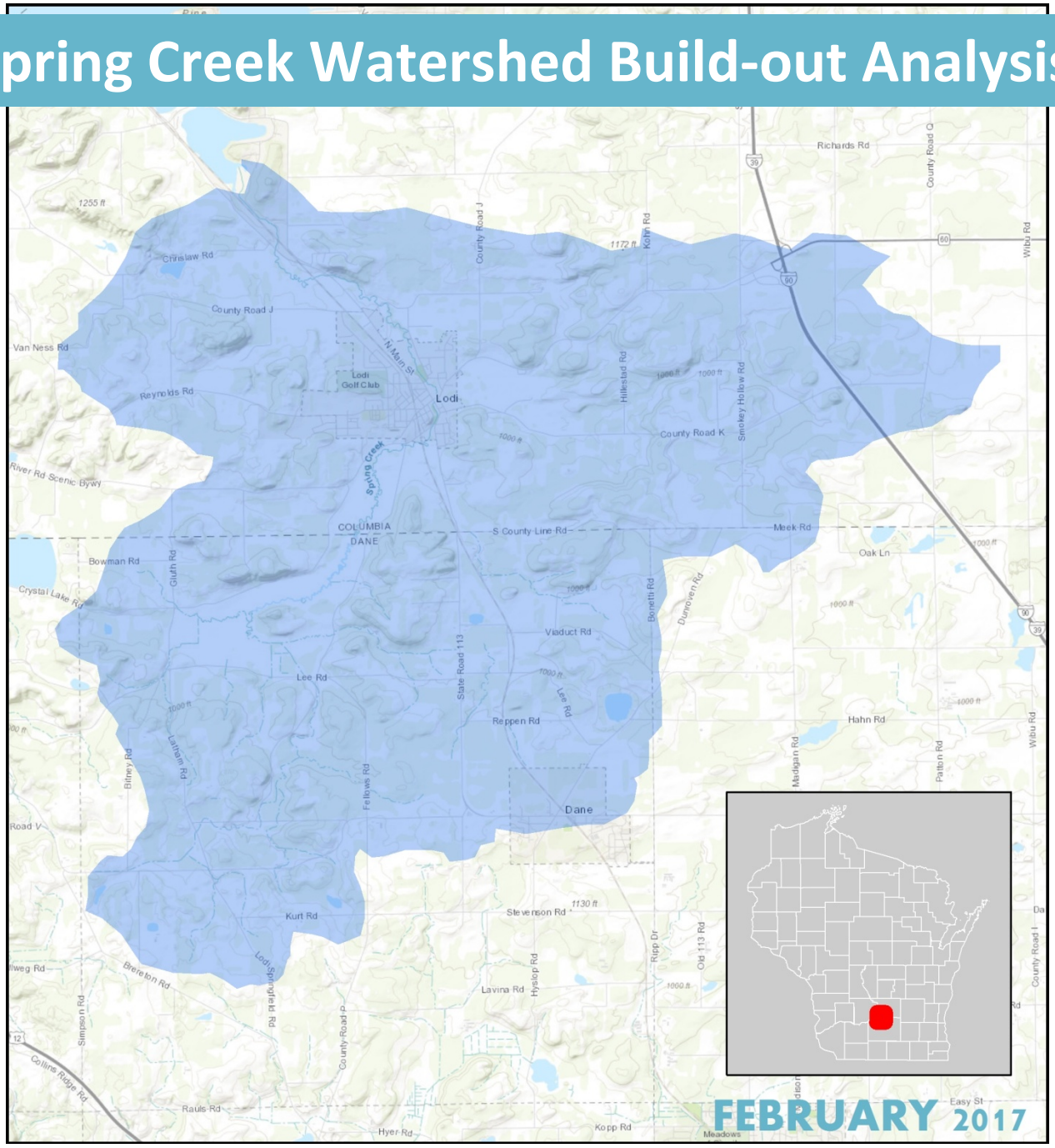
Spring Creek Watershed Build-out Analysis



PREPARED FOR

Columbia County
Land & Water Conservation Dept
120 W Conant St
Portage, WI 53901

PREPARED BY

POINT MAPPING LLC

Spring Creek Watershed Build-out Analysis

Columbia and Dane County, Wisconsin

Prepared by Point Mapping LLC

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Contact:

Dan McFarlane
pointmappingllc@gmail.com

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EXECUTIVE SUMMARY

The Spring Creek watershed in south-central Wisconsin drains approximately 47 square miles from both Columbia and Dane Counties. Spring Creek flows through the City of Lodi and the biologically diverse Lodi Marsh State Natural Area. It is a coldwater class II trout stream that eventually drains to Lake Wisconsin. Much of the watershed is farmed, but over the years development pressure has increased.

A residential build-out analysis is a technique used to measure and quantify amount and location of potential development in an area. It illustrates the form, pattern, and density of development that could take place under current zoning and physical land constraints. Build-out studies are typically intended to clarify whether potential development under current regulations will compliment or contradict planning goals. Build-out models use spatial and technical data to examine potential development scenarios and the resultant land use changes. They do not predict when the full build-out of available lands may occur.

Point Mapping LLC partnered with the Columbia County Land and Water Conservation Department to evaluate the complete residential build-out of available lands in the Spring Creek watershed and to estimate potential changes in impervious surfaces that may contribute to additional water quality implications in the future.

The Spring Creek Watershed build-out model findings include:

- There are currently 1,998 existing buildings in the watershed.
- Nearly 70% of the land in the watershed is developable.
- 996 new homes could be built under current zoning regulations (964 in Columbia County, 32 in Dane County)
- At full build-out, impervious surface area is predicted to increase from 4.2% to 7.3%.

1.0 INTRODUCTION

Point Mapping LLC performed a residential build-out analysis for the Columbia County Land and Water Conservation Department (LWCD) within the Spring Creek Watershed in south-central Wisconsin. The Spring Creek Watershed drains approximately 31,214 acres, or about 49 square miles, of farmland, forests, urban, and low-density residential and includes several political jurisdictions with land in portions of Dane and Columbia Counties (Figure 1). Over the years, millions of dollars have been invested in the area on resource management tools, such as dairy manure storage structures, conservation easements, best management practices, and nutrient management. The region has experienced significant development pressure over the years. The watershed's pastoral landscape, panoramic views, glaciated terrain, and commuting distance to Madison attract a variety of homeowners. If not controlled, this development pressure may negatively impact water quality. The challenge, similar to many other watersheds in the state, is to reduce nutrient loading downstream to prevent a future decline in water quality and trophic status. Although agricultural areas generate most of the nonpoint source pollution in the drainage basin, research has shown that urban and low-density developed areas can contribute significantly to pollutant loadings in watersheds as well. Understanding the impact of future development on water quality is key to developing adequate land use management plans that meet watershed management goals.

A build-out analysis is a model estimating a community's potential for development based on existing conditions using a certain set of assumptions, including existing land use regulations (e.g., zoning) and environmental constraints. The build-out results are only estimates of potential scenarios. While many of the assumptions may be subject to debate, no assumption is going to provide a precise prediction of the future. The emphasis of this type of analysis is to estimate *potential* capacity for new residential development and to help understand possible impacts on water and other natural resources. While a build-out study typically identifies the maximum amount of development that could occur within a community, it does not imply that this level of development will be reached within any specific time frame.

Performing a build-out reveals what land is available for development, how much development can occur, and the potential development densities. Municipalities can use the analysis as a tool for planning future development patterns. The build-out analysis models potential impacts of future development on surface water and other natural resources, helping decision-makers set water quality goals for both impaired and high-quality waters.

The build-out analysis focuses on establishing a maximum amount of development, projected well into the future. While the build-out may provide a framework for understanding the amount of potential development, it does not account for future changes in regulations or economic decisions of individual property owners, nor does it provide any guidance about how quickly build-out conditions will be reached. The development potential, based on land use rules applied across zoning districts, is generalized, and the build-out is not intended to be a detailed study of individual parcels.

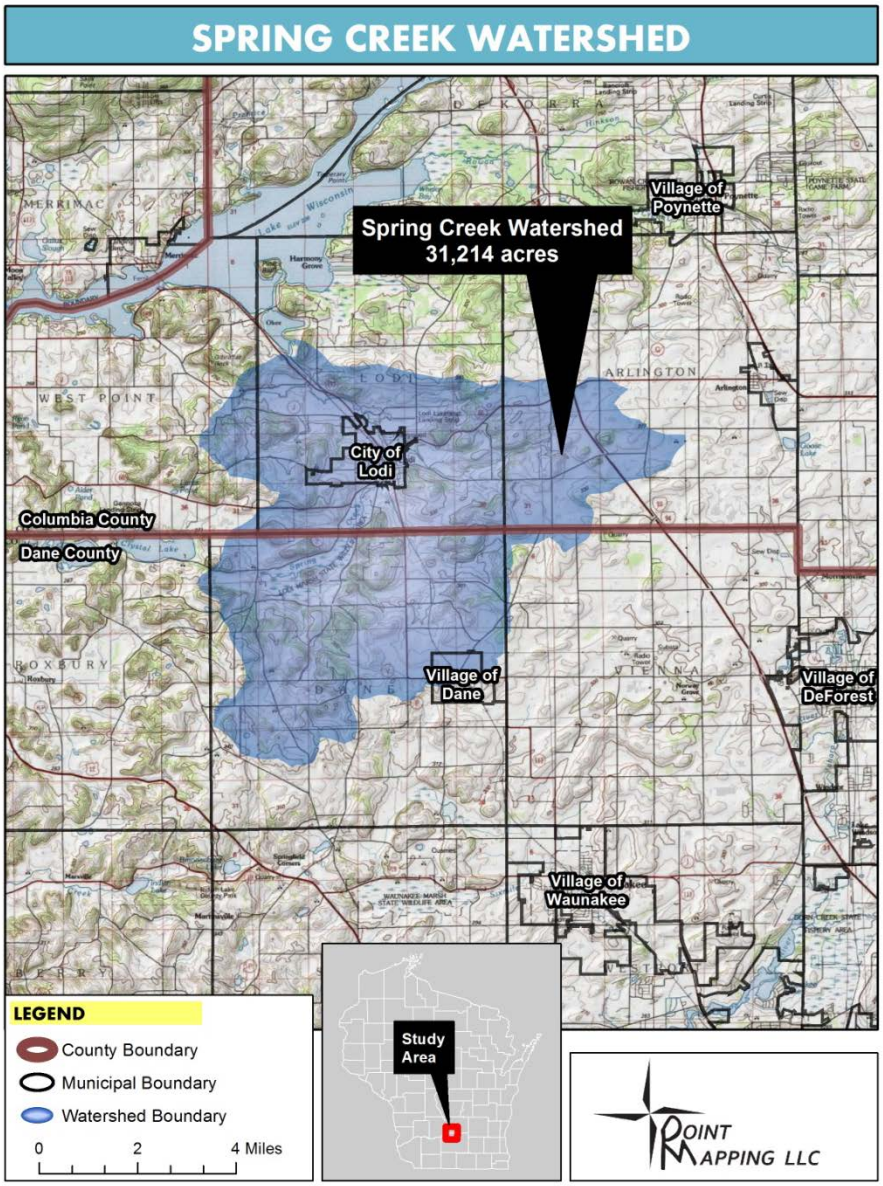

Figure 1. Spring Creek Watershed

2.0 METHODS

The project began by using a digital elevation model (DEM) and hydrologic modeling techniques to determine the watershed contributing runoff to the stream. The watershed was determined to be about 31,214 acres. Next, several assumptions were made in order to conduct the build-out analysis for the Spring Creek watershed. First, the build-out only considered lands available for development. These properties were identified using current tax parcel information class codes. The study only considered as-of-right uses, or uses permitted in each zone without the need for a variance. In addition, the analysis does not reconcile or consider non-conforming or grandfathered uses.

The build-out process utilizes Geographic Information Systems (GIS) technologies to illustrate the impact of the build-out scenario assumptions. Data and guidance for the analysis was provided by the Columbia County LWCD. Point Mapping LLC conducted the build-out analysis using ESRI ArcMap version 10.3 geographic information system software and Community Viz version 4.x. Community Viz is a GIS-based decision support tool designed to help planners and resource managers visualize, analyze, and communicate about important land use decisions. Community Viz's 'Build-out Wizard' calculated the development capacity of the study area (numerically and spatially) to project and display how future development might occur over time in the Spring Creek Watershed. The build-out process is both additive and reductive in nature, meaning that some data or values are added to existing conditions, and some data or values are reduced from existing conditions.

The build-out analysis was performed according to the following general steps:

- Collect data on existing conditions in the study area: existing buildings, zoning, and land cover.
- Collect and/or create GIS data and development constraint layers.
- Obtain input on developable and non-developable land from stakeholders.
- Analyze watershed build-out potential using Community Viz Build-out Wizard Tool.
- Project future land uses based on build-out results.
- Present results in tables and maps.

In 2014, Point Mapping LLC acquired an ESRI file geodatabase from Columbia County that contained most of the spatial data required for the build-out analysis. All layers were projected to the WTM projection and duplicate layers (e.g. soils from Columbia Co. and soils from Dane Co.) were spatially joined.

The amount of impervious surface associated with different minimum lot sizes was estimated from locally derived impervious surface coefficients. Impervious surfaces in the form of homes, driveways, and roads were digitized using high-resolution aerial photography. The impervious surfaces were combined with a parcel layer to calculate an average percent imperviousness for different lot sizes within the watershed.

2.1 Existing Buildings

The location and number of existing buildings in the Spring Creek Watershed area was determined using a building footprint layer (Dane County only), tax parcel attributes, and high-resolution digital orthophotographs. A determination of existing buildings in the Columbia County portion of the watershed was conducted by selecting tax parcels that had an improvement value greater than or equal to $10,000. A total of 1,998 buildings were mapped in the watershed.

Dane County	
Village of Dane	275
Town of Dane	250
Town of Vienna	2

Columbia County	
City of Lodi	1,071
Town of Arlington	99
Town of Lodi	277
Town of West Point	24

2.2 Existing Land Cover

A land cover inventory documents the physical materials at the surface of the ground, such as developed land, water, or grass. Conversely, a land use inventory records how the land is utilized by people. This land cover inventory uses data from the Wisconsin Department of Natural Resources (WDNR) WISCLAND 2.0 database, which incorporates remote sensing technologies. The inventory was conducted using a 30-meter resolution and typically underestimates developed land cover types, because developed land cover is oftentimes hidden under forest canopy. The WISCLAND 2.0 layer was modified to a finer 5-meter resolution and adapted to include road areas and small developed patches to more accurately reflect the current landscape.

2.3 Existing Zoning

Crucial to a build-out analysis is the feasibility of modeling zoning ordinance requirements. Certain zoning requirements are too specific to incorporate into the analysis. With that in mind, the analysis makes use of the following caveats in determining build-out zoning restrictions:

- Future lots are made with the smallest size allowable for the zoning district, taking into account minimum lot size and the minimum buildable area.
- Potential unit types (single family, multi-family, commercial) are not specified.
- Road and shoreline frontage requirements are not specified.

Zoning information used in the build-out analysis represent restrictions that apply in the sections of each town/county/city/village that fall within the watershed area boundary, and these restrictions are shown below in Table 1.

There are currently 23 zoning districts that allow for residential development in the watershed. The existing zoning codes are a Euclidean zoning code, which has widely been utilized throughout the state. This Euclidean code separates land uses into distinct districts and establishes bulk and use standards for each permitted use. There are also overlay districts (i.e. special districts) that address unique character areas and encompass a portion of one or more zoning districts. Overlay zoning districts were not considered as part of this analysis.

Table 1. Base zoning standards that permit residential development.

Zone	Description	Building Setbacks	Min. Lot Size	Min. Lot Width	Lot Coverage
DANE COUNTY (Town of Dane and Vienna)					
A-2(1)	Agriculture District	side – 25 rear – 50	1 ac	100 ft.	Max 30% (Residential Uses)
A-2(2)	Agriculture District	side – 25 rear – 50	2 ac	100 ft.	Max 10% (Residential Uses)
A-2(4)	Agriculture District	side – 25 rear – 50	4 ac	100 ft.	Max 10% (Residential Uses)
A-2(8)	Agriculture District	side – 25 rear – 50	8 ac	100 ft.	Max 10% (Residential Uses)
A-2	Agriculture District	side – 25 rear – 50	16 ac	100 ft.	Max 10% (Residential Uses)
R-1	Residence District	side – 25 rear – 50	20,000 sq. ft.	100 ft.	Max 30% (Residential Uses)
R-1A	Residence District	side – 25 rear – 50	1 ac	100 ft.	Max 20% (Residential Uses)
R-3	Residence District	side – 10 rear – 25	20,000 sq. ft.	100 ft.	Max 35% (Residential Uses)
R-3A	Residence District	side – 10 rear – 25	20,000 sq. ft.	100 ft.	Max 30% (Residential Uses)
RH-1	Rural Homes District	side – 10 rear – 50	2 ac	150 ft.	Max 10% (Residential Uses)
RH-2	Rural Homes District	side – 10 rear – 50	4 ac	150 ft.	Max 10% (Residential Uses)
RH-3	Rural Homes District	side – 10 rear – 25	8 ac	150 ft.	Max 10% (Residential Uses)
RH-4	Rural Homes District	side – 10 rear – 25	16 ac	150 ft.	Max 10% (Residential Uses)

Zone	Description	Building Setbacks	Min. Lot Size	Lot Coverage	Min. Lot Width
VILLAGE OF DANE					
RD	Rural Development	side – 10 rear – 25	2 ac		100 ft.
R2	Single Family Medium Density	side – 10 rear – 25	0.17 ac		75 ft.
COLUMBIA COUNTY (Town of Arlington, Lodi, and West Point)					
A-1	Agriculture District	side – 10 rear – 25	35 ac		200 ft.
A-2	Agriculture District	side – 10 rear – 25	1 ac		200 ft.
R-1	Single Family Residence District	side – 10 rear – 25	1 ac	Max 20% (Residential Uses)	100 ft.
R-2	Multi-Family Residence District	side – 10 rear – 25	1 ac	Max 30% (Residential Uses)	100 ft.
RR-1	Rural Residence District	side – 10 rear – 25	1 ac	Max 20% (Residential Uses)	150 ft.
CITY OF LODI					
R-1	Single Family	side – 10 rear – 15	0.2 ac		75 ft.
R-2	Single and Two Family	side – 10 rear – 15	0.25 ac		75 ft.
R-3	Multi-Family	side – 10 rear – 15	0.4 ac		100 ft.

2.4 Development Constraints

To determine where development constraints may occur in the study area, build-out calculations deduct land unavailable to development due to physical constraints, including environmental restrictions (e.g., steep slopes, wetlands), zoning restrictions (e.g., shoreland, street right-of-ways, and building setbacks), and practical design considerations (e.g., lot layout inefficiencies). Existing buildings also reduce the capacity for new development. With the exception of existing buildings, Point Mapping LLC obtained all development constraints and geographic datasets from the Columbia County LWCD. GIS data used to model development constraints include:

- Conserved land
- Public land
- Waterbodies and watercourses appearing on the WDNR's Surface Water Data Viewer
- Wetlands and hydric soils
- Existing buildings
- 100 year floodplain
- Steep slopes (>25%)
- Waterbody setbacks (typically 75 ft)
- Road setbacks – based on road type

Protected open space, already developed areas, and land that is undevelopable for environmental reasons (wetlands, surface water, steep slopes, and adjacent buffered lands) were identified as unavailable for new residential development. The development constraints considered above do not represent the full range of possible restrictions or resources that may be found in the field. For example, rare and/or State-listed species may be present in a given area, but are not considered because data regarding their specific locations are not available. Small, unmapped wetlands may also be present in a given area.

2.5 Build-out Assumptions

To determine how many residential dwelling units can be built on the available buildable land, various density and other design factors are considered based on the zoning requirements. However, the build-out analysis includes some simplifying assumptions.

- Building setbacks and separation distances were estimated based on the average front and rear setbacks specified by each municipality's dimensional requirements.

- Setbacks are measured from the building center points in Community Viz. To account for this, building footprints are estimated to avoid building overlap. The estimated dimensions of the minimum building footprint was set to be 35 feet by 35 feet. This number was added to the average front/rear setback for each zone to estimate the minimum separation distance between dwelling units.

- Efficiency factors adjust the density values on a property to account for common density losses. Lot efficiency refers to the amount of land on a parcel that is available for construction after addressing such considerations as drainage facilities, parcel contiguity, right-of-ways, utilities, and road frontage. These are entered as a percentage, where 100% means complete efficiency (no density loss) and 0% means no buildings are estimated for a particular zone. A 75% efficiency factor was used for this study.

3.0 BUILD-OUT RESULTS

3.1 Buildable Area

An estimated 20,889 acres (67%) of the land within the Spring Creek watershed is developable (Table 2, Figure 2, & Figure 3). The towns of Lodi, Arlington, and Dane have the most land in the study area and thus have the largest amount of acreage available for development. More than half of the total land in all municipalities, other than within the City of Lodi, is buildable. The build-out analysis results estimate that this developable area, under current zoning regulations, can accommodate an additional 996 residential dwelling units. Thirty-four percent of the remaining land in the watershed is unbuildable because of the constraints, such as wetland, steep slopes, and buffers, around lakes and streams. Although well over half the watershed is available for development, not all of this can be converted to residential or developed land uses. In several cases, the land is zoned for agriculture, which in Dane County prohibits residential dwelling units.

Table 2. Buildable area by municipality

Municipality	Total Area (acres)	Percent of Watershed Area	Buildable Area (acres)	Percent Buildable Area
		Columbia County		
City of Lodi	1,065	3%	122	11%
Town of Arlington	5,067	16%	4,260	84%
Town of Lodi	9,569	31%	6,455	67%
Town of West Point	1,193	4%	910	76%
		Dane County		
Village of Dane	417	1%	253	61%
Town of Dane	13,389	43%	8,465	63%
Town of Roxbury	59	0.2%	45	76%
Town of Vienna	456	1%	379	83%
Totals	***31,215***		***20,889***	***67%***

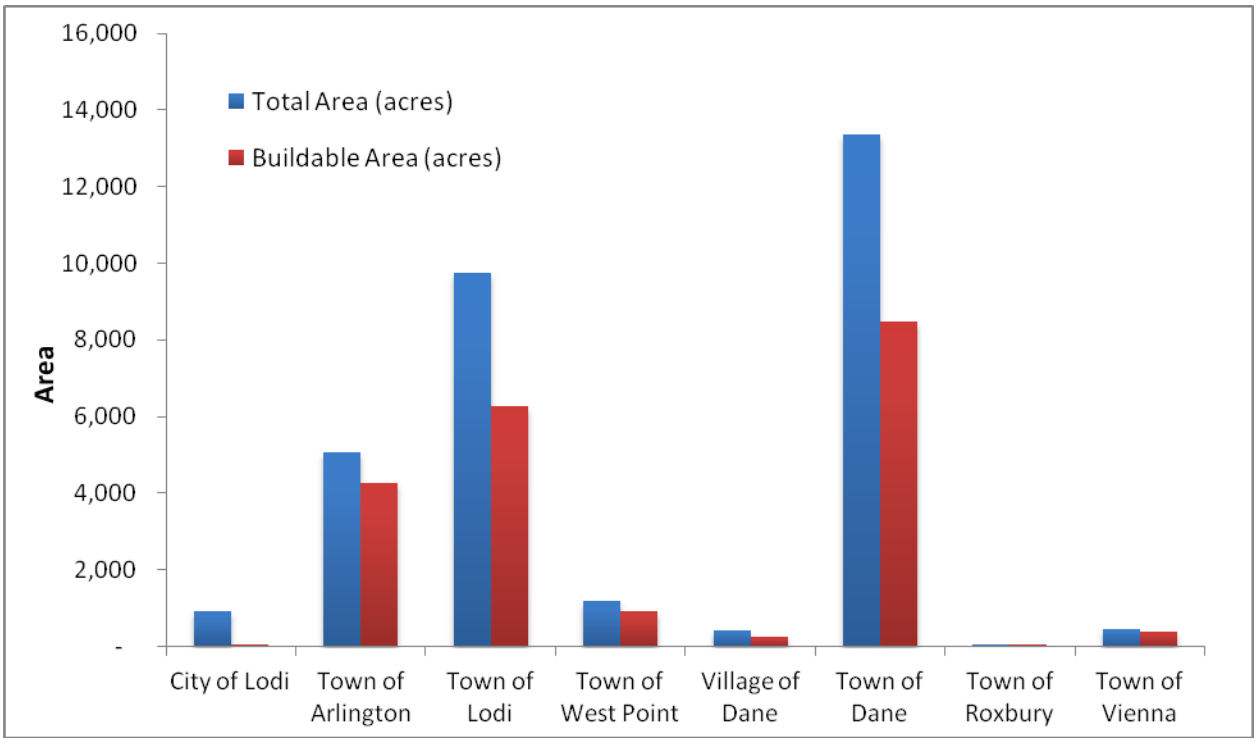

Figure 2. Total area vs total buildable area by municipality.

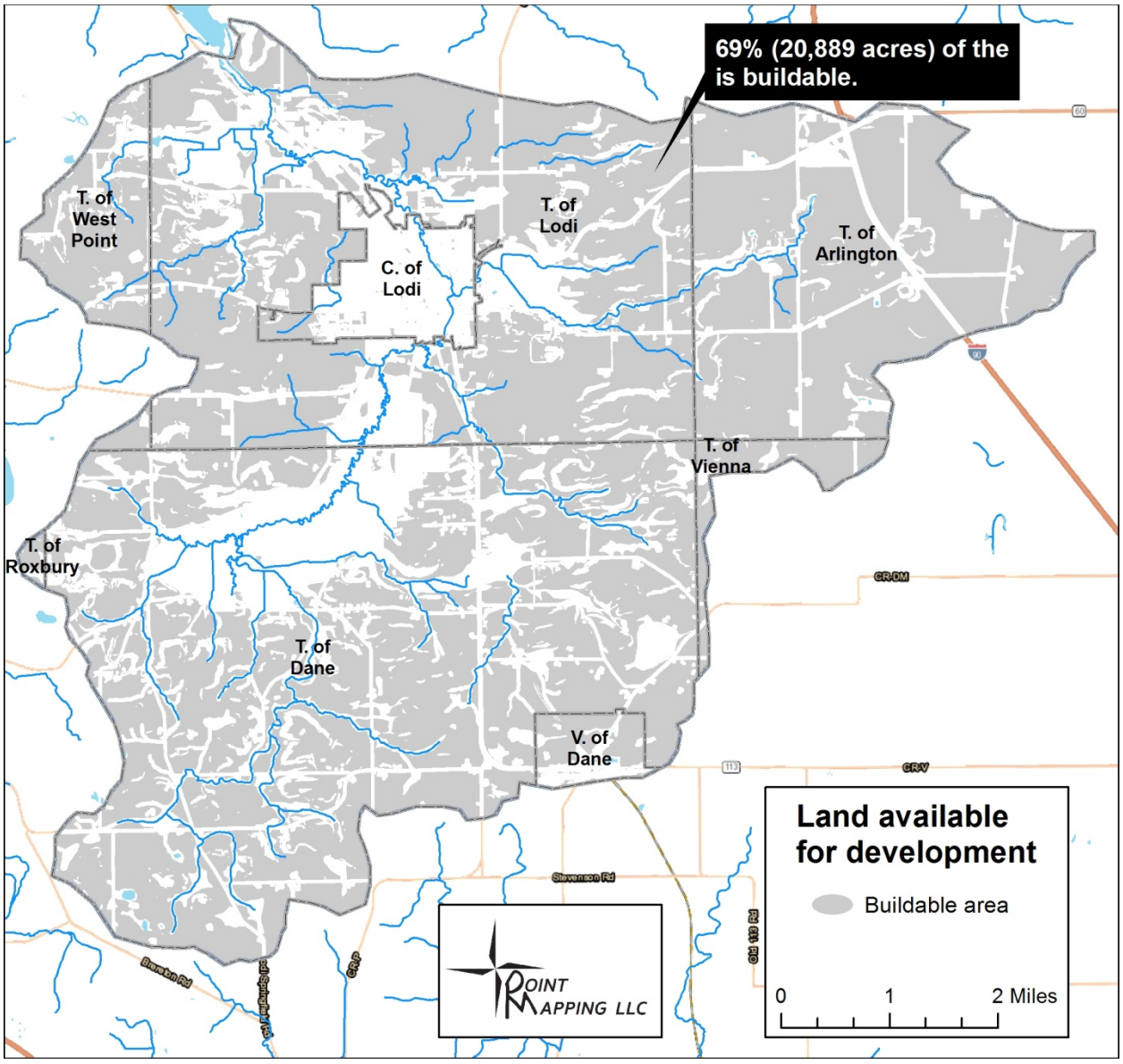

Figure 3. Buildable area by municipality. The development constraints considered above do not represent the full range of possible restrictions of resources that may be found in the region.

In Columbia County, agricultural zoning districts that allow for single-family development have the most land available for new homes (Table 3). The A-1 zoning district in Columbia County makes up the largest portion of developable land in the watershed at 10,390 acres. Much of the rural land in Dane County is zoned exclusive agriculture, which prohibits residential development.

Table 3. Buildable area by zone

Zone	Total Area (acres)	Total Buildable Area (acres)	Percent Buildable Area
Columbia County			
A-1	11,669	10,390	89%
A-2	133	105	79%
R-1	819	503	61%
RR-1	33	13	39%
City of Lodi			
R-1	119	107	90%
R-2	19	1	5%
R-3	17	4	24%
Dane County			
A-2	189	151	80%
A-2(1)	2	1	50%
A-2(2)	9	6	67%
A-2(4)	20	9	45%
A-2(8)	17	14	82%
R-1	3	1	33%
R-1A	11	5	45%
R-3	1	1	100%
R-3A	2	1	50%
RH-1	72	42	58%
RH-2	49	29	59%
RH-3	82	56	68%
RH-4	85	76	89%
Village of Dane			
R2	77	18	23%

3.2 Projected Buildings

In 2016, 1,998 dwelling units are estimated to have existed in the Spring Creek watershed. In the build-out scenario based on current regulations, an additional 996 dwelling units could exist, a potential increase of 50% (Table 4, Figure 5a and b). New dwelling units are projected to occur in all zones and in most municipalities within the study area. In Columbia County, the Town of Lodi is projected to experience the largest increase in new buildings. Of the 996 potential new dwelling units, 964 (or 97%) would occur within Columbia County. Only 32 new dwellings units are possible in Dane County. Table 5 also breaks down the potential new dwellings units by zoning district.

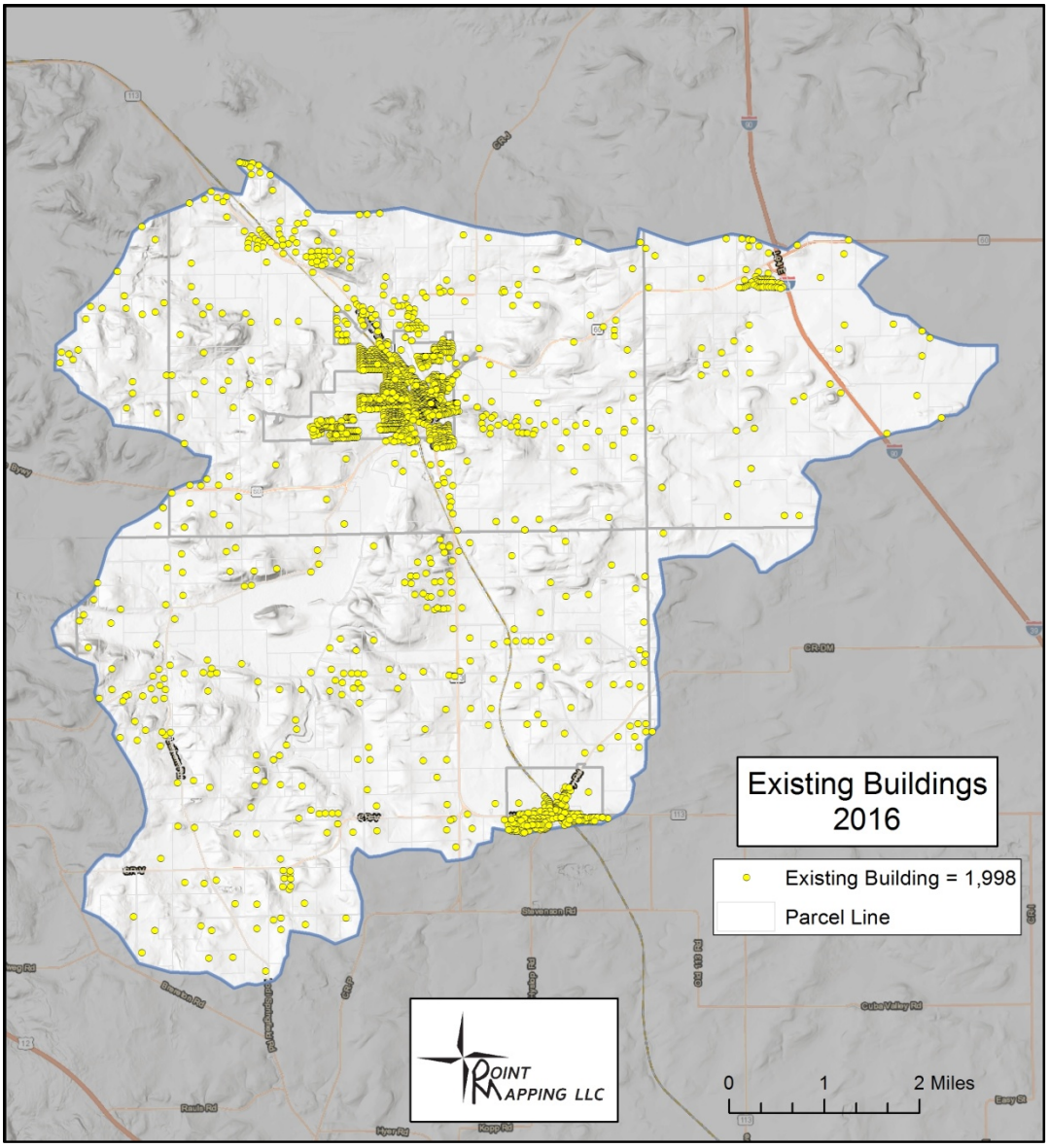

Figure 4. Current buildings within the watershed at full build-out.

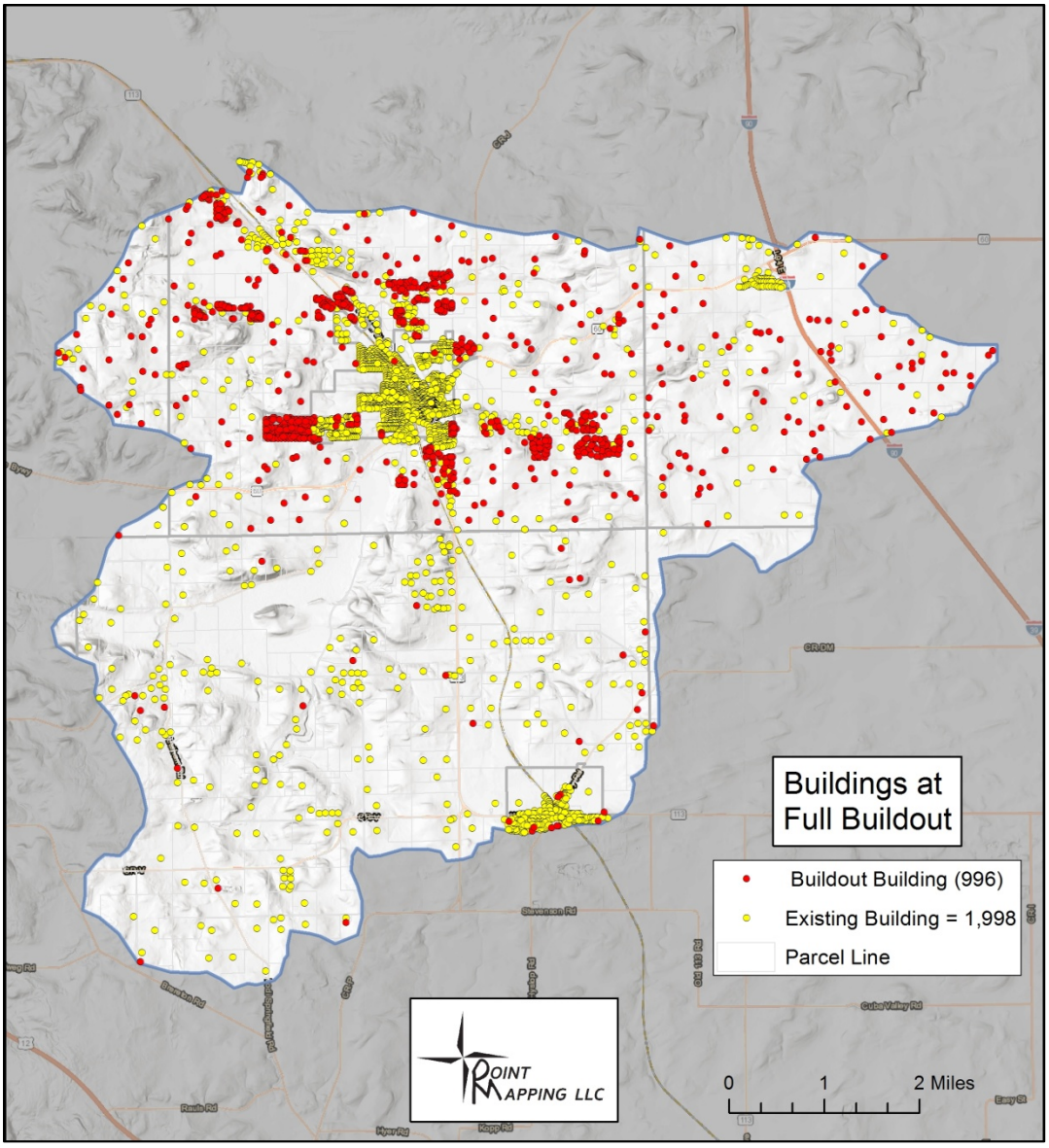

Figure 5a. Projected buildings at full build-out.

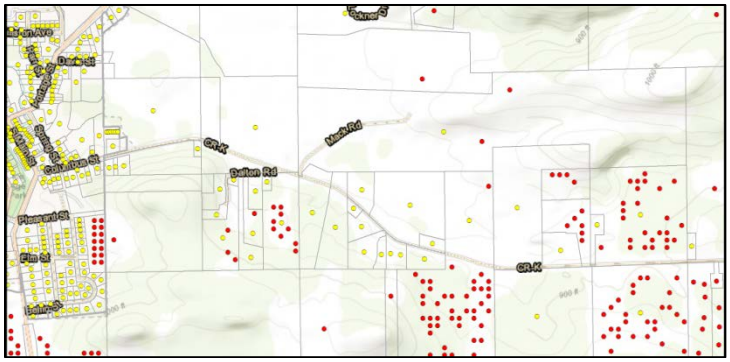

Figure 5b. Close up of projected buildings east of Lodi along Hwy K.

Table 4. Build-out results by municipality.

Municipality	No. Existing Buildings	No. Buildings at Build-out	Percent Increase
Columbia County			
City of Lodi	1071	203	19
Town of Arlington	99	93	94
Town of Lodi	277	645	233
Town of West Point	24	23	96
Dane County			
Village of Dane	275	9	3
Town of Dane	250	22	9
Town of Roxbury	0	0	0
Town of Vienna	2	1	50

Table 5. Number of new buildings by zoning district.

Zoning District	Build-Out
Columbia County	
A1	236
A2	58
R1	462
RR1	5
City of Lodi	
R1 & PUD	164
R2	33
R3	6
Dane County	
A-2	6
A-2(1)	0
A-2(2)	2
A-2(4)	0
A-2(8)	1
R-1	1
R-1A	0
R-3	0
R-3A	0
RH-1	8
RH-2	1
RH-3	2
RH-4	2
Village of Dane	
VD - R2	9
Total	**996**

3.3 Existing Land Cover

Figure 6 shows existing land cover in the watershed. The entire watershed's existing developed area is roughly 1,594 acres, or just over 4% (Table 6. Current and projected land cover.). This includes roads, yards, structures, and other developed areas based on the WISCLAND 2.0 land cover layer. The projected change in land cover at complete build-out yielded an increase of 684 developed acres. Most of the new development (462 acres) occurs in the Columbia County portion of the watershed where zoning regulations permit more residential development.

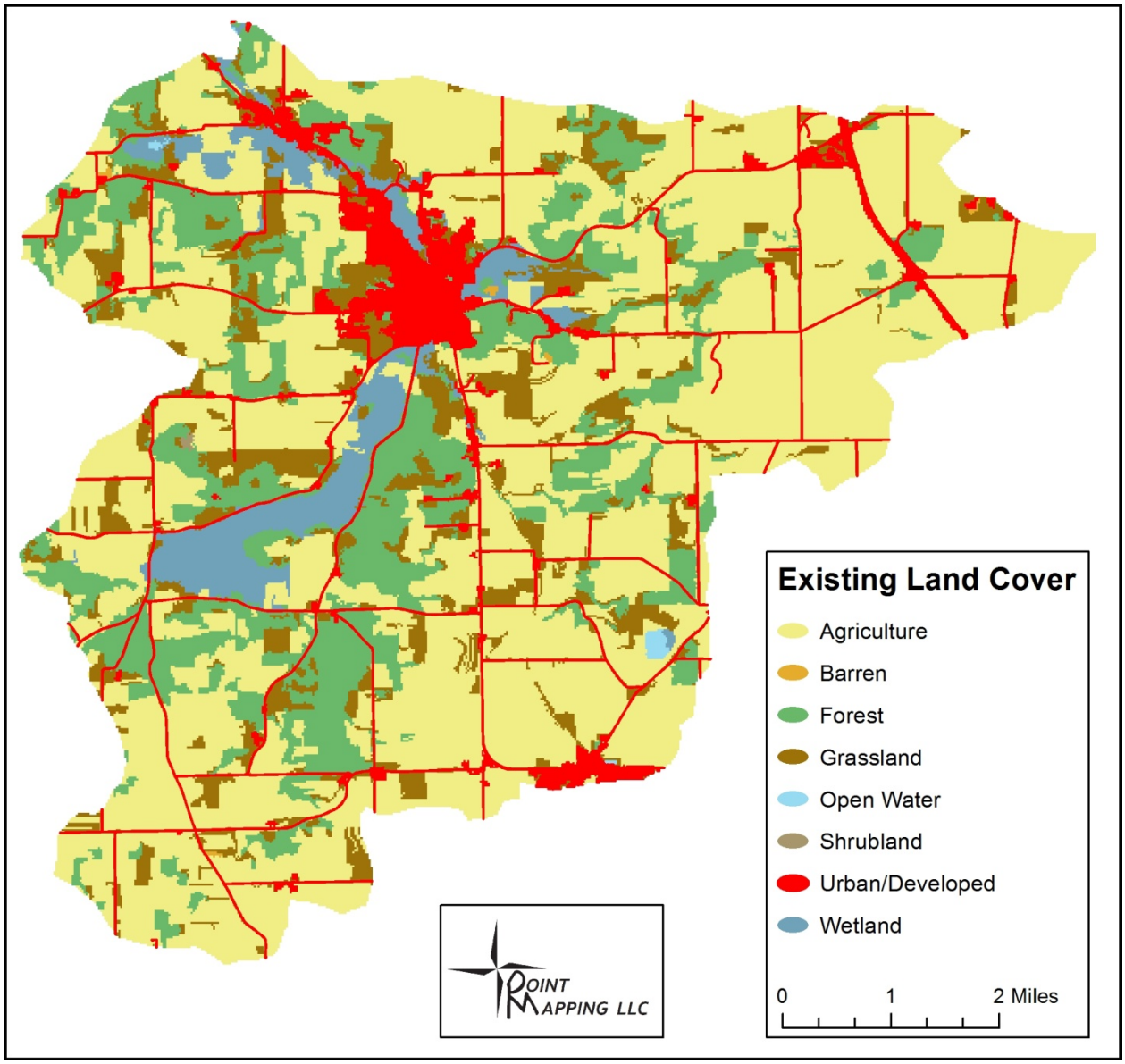

Figure 6. Existing land cover in the Spring Creek watershed.

Table 6. Current and projected land cover.

Land cover	Acres 2016	Projected at build-out
Agriculture	18,605	18,244
Barren	25	18
Forest	5,735	5,539
Grassland	3,729	3,609
Open Water	42	42
Shrubland	9	9
Developed	1,594	2,278
Wetland	1,475	1,475

3.4 Impervious Surfaces

The amount of impervious surface associated with different development patterns was estimated from locally derived impervious surface coefficients. A subset of impervious surfaces were mapped using high-resolution aerial photography with the study area. The resulting layer was overlaid with the digital tax parcel layer to calculate an average percent imperviousness for different residential lot sizes. The coefficients were applied to the final build-out scenario to approximate the amount of potential impervious surface (Table).

Table 6. Impervious surface coefficients by parcel size.

Lot Size (acres)	Impervious Coefficient
0.25	19.5%
0.5	17.9%
1	19.0%
2	13.0%
5	9.8%
10	6.5%
40	1.0%

The watershed's existing development was found to have roughly 4.2 percent impervious surfaces. The projected land use patterns at complete residential build-out yielded an increase of an additional 3.1 percent impervious surface (Figure 7). Research suggests that lake and stream health begin to decline when the amount of impervious surface reaches 10 percent and become severely degraded when the imperviousness exceeds 30 percent. In the current regulations build-out scenario, impervious surfaces watershed-wide are estimated to be 7.3 percent, suggesting water quality is not severely impacted due to hard surfaces. It should be noted this data likely underestimates the actual amount of impervious surfaces in the

watershed. Leaf-on aerial photography was used to map impervious surfaces, so tree canopies mask many features from view. Therefore, the threshold for maintaining water quality based on projected increases in dwelling units and impervious surfaces may suggest water quality problems in the future if development continues without surface water runoff mitigation.

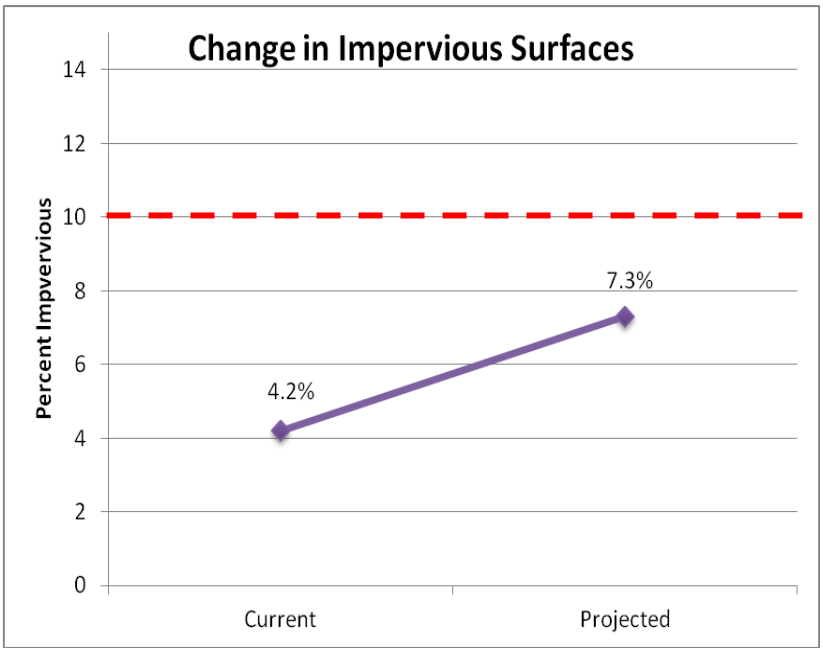

Figure 7. Potential change in impervious surfaces

4.0 DISCUSSION AND SUMMARY

The results of the analysis indicate there may be significant changes in residential development in the Spring Creek watershed. Based on the development constraints and zoning requirements outlined earlier, there are an estimated 20,889 acres of developable land remaining in the Spring Lake watershed. Build-out results estimate that this developable area, under current zoning, can accommodate an additional 996 dwelling units or approximately 50% more than the current number of existing developed properties in the watershed. Although the exact amount of additional development may vary based on the amount of land protected as open space, zoning and other regulations, and socioeconomic factors, the build-out analysis indicates significant additional development could occur.

The study provides a “worst-case scenario” based on current development standards and should be viewed as an estimate only. However, the study is a useful planning tool that can guide future development activities in the watershed and aid efforts to target sub-watershed areas for land conservation. Most of the new development is projected to occur in the

Columbia County portion of the watershed, primarily clustered in and around the outskirts of the City of Lodi, along steeper slopes or in close proximity to stream corridors. These results signal the importance of addressing the spatial disparities of new growth associated with potential stormwater runoff and water quality. The results also highlight the differences between the level of development allowed under county zoning between Columbia and Dane County, particularly within agricultural zoning districts. Without acknowledging the full scope of potential future growth, there is little incentive to adopt the necessary measures to control or mitigate the negative cumulative impacts of such development.

As indicated in Figure 5, several hotspots of dense development could occur throughout the watershed. These areas should be assessed and prioritized for mitigation and protection because of their potential to have a large impact on the local impervious surface quantity in an area that currently has very little impervious cover. Another consideration would be to 'down zone' these areas to a less dense residential category.

Limiting the amount of impervious surface cover in the watershed should be another management goal as projected build-out levels indicate that hard surfaces could reach the 10 percent threshold over time. As development continues to increase throughout the watershed, the need for policies designed to mitigate the impacts of impervious surface will be needed. It may be feasible to accomplish this through widespread participation in the County's Farmland Preservation Program, since much of the new development is predicted to occur on agricultural land.

Future development will increase the amount of runoff that eventually drains to Spring Creek and, therefore, may result in greater amounts of nutrients entering Lake Wisconsin. Future work should focus on modeling the amount of nutrient loading based on this study as well as alternative development scenarios. Similarly, development standards that result in no net increase of stormwater should be considered for all new development, since they utilize design principles to capture and treat polluted runoff from impervious surfaces. Other tools, such as conservation or cluster subdivisions, should be encouraged to protect open space and water quality.

While the build-out model is a useful tool to project future land use patterns, it does have limitations. The timing of development is not considered. This may impact the pattern of potential development, especially when open space protection strategies are phased in over many years, increasing the likelihood that some of the targeted pieces of land will be developed before they can be purchased or protected.

While acknowledging that political, social, and economic conditions will likely alter the future, a build-out model still provides a straightforward approach to project a vision of the future

landscape condition under existing policies. Additionally, the model allows the examination of the magnitude of potential environmental conditions and consequences so that management actions under consideration can be critically evaluated to ensure their effectiveness.