant role as biogenic units.

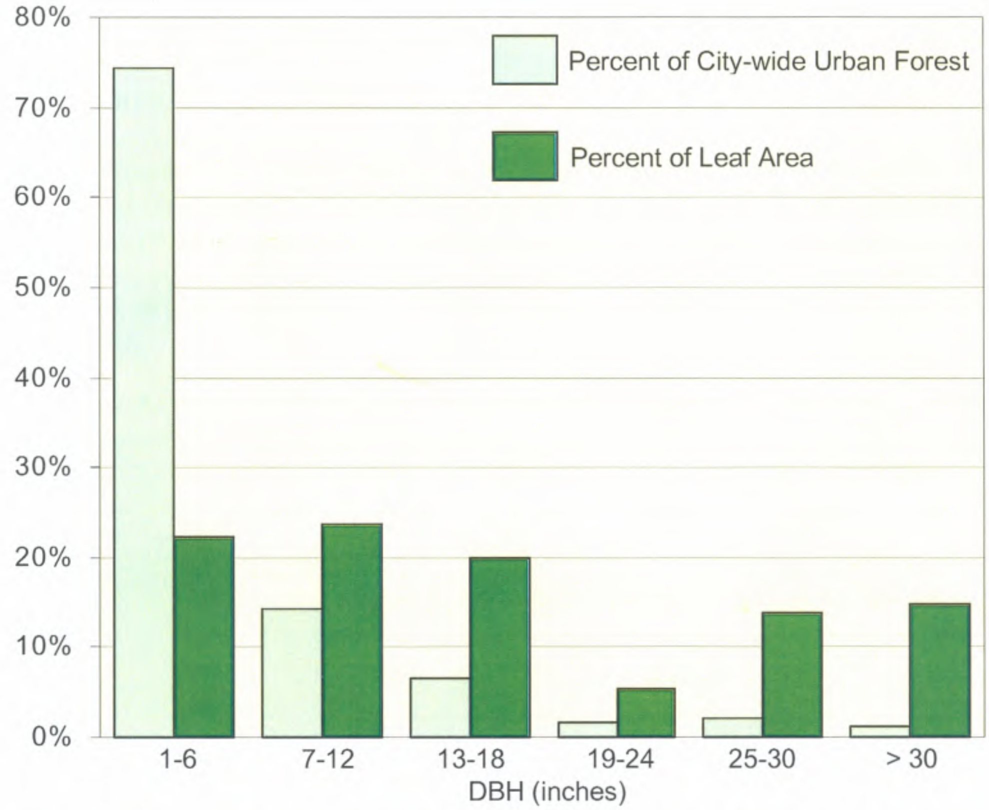

Figure 2. Size and Leaf Area Distribution in the City-wide Urban Forest

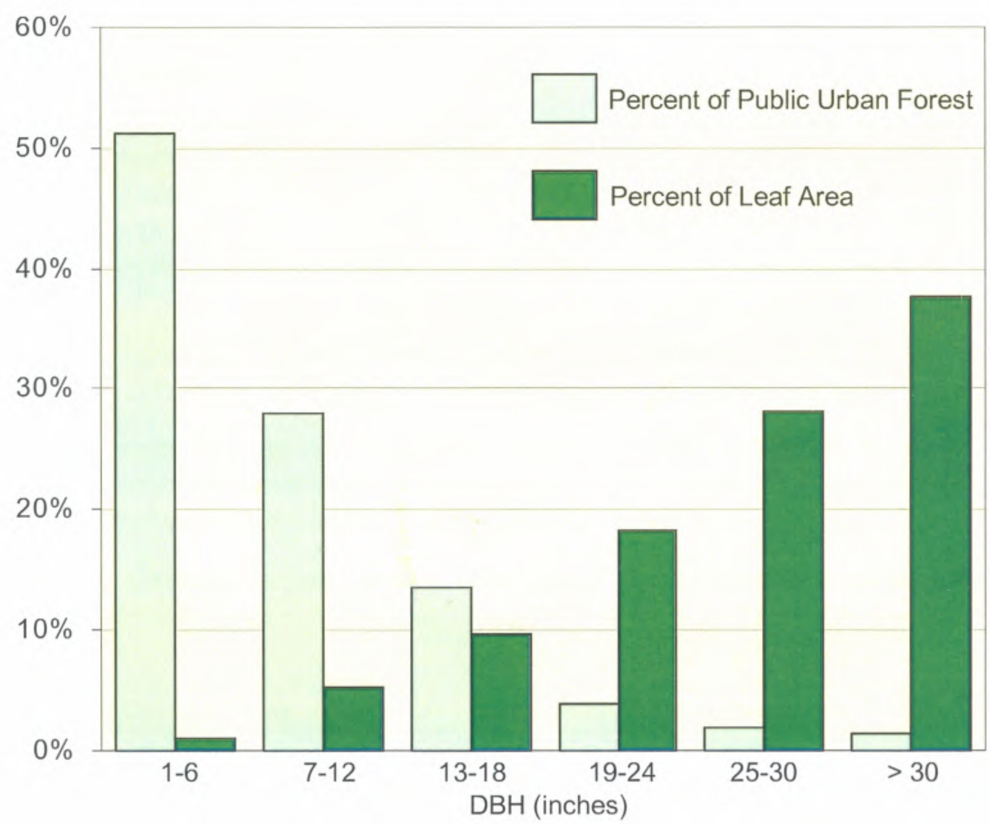

Figure 3. Size and Leaf Area Distribution in the Public Urban Forest

Air Pollution Removal

Trees remove air pollution by capturing the pollutants on the surface of the leaves and actually taking the pollutants into the leaf tissue via the stomata' where the pollutants are metabolized and removed from the air. The pollutants that have been studied in relation to trees are ozone (0_3), carbon monoxide (CO), sulfur dioxide (SO?), nitrogen dioxide (NO?), and particulate matter less than 10 microns (PM10). The results of air pollutant removal by trees in Kent are shown in Table 4. The annual removal rate of each pollutant in metric tons[3] is shown along with the monetary value of pollution removal using the median externality values for the United States for each pollutant.

Table 4. Annual Air Pollution Removal and Associated Economic Value

Sector	O_3	PM10	NO_2	SO_2	CO	Totals
City-wide Quantity (metric tons/year)	29.76	20.69	9.24	6.56	1.17	67.42
City-wide Value ($/year)	$200,892	$93,293	$62,392	$10,817	$1,128	$368,500
Street and Park Trees Quantity (metric tons/year)	2.50	2.08	0.84	0.55	0.11	6.08
Street and Park Trees Value ($/year)	$16,815	$9,371	$5,637	$895	$99	$32,800

The street and park trees contribute $32,800 annually in terms of air pollution removal most of which is due to ozone removal. Citywide, the value is much higher—about $370,000 annually—including all private trees as well as public trees.

Carbon Sequestration

Trees take up carbon dioxide during the process of photosynthesis. Most of this carbon is sequestered or stored in the plant's woody tissue. The rate of carbon dioxide uptake was estimated in this study and the results are shown in Table 5. Carbon is industrially traded in the world market in an attempt to slow the rate of accumulation of carbon dioxide (CO_2) in the atmosphere that causes global warming. The price per metric ton of carbon used in these models is $20.30.

Citywide, trees take up 2,713 metric tons of carbon annually valued at $55,100 per year. The public tree subset takes up 417 metric tons totaling a value of $8,460 per year.

These are net values that take into account respiration and other natural carbon emissions due to metabolic activity of the trees. Certain species, such as oaks *(Quercus* spp.) and sweetgum *(Liquidamber styraciflua),* are higher emitters than other species.

Table 5. Carbon Sequestered Annually and Associated Economic Value

	Carbon uptake (metric ton/year)	Economic Value ($/year)
City-wide Trees	2,713	$55,100/year
Street and Park Trees	417	$8,460/year

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[2] Stomata are microscopic pores in the epidermis, especially on the undersurface of the leaf.
[3] One metric ton is equal to 1.1023 tons (short, US).

Energy Savings

Trees provide shade in urban areas and, thus, decrease the amount of heat energy absorbed by roads, sidewalks, buildings, and other hardscape features. This results in lower temperatures than in urban areas where there are no trees. This overall cooling effect along with the direct shading of buildings by trees results in lower energy costs to cool buildings. Shaded buildings use approximately 20 percent less energy for air-conditioning. Trees also cool urban areas indirectly as leaves lose water through evapotranspiration and air moves under shaded tree crowns.

Residents in the City of Kent realize about $340,000 in annual energy savings by having trees in their yards and along the streets. The public park and street trees save residents about $100,000 annually.

Compensatory Value

Trees can be evaluated based on industry accepted appraisal methods that account for the species, size, condition, and location of the tree. These appraisal methods are used for insurance claims against losses due to trespass, vandalism, and accidents that destroy or partially damage landscape trees. The UFORE model estimates the compensatory value for all the trees in the City of Kent at $270 million and the public street and park trees at about $44 million.

STRATUM

Stormwater Mitigation

Trees reduce the volume of water from rainfall events that must be managed in urban areas. They slow the stormwater flow by intercepting rainwater on leaves, branches, and trunks. This net reduction in total volume and peak flow decreases the potential for flooding and reduces the amounts that stormwater control systems must handle. Cities can greatly benefit from increasing urban canopy cover and decreasing impervious surfaces as far as stormwater management costs are concerned. Ecologically, it is best if rainwater can infiltrate into the soil, groundwater, and natural streams and recycle back into the hydrological cycle without being piped or stored.

This study evaluated stormwater benefits from the public trees only—street and park trees. The model did not address the city-wide tree data. Based on the STRATUM results, the public trees intercept about 3,700,000 cubic feet of rainfall per year, resulting in an annual savings of $755,600. These are avoided stormwater management costs.

Annual Environmental Benefits and Costs of the Urban Forest

Table 6 summarizes the value of the benefits of the urban forest in the City. The entire urban forest provides an estimated total of $764,000 annually in environmental benefits, excluding the stormwater interception benefits, which cannot be calculated using the STRATUM model.

The public trees contribute annual benefits valued at $893,460 primarily due to stormwater interception, which is 85 percent of the total value. The City provided us with information on costs relating to urban forestry operations in the City—estimated at $236,500. This indicates a benefit to cost ratio of 4 to 1.

Table 6. Comparison of the Annual Benefits and Costs of Kent's Urban Forest

Environmental Benefits and Costs	***Citywide Urban Forest Benefits Based on 666,000 trees $/year***	***Public Tree Benefits Based on 50,100 trees $/year***
Air pollution reduction/mitigation	$368,500	$32,800
Carbon sequestration	$55,500	$8,460
Stormwater interception/mitigation	Not calculated	$755,600
Energy savings	$340,000	$96,600
Total Annual Public Tree Benefits	**$764,000**	**$893,460**
Total Annual Public Tree Program Costs	None	**$236,500**
Cost benefit ratio	Not applicable	4 : 1
Net Benefits	Not applicable	**$656,960**
Annual Contribution per tree	$1.15[1]	$17.83

[1]This value does not include stormwater interception/mitigation benefits.

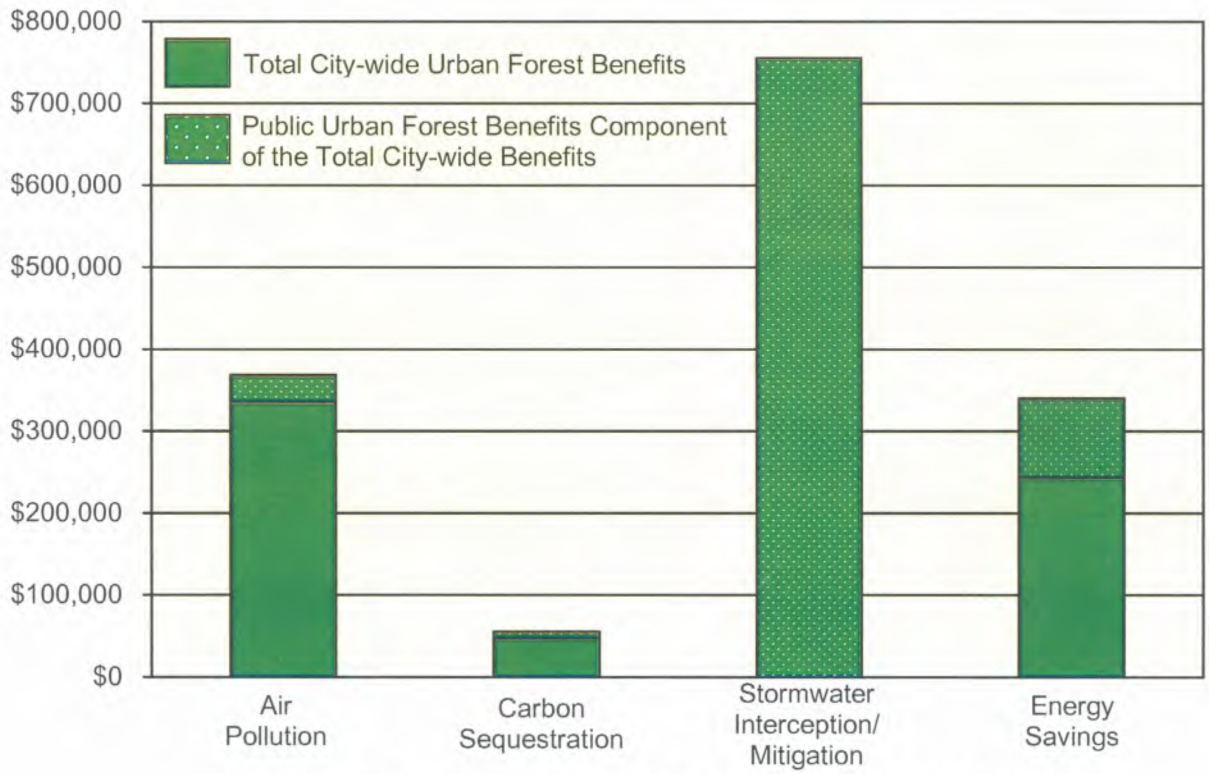

Figure 4. Summary of Annual Benefits of the Urban Forest

City-Wide Urban Forest

This study and analysis suggests there is justification for more attention and funding for urban forestry planning, design, management, and maintenance in the City. Planning for a greener and healthier City can begin by including urban forestry in all project discussions and considering creative ways to ensure the private and public tree canopy is kept healthy, safe, and enhanced by well planned planting projects.

The Environmental Health Matrix identified undeveloped areas that are important ecologically and are providing important health and safety functions. Approximately 729 acres or 12 percent of the undeveloped land area in Kent rates as having high ecological integrity and environmental importance. This information can be used to:

- Assist with site design reviews
- Develop stream and wetland set-back requirements (often included in NPDES Stormwater Phase II plans)
- Determine areas for future acquisition as open space
- Justify conservation development recommendations
- Encourage low-impact development practices

The structure and beneficial functions of all the trees in the City of Kent were quantified using scientific models to give an overview of the canopy and its value. When looked at in its entirety, the urban forest in the City contributes $764,000 in annual environmental benefits, not including stormwater benefits. The compensatory value of the trees is estimated at $270 million. It is clear that trees are important and contribute to the overall quality of life in the City. These data suggest that Kent should consider ways to increase canopy throughout the City—especially on private property—to increase the benefits enjoyed by the residents and visitors.

The majority of the urban forest is in private ownership. Enhancement of this component of the urban forest relies on public education, tree planting assistance programs, and incentives to plant appropriate trees in the landscape. Some cities have adopted ordinances empowering the city to plant trees on private property if certain conditions are met. Another approach is requiring tree preservation or canopy replacement when trees must be removed during subdivision development or lot redevelopment.

Public Urban Forest—Street and Park Trees

The environmental contribution of the public trees is estimated at $893,460 annually; an individual tree contributes an average value of $17.83 annually. The City is responsible for these trees. The costs currently incurred by the City relating to tree maintenance are about $236,500. This translates into a benefit to cost ratio of about 4 to 1. In other words, every dollar spent on urban forestry related issues results in environmental benefits worth $3.80.

Urban Forestry Program Funding

The purpose of this study is to examine the feasibility of establishing a biogenic public utility in the City of Kent. Such a public utility would allow for assessing fees based on the value of the benefits being provided by the trees. The funding would be used to plan, manage, maintain *(e.g.,* plant, trim, remove hazards, and perform other plant health care operations), and generally enhance the canopy cover of the public right-of-way, parks, and other city-owned trees. There are two methods the City of Kent could employ: establish a unique ordinance for a Biogenic Public Utility similar to the current stormwater utility; or roll the urban forestry functions in with the current stormwater utility. A comprehensive urban forestry management plan based on a complete inventory of the City's street and park trees should be prepared to establish yearly maintenance needs and to plan for future planting. This strategic planning would set the stage for establishing canopy goals, and improving species diversity and overall tree health in the City.

Establishing a Biogenic Public Utility

The justification to codify the establishment of such a utility and to codify fair and equitable rates to be paid to the City by residents is based on benefits that affect the public health and safety and quality of life of the residents—cleaner air, less flooding, reduced energy costs, and reduced carbon dioxide. The annual benefits of the street and park trees are estimated to be $893,460 for these functions. Over 10 years, assuming a minimum of sustainable canopy, the benefits add up to nearly $9 million. For example, if only 50 percent of the value of the benefits were used to justify assessments, Kent could assess and invest approximately $450,000 per year in the urban forestry program. A sample ordinance for a Biogenic Public Utility is in Attachment B. This idea has been discussed for about 10 years among urban forestry professionals as a logical approach for managing the green infrastructure in cities. This approach begins to bring needed attention and funding to the green infrastructure in cities to soften and quiet the landscape and improve health and welfare of residents.

Incorporating Urban Forestry into City Stormwater Utility

Another approach to funding the urban forestry program in Kent is to include urban forestry in the current stormwater utility program. This could be justified because the stormwater mitigation function of the public trees contributes 85 percent of the total estimated economic value calculated in this study. The current utility maintenance functions could include the urban forestry program as well as the traditional stormwater management operations.

Appendix A
Environmental Health Matrix, City of Kent, Ohio, 2004

Ecosystem Analysis of Significant Natural Areas

City of Kent, Ohio

July, 2004

DAVEY
RESOURCE GROUP
A Division of The Davey Tree Expert Company

Ecosystem Analysis of Significant Natural Areas

City of Kent, Ohio

July, 2004

Prepared by

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Appendix

Introduction

Davey Resource Group identified and quantified the environmental benefits of the natural resources in the remaining significant natural areas, including undeveloped lands and greenspaces, in the City of Kent, Ohio.

This study was performed with assistance from a National Urban and Community Forestry Council (NUCFAC) grant as a component of the *Feasibility Study: The Urban Forest as a Biogenic Utility* for the City of Kent.

The delineation of the study area is based on aerial photograph analysis of the remaining natural areas of the City of Kent. The study area encompasses 1,479 acres, which is approximately 25 percent of the City of Kent.

The ecosystem analysis methodology developed by Davey and used in this study is the Environmental Health Matrix (EHM). The EHM is based on indices similar to other federal and state indices used to measure ecological health, biological diversity, habitat, and environmental community functions, including: the Index of Biotic Integrity (IBI); the Invertebrate Community Index (ICI); the Quality Habitat Evaluation Index (QHEI); the Hilsenhoff Biotic Index; the River Continuum; Gap Analysis Program (GAP); and other measurement techniques that have been developed by ecologists.

The EHM estimates the value of land in terms of ecological integrity and public health and safety functions. These data are intended to provide planners and decision makers with qualitative information on the integrity and function of the City's natural resources. In addition, these data establish a benchmark so ecosystems can be evaluated in the future to determine if policies and efforts have improved, maintained, or degraded their ecological health.

The purpose of this study is to assist the City of Kent in the preservation of their natural resources. The goals of the study are to:

- Identify areas for preservation based on their high ecological integrity and public health and safety functions;

- Identify resources which provide a high level of public health and safety functions; and

- Identify opportunities for restoration throughout the City where the ecological integrity and the natural resources can be improved.

This report explains the methods and rationale used to develop the EHM. The methodology is followed by the results of the Davey study and recommendations for the City of Kent.

The EHM characterizes the current state of the natural resources and provides rationale for protecting environmentally sensitive areas. This natural resource study draws from the expertise of Davey scientists—wetlands ecologists, biologists, and botanists—to provide a comprehensive multidisciplinary approach to the collection of sound scientific data.

The EHM has two main components—ecological health and public health and safety functions. First, these two components were analyzed separately to examine the ecological health of the natural areas and the public health and safety functions provided by lands in the study area. Then, these data were combined to create a composite map that identifies lands in the study area that have high ecological value and provide increased public health and safety benefits to the City of Kent.

Analysis of aerial photographs identified areas based on vegetation communities and land cover of natural areas in the City. Numerous areas with a variety of vegetation communities and cover types were field-checked within all parts of the study area. Selection of these areas was based on size, natural features present, and accessibility form public access areas. The areas where on-site field verification was performed are identified in Appendix A.

The natural areas identified by aerial photograph analysis included forests, wetlands, sapling and shrub thickets, and old fields. These areas were qualitatively evaluated to develop the ecological health component of the EHM. Then, an analysis of public health and safety benefits was performed by assigning values to ecosystems based on the functions the land provides.

The final step of the EHM combined the ecological health values and the public health and safety functions values to establish one composite score for all the natural areas in the City of Kent.

Scores for ecological health and public health and safety functions represent objective qualitative values in a quantitative form based on best professional scientific judgment. These values reflect the importance of land areas to the natural environment and natural environmental processes.

Vegetation Mapping

Davey identified the vegetative cover of the remaining natural resources within the City of Kent using aerial photographs taken in 2000. Field reconnaissance of selected areas conducted in April, 2004 verified remotely sensed data (Appendix A). Vegetation cover types were classified for natural areas throughout the study area. A total of 166 different natural areas, totaling 1,479 acres, were identified and subsequently analyzed. After classifying the vegetative and land cover types, these data were entered into a Geographic Information System (GIS) database.

Natural Areas

Map 1 shows the following vegetative cover categories for natural areas identified by aerial photograph analysis.

Old Fields are primarily herbaceous upland vegetation areas. Most old fields were farmed or otherwise disturbed until recent years. This category was further sub-classified according to approximate age as follows:

- **Early old fields** and fallow agricultural fields contain all herbaceous vegetation.
- **Moderate old fields** are mostly herbaceous with some shrubs and saplings.
- **Late old fields** contain a mixture of herbaceous and woody vegetation (less than 50 percent woody vegetation).

Photograph 1. *This early old field is located on Meloy Road, north of Kent Bog.*

Forests are areas where deciduous trees are the dominant vegetation. This category was further sub-classified according to approximate age as follows:

- **Early Successional Forest**
- **Moderate Successional Forest**
- **Late Successional Forest**

Photograph 2. *Late successional forests, which provide important riparian buffers, are located along both sides of the Cuyahoga River in some areas of the City of Kent.*

Pine Forests usually consist of planted non-native conifers (except the native white pine), which generally occur in rows and are homogenous in nature.

Wetlands have standing water and/or saturated soils sufficient for the development of hydrophytic vegetation during the growing season. These areas were further sub-classified according to the following types:

- **Marshes** are dominated by emergent herbaceous vegetation and typically have standing water into the growing season.
- **Wet meadows** are dominated by herbaceous plants, seasonally inundated and/or saturated in spring and fall months, and typically dry during summer months.
- **Scrub/shrub wetlands** are dominated by shrubs and/or saplings.
- **Lowland woods** are wetlands that are forested.

Photograph 3. *This vernal pool is located within a lowland woods.*

Photograph 4. *Kent Bog is predominantly a shrub/scrub wetlands dominated by highbush blueberry and other shrubs, as well as tamarack trees.*

Sapling/Shrub Thickets are areas dominated by shrubs and/or saplings. Old fields with greater than 50 percent woody vegetation are also generally placed in this category. This category was further sub-classified according to approximate age as follows:

- Early successional sapling/shrub thicket
- Moderate successional sapling/shrub thicket
- Late successional sapling/shrub thicket

Parks contain areas of lawn and trees that appear to be in a park-like setting. Almost half of the park areas are located on the Kent State University campus; other park areas include the Standing Rock Cemetery, Fuller Park, Plum Creek Park, and The Davey Tree Expert Company headquarters.

Photograph 5. *Due to the high level of mowing and maintenance, the Standing Rock Cemetery was placed in the* Parks *vegetation and land cover category.*

Photograph 6. *The portion of Fuller Park along Middlebury Road contains mature trees; however, this area was classified as* Park *because of the maintenance activities such as mowing.*

Ecological Health

The variables of the ecological health component of the EHM measured the ecological integrity of the natural areas in the study area. The ecological health variables analyzed included:

- Species diversity
- Uniqueness of habitat
- Level of disturbance
- Hydrology
- Impact on adjacent areas

The 166 natural areas were ranked with a value of zero to four for species diversity, uniqueness of habitat, level of disturbance, and hydrology. A qualifier value of negative one, zero, or positive one was assigned to the impact on adjacent areas variable. The values were assigned as described below.

Species diversity refers to the number of different species inhabiting an area. It measures whether a monoculture or a rich mix of flora and fauna dominates habitats. The range of potential scores is zero to four. Zero indicates habitats dominated by a monoculture, and four indicates a rich mix of flora and fauna. Examples include:

- 0 — Agricultural fields
- 1 — Fallow fields with relatively few herbaceous species
- 2 — Even aged forests dominated by pioneer species *(i.e.,* little species diversity)
- 3 — Uneven aged forests with developed canopy and understory, diverse old fields with trees and shrubs, and intermixed streams and wetlands *(i.e.,* good species diversity)
- 4 — Natural forests and wetlands with good species diversity and a variety of habitat types

Uniqueness of habitat refers to the type of habitat, its scarcity relative to the remainder of the region, and its suitability to support a diversity of plant and animal species. This variable identifies the presence or absence of unique and valuable habitat essential for desirable wildlife. The range of potential scores is zero to four. Zero indicates little or no habitat available to wildlife, and four indicates unique and valuable habitats essential for desirable wildlife. Examples of the range of scores include:

- 0 — Little or no available habitat for desirable wildlife
- 1 — Limited cover or food sources for wildlife
- 2 — Mid-successional habitats with acceptable levels of cover
- 3 — Nearly mature successional habitats with a variety of cover and food sources
- 4 — Nesting or breeding ground for threatened or rare species, wildlife corridors, undisturbed mature forest, or high-quality wetlands

Level of disturbance refers to both human and natural disturbances present in an area. It considers the effect of human activities within the area and acknowledges human activities within adjacent regions that impact the environment of the subject area. The range of potential scores is zero to four. Zero indicates the greatest amount of human-induced disturbance, and four indicates the least amount of human-induced disturbance. Examples of the range of scores include:

- 0 — Recently disturbed *(e.g.,* clear-cut forest or agricultural field)
- 1 — Old fields, early successional habitats, and natural areas with significant recent disturbance
- 2 — Mid-successional habitats *(e.g.,* young forest and old fields, forests, **and** wetlands with some disturbance, such as selective logging and all-terrain vehicle use)
- 3 — Well-established natural communities with minimal disturbance
- 4 — Mature undisturbed natural areas

Hydrology considers the physical attributes of **an** area relative to the movement of water. It does not consider biological attributes of wetlands, such as wildlife habitat. The range of potential scores is zero to four. Scores are assigned according to the following classifications:

- 0 — Barren fields and open soil
- **1 —** Upland fields
- 2 — Forested upland without adjacent streams or wetlands
- 3 — Isolated wetlands and natural areas adjacent to streams
- 4 — Natural wetlands adjacent to streams serving as flood control basins

Impact on Adjacent Areas recognizes that land cover types may influence the quality of the environment in adjacent areas. This qualifier is used to assess impact on adjacent areas. Encroaching development and incompatible use of land next to natural areas necessitates evaluation of impacts. The threat to natural areas occurs when an urbanizing area surrounds a remaining natural resource. The potential scores are as follows:

- -1 — Characteristics of polygon negatively impact adjacent areas *(e.g.,* agricultural lands immediately adjacent to a wetland)
- 0 — Characteristics of polygon have no significant impact on adjacent areas *(e.g.,* a hardwood forest adjacent to a coniferous forest)
- +1 — Characteristics of a polygon positively influence adjacent areas *(e.g.,* a forest surrounding a wetland)

Scores were assigned based on the above scoring system for each natural area identified within the City of Kent (Appendix A). The aggregate score of each natural area is shown on the **Ecological Health** map (Map 2).

Public Health and Safety

The variables of the public health and safety functions component of the EHM were analyzed to illustrate landscape characteristics affecting public health and safety issues for the natural areas in the City of Kent. Values were assigned based on functions the ecosystem provided, including flood abatement, water quality protection, environmental functions *(i.e.,* stormwater retention), and functions of the vegetation *(i.e.,* oxygen production, carbon sequestering, and capture of air-borne particulates). Qualifier values of negative one, zero, and positive one were assigned to the 166 identified natural areas in the City.

To evaluate public health and safety issues related to environmental functions, the following metrics were analyzed:

- Erosion hazard and prevention
- Flooding hazard and prevention
- Buffering capacity to protect water quality
- Air quality

Erosion hazard and prevention evaluates the relationship between erosion potential and vegetative cover of an area. The value of vegetation for preventing erosion is greatest in areas of steep slopes— those approximately 12 percent or greater. These areas are in need of protection from development. Conversely, areas of gentle slopes and little vegetation, while still prone to erosion, may be best suited for development. Thus, a steep slope with little or no vegetation would score a negative one, while a steep slope with good vegetation cover would score a positive one. Nearly level areas receive a score of zero. The erosion hazard and prevention scores range from:

- -1 — Least vegetative value to erosion prevention and greatest erosion hazard
- 0 — Nearly level areas
- +1 — Greatest vegetative value to erosion prevention

Flooding hazard and prevention identifies areas with high flooding potential that retain floodwater and prevent flooding elsewhere. Flooding hazard is generally highest in floodplains and wetlands. Most wetlands are assigned high values for flooding hazard because they are found in the lowest landscape positions. Evidence of flooding *(e.g.,* drift lines, surface scouring, and scars on tree trunks from ice and floating debris) along with elevation in relation to the stream is considered in assigning flooding potential values. The flooding hazard and prevention scores range from:

- -1 — Impervious surfaces
- 0 — Uplands
- +1 — Wetlands and floodplains

Buffering capacity to protect water quality examines the relationship between an area's vegetation cover type and size and its ability to function as a buffer that protects the water quality of adjacent water features. Examples of scores include:

- -1 — Areas with no natural vegetation adjacent to a water feature *(e.g.*, an agricultural field bordering a permanent stream, pond, or wetlands)
- 0 — Areas not adjacent to water bodies
- +1 — Areas with natural vegetation bordering a permanent stream, pond, or wetlands

Air quality is a metric used to evaluate the effects of tree cover within the study area. Tree cover has a positive influence on air quality by removing pollutants, carbon sequestering, and oxygen production. The air quality scores range from:

- +1 — Tree canopy cover is 25 percent or greater
- 0 — Tree canopy cover is between 10 percent and 25 percent
- -1 — Tree canopy cover is 10 percent or less

Scores were assigned based on the above scoring system for all identified natural areas (Appendix A). The scores of each variable evaluated were aggregated and are shown on the **Public Health and Safety** map (Map 3).

Composite Environmental Health Matrix

The final step of the EHM combined the results of the ecological health scores and the public heath and safety scores to one aggregate score—the composite environmental health matrix score (Appendix A). Map 4 shows the **Composite Environmental Health Matrix Scores** for all land in the study area.

Natural Resources of the City of Kent

The City of Kent contains a variety of natural areas, which make significant contributions to the overall ecological health of the City and provide many public health and safety benefits to its residents (Map 1). Of the City's remaining natural areas, almost half is forested and an additional fourth is wetlands. The remaining natural areas are a combination of old fields, sapling/shrub thickets, and parks. The total acreage of each vegetation cover type is shown in Table 1.

Although most of the City of Kent is developed, significant natural areas remain. These areas are concentrated in the northwestern part of the City, between West Main Street and Fairchild Avenue, and in the southern part along Sunnybrook Road and Mogadore Road. Other scattered natural areas are also present, especially along the Cuyahoga River. Development pressure is high along Fairchild Avenue, but much of the remaining land here, and throughout the rest of the City, cannot be developed due to unstable soils, wetlands, or inaccessibility due to the Cuyahoga River and railroad tracks. The highest quality remaining natural areas are located along the Cuyahoga River and Sunnybrook Road and include a complex of woods, wetlands, and riparian areas as well as Kent Bog.

Table 1. Acreages of Vegetation Types

Vegetation Type	Size (Acres)	% of Study Area	% of City of Kent
Forest	**710**	**48%**	**12%**
Early Successional	223	15%	4%
Moderate Successional	320	22%	5%
Late Successional	138	9%	2%
Pine	28	2%	<1%
Wetlands	**365**	**25%**	**6%**
Marsh	122	8%	2%
Wet Meadow	5	<1%	<1%
Scrub/Shrub	130	9%	2%
Lowland Woods	108	7%	2%
Old Fallow Fields	**166**	**11%**	**3%**
Early	59	4%	1%
Moderate	58	4%	1%
Late	49	3%	1%
Sapling/Shrub Thickets	**109**	**7%**	**2%**
Early Successional	36	2%	1%
Moderate Successional	5	<1%	<1%
Late Successional	68	5%	1%
Park	**129**	**9%**	**2%**

Riparian Areas

The City of Kent contains significant riparian areas along the Cuyahoga River and Plum Creek. Most of the Cuyahoga River riparian corridor is protected as parkland and contains mature trees and wetlands. The Plum Creek riparian corridor contains extensive spring-fed wetlands and woodlands in the portion along Sunnybrook Road. Since most of these areas are not permanently protected, this riparian corridor may be under development pressure in the future. Although the wetlands will probably not be developed, the surrounding uplands may be in danger.

Forests

The remaining natural areas in the City of Kent are a mixture of upland woods and various wetlands. These upland woods contain red oak, white oak, green ash, pin oak, American elm, shagbark hickory, green ash, white ash, red maple, sugar maple, black cherry, American beech, and other tree species. These areas contain a variety of ages of trees, from saplings to mature trees. Because there is very little farming in Kent, some areas of young trees may have been farmed at one time and now have been left to naturally regenerate. There are several areas of planted pine and spruce trees within Kent.

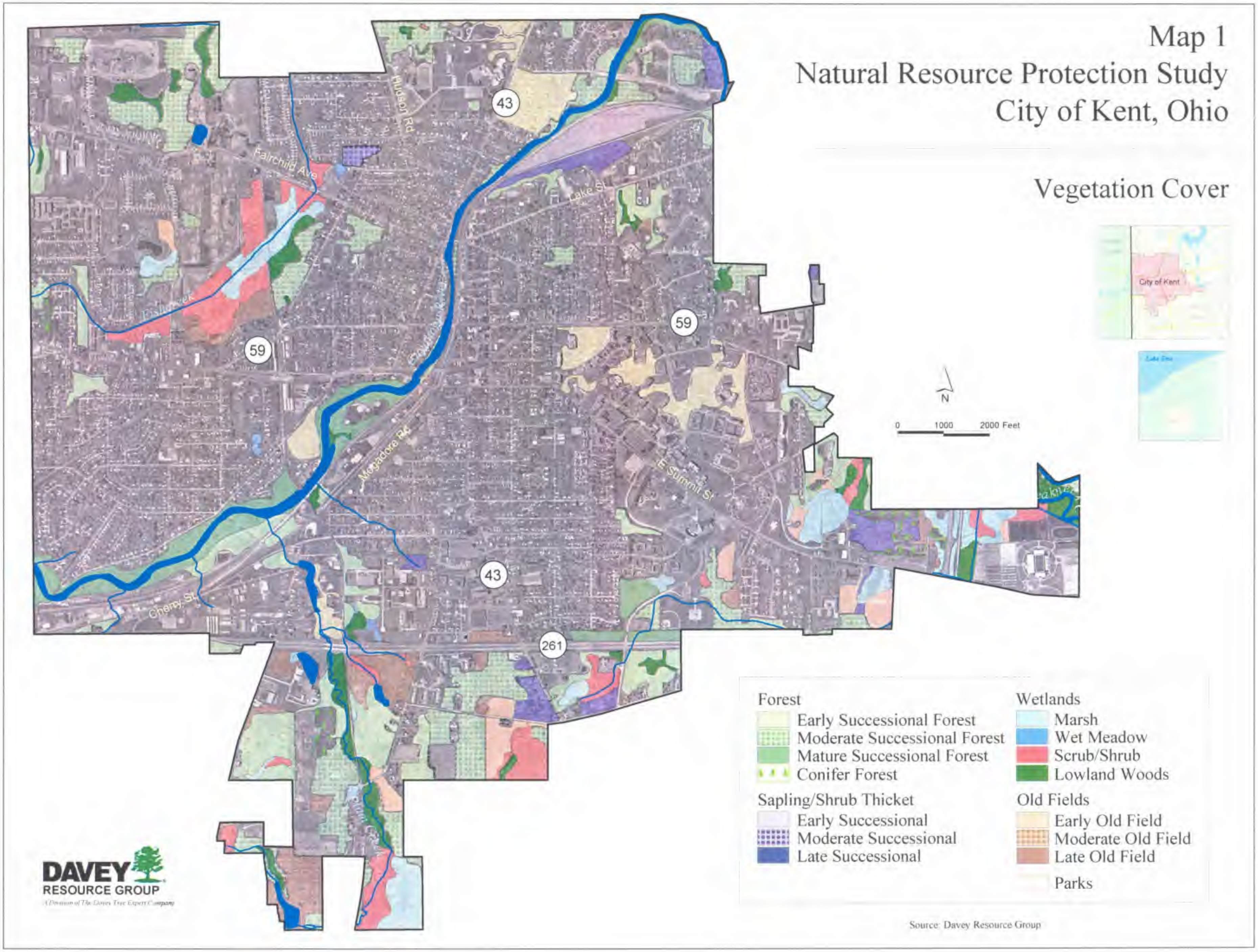
Forested areas within the wetlands and floodplains contain trees such as silver maple, green ash, pin oak, swamp white oak, black willow, sycamore, box elder, and American elm. Most of these woods tend to be somewhat younger and have more even-aged stands of trees. Farming likely occurred in many of these areas at one time. Many areas of the Cuyahoga River have a very narrow or nonexistent floodplain due to the sandstone bedrock in the area, which elevates the land surrounding the river.

Wetlands

Remaining wetlands in the City of Kent are concentrated along Plum Creek and Fish Creek. Plum Creek contains extensive, spring-fed, marshes, lowland woods, and scrub/shrub wetlands. These wetlands are some of the highest quality in the City. Kent Bog, a unique, protected natural area through the Ohio Department of Natural Resources, Division of Natural Areas and Preserves, is also located in this area.

The wetlands surrounding Fish Creek in the vicinity of Fairchild Avenue are of lower quality. Draining for agricultural use has altered these wetlands. The extensive muck soils in this area provide evidence that these wetlands were once much more extensive than what currently exists. Areas of marsh, wet meadow, scrub/shrub wetlands, and lowland woods still exist in this area. Extensive development is now occurring on the surrounding uplands, which will negatively impact the wetlands through sedimentation, stormwater runoff, and habitat fragmentation.

Other scattered wetlands are located throughout the City. Several wetlands located in the vicinity of Kent State University are mostly isolated by development. Small, isolated vernal pools, lowland woods, and scrub/shrub wetlands are found throughout the City, particularly in the area of Davey Tree and Kent School, between North Mantua Street and Hudson Road.


Map 1
Natural Resource Protection Study
City of Kent, Ohio
Vegetation Cover
43
59
43
59
261
Hudson Rd
Fairchild Ave
Lake St
Mogadore Rd
E Summit St
Cherry St
City of Kent
N
0 1000 2000 Feet
Forest
Early Successional Forest
Moderate Successional Forest
Mature Successional Forest
Conifer Forest
Sapling/Shrub Thicket
Early Successional
Moderate Successional
Late Successional
Wetlands
Marsh
Wet Meadow
Scrub/Shrub
Lowland Woods
Old Fields
Early Old Field
Moderate Old Field
Late Old Field
Parks
DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company
Source: Davey Resource Group

Ecological Health

This component of the EHM provides information to guide decisions regarding acquisition and protection of environmentally significant lands and restoration of ecologically degraded lands. Decision-makers and planners can prioritize lands to be set aside as open space, acquired, or restored by examining the relative ecological integrity ranking of each ecosystem.

Map 2 shows the composite ecological health scores for the City's natural areas. Table 2 shows the total acreage of areas identified in City of Kent that received high, moderate, and low ecological health scores, and Table 3 identifies the sizes of these areas with respect to vegetation type.

Table 2. Total Acreage of Low, Moderate, and High Scoring Areas for Ecological Health

Ecological Health Score	Area (Acres)	% of Natural Areas	% of City of Kent
Low (6 – 9)	174	12%	3%
Moderate (10 - 14)	846	57%	14%
High (14 - 17)	459	31%	8%

Table 3. Acreages of Vegetation Type with Low, Moderate, and High Ecological Health Scores

Ecological Health Score	Area of Vegetation Type (Acres)				
	Forest	Wetlands	Old Fields	Sapling/Shrub Thickets	Park
Low (6 – 9)	19	0	31	6	118
Moderate (10 - 14)	506	91	135	103	11
High (14 - 17)	184	274	0	0	0

More than half (57 percent) of the natural areas received a moderate ecological health score, and an additional 31 percent received a high score. The majority of the moderate scoring areas was forested, and all of the high scoring areas were either wetlands (60 percent) or forests (40 percent).

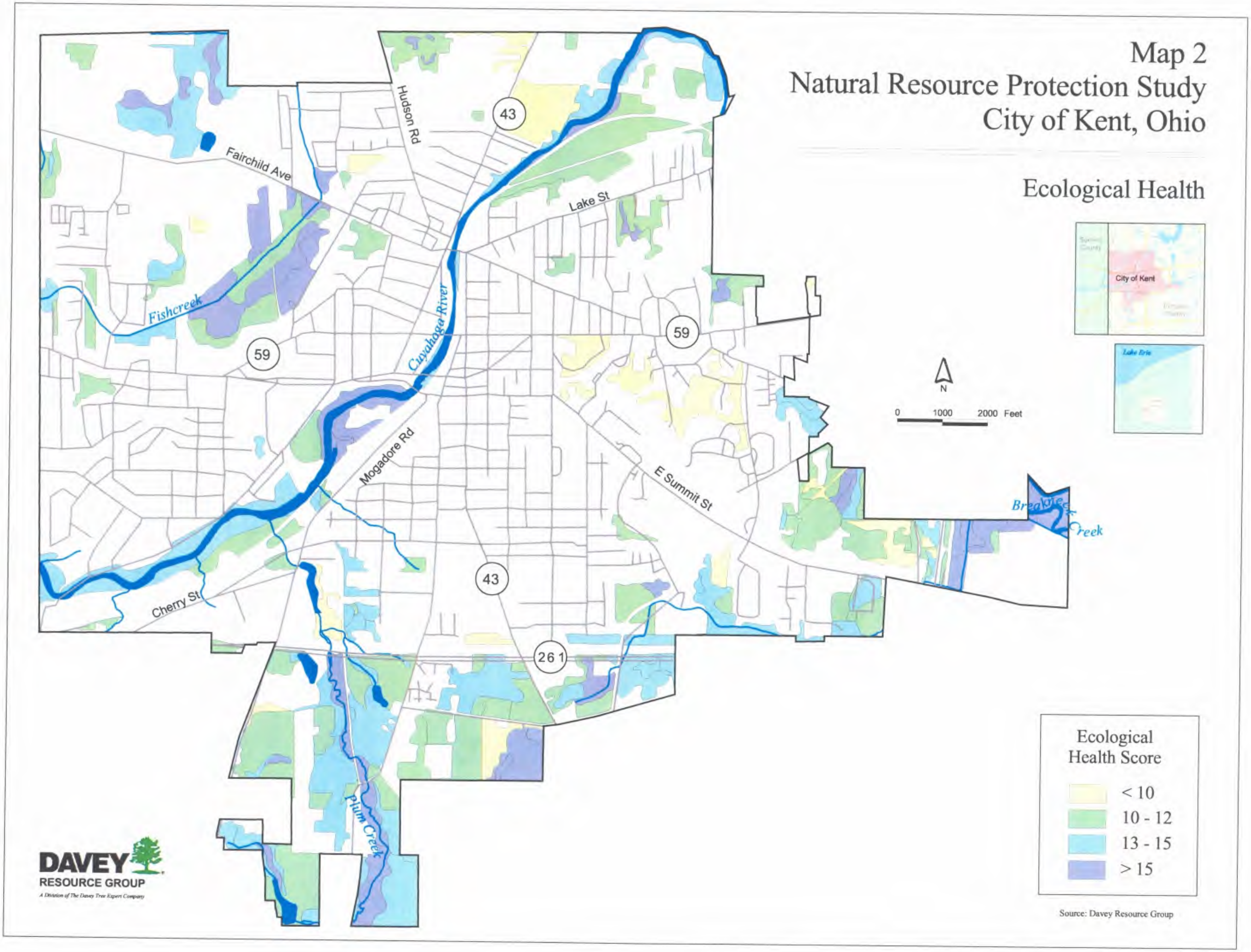
The composite ecological health map shows the relative ecological health of the natural areas in the City of Kent. The highest scoring areas are concentrated along the Plum Creek, Breakneck Creek, and Cuyahoga River riparian corridors. In addition, the Kent Bog wetlands and forest complex scored highly. These highest scoring areas are all wetlands or forests, are remarkable for their size, diversity, and, in many areas, are undisturbed.

The highest concentration of natural areas that remains in Kent are located south of Ohio 261, an area that is currently under high development pressure. The composite ecological health map can be used to show which areas are most worthy of protection as development occurs.

The majority of the remaining natural areas within the City of Kent have moderate ecological values. Smaller wooded areas and disturbed areas (e.g., by development or urbanization) scored somewhat lower than the pristine forests. Many of the wooded areas throughout the study area are similar in terms of ecological quality as reflected in the close scores these areas received in the analysis.

Low scoring areas are primarily the parks, including Kent Sate University, the Standing Rock Cemetery, and The Davey Tree Expert Company property. All of these areas are maintained by mowing and have little species diversity.

As land use and land cover change over time, the ecological health can be recalculated to reflect environmental impacts. Activities, such as conversion of natural wooded areas to subdivisions or parking lots, would significantly decrease the composite ecological health score over time; whereas, an increase in the composite ecological health score could be achieved by tree planting and increasing canopy cover by allowing natural succession to occur in the sapling/shrub thicket areas.


Map 2
Natural Resource Protection Study
City of Kent, Ohio
Ecological Health
City of Kent
Lake Erie
N
0 1000 2000 Feet
Ecological Health Score
< 10
10 - 12
13 - 15
> 15
Source: Davey Resource Group
Hudson Rd
Fairchild Ave
Lake St
Fishcreek
Cuyahoga River
Mogadore Rd
E Summit St
Cherry St
Plum Creek
Breakneck Creek
43
59
261
DAVEY
RESOURCE GROUP
A Division of The Davey Tree Expert Company

Public Health and Safety

Natural areas that can be protected based on public health and safety values include floodplains, wetlands, areas with high water tables, and areas subject to landslides. Other zones that can be protected include transition areas (*i.e.*, buffer zones), steep slopes, high ground water pollution potential areas, and aquifer recharge areas. In addition, tree cover and permeable surfaces reduce the incidence and severity of floods, reduce soil erosion, and improve surface and groundwater quality.

Map 3 identifies areas that provide the greatest public health and safety benefits. Table 4 shows the total acreage of areas identified in City of Kent that received high, moderate, and low public health and safety scores, and Table 5 identifies the sizes of these areas with respect to vegetation type.

Table 4. Total Acreage of Low, Moderate, and High Scoring Areas for Public Health and Safety

Public Health and Safety Score	Area (Acres)	% of Natural Areas	% of City of Kent
Low (0 – 1)	277	19%	5%
Moderate (2 – 3)	1,069	72%	18%
High (4)	133	9%	2%

Table 5. Acreages of Vegetation Types with High, Moderate, and Low Public Health and Safety Scores

Public Health and Safety Score	Area of Vegetation Type (Acres)				
	Forest	Wetlands	Old Fields	Sapling/Shrub Thickets	Park
Low (0 – 1)	38	3	49	58	129
Moderate (2 – 3)	554	318	117	51	0
High (4)	90	44	0	0	0

Almost three-fourths (72 percent) of the City's natural areas received a moderate public health and safety score, and 20 percent scored low. Most of the moderate scoring areas and all of the high scoring areas were forests and wetlands.

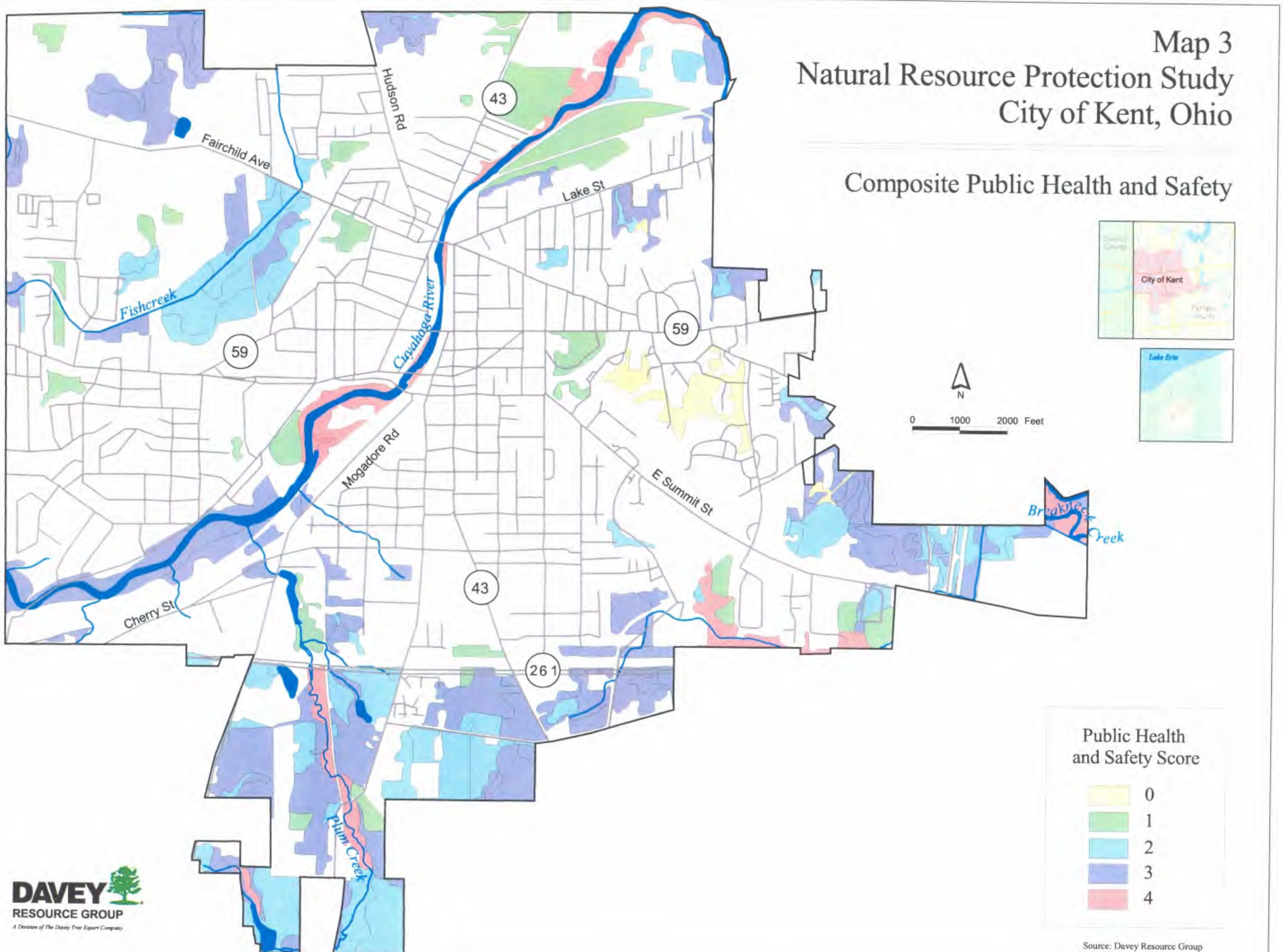
Public health and safety values are high within natural forested areas and wetlands and lowest within highly disturbed areas. The highest scoring areas tend to be wetlands with associated streams and floodplains as well as steeply sloping wooded areas. Forests and wetlands within the riparian corridors of the Cuyahoga River and Plum Creek consistently receive the highest scores throughout the City, indicating the need for protection of these areas.

Low scoring areas mostly include parks. The difference in the scores of these areas is due to the amount of recent disturbance, type of vegetation cover, and proximity to streams.

Many of the polygons received a moderate public health and safety value. These areas are typically natural areas that are not associated with streams or large wetlands systems and that do not have steep slopes.

Map 3
Natural Resource Protection Study
City of Kent, Ohio

Composite Public Health and Safety



Source: Davey Resource Group

Composite Environmental Health Matrix

Map 4 shows the composite EHM scores—a combination of the ecological health scores and the public health and safety functions scores—for natural areas in the City of Kent. This composite value provides a measurement of the environmental health. Table 6 shows the total acreage of areas identified in City of Kent that received high, moderate, and low EHM scores, and Table 7 identifies the sizes of these areas with respect to vegetation type.

Table 6. Total Acreage of Low, Moderate, and High Scoring EHM Areas

EHM Score	Area (Acres)	% of Natural Areas	% of City of Kent
Low (6 – 10)	142	10%	2%
Moderate (11 – 15)	607	41%	10%
High (16 - 21)	729	49%	12%

Table 7. Acreages of Vegetation Types with Low, Moderate, and High EHM Scores

EHM Score	Area of Vegetation Type (Acres)				
	Forest	Wetlands	Old Fallow Fields	Sapling/Shrub Thickets	Park
Low (6 – 10)	3	0	15	6	118
Moderate (11 – 15)	292	58	151	95	11
High (16 - 21)	414	307	0	8	0
Total	**709**	**365**	**166**	**109**	**129**

Almost half (49 percent) of the City's natural areas received a high EHM score, and 41 percent received a moderate score. The majority of the low scoring areas were located in the parks areas, and 99 percent of the high scoring areas were either forested or wetlands.

Low values of less than ten indicate degraded natural areas. These areas are primarily located in parks where management practices, such as mowing, remove natural vegetation. These areas provide very little ecological benefits compared to higher scoring areas mainly due to their lack of habitat, species diversity, and higher level of disturbance to the natural environment.

Moderate values ranging from 11 to 15 indicate an area has relatively intact flora and fauna but could be improved through selective management practices. Areas with moderate values include the majority of the identified old fields and scrub/shrub thickets. Of the forested areas identified, most were early successional.

High values are those that exceed 16. These areas are generally undisturbed, diverse natural areas that should be protected by focused natural resource management. All of the areas that received high values are wetlands and/or forested. Moderate successional forests, late successional forests, and lowland woods were the three most predominate vegetation cover types identified with high values.

Several large contiguous areas were identified that provide the greatest public health and safety value and maintain high ecological integrity. These areas tend be situated along Plum Brook, the Cuyahoga River, and Breakneck Creek. In particular, the large wetlands along Breakneck Creek and Plum Creek received high values. Other high scoring areas include the wetlands along Fish Creek and Fairchild Avenue, which are currently under high development pressure.

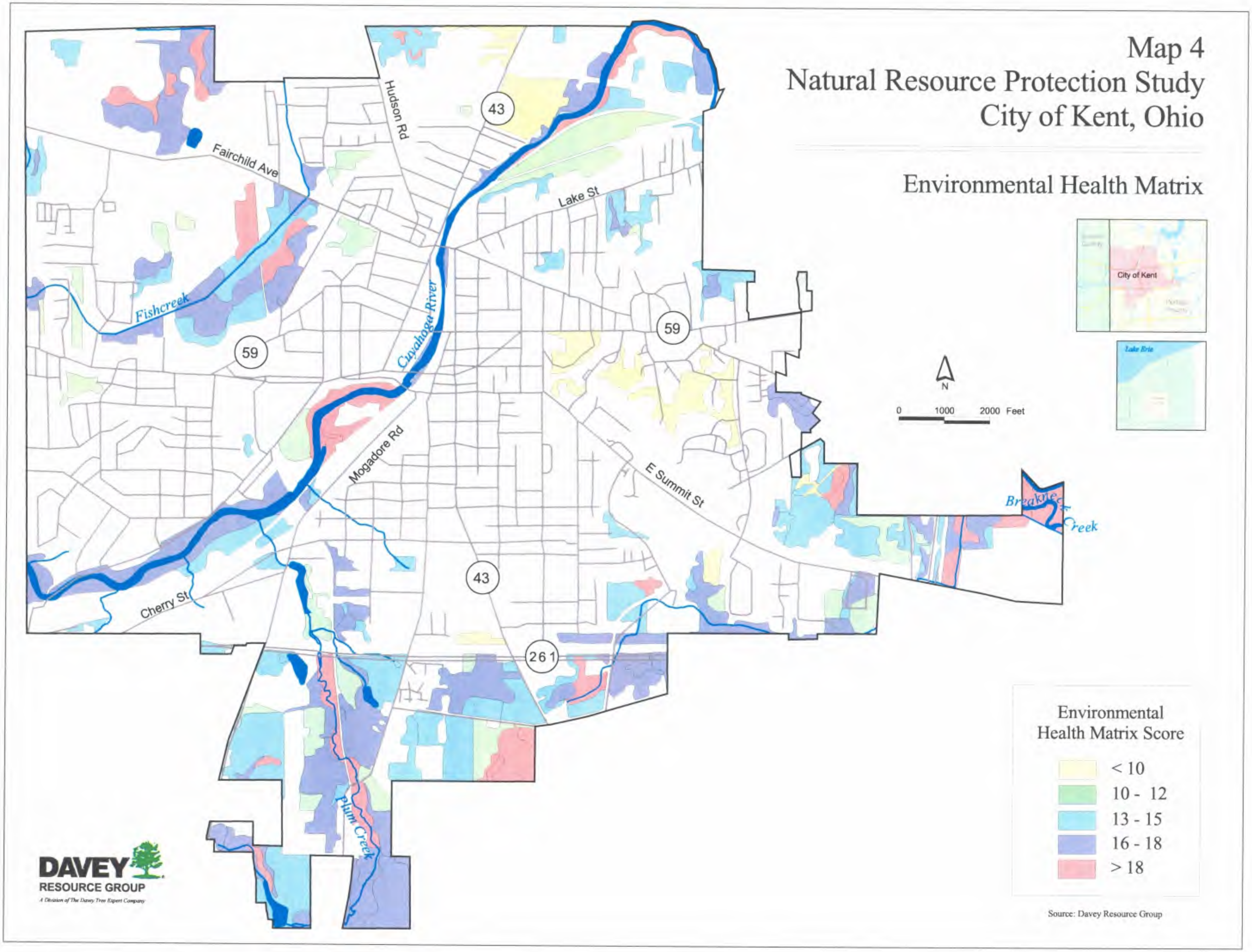
Photograph 7. *This early old field (polygon 65) scored a total EHM score of 11 mainly due to a lack of plant diversity and the presence of non-native plant species.*

Photograph 8. *This forested and shrub/scrub wetlands (polygons 59 and 62) is located along Plum Creek near Sunnybrook Road. These areas received high EHM values due to the buffer functions they provide for Plum Creek, high level of plant and animal diversity, and a lack of recent disturbance.*

Photograph 9. *This lowland woods (polygon 164) is surrounded by a late successional forest (polygon 28). This area is a diverse wetland with intact upland buffers, and serves as a buffer for the Cuyahoga River. It is located within Fred Fuller Park.*

Photograph 10. *This mature forest (polygon 8) received a high EHM score due to plant and animal diversity as well as the buffer functions it provides to adjacent natural areas.*

Photograph 11. *This mature forest (polygon 27) is located along the Cuyahoga River. Due to the presence of the mature, undisturbed woodlands, this high-quality riparian zone received a high EHM score.*


Map 4
Natural Resource Protection Study
City of Kent, Ohio
Environmental Health Matrix
Hudson Rd
43
Fairchild Ave
Lake St
Fishcreek
Cuyahoga River
59
59
Mogadore Rd
E Summit St
43
261
Cherry St
Plum Creek
Breakneck Creek
City of Kent
Lake Erie
N
0
1000
2000 Feet
Environmental Health Matrix Score
< 10
10 - 12
13 - 15
16 - 18
> 18
Source: Davey Resource Group
DAVEY
RESOURCE GROUP

Recommendations

The cumulative impacts of land use conversion not only led to a decrease in biodiversity and habitat loss but also decreased the ecological quality and quantity of the natural resources that provide important environmental functions. The remaining natural ecosystems in the City of Kent contain a reservoir of genetic diversity, prevent erosion and flooding, and provide recreation and tourism opportunities.

This ecosystem analysis assesses the current composition, integrity, and functions of natural resources within the City of Kent. These data can provide the City's residents and decision-makers with a better understanding of the quality and value of their natural landscape.

These data can be used to guide policy and regulation changes at the local level to protect the remaining natural resources in the City of Kent. The relative scores of these natural areas can be used to prioritize lands for protection through acquisition, conservation easements, and transfer or purchase of development rights.

Riparian Areas

A key issue identified as a result of this study for the City of Kent to focus on is the protection of existing high-quality riparian areas. Protection of these riparian areas can provide many benefits to the overall ecological health and public health and safety of the City. High-quality riparian corridors are generally wooded, have regions of wetlands and floodplains, and contain sensitive soils that maintain a buffering capacity to the waterway. These riparian areas are a critical component to avoiding flooding, erosion, sedimentation, increased stormwater runoff, and increased pollution of the City's water resources.

Restoration efforts of unvegetated streams and lower-quality riparian areas should be encouraged. In most cases, healthy vegetation can be reestablished in riparian areas by ceasing the existing maintenance practices. Woody vegetation will regenerate quickly through dispersion. Maintenance should be limited to the control of invasive plant species. Planting may be necessary in heavily disturbed areas that are prone to erosion. Any planting that is done should use only native species, preferably from the local area. Planted material will need to be maintained for the first few years until it becomes established. In approximately 20 years, a young forest could be established along these streambanks, greatly improving the ecological health of these riparian areas.

The environmental health matrix scores can be used to identify riparian areas that should be protected or restored. An effort should be made to have a continuous corridor of natural—preferably forested—vegetation throughout all riparian areas in the City of Kent. The long-term goal would be to have a nearly continuous natural wooded riparian corridor along all waterways. Much of this land is already in a natural state; however, the City should consider protecting the entire riparian corridor.

The riparian corridor along Plum Creek is composed of large contiguous wetlands systems and forests. These natural areas provide the highest quality riparian corridor in the City of Kent. Because of extensive wetlands, most of this land may be protected through federal and state regulations. To maintain the integrity of this land, at least some of the uplands surrounding the large wetlands complex should be preserved as well as the wetlands.

Only a small portion of the Breakneck Creek corridor is located within Kent. This area contains extensive, high-quality wetlands and also the well field for the City. The remaining natural areas here cannot be developed because of wetlands.

The Cuyahoga River riparian corridor consists of both natural and developed areas. Because of its location within the downtown area of Kent, restoration of significant riparian corridors along the Cuyahoga River would be very difficult.

Forested and Riparian Natural Areas Corridors

The forests throughout the City of Kent should be protected as they improve the quality of life in the City by reducing air pollution, urban heat island effect, soil erosion, and noise pollution, and creating wildlife and plant diversity. Trees in residential areas also conserve energy by shading and cooling structures and, thus, reducing cooling costs. Creating natural area corridors can connect fragmented forested areas to improve the ecological health and increase the public health and safety benefits they provide. Not only will these corridors improve the quality and quantity of forested areas, but they can also provide and expand on recreational opportunities for residents of the City.

Development of this system of corridors can be challenging for the City to achieve alone. Environmentally sensitive development within this system of corridors should be a priority. Even narrow wooded corridors provide valuable habitat for wildlife and connect fragmented natural areas. Landowners should be encouraged not to maintain fencerows and field boundaries, allowing these areas to become wooded. When development occurs, corridor protection should be incorporated into site plans.

The riparian areas of the larger drainageways, particularly Plum Creek, lend themselves to development of natural area corridors. Most of these corridors are naturally vegetated, with scattered developed areas. The focus within Kent should be preservation of existing high-quality riparian corridors. The developed areas along the streams, particularly the Cuyahoga River, do not present a feasible restoration opportunity in most areas.

Conclusion

A variety of high-quality natural ecosystems remain in the City of Kent. These ecosystems support the natural resources that provide the City with a multitude of benefits. The EHM prioritized natural lands for protection based on ecological health and justifies preservation efforts by mapping the public health and safety functions of developed and undeveloped lands in the study area.

The EHM process evaluated the current composition, integrity, and functions of the significant natural resource areas within the City. This evaluation of existing natural resources can provide decision makers with a better understanding of the natural landscape and the necessary data to implement natural resource management tools. These data can be used to:

- Prioritize the City's remaining natural areas for protection based on ecological health
- Justify preservation efforts by identifying the public health and safety functions of the City's natural resources
- Establish a benchmark so ecosystems can be evaluated in the future to determine if policies and efforts have improved, maintained, or degraded the environmental health of the City

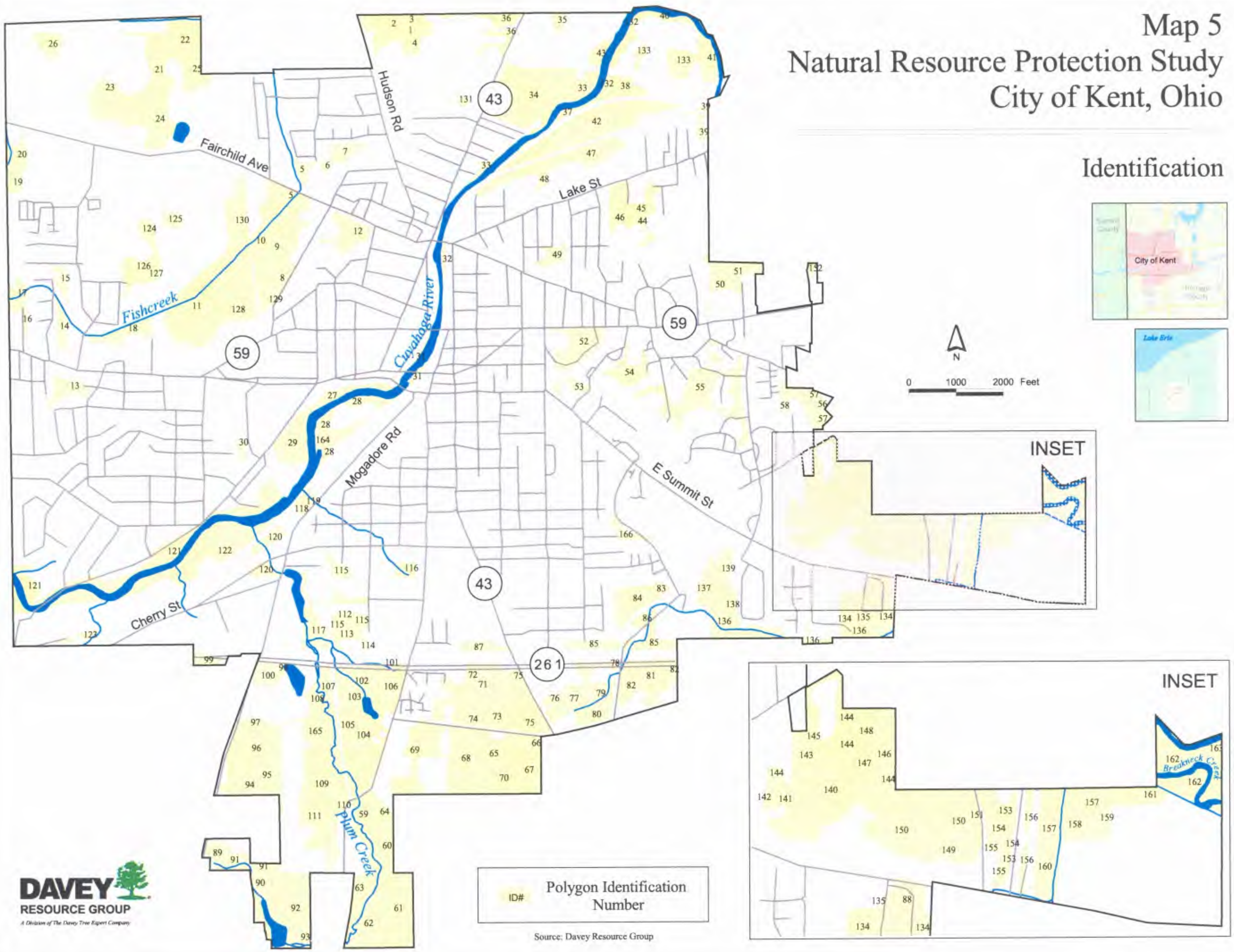
This study identified the qualitative value of ecological integrity and public health and safety functions of the City's natural resources. Over time, a combination of preservation and restoration efforts can improve the ecological integrity and public health and safety functions of the City's natural resources.

Appendix A

Environmental Health Matrix Polygon Identification and Values

Map 5
Natural Resource Protection Study
City of Kent, Ohio

Identification



The City of Kent Environemtal Health Matrix (EHM) Scoring Worksheet

Vegetation Cover Type Abbreviations

LW Lowland (Wetlands) Forest
MA Marsh
WM Wet Meadow
PSS Scrub/Shrub Wetlands

F1 Early Successional Forest
F2 Moderate Successional Forest
F3 Late Successional Forest
P Pine
PA Park

OF1 Early Old Field
OF2 Moderate Old Field
OF3 Late old field
S1 Early Successional Sapling/Shrub Thicket
S2 Moderate Successional Sapling/Shrub Thicket
S3 Late Successional Sapling/Shrub Thicket

Polygon #	Cover Type	Notes	Size	Level of Disturbance	Uniqueness of Habitat	Species Diversity	Impact on Adjacent Areas	Hydrology	Ecological Health Score	Erosion	Flooding	Water Quality Buffer	Air Quality	Public Health and Safety Score	Composite EHM Score
			(acres)	(0 to 4)	(0 to 4)	(0 to 4)	(-1 to 1)	(0 to 4)	(-1 to 17)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-4 to 4)	(-5 to 21)
1	F2	Field Checked	18.68	3	3	3	1	2	12	1	0	1	1	3	15
2	LW	Field Checked	1.14	3	4	4	1	4	16	0	1	1	1	3	19
3	PSS	Field Checked	0.33	4	4	4	1	4	17	0	1	1	0	2	19
4	LW	Field Checked	0.72	3	4	4	1	4	16	0	1	1	1	3	19
5	PSS	Field Checked	10.07	3	4	4	1	4	16	0	1	1	0	2	18
6	WM		1.22	2	2	2	1	4	11	0	1	1	-1	1	12
7	S2		5.38	2	2	2	1	2	9	0	0	0	1	1	10
8	F2	Field Checked	16.27	4	4	4	1	3	16	0	0	1	1	2	18
9	LW		9.96	4	4	4	1	4	17	0	1	1	1	3	20
10	MA	Field Checked	26.65	2	3	2	1	4	12	0	1	1	0	2	14
11	PSS		28.91	3	4	4	1	4	16	0	1	1	0	2	18
12	F2	Field Checked	10.19	2	3	3	1	2	11	0	0	0	1	1	12
13	F1	Field Checked	6.88	2	3	3	1	2	11	0	0	0	1	1	12
14	F1		4.88	2	3	3	1	2	11	0	0	0	1	1	12
15	F1		3.45	2	3	3	1	2	11	0	0	0	1	1	12
16	P	Field Checked	1.81	3	2	2	1	2	10	0	0	1	1	2	12
17	F2		4.67	3	3	3	1	4	14	0	1	1	1	3	17
18	PSS	Field Checked	8.28	2	3	3	1	4	13	0	1	1	1	3	16
19	F1	Field Checked	8.42	2	3	3	1	3	12	0	1	1	1	3	15
20	LW		1.00	3	3	3	1	4	14	0	1	1	1	3	17
21	LW	Field Checked	2.15	4	4	4	1	4	17	0	1	1	1	3	20
22	LW		7.43	3	4	4	1	4	16	0	1	1	1	3	19
23	LW	Field Checked	6.96	3	4	4	1	4	16	0	1	1	1	3	19
24	F2	Field Checked	45.98	3	4	4	1	3	15	0	1	1	1	3	18
25	F2		7.92	3	3	3	1	3	13	0	1	1	1	3	16
26	F2	Field Checked	6.23	3	3	3	1	2	12	0	0	0	1	1	13
27	F3	Field Checked	10.81	3	4	4	1	4	16	1	1	1	1	4	20
28	F3	Field Checked	15.84	4	4	4	1	4	17	1	1	1	1	4	21
29	PA	Fuller Park, Field Checked	11.04	2	3	2	1	2	10	0	0	0	1	1	11
30	WM		1.80	2	3	3	1	4	13	0	1	0	0	1	14
31	F2	Field Checked	3.87	2	3	3	1	4	13	1	1	1	1	4	17
32	F2	Field Checked	1.32	2	3	3	1	4	13	1	1	1	1	4	17
33	F2		13.90	2	3	3	1	4	13	1	1	1	1	4	17
34	PA	Cemetary, Field Checked	36.53	1	2	2	0	1	6	0	0	0	1	1	7
35	F1		2.23	3	3	3	1	2	12	0	0	0	1	1	13
36	PA	Davey, Field Checked	9.67	2	2	2	1	1	8	0	0	0	1	1	9
37	F3		4.50	3	4	4	1	4	16	1	1	1	1	4	20
38	F2		6.90	2	3	3	1	3	12	0	0	1	1	2	14
39	F1		3.35	2	3	3	1	3	12	0	1	1	1	3	15
40	F3	Field Checked	8.55	3	4	3	1	4	15	1	1	1	1	4	19
41	S3		7.85	3	3	3	1	4	14	1	0	1	1	3	17
42	S1		35.82	2	3	3	1	2	11	0	0	1	0	1	12
43	F1		3.82	2	3	3	1	4	13	1	1	1	1	4	17

Polygon #	Cover Type	Notes	Size	Level of Disturbance	Uniqueness of Habitat	Species Diversity	Impact on Adjacent Areas	Hydrology	Ecological Health Score	Erosion	Flooding	Water Quality Buffer	Air Quality	Public Health and Safety Score	Composite EHM Score
			(acres)	(0 to 4)	(0 to 4)	(0 to 4)	(-1 to 1)	(0 to 4)	(-1 to 17)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-4 to 4)	(-5 to 21)
44	OF3		1.12	2	3	3	1	1	**10**	0	0	0	0	**0**	**10**
45	F1	Field Checked	14.55	2	3	3	1	3	**12**	0	1	1	1	**3**	**15**
46	LW		2.81	3	4	4	1	4	**16**	0	1	0	1	**2**	**18**
47	S3		16.94	2	3	3	1	2	**11**	0	0	1	0	**1**	**12**
48	F1		5.12	2	3	3	1	2	**11**	1	0	1	1	**3**	**14**
49	F2		4.60	2	3	3	1	2	**11**	1	0	0	1	**2**	**13**
50	LW	Field Checked	3.23	3	4	4	1	4	**16**	0	1	0	1	**2**	**18**
51	F2	Field Checked	10.05	3	3	3	1	2	**12**	1	0	1	1	**3**	**15**
52	PA	KSU, Field Checked	14.55	1	2	2	0	1	**6**	0	0	0	1	**1**	**7**
53	PA	KSU, Field Checked	3.32	1	2	2	0	1	**6**	0	0	0	1	**1**	**7**
54	PA	KSU, Field Checked	9.57	1	2	2	0	1	**6**	0	0	0	0	**0**	**6**
55	PA	KSU, Field Checked	33.52	1	2	2	0	1	**6**	0	0	0	0	**0**	**6**
56	MA	Field Checked	4.65	3	4	3	1	4	**15**	0	1	1	0	**2**	**17**
57	F2	Field Checked	5.74	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
58	F1	Field Checked	2.56	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
59	LW	Field Checked	12.31	3	4	4	1	4	**16**	1	1	1	1	**4**	**20**
60	F2		9.49	3	4	3	1	3	**14**	1	0	1	1	**3**	**17**
61	MA	Field Checked	25.40	3	3	4	1	4	**15**	0	1	1	0	**2**	**17**
62	PSS	Field Checked	18.11	3	4	4	1	4	**16**	0	1	1	0	**2**	**18**
63	F2	Field Checked	2.90	2	3	4	1	3	**13**	1	0	1	1	**3**	**16**
64	OF1		7.07	2	2	3	1	2	**10**	0	0	1	0	**1**	**11**
65	OF1	Field Checked	13.97	2	2	2	1	2	**9**	1	0	1	0	**2**	**11**
66	F2	Field Checked	2.49	4	4	4	1	3	**16**	1	0	1	1	**3**	**19**
67	PSS	Kent Bog, Field Checked	19.12	4	4	4	1	4	**17**	0	1	1	1	**3**	**20**
68	F2	Field Checked	28.23	2	3	3	1	2	**11**	1	0	0	1	**2**	**13**
69	F1		10.97	2	3	3	1	2	**11**	1	0	0	1	**2**	**13**
70	LW	Kent Bog, Field Checked	1.98	4	4	4	1	4	**17**	0	1	1	1	**3**	**20**
71	F2	Mall Property, Field Checked	29.70	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
72	OF3	Mall Property, Field Checked	2.30	2	3	3	1	2	**11**	1	0	0	0	**1**	**12**
73	OF1	Mall Property, Field Checked	5.35	2	2	3	1	3	**11**	1	0	1	0	**2**	**13**
74	OF3	Mall Property, Field Checked	2.32	2	2	3	1	3	**11**	1	0	1	0	**2**	**13**
75	S3	Mall Property, Field Checked	14.78	2	3	3	1	3	**12**	1	0	1	1	**3**	**15**
76	F1	Meloy	7.46	2	3	3	1	3	**12**	1	0	1	1	**3**	**15**
77	MA	Meloy, Field Checked	4.30	3	3	3	1	4	**14**	0	1	1	0	**2**	**16**
78	LW	Meloy, Field Checked	1.03	2	3	3	1	4	**13**	0	1	1	1	**3**	**16**
79	PSS	Meloy, Field Checked	9.33	3	4	4	1	4	**16**	0	1	1	1	**3**	**19**
80	S3	Meloy, Field Checked	5.84	2	3	3	1	3	**12**	1	0	1	1	**3**	**15**
81	LW	Meloy	3.35	3	3	3	1	4	**14**	0	1	1	1	**3**	**17**
82	F1	Field Checked	18.54	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
83	MA		2.94	3	4	4	1	4	**16**	0	1	1	1	**3**	**19**
84	F3	Field Checked	10.41	2	3	3	1	2	**11**	1	0	1	1	**3**	**14**
85	F3	Field Checked	11.27	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
86	F2	Field Checked	4.75	2	3	3	1	3	**12**	1	0	1	1	**3**	**15**
87	OF2	Field Checked	4.84	2	2	2	1	1	**8**	1	0	0	0	**1**	**9**
88	MA	Field Checked	7.38	2	4	4	1	4	**15**	0	1	1	0	**2**	**17**
89	PSS	Field Checked	3.37	3	3	4	1	4	**15**	0	1	1	0	**2**	**17**
90	LW		3.27	3	4	4	1	4	**16**	1	1	1	1	**4**	**20**
91	F2		9.22	3	3	4	1	3	**14**	1	0	1	1	**3**	**17**
92	OF2		32.07	2	3	3	1	3	**12**	1	0	1	0	**2**	**14**
93	F1		3.04	3	3	3	1	3	**13**	1	0	1	1	**3**	**16**
94	MA		1.66	3	3	4	1	4	**15**	0	1	1	0	**2**	**17**
95	PSS		1.71	4	4	4	1	4	**17**	0	1	1	1	**3**	**20**
96	F1		34.07	3	3	3	1	2	**12**	1	0	1	1	**3**	**15**
97	OF2		3.06	2	2	3	1	1	**9**	1	0	1	0	**2**	**11**
98	MA		1.29	2	3	3	1	4	**13**	0	1	1	0	**2**	**15**
99	F1		3.18	3	3	3	1	2	**12**	1	0	0	1	**2**	**14**
100	OF3		6.23	2	3	3	1	2	**11**	1	0	1	0	**2**	**13**

Polygon #	Cover Type	Notes	Size	Level of Disturbance	Uniqueness of Habitat	Species Diversity	Impact on Adjacent Areas	Hydrology	Ecological Health Score	Erosion	Flooding	Water Quality Buffer	Air Quality	Public Health and Safety Score	Composite EHM Score
			(acres)	(0 to 4)	(0 to 4)	(0 to 4)	(-1 to 1)	(0 to 4)	(-1 to 17)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-1 to 1)	(-4 to 4)	(-5 to 21)
101	PSS		0.60	2	3	3	1	4	13	0	1	1	0	2	15
102	PSS		3.30	2	3	3	1	4	13	0	1	1	1	3	16
103	OF2		6.96	2	2	3	1	2	10	1	0	1	0	2	12
104	F1	Field Checked	25.04	3	3	3	1	3	13	1	0	1	1	3	16
105	MA		0.61	3	4	3	1	4	15	0	1	1	0	2	17
106	OF3	Field Checked	19.85	2	3	3	1	3	12	1	0	1	0	2	14
107	LW		12.45	4	4	4	1	4	17	1	1	1	1	4	21
108	F1		8.11	3	3	3	1	3	13	1	0	1	1	3	16
109	F2		29.60	3	3	4	1	3	14	1	0	1	1	3	17
110	MA		1.94	2	3	2	1	4	12	0	1	1	0	2	14
111	OF2		3.33	2	3	3	1	2	11	1	0	0	0	1	12
112	MA		0.53	2	3	3	1	3	12	0	1	1	0	2	14
113	LW		3.29	3	3	3	1	4	14	0	1	1	1	3	17
114	WM	Field Checked	1.76	2	3	3	1	4	13	0	1	1	0	2	15
115	F1	Field Checked	12.30	3	3	3	1	3	13	1	0	1	1	3	16
116	S3		3.35	2	2	2	1	3	10	0	1	1	1	3	13
117	PA	Plum Creek, Field Checked	10.79	2	2	2	1	2	9	0	0	0	1	1	10
118	LW		1.70	2	3	3	1	4	13	0	1	1	1	3	16
119	F1		1.72	2	3	3	1	3	12	0	1	1	1	3	15
120	F1		8.19	2	3	3	1	3	12	0	1	1	1	3	15
121	F3	Middlebury, Field Checked	76.74	3	4	4	1	3	15	1	0	1	1	3	18
122	F1	Field Checked	14.95	2	3	3	1	3	12	1	0	1	1	3	15
123	F1		2.63	2	2	3	1	3	11	1	0	1	1	3	14
124	OF1	Leasepark, Field Checked	3.89	2	3	3	1	2	11	1	0	0	0	1	12
125	F2	Field Checked	2.66	2	2	2	1	2	9	0	0	0	1	1	10
126	MA	Field Checked	5.81	3	4	4	1	3	15	0	1	0	1	2	17
127	F2	Field Checked	5.08	2	3	3	1	2	11	1	0	0	1	2	13
128	OF3	Field Checked	16.70	2	3	3	1	3	12	0	1	1	0	2	14
129	LW	Vernal Pool, Field Checked	0.33	4	4	4	1	3	16	0	1	0	1	2	18
130	PSS	Kamburoff	13.22	3	4	4	1	4	16	0	1	1	1	3	19
131	F1		1.12	2	3	3	1	1	10	0	0	0	1	1	11
132	LW	River Bend	3.98	3	4	4	1	4	16	0	1	1	1	3	19
133	F2	River Bend	9.38	2	3	3	1	2	11	1	0	0	1	2	13
134	OF1	Field Checked	14.41	2	2	3	1	2	10	1	0	0	0	1	11
135	S3	Field Checked	1.87	2	3	3	1	2	11	1	0	1	1	3	14
136	F2	Field Checked	27.00	3	3	3	1	4	14	1	1	1	1	4	18
137	PSS	Field Checked	1.23	2	3	3	1	4	13	0	1	1	0	2	15
138	OF2		3.21	2	2	3	1	2	10	1	0	0	0	1	11
139	OF1	Field Checked	5.85	2	2	2	0	2	8	1	0	0	0	1	9
140	MA	Field Checked	18.31	2	3	2	1	4	12	0	1	1	0	2	14
141	OF1	Field Checked	3.44	2	3	3	1	3	12	1	0	1	0	2	14
142	MA	Field Checked	0.89	3	3	3	1	4	14	0	1	1	0	2	16
143	P		1.51	3	2	3	1	2	11	1	0	1	1	3	14
144	F1		11.85	2	3	3	1	3	12	1	0	1	1	3	15
145	OF1		3.09	2	2	3	0	2	9	0	0	0	0	0	9
146	LW		4.50	3	4	3	1	4	15	0	1	1	1	3	18
147	PSS		4.17	3	4	4	1	4	16	0	1	1	1	3	19
148	LW		2.72	3	4	4	1	4	16	0	1	1	1	3	19
149	P		14.28	2	2	2	1	2	9	1	0	1	1	3	12
150	S3		16.50	2	3	3	1	2	11	1	0	1	1	3	14
151	OF2		2.30	2	3	3	1	2	11	1	0	1	0	2	13
152	S3		1.08	2	2	2	1	1	8	1	0	0	1	2	10
153	MA		5.39	2	4	3	1	4	14	0	1	1	0	2	16
154	P		1.70	2	2	2	1	2	9	1	0	1	1	3	12
155	OF2		2.67	2	3	3	1	3	12	1	0	1	0	2	14
156	MA		3.02	2	3	2	1	4	12	0	1	1	0	2	14
157	MA		11.34	3	4	4	1	4	16	0	1	1	0	2	18

Polygon #	Cover Type	Notes	Size	Level of Disturbance	Uniqueness of Habitat	Species Diversity	Impact on Adjacent Areas	Hydrology	Ecological Health Score	Erosion	Flooding	Water Quality Buffer	Air Quality	Public Health and Safety Score	Composite EHM Score
			(acres)	*(0 to 4)*	*(0 to 4)*	*(0 to 4)*	*(-1 to 1)*	*(0 to 4)*	*(-1 to 17)*	*(-1 to 1)*	*(-1 to 1)*	*(-1 to 1)*	*(-1 to 1)*	*(-4 to 4)*	*(-5 to 21)*
158	PSS		4.12	4	4	4	1	4	**17**	0	1	1	1	**3**	**20**
159	OF1		1.75	2	3	3	1	3	**12**	1	0	1	0	**2**	**14**
160	LW		6.05	3	4	4	1	4	**16**	0	1	1	1	**3**	**19**
161	PSS		4.37	3	4	4	1	4	**16**	0	1	1	1	**3**	**19**
162	LW		14.01	4	4	4	1	4	**17**	1	1	1	1	**4**	**21**
163	F2		3.19	4	4	4	1	3	**16**	1	0	1	1	**3**	**19**
164	LW	Field Checked	1.64	3	4	4	1	4	**16**	1	1	1	1	**4**	**20**
165	P		9.09	3	2	2	1	2	**10**	1	0	0	1	**2**	**12**
166	F1		4.44	2	3	3	1	2	**11**	1	0	0	1	**2**	**13**

Appendix B
Davey Resource Group Personnel Profiles

Ana Burns, M.S.E.S. (Project Manager), is a biologist responsible for project management, data analysis, and report writing for ecological surveys, watershed studies, park inventories, and other projects. She has managed multiple 401/404 permitting projects along with numerous natural resource inventory and planning projects. Ms. Burns is knowledgeable of state and federal stream and wetlands regulations, all aspects of Section 401 and 404 permitting, isolated wetlands regulations, and compensatory mitigation for unavoidable impacts to streams and wetlands. She has reviewed and assessed erosion and sediment control plans and is familiar with NPDES regulations. In addition, Ms. Burns has provided assistance with grant writing and managing grant funded projects and has experience in aerial photograph interpretation and geographic information systems (GIS). She joined Davey Resource Group in August, 2002 after working for three years as an environmental planner for a county planning department. In this position, she gained valuable experience in facilitating public meetings, developing educational outreach materials, and assisting the Planning Commission and their subcommittees in implementing and enforcing comprehensive plans and zoning ordinances. Ms. Burns also served as the primary liaison for the Historic Preservation Board in her community. Ms. Burns graduated from Indiana University with a Bachelor of Science degree in biology, and holds a Master of Science degree in environmental science from IU's School of Public and Environmental Affairs.

Michael R. Binkley, M.A., GIS Project Manager, is a Geographic Information Scientist with ten years of experience applying GIS technology to environmental analysis and natural resource management. Mr. Binkley maintains extensive knowledge of contemporary GIS software as well as their common operating system software and hardware platforms. In addition, he is an experienced programmer with emphasis on Visual Basic and various GIS programming languages. Mike currently supervises GIS operations at Davey. Mike received a master of arts in geography and a bachelor of science with honors in natural resource conservation with minors in climatology and geography from Kent State University. Mike is also a member of several professional organizations; these affiliations include the American Society for Photogrammetry and Remote Sensing, Association of American Geographers, Ohio Academy of Science, American Geophysical Union, and the Water Resources Research Institute.

Elizabeth Buchanan, Ph.D., Manager of Biological Services, oversees the urban forestry consulting services at Davey Resource Group. This includes the Urban Forestry Solution work group, the Municipal Urban Forestry work group, and the Natural Resources Consulting work group. She has extensive experience with urban forestry consulting over the past 20 years. Her clients have included the City of Vancouver, BC; Providence, RI; Mobile, AL; and Winter Park, FL, among others. She has been involved in the conceptual design of various urban forestry management software systems and has performed operations reviews of urban forestry programs. She performs tree appraisals and has served as expert witness on tree litigation cases. She is currently the project manager for the Tree Preservation contract for the Architect of the Capitol's Capitol Visitor's Center construction project. Dr. Buchanan reports to the Vice President and General Manager of Davey Resource Group and is responsible for managing operating work groups and business development. She holds a bachelor's degree, a master's degree, and a doctorate in biology, with an emphasis in botany. Her role is business development and project quality control to ensure client satisfaction. She is a Board Certified Master Arborist (OH-0639B) and a member of the American Society of Consulting Arborists. She is a volunteer on several committees for the International Society of Arboriculture.

Kenneth John Christensen is a biologist with more than 23 years of experience in the natural resource field. Mr. Christensen assists in plant surveys and wetlands delineations and in the field identification of vertebrate populations, especially amphibians, reptiles, and mammals. He currently holds a permit from the State of Ohio to conduct mist-netting surveys for the federally endangered Indiana bat *(Myotis sodalis).* Proficient with AutoCAD software, Mr. Christensen is responsible for managing the GPS data collection and AutoCAD mapping operations for all natural resource studies. As a *Certified Arborist* by the International Society of Arboriculture, he performs tree appraisals and inventories and also develops tree preservation plans. Mr. Christensen has been involved in all aspects of wetland and stream restoration projects, including design, planting, and implementation. He is also involved with the subsequent monitoring of mitigation and restoration projects to ensure that such endeavors reach an expected successful conclusion. Mr. Christensen has also completed training through the Ohio Environmental Protection Agency (EPA) for the following: Headwater Habitat Evaluation Index (HHEI) and Ohio Rapid Assessment Method (ORAM) v5. Clients for these mitigation, stream restoration, and tree preservation projects have included the Ohio Wetlands Foundation, Medina County Park District, Metro Parks Serving Summit County, and American Electric Power. He is a member of the Ecological Landscaping Association and holds a Bachelor of Science degree in conservation from Kent State University.

Todd A. Crandall, M.En., is a wetlands scientist that is responsible for all wetlands delineations performed at Davey Resource Group. Mr. Crandall also performs ecological surveys, vegetation cover mapping, plant identification, Section 401-404 and isolated wetlands permitting, and prepares restoration and mitigation plans. Mr. Crandall is responsible for vegetation monitoring at numerous wetland mitigation sites throughout Northeast Ohio. He has completed several large-scale wetland inventories for the Cuyahoga Valley National Park, as well as Cuyahoga, Portage, and Summit Counties in Ohio. He is certified for wetlands studies by the U.S. Army Wetlands Delineator Certification Program, and is a certified Professional Wetlands Scientist (PWS) through the Society of Wetland Scientists. He has completed the 40-hour OSHA health and safety training (OSHA Standard 29 CFR 1910.120). Mr. Crandall has also completed training through the Ohio Environmental Protection Agency (EPA) for the following: Headwater Habitat Evaluation Index (HHEI); Ohio Rapid Assessment Method (ORAM) v5; and Vegetation Index of Biotic Integrity (VIBI). He has 14 years of experience and holds a bachelor's degree from Hiram College in biology and a master's degree in environmental science from Miami University.

Deborah Sheeler, M.A., has five years of experience and education specializing in GIS Analyses and Natural Hazards research. She is currently a GIS Analyst/Cartographer at Davey, where she focuses on designing, creating, and producing maps through the use of advanced GIS software and automated mapping. In addition to geographic analyses and generating maps, she has experience in the field of aerial photography and remote sensing as a graduate teaching assistant and four years experience in monitoring, maintaining, and technical support for pen-based computers. Ms. Sheeler has a Master's of Arts degree in geography from Kent State University and a Bachelor's of Science degree in geography from Central Missouri State University with a minor in earth science.

Appendix B
Draft Biogenic Public Utility Ordinance

Ordinance for Biogenic Public Utility for City of Kent - Draft Version_1.0

Chapter 999
Biogenic Public Utility

999.01 Biogenic Public Utility

The Biogenic Public Utility or City Urban Forest provides services such as air pollution mitigation, stormwater runoff reduction, reduced energy costs and carbon dioxide uptake (sequestration) and storage for all taxpayers within the corporate limits of the City of Kent. It is hereby declared necessary for the protection of the public health, safety, welfare and convenience of the City and its inhabitants to codify the establishment of the biogenic city utility and to codify just and equitable rates or charges to be paid to the City for such services which shall be used for the payment of the cost of the management, maintenance, operation, repair, planting, replacement and all related costs of sustaining and continually improving the public urban forest system.

999.02 Findings, Determinations and Power

It is hereby found, determined, and declared that the urban forestry system – i.e., all the street trees, park trees, and other public trees in the City - provides services to all residents within the incorporated City limits. The beneficiaries of the public urban forestry system include all residents within the City of Kent which benefit by the provision, maintenance, and enhancement of the public urban forest. Such benefits of city trees may include, but are not limited to environmental benefits (cleaner air, reduced stormwater runoff, energy savings from cooling effects of trees, and CO_2 reduction through carbon sequestration and storage), aesthetic benefits (beauty of trees, increased property value in some cases), and psychological and sociological benefits (quality of life).

The biogenic public utility, under the direction of the Director of Public Service shall, and does, have the power to:

1) Prepare regulations as needed to implement this Chapter and forward the same to City Council for consideration and adoption, and adopt such policies

and procedures as are required to implement said regulations or carry out other responsibilities of the biogenic public utility.

2) Administer the management, planning, maintenance, and enhancement of the urban forestry system, including capital improvements (easement acquisition, landscape/hardscape improvements, planting of new trees, etc.).
3) Administer and enforce this Chapter and all regulations and procedures adopted relating to the management, planning, maintenance, and enhancement of the urban forestry system, including but not limited to, the quantity, quality, and species of the city's urban forest.
4) Inspect private trees that have parts of trunks or limbs extending into the public right of way to determine the compliance of these trees with this Chapter and any regulations adopted pursuant to this Chapter.
5) Advise City Council, the City Manager and City departments on matters relating to the biogenic public utility.
6) Prepare and revise a comprehensive urban forestry management plan for adoption by City Council periodically.
7) Review plans, approve or deny, inspect and accept all additional planting plans associated with new developments.
8) Establish and enforce regulations to protect and maintain the health and growth of trees within the biogenic utility in compliance with the comprehensive urban forestry management plan as now adopted or hereafter amended.
9) Ensure all trees in the biogenic public utility are managed for public safety. Perform regular tree risk assessments and priority pruning and removal as determined by the City Urban Forester.
10) Analyze the cost of services and benefits provided, and the system and structure of fees, charges, fines and other revenues of the biogenic utility annually.

999.03 Definitions

For the purpose of this Chapter, the following definitions shall apply; words used in the singular shall include the plural, and the plural, the singular; words used in the present tense shall include the future tense. The work "shall" is mandatory and not discretionary. The word "may" is permissive. Words not defined herein shall be construed to have the meaning given by common and ordinary use as defined in the latest edition of Webster's Dictionary.

1) "Billing period" means the period identified from the first day of the month to the last day of the month. All bills rendered during a month are for the period beginning on the first day of the same month and are valid for that entire month unless otherwise identified.
2) "Biogenic Public Utility" means the utility service produced by living organisms (the urban forest) that supply the general public with an essential commodity or service, such as cooling, clean air, flood control, and carbon sequestering and storage.

3) "Biogenic Public Utility Agency" means the entity that oversees the operation and management of Biogenic Public Utility services in the City.
4) "Biogenic Public Utility fee" means a fee authorized by Ordinance(s) established to pay operations and maintenance, and new and replacement tree planting, and debt service.
5) "Biogenic Public Utility Easement" means a right-of-way
6) "Biogenic Public Utility Fund" (Fund___) means the enterprise fund created by City Council to operate, maintain and improve the system and for such other purposes as stated in this Chapter.
7)
8) "Bonds" mean revenue bonds, notes, loans or any other debt obligations issued or incurred to finance the costs of planting trees or any other major expense related to increasing the urban forest canopy in the City.
9) "City Tree" includes any publicly owned woody perennial plant which when mature has the following characteristics: a single main axis or stem commonly achieving fifteen (15) feet in height, and capable of being shaped and pruned to develop a branch free trunk at least nine (9) feet in height or capable of being pruned in such a manner that the branching will grow parallel with the sidewalk or street. A city trees is also referred to as a biogenic public utility unit. City trees include, but are not limited to, street trees, park trees, and public trees on any other city owned land. A single city tree can be referred to as a biogenic utility unit. The entire population of city trees can be referred to as the biogenic public utility or the municipal urban forest.
10) "City Tree List" means the officially adopted list for the planting of certain types, varieties, and species of trees in public right-of-ways within the City.
11) "Calendar year" means a twelve month period commencing on the first day of January of any year.
12) "Costs of Planting" means costs reasonably incurred in connection with providing capital improvements to the system or any portion thereof, including, but not limited to, the costs of:
    a. Purchasing and installing trees in the public right of way, including all hardscape construction materials (e.g. tree grates, structural soil for tree pits downtown, for example) used in connection therewith,
    b. Urban forestry professional services, legal and other professional services,
    c. Insurance premiums taken out and maintained during planting/installation projects, to the extent not paid for by a contractor,
    d. Any taxes or other charges which become due during tree installation,
    e. Expenses incurred by the City on its behalf with its approval in seeking to enforce any remedy against contractor or sub-contractor in respect of any default under a contract relating to tree planting operations,
    f. Principal of interest of any bonds, and
    g. Miscellaneous expenses incidental thereto.
13) "Debt service" means, with respect to any particular calendar year and any particular series of bonds, and amount equal to the sum of (i) all interest

payable on such bonds during such calendar year, plus (ii) any principal installments of such bonds during such calendar year.

14) "Developed property" means that which has been altered from its natural state by the removal of vegetation and/or topsoil or by the addition of any improvements such as a building, structure, impervious surface, change of grade, or landscaping. For new construction a property shall be considered developed pursuant to this ordinance:
15) Upon issuance of a Certificate of Occupancy, or upon completion of construction of final inspection if no such certificate is used: or
16) Where construction is at least 50 percent complete and construction is halted for a period of three months.
17) Where vegetation and/or topsoil has been removed leaving exposed soil surfaces for a period of three months.
18) "Director" means the Director of Public Service, or his designee.
19) "Dwelling unit" means any residential space for habitation as classified by the City building Code.
20) "Equivalent Residential Unit" or ERU means the statistical average horizontal impervious areas of "residential units" (single family, mobile homes, multifamiliy, condominiums, etc., within the City of Kent). The horizontal impervious area includes, but is not limited to, all areas covered by structures, root extensions, patios, porches, driveways, and sidewalks
21) "ERU rate" means a Biogenic Public Utility fee charged on each ERU as established by City Council.
22) "Exempt property" means public rights of way, public streets, public alleys and public sidewalks
23) "Median area" means a planting strip that serves as a traffic island within a public street.
24) "New Plantings and Replacement Plantings" means costs of new tree plantings and associated capitol improvements to hardscapes or the replacement of existing trees or purchasing and installing new hardscape for the urban forest system or land acquisitions for preserving urban forests and any related costs thererto, or paying extraordinary maintenance (e.g., storm damage clean up etc.) or any other expenses which are not costs of operation and maintenance or debt service.
25) "Nonresidential developed property" means any lot or parcel not exclusively residential as defined herein, including transient rentals such as hotels and motels.
26) "Operating Budget" means the annual operating budget adopted by the City for the succeeding calendar year.
27) "Operations and maintenance" means the current expenses, paid or accrued of tree maintenance (including pruning, trimming, spraying, root-pruning, fertilizing, staking, guying, bracing, cabling, irrigating, planting, transplanting, removing, treating for disease or injury, and any other similar act which promotes the life, growth, health, utility function, or beauty of trees), as calculated in accordance with sound accounting practice, and includes, without limiting the generality of the foregoing, insurance

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premiums, administrative expenses, labor, executive compensation, and cost of materials and supplied used for current operations, and charges for the accumulation of appropriate reserves for current expenses not annually incurred, but which are such as may reasonably be expected to be incurred in accordance with sound accounting practice.

28) "Parkways" means open areas between the curb and sidewalk.
29) "Plant" includes trees, shrubs, or any other plant material (non-woody, annual or perennial) in nature.
30) "Public Places" means all publicly owned grounds other than streets or parks which are publicly owned and open to the public.
31) "Residential property" means any lot or parcel developed exclusively for residential purposes including, but not limited to, single family homes, manufactured homes, multifamily, apartment buildings, and condominiums.
32) "Revenues" mean all rates, fees, assessments, rental or other charges or together income received by the Biogenic Utility Fund, in connection with the management and operation of the public urban forest, including amounts received from the investment or deposit of moneys in any fund or account and any amounts contributed by the City, all as calculated in accordance with sound accounting practice.
33) "Street" means a way or place of whatever nature, publicly maintained and open to the use of the public for purposes of vehicular travel.
34) "Tree well" means a cavity of specific shape, construction, and dimension per standard plans and specifications of the City and designated to facilitate the maintenance and existence of a biogenic public utility unit (i.e. a tree).
35) "Undisturbed Property" means real property which has not been altered from its natural state by dredging, filling, removal of trees and vegetation or other activities which have disturbed or altered the topography or soils on the property.
36) "User Fee District" means the area or property within the corporate limits of the City of Kent.
37) "Vacant improved property" means vacant property which is, or could reasonably be, served by any subdivision improvements that allow egress.

999.04 Biogenic Public Utility Goals

Intent: The Biogenic Public Utility serves a variety of purposes beyond utilitarian functions that promote the general health, safety, welfare, and economics for its citizens. To further ensure the public good, the following goals are established.

(1) Increase the long-term Biogenic Public Utility stability with continued species and age diversity plantings.
(2) Mitigate stormwater runoff by increasing tree canopy.
(3) Reduce energy consumption by providing shade and evaporative cooling through evapotranspiration.
(4) Balance Biogenic Public Utility services with cost requirements.
(5) Reduce local air pollution including particulates by maintaining and enhancing tree canopy levels.
(6) Reduce wind speed and direct airflow.

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(7) Reduce noise pollution.
(8) Provide habitat for birds.
(9) Reduce potential for soil erosion.
(10) Increase property values.
(11) Reduce ultra violet light under the canopy.
(12) Screen unsightly areas.
(13) Increase public well-being, relaxation, and contentment.
(14) Enhance visual and aesthetic qualities throughout the City that attract visitors and businesses and serve as a source of community pride and economic vitality.

999.05 Biogenic Public Utility Fee

Subject to the provisions of this Chapter, each and every residential developed property, nonresidential developed property and vacant improved property, other than exempt property, within the corporate limits of the City, and the owners and non-owner users thereof, have imposed upon them a biogenic public utility fee. In the event the owner and non-owner users of a particular property are not the same, the liability for each the owner and non-owner user for the fee attributable to that property shall be joint and several. The biogenic public utility fee shall be a monthly or a regular interval service charge and shall be determined by the provisions of the Chapter and the ERU and ERU Rate which shall be established and changed from time to time by City Council.

The monthly biogenic public utility rate shall be established based on the most current data and scientific models for calculating the value of the environmental benefits provided by the city's urban forest.

999.06 Biogenic Public Utility Fee Collection

The fee provided in Section .04 shall be billed to the person or entity currently receiving the City's utility bill for water, sewer and recycling services. The owner of the parcel of property in question shall always be responsible for said bills.

Such fee shall appear on the utility bill rendered by the City for water, sewer and recycling services as a separate item and shall be considered an integral part of such bill. Failure to remit the entire amount of the charges for all services shall constitute a delinquency, with termination of all services to take place in accordance with the provisions of Section .07 of the Codified Ordinances, thirty days after such delinquency. However, upon proof satisfactory to the Director of Budget and Finance that service for the collection of recyclable material is not required at any billing unit, due to vacancy or other reasons, such fee shall be waived by the Director.

For those properties within the corporate limits of the City that do not utilize the City's water, sewer, or recycling services, the property owner, or their designee shall be billed separately for the biogenic public utility fee and the stormwater fee.

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999.07 Biogenic Public Utility Fee Determination

The rate determination methodology for the Biogenic Public Utility is the same as for the City's Stormwater Utility (Chapter 921). This uniform schedule or rate for the services and use of the biogenic public utility by the owner, tenant, or occupant of the premises using the services and facilities of said system is determined as follows:

a. The City Council, upon recommendation of the City Manager, shall, by ordinance establish reasonable rates for Biogenic Public Utility functions for each single family residence; each single family residence shall be bill at a flat fee established by the City Council for a Residential Unit (ERU).
b. For all residential and nonresidential properties, that is enterprise, business establishment, building, or other occupancy not covered by subsections (a) and (b) of this section, the rate shall be computed based on the total impervious area of the property divided by the average impervious area of an ERU times the rate established for an ERU. The billing amount shall be updated by the Deputy Service Director/Superintendent of Engineering based on any additions to the impervious areas as approved through the building permit process.

999.08 Biogenic Public Utility Fund

The revenues received pursuant to this Chapter 999 shall be deposited with the Budget & Finance Director and shall be kept in a separate and distinct fund known as the Biogenic Public Utility Fund (Fund 999). The Biogenic Public Utility Fund shall be used for the payment of the cost of the management, maintenance, operation and enhancement of the Biogenic Public Utility (also referred to as the Pubic Urban Forest or City Trees). Any surplus in the Biogenic Public Utility Fund may be used for the enhancement and improvement of the public urban forest, for easement acquisition for primary purpose of planting trees, for the payment of interest on any indebtedness incurred for easement acquisition thereof, and for the creation of a sinking fund for the payment of such indebtedness, but shall not be used for any other purpose.

999.08 Biogenic Public Utility District Review and Appeals Board

a. The City of Kent Stormwater District Review and Appeals Board is hereby established. Said Board shall consist of six (6) members. The City Finance Director, the Deputy Serivce Director/Superintendent of Engineering, the Public Service Director, and the City Urban Forester shall be members. The other two (2) members shall consist of electors of the City appointed by Council. Appointed members must be removed by the City Manager with approval of a vote of two-thirds (2/3) of the members of Council. The term of office for appointed members of said Board shall be two (2) years. Should a vacancy occur on the Board, the remaining portion of the unexpired term shall be filled by Council.
b. The Board is authorized to hear appeals regarding disputes and complaints brought by owners and non-owners concerning application of this chapter, including the authority to make adjustments as appropriate to provide relief from a strict application of the provisions of this chapter due to unique circumstances, while accomplishing the intent of this chapter, as follows:

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i. Calculation of the total number of building units assigned to a property that are claimed to be inaccurate due to alleged inaccuracies in data utilized by the billing staff.
ii. Adjustments arising from a break in billing units due to change in property ownership, account responsibility or similar matters.
iii. Any other adjustments or credit against billing units assigned to a property which wholly or partially enhances the biogenic public utility by donating easements with trees or with the potential to support healthy trees, or other similar actions which result in verifiable additions or enhancements to the city's urban forest.

c. Any appeal must be filed in writing, must describe the specific error alleged, and contain the resolution of said dispute which the appealing part feels is correct. Said Board may request additional information from either the appealing party or the City. The decision of said Board shall be final.

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