ANALYSIS OF PARK ACCESSIBILITY IN REDAN, GEORGIA
WEB GIS APPLICATION

by

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List of Abbreviations

GIS	Geographic Information System
GISci	Geographic Information Science
SSI	Spatial Sciences Institute
USC	University of Southern California
CDP	Census Designated Place
PFR	Park Friendly-Redan
IPH	Initial Population per Household
EP	Estimated Population of Census Block Group

Abstract

People use parks and facilities for different social, economic, and physical reasons. Access to parks enables a higher quality of life for those who can visit them (Wolf 2017). Park accessibility studies have stressed the importance of park accessibility as a component of environmental justice (Park 2017).

The broad goal of this project was to help reduce the disparity between people with little access to parks and those who do have ample access to park space and amenities. The objective of this specific project was to provide decision makers with access to park information and analyze the accessibility of neighborhood parks in Redan, Georgia. The outcome was a web application with an accessible interface that allows stakeholders to conduct analysis of neighboring parks on their technological devices. Through this application, entitled "Park Friendly-Redan", members of the community, park directors, and local officials can learn about neighborhood parks and share insights on recreational facilities and upcoming park projects. Analytic methods included dasymetric mapping, which plots the population using parcel data and a network analysis, resulting in a tool that creates service areas based on specified road distances. The analysis was integrated into an interactive web application. City developers and park planners that design future park projects will have the opportunity to use the tools needed to run real-time analyses and gather input from community residents regarding parks in their neighborhood. Future goals include a volunteered geographic information (VGI) system where users input information on facilities and add community concerns. It is hoped that the outcome of this project will promote user engagement and lead to a deeper discussion within the community regarding park goals and accessibility.

Chapter 1 Introduction

The term accessibility is defined by how easy it is for people to reach a location, the opportunity to enjoy settings that are open to the public and that are within walking distance from people's homes (Rigolon et al. 2014). Over the years, methods of assessing park accessibility have improved, helping researchers better understand park amenities, usage, and space. However, making park accessibility analysis available on the web has been inadequate in comparison. This project serves as an example of how the web can be used to further the ability of the public to understand park accessibility and use technologies available to better represent the state of current research. The purpose of this study is to assist in making park accessibility metrics available to the stakeholders interested in what facilities or park land are available to residents of the community. This was done through a web GIS (Geographic Information System) application that residents of the community, as well as urban planners, could use to better understand park data, share input with other users, and perform their own analysis from tools available in the application. "Park Friendly-Redan" allows users to perform their own analysis, which can facilitate the accessibility of parks. This is especially critical in regions with lower access.

This chapter defines the scope of the project and the motivating factors contributing to this study of park accessibility. Section 1.1 explains the significance of research on park accessibility and how this project can contribute to the park accessibility area of research. The following section (1.2) will discuss web applications and how they have impacted the study of park accessibility. Section 1.3 is a detailed overview of the Redan, Georgia study site. The claims and research objectives are covered in section 1.4. The final overview of the project and the breakdown of this thesis will be explained in section 1.5

1.1 Motivation

Parks provide benefits to neighborhoods and communities. Parks and green spaces have a strong correlation with the health and wellness of individuals within communities. Nature, including small plots or parcels, is profoundly important for the health of the mind and body (Wolf 2017). Park accessibility is not limited to the individual level, as there is much research showing how parks impact the whole community. People of different ages, ethnicities, cultures, and social statuses can come together in a common space. The presence of open landscapes and/or trees appears to promote community connections, interpersonal relationships, and supportive networks (Wolf 2017). Parks provide an identity for citizens and are a major factor in the perception of the quality of life in a given community. Parks and recreation are often cited as one of the most important factors in surveys of how livable communities are (NRPA 2010). It is important that parks are made accessible to all, not just for exercise and recreational activities, but also as places that foster interaction and support community engagement. Health, wellness, and community interaction should be among the primary motivating factors for those who design park placement.

Park accessibility literature has addressed the inadequacy of parks in specific neighborhoods and communities as an environmental justice problem as parks are not equitably distributed across urban environments (Rigolon et al. 2014). For example, in Denver Colorado, it was shown that high-income neighborhoods had the highest access to parks, and differences were even higher for parks with play amenities including slides, swings, and climbing structures (Rigolon et al. 2014). The amenities of a park or lack thereof can determine the usage of a park. The lack of parks limits the positive benefits on mental and physical health of young people that the community could receive.

Access to parks should not be the only factor when decision-makers are prioritizing what investments are needed in a specific location. Research on the disadvantages or concerns of parks, also known as dis-amenities, is a growing issue in park accessibility literature. Park design, upkeep, available green spaces, and recreation activities factor into the benefits the park has on the community (Rigolon et al. 2014). Dis-amenities are important to park accessibility research because any negative characteristic of a park or the surrounding community can deter residents from using the public park.

The negative traits of a park and/or the surrounding community can have a large effect on how the park is used and how many residents visit the site. In an article addressing the intersection between green space access and environmental justice, Jennings et. al, (2012) stresses the importance of understanding that degraded landscapes and decreased environmental quality impact human health. The article details how negative environmental concerns of a community stem from charges that environmental burdens such as landfills, toxic-emitting facilities, and other environmental hazards are disproportionately located near socially disadvantaged groups (Jennings et al. 2012). In relation to the dis-amenities of a park, the impact of the surrounding environment should be calculated when addressing park accessibility of a community. This project, entitled Park Friendly-Redan (PFR), will take the discussion regarding negative tracks of a park further by allowing the public to post feedback and concerns about park dis-amenities such as recent crime activity, drug use, trash, and other safety concerns. Redan, located in DeKalb County, Georgia, parks vary in size, amenities, and spatial distribution. The analysis of Redan can easily be translated to other small communities, which can be overlooked in park accessibility analysis, especially when the study area has a larger scope.

1.2 Spatial Sciences Web Application

The GIS tools used in this project are frequently used across different fields of study around the world. In the spatial sciences, web GIS applications provide GIS functions that assist in visualization, communication, and decision-making (Fu et al. 2011). Using Esri mapping applications, many cities have provided their communities with web applications that allow both citizens and local officials to survey areas and gather information on parks. The importance of web applications in spatial sciences can be seen today and will continue to grow in the future. Web sites, in contrast with web applications, are content-oriented and are designed to facilitate browsing and consumption of mostly static information (Vora 2009). The use of web applications allows users to not only read information but use real-time data and tools to decipher their own conclusions (Vora 2009).

This project uses web application features to improve how readily available park data is to stakeholders. A feature of web applications is that users do not need to "download and install separate software to use different web applications because they can be accessed from almost anywhere, as long as the computer they use has a web browser or internet connectivity" (Vora 2009). The simplicity of using web applications has helped foster public interaction, and user engagement continues to increase. Many web applications provide maps and data services to the public but do not allow users to engage with analytical functions. In this project, users are able to reassign a vacant land parcel as a potential new park location and create new service areas based on park entrances. These are among the primary features that make this application unique in contrast to other studies. This project will provide stakeholders with a means of assessing park accessibility through spatial software and network analysis.

PFR is a continuation of web GIS applications for parks, providing spatial analysis tools, and making park information accessible to the public on various technological devices. PFR is a web-based GIS application developed during this project that enables users to evaluate park accessibility within Redan. The application allows users to open a web browser and have access to Redan park data and the tools needed to perform an analysis of their choosing. PFR uses the most recent methods for calculating distance and time between parks and parcels and uses them to measure accessibility. A previous study on park accessibility, ParkServe, gives a rating of "Park Need" to areas of low accessibility and rates them one through five, with one being the area of most need. An objective of PFR is to use a similar design, but with a network data model to analyze park accessibility instead of buffer analysis. The buffer analysis tools, like the one in the ParkServe application, use straight-line measurements that do not account for transportation barriers, including private property or rivers. In terms of accessibility, to determine if a park is within the adequate distance of residents, roadways are the most reliable distance to and from parks. The network analyst tool uses a network of streets to evaluate the best routes which can then be used to define an area of accessibility.

Network analysis has proven useful in park accessibility analysis by providing precise metrics. Jimenez's (2016) research on park accessibility in Downey, California, uses network analysis instead of distance buffers. As mentioned by Jimenez, service area analysis represents the distance traveled by road network and conveys a service area depending on the specified distance. Thus, PFR is a contribution to spatial sciences as it uses current analysis methods and integrates the methods into a web application available for the public.

1.3 Study Site

Redan, Georgia is a suburban area located on the periphery of metropolitan Atlanta that is primarily single-family homes (US Census 2019). This CDP is a part of unincorporated Dekalb County, meaning there is no city level scale of analysis for this community. Redan is 9.6 square miles, with a population of 33,015 residents. Redan, Georgia is a 95.1 percent African American community with a smaller population of White and Hispanic residents (US Census 2019). A set of studies over the past decade has advanced our understanding of how access to parks varies across neighborhoods, especially in different racial, ethnic, and socioeconomic compositions (Park 2017). Park accessibility research has focused on large cities and areas of dense population, but it is just as important to look at smaller communities. This study site was chosen because the community of Redan is 5 miles outside of metro Atlanta.

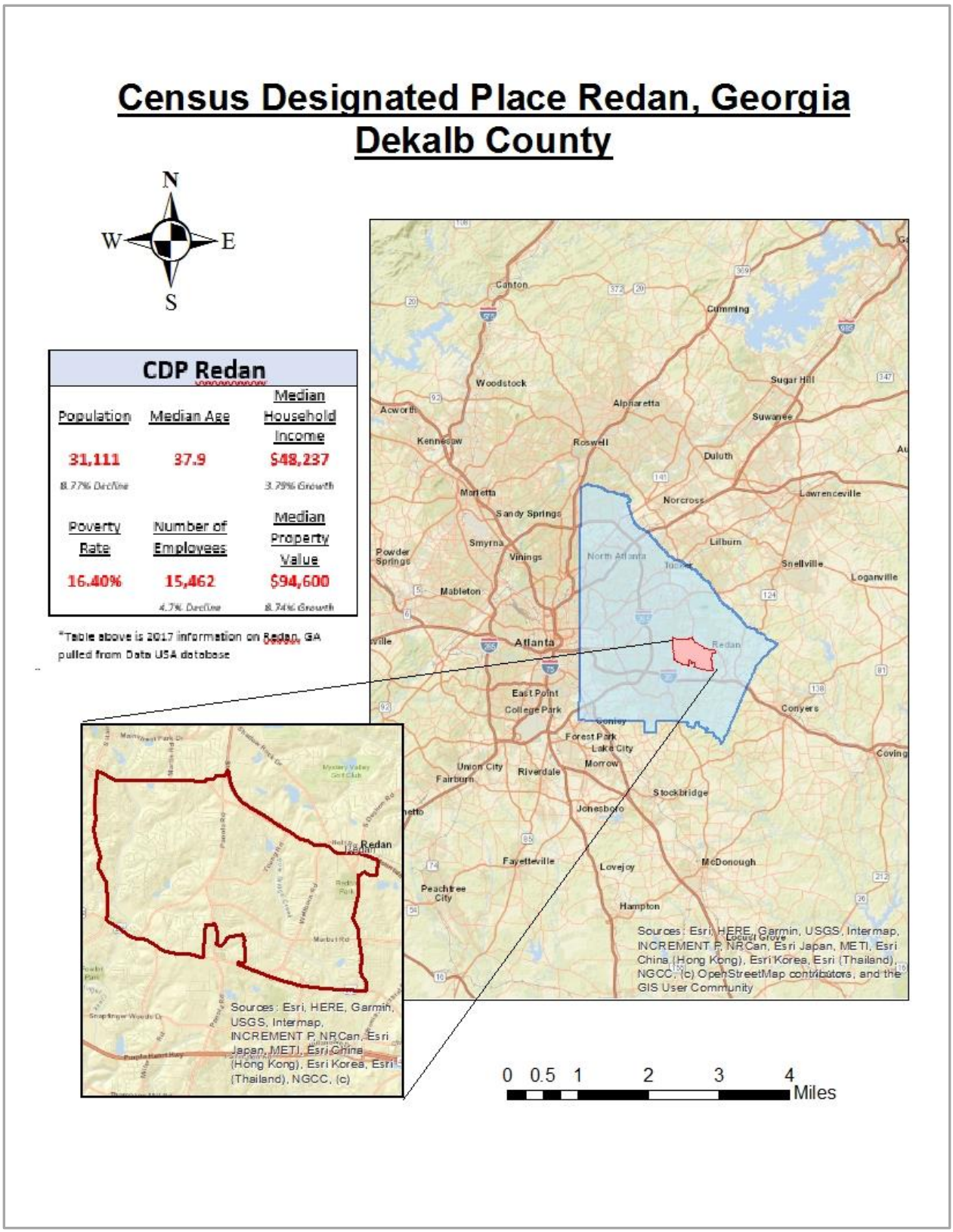

Figure 1 CDP Redan, Georgia

Racial and socioeconomic disparities exist in regard to park accessibility. Park accessibility research examines the demographics and land-use of an area. There are also other factors in addition to distance, including size, location, facilities, the surrounding environment, and public perception (Park 2017). Studies that factor in demographic and household income has shown that areas with more African Americans, Latinos, and Asians in urban areas had lower rates of park access when compared to predominately white areas in Los Angeles (Weiss et al. 2011).

In Redan, Georgia, approximately 95 percent of the population identified as African American in 2010 (US Census 2019). Table 1 shows that the median household income between 2013-2017 in Redan is lower than the general population but within 10 percent of the median income of the entire state of Georgia. This community differs from Atlanta, Georgia, where "results suggest that the spatial accessibility of green spaces in Atlanta is not evenly distributed. Neighborhoods with a higher concentration of African Americans had significantly poorer access to green spaces" (Dai et al. 2011). This community was chosen for the study because it is more suburban, as a contrast to areas that have been more studied such as in metropolitan Atlanta.

ALL TOPICS	Georgia	Redan CDP, Georgia
Median household income (in 2017 dollars), 2013-2017	$52,977	$48,237
PEOPLE		
Population		
Population estimates, July 1, 2018, (V2018)	10,519,475	X
Population estimates base, April 1, 2010, (V2018)	9,688,709	X
Population, percent change - April 1, 2010 (estimates base) to July 1, 2018, (V2018)	8.6%	X
Population, Census, April 1, 2010	9,687,653	33,015

Table 1 Median household income table of all Georgia and Redan

The goal of this study was to implement a web-based geographic information system (GIS) application for the general public, urban developers, and park planning committees as they design the next phases for new and existing parks. This project rates the accessibility of parks in the area to provide a clear understanding of which residents do not have easy access to a park. The web application for this project could be replicated across the country and enable other communities to gain park accessibility.

1.4 Research Question

Through PFR, park planning officials can use the web application to familiarize themselves with amenities needed at a park site, any major concerns that deter park usage, gather feedback from residents, and use spatial tools to run analyses firsthand. The objective of this study was to analyze access to parks and amenities. If proven that some neighborhoods in Redan have disproportionate access to parks in comparison to other neighborhoods, the web application

would confirm what areas were lacking and provide a means to evaluate what amenities and features could be added to best serve the public.

1.5 Organizational Framework/ Project Goals

This thesis consists of five chapters that explain the background, methodology, results, and conclusion of this research project. Chapter 2 is a review of the literature on park accessibility. This chapter discusses why park accessibility is important to a community and demonstrates what benefits parks can provide for a community. This chapter also explains why the study of park accessibility is especially important in Redan. Chapter 3 is a detailed explanation as to how the web application was designed and created. The chapter explains the data used in the project and where it was obtained, as well as the data used for the service area analysis. The chapter goes over dasymetric mapping and how population data was added to parcel data so that the usage of parks is accurately represented. The chapter then details how the web application was built using Esri. Chapter 4 is a discussion of the results of the web application. This chapter also goes into detail as to how the application was tested and how the application performed for users in the Parks and Recreation department of the Dekalb County government. The final chapter is an examination of the future goals of the project. It includes a summary of challenges and limitations.

Chapter 2 Related Work

This paper is a framework for a new web-based application that expounds upon park accessibility studies. The trends in analytical methods and the approaches to the interaction between the public and data are explained and presented in park accessibility literature. This research expands upon the studies completed to improve the accessibility of parks. Based on the review of previous park accessibility literature, the goal of this project is to connect the gap between the new analytical techniques, such as network analyst, dasymetric mapping, and park rating, used for assessing parks and the applications available to the public through the internet.

2.1 Park Accessibility Literature

Access to parks can facilitate physical exercise, mental strengthening, and social interactions, whereas the lack of access to parks in a community can limit these positive outcomes to a community. Dajun Dai (2011), with the Institute of Public Health at Georgia State University, used a GIS to quantify and assess spatial accessibility to green spaces at the census tract level in Atlanta, Georgia. Alongside an evaluation on what factors influence the access to parks, Dai (2011) used a Gaussian-based two-step floating catchment area method to measure green space access. Dai found geographic disparities in green space accessibility evident in Atlanta. More importantly, neighborhoods with low socioeconomic status and primarily African American neighborhoods had limited access to parks. Dai's research was completed at the city level while this project examines a smaller community in the Atlanta region. Studies like Dai's has brought attention to what areas are lacking, especially in inner cities and lower-income communities. Many studies such as Weiss et al. have shown a correlation in minority communities and a lack of park accessibility.

2.2 Strategic Questions

The objective of this research is to help park directors and local planners evaluate what residential areas have limited access to parks and how to assess the best locations for new parks. The National Recreation and Park Association published an article by Peter Harnik (2003), the director of the Trust for Public Land's Center for City Park Excellence, that defined how an excellent park system is to be measured. In the article, "a multifaced group of 25 urban and park experts convened by the Trust for Public Land" came together and outlined what determinants made for a successful park system (Harnik 2003). The measures outlined in the article are average among the acceptable park distances used by cities across the country. The measurements of distance range from one-eighth of a mile to as much as a mile. Preferably, people and parks are no farther than ten to fifteen minutes apart by foot in dense areas or ten to fifteen minutes apart by bicycle in spread-out sections Harnik (2003). Ideally accessible parks would be within one-quarter mile of any resident, but a half mile distance was also acceptable.

The concept of rating a park based on gross acreage, facilities, and its surroundings is critical in park literature when determining how much a park is used by residents. As a part of the journal *Urban Design*, Vikas Mehta's article "Evaluating Public Space" examined the quality of public space. Mehta's article (2013) uses an index to measure the quality of public space by the five factors of safety, comfort, pleasure-ability, inclusiveness, and meaningful activity. This index helps to evaluate the status of each park based on these factors in the area and rates each park accordingly. PFR research would also include an index to rate the value of parks in Redan, Georgia. Related literature on park accessibility does not solely examine the distance to parks from residential homes. In Harnik's article "The Excellent Park System" he explains that cities should make parks readily "available for a wide range of challenged persons including the

elderly, infirm, blind, and those confined to wheelchairs. This includes appropriate surfacing material, ramps, signs, handicapped parking, etc" (Harnik 2003). PFR addresses the best practices in terms of rating park accessibility in Redan by using more factors than distance, a determination of areas of the community that are most in need, and a proposal for urban planners to more evenly spread acreage and facilities across the community.

2.3 Dis-amenities

Distance to parks is not the only factor addressed in measuring park accessibility. In a previous study on park quality and neighborhood environment, Park (2017) considers how various factors related to parks other than distance such as size, location, facilities, the surrounding environment, and perceptions affect park use. There is park accessibility literature that deals with the dis-amenities of parks and how the lack of amenities devalues parks and neighborhoods. One of the customized query tools of this project, called Dis-amenities, is designed to give stakeholders feedback on dis-amenities of the park and surrounding neighborhood. These include crime, pedestrian safety, and noxious land uses when examining access to parks (Park 2017). This study implements a web-based geographic information system (GIS) application that will serve urban developers and park planning committees as they design the next phases for new and existing parks. The web application for this project has the potential to be replicated across the world, helping many communities obtain better park accessibility.

In PFR, the web application has a customized tool called Dis-amenities, in which stakeholders can see what concerns residents have about park dis-amenities in their community. In this instance, dis-amenities are considered negative traits that impact the usage or access to parks. The dis-amenities associated with a neighborhood can adversely impact park usage. The tool lists out the following categories pedestrian safety, facility cleanliness, ground maintenance,

and the surrounding neighborhood, and provides insight on the conditions of each park. This tool will help planners and local government officials make informed decisions as it relates to neighborhood parks.

2.4 Web GIS Related to Parks

Web GIS tools and applications are being used across park research to provide local governments and the public with tools and services that support the use of parks. The Trust for Public Land organization has created a web application called ParkServe, which serves many cities in the United States. ParkServe uses a series of measures based on the areas of acreage, accessibility, investment, and facilities to determine a city's park score (Jimenez 2016). ParkServe, being a web application, provides a unique experience to the research and analysis of park accessibility. ParkServe clearly shows what areas of the community are in high "park need" status in relation to the rest of the city. The web application effectively shows how many people are served at each park and provides a visual representation of the service area. Besides clicking on each park to see the service area, the web application has limited interaction for users. This thesis is a continuation of this work by not only presenting an application to the public but allowing users to share input and use tools within the application to run their own analysis.

The Trust for Public Land developed the ParkServe index for the 100 largest cities in the US (Trust for Public Land 2018). While this application focuses on the major cities within the United States, this thesis focuses on Redan and have a framework that other small communities can replicate easily. The index of ParkServe is partially based on amenities in each park, which include basketball hoops, playgrounds, off-leash dog parks, restrooms, recreation, senior centers, splash pads, and spray grounds (Trust for Public Land 2018). The web application does not show which parks contain these amenities. PFR includes data on park amenities as well as the VGI so

users can provide input on facilities at various locations. PFR is embedded in a story map including imagery of each park within the scope of the project.

Web GIS applications have assisted local governments by providing the public with new ways to inform themselves. Regarding parks, Esri's software ArcGIS Online, local governments can design their own Park Locator application using Esri's Web AppBuilder. The web application allows users in the public to perform tasks including locating a park by distance, collecting information on specific parks, and viewing the map to examine the community. According to Esri, Park Locator supplements customer service by government organizations. Figure 2 shows an example park locator for an area in the state of Illinois. In the app, a user can select a point and the default distance of 1-mile will set a buffer around the area. On the right-hand side of the application, there is a list of parks and detailed information about the given sites. This is an example of how web GIS applications are providing services and information to the public, whereas in the past, gathering such information was not as easily accessible.

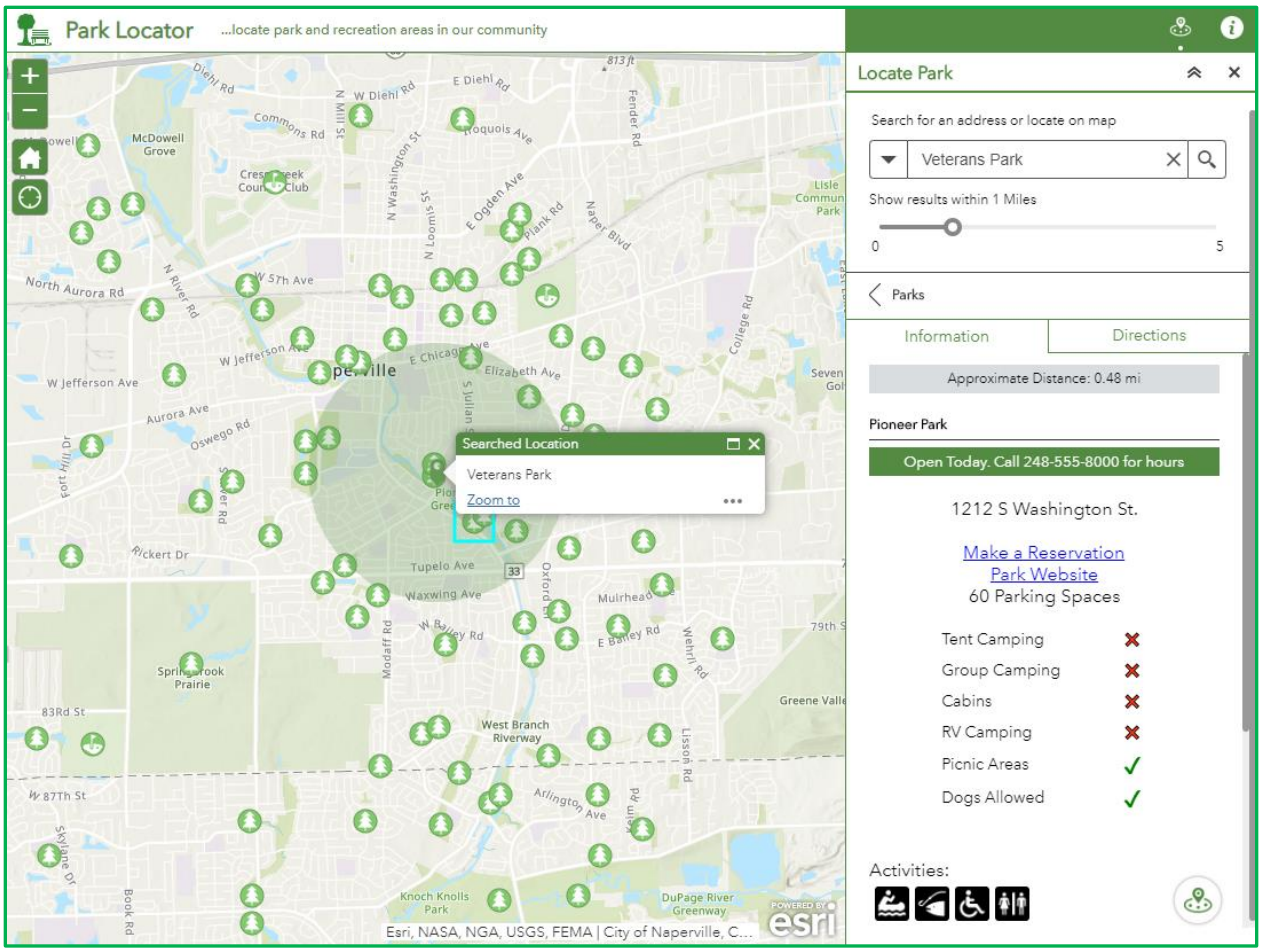

Figure 2 Esri Web Application Park Locator

The significance of a web GIS in park accessibility literature has grown over the years. As the methods and tools used to analyze park accessibility have developed, the growing use of web GIS is vital to the study. Ghaemi et al. (2009) used the combination of analytical methods, geospatial data, and web-based applications to design the first online planning tool that supported recreational open space, habitat conservation, and watershed health in the Green Visions Project Platform. This platform enabled the pubic to perform tasks and obtain their own results based on the analysis. This tool, therefore, provided users with an easy way to instantly calculate disparities in park access, and the effects of adding one or more new parks on such disparities (Ghaemi et al. 2009). This tool is no longer online or available to the public. In the web

application, users were able to interact with the data and had the ability to perform tasks such as to click on a feature within the map to see attributes regarding that data. Another important tool within the application was the Interactive Park Analysis Tool. With the Interactive Park Analysis Tool embedded in the application, users could select an empty plot of land and turn that area into a park. With the change from a plot of land to park, the application would show how disparities in park accessibility would change in the community. Green Visions Project Platform is no longer available to the public, but the abilities and tools available to the public were profound and would still be useful to the public today. Similar to this project, the intended users of the Green Visions Project Platform were environmental planners and municipalities. This project expands on the design of previous literature by encouraging residents of the community to use the application and share feedback on park quality and amenities.

Chapter 3 Methods

This project provides stakeholders with an online park accessibility web application for Redan, GA. The detail regarding the design and structure of the web application is discussed in this chapter as well as any spatial analysis tools embedded in the application for user purposes. This project takes GIS techniques and user interface to the next level regarding assessing park needs. The future goal of this interface will allow stakeholders to comment on park dis-amenities and facility conditions that may be useful in the decision making of future park plans. Once the preliminary draft is complete, the web GIS application was reviewed and tested by members of Dekalb County, including the Parks and Recreation staff. A detailed overview of the results is addressed in Chapter 4. This chapter is separated into the following sections: Data Collection and Preparation, Dasymetric Mapping, Network Analyst Tool, and web application design.

3.1 Data Collection and Preparation

This section describes how the data was processed and used in the initial analysis of Redan parks and what data was added to the web application. Table 2 below shows the data used for this project and what each data set brought to the project. Most of the data used came from Dekalb County GIS department and the U.S. Census Bureau.

Data	Type	Scale	Accuracy	Precision	Availability
Parks	Polygon	All parks within Redan and within a 1-mile buffer of the CDP boundary.	Collected from Dekalb County Parks and Recreation Dept.	The spatial representation of parks will be reliable through Redan and surrounding areas.	This dataset was acquired from the Parks & Rec dept of Dekalb County
Parcels	Polygon	All parcels within the boundary of Redan or in proximity of the listed parks.	Collected from Dekalb County GIS department.	In the shapefile, parcels line up next to each other and are consistent throughout the county.	This data was acquired from the GIS dept of DeKalb County
Census Blocks Groups	Polygon	Listing of all Census Blocks Groups in the Redan area.	The data was gathered from online from the U.S. Census Bureau	The Census Block Group data includes groups outside of Redan so that the population of park users is accurately estimated.	Census Block data will be combined with the 5-year American community survey through dasymetric mapping.
Streets	Line	Dekalb County has an updated street layer that shows only the roads and highways in relation to the county.	To remain consistent with Park and Parcel data, the Streets layer collected from Dekalb County GIS department will be used.	This data may not have clarification on sidewalk access, which would be great for evaluating pedestrian walk paths.	This data was acquired from the GIS dept of DeKalb County.

Table 2 Data Description

3.1.1. Park Shapefile

The park shapefile used in this project was a dataset that held all parks and green spaces within Dekalb County. The data set had to be cleaned so that golf courses and private spaces were not included in the park count. The only parks and spaces that are included in the final park file for this project were parks and green spaces within Redan and within a 1-mile buffer of the CDP boundary line. A 1-mile buffer was chosen for this application because the literature on park accessibility analysis has shown that an accessible park should be within ¼ mile of a home

(Harnik 2003). This is not always the case, but the measure of ¼ mile is the desired distance. The attributes of park data included an address, acreage, and amenities, which include basketball courts, swimming pools, fields, and trails. The DeKalb Recreation and Park website has a park map that has divided and labeled each area within a park such as pools, fields, and courts. A contracting company digitized these facilities but unfortunately, the data was not available for use in the PFR application. Fortunately for PFR, obtaining the number of facilities available at each location was straightforward. The park data does not have information on restrooms and water fountains, which will be added in the future work for dis-amenity calculations. In order to complete the service area analysis, the tool needs a point for each park. The points on each park are located at the entrance(s) of the park, and these points are called *Access Points*.

Park Name	Acres	Ballfields	Football	Soccer	Pool	Tennis Courts	Multi-Use Fields	Rec. Center	Picnic Shelter	Play-ground	Nature Trails	Golf Course	Parking Lot
Biffle Park	10.0	0	0	0	0	0	0	0	1	0	1	0	1
Emmie Smith Park	8.0	0	0	0	0	0	1	0	1	2	0	0	1
Fowler Park	52.0	0	0	0	0	0	0	0	0	0	1	0	1
Gregory Moseley Expansion	9.8	0	0	0	0	0	0	1	0	0	0	0	0
Gregory Moseley Park	8.0	0	0	0	0	0	1	0	1	1	0	0	0
Hairston Expansion	12.7	0	0	0	0	0	1	0	0	0	0	0	0
Hairston Park	33.0	0	0	0	0	0	0	0	0	3	1	0	1
Lithonia Park	53.0	0	0	0	1	0	1	0	1	0	0	0	3
Mystery Valley Golf Course	265.0	0	0	0	0	0	0	0	0	0	0	18	0
Redan Expansion	0.9	0	0	0	0	0	0	0	0	0	0	0	0
Redan Park	65.0	0	2	0	0	2	0	1	1	2	0	0	3
SE Athletic Expansion	17.0	0	0	0	0	0	0	0	0	0	0	0	0
SE Athletic Park	80.0	5	0	8	0	0	0	0	0	0	0	0	3

Table 3 List of Parks in Redan Park Accessibility Analysis

3.1.2. Access Points Shapefile

In order to use the service area analysis, there needed to be a point at each park showing where the site connects to roadways. The service area tool uses road networks to provide a service area based on distances set by the user. To verify where each park entrance was located, every park in this research was visited, and using a Trimble Geo7X device each entrance was plotted and added as a point. Some park entrances were shaded by the canopy of trees, so the accuracy of points cross referenced to satellite imagery on Google Maps confirmed the locations. Walking the parks also helped in verifying the facilities shown in Table 3. A new point feature class was created in ArcGIS desktop, and a point was set at each park entrance called Access Points. Some parks had more than one entrance.

3.1.3. Parcel Shapefile

The raw dataset on parcels came from the Dekalb County GIS Department that presented all parcels within Dekalb County and included the zoning category of each parcel. Before sending the data, the Dekalb County GIS department wiped any revealing personal information for privacy purposes. This information included the owner's name and address fields from the dataset. The parcel dataset had to be clipped, so the only parcels included in the final shapefile were parcels that would be useful in the Redan park accessibly analysis. All parcels within the Redan boundary were included in the file. The project accounts for residents that live outside the Redan boundary line since there is a 1-mile buffer around the boundary of Redan. The additional parcels are used to gather an accurate determination of how many residents are within the measured distance to each park, which at times included some of Dekalb County's population outside of the Redan boundary line.

The zoning information provided by the county was not sufficient in supplying parcel details. In order to obtain accurate information, a request was placed with the DeKalb County Tax Appraisal department for the most recent tax digest. For members of the community, the tax digest would cost one hundred dollars, but this document is free for students who can show proof of their university attendance. With the tax digest, each parcel had information including the number of units, number of bedrooms, the year a structure was built, and the land use type of the parcels. The *land use* of each parcel was critical to find which parcels had residents as seen in Table 4.

Land Use #	Land Use Categories
100	Residential vacant
101	Residential 1 family
102	Residential 2 family
103	Residential 3 family
106	Single Family Residential Condominium
107	Single Family Residential Townhouse
114	Vacant Lot up to 1.99 acres
115	Vacant 2.00 to 5.99 acres
116	Vacant 6.00 to 10.99 acres
118	Vacant 20.00 to 29.99 acres
188	Homeowner Association Common Area **
211	Apartment - Garden (3 story & under)
300	Vacant Commercial Land **
320	Commercial Auxiliary Improvements **
369	Day Care Center
388	Club House
389	Country Club with Golf Course
401	Manufacturing/Processing
600	Vacant Exempt Land
601	Cemetery
612	School
620	Churches

Table 4 List of Land Use Categories in Redan

After clipping the parcels, the next step was to take the columns needed from the tax digest and save them in a new excel .csv file. Parcel ID is a column needed to reference the

parcels. When the new .csv file was created, added to ArcGIS Pro or ArcGIS desktop. The join tool added the new table to the parcel layer. In the Join properties box, the "Keep Only Matching Records" button was selected. This action kept only the information from the tax digest that had matching Parcel IDs with the parcels in Redan. The remaining records were excluded from the parcel layer. Once this step was completed, the parcel layer was ready for dasymetric mapping, which is covered in section 3.2 of this chapter.

3.1.4. Vacant Sites

A separate parcel layer showing vacant parcels was needed for the PFR web application. From the parcel shapefile, the Select by Attribute tool was used to select all Redan parcels with land use codes of 114, 115, 116, 118. These parcels are vacant sites of various sizes. A new layer was created from the selected parcels, called *Vacant Sites*.

3.1.5. Street Shapefile

The street shapefile in this project is used in the network analyst (New Service Area) tool. The street shapefile from Dekalb County did not need to be updated for this project. The GIS department of Dekalb clipped a larger street feature class, so that the only streets and highways in the layer were within Dekalb county. The only streets and highways that came from outside Dekalb County were major intersections.

3.1.6. Census Blocks Groups and Population

The census block groups shapefile and the 5-year American Community Survey (ACS) population table were acquired from the U.S. Census Bureau. Census blocks groups are a subset unit from census tracks designed by the United States Census Bureau. Census block groups are the smallest groups for statistical analysis and data representation. The ACS data used for this

project is from the 2010 census. The blocks used for this project were the census blocks that included a parcel from the final parcel layer. The ACS table included a population count distinct to each census block. Block groups and tabular population data are available for free to download at the county level from the Census Bureau website. The next section on dasymetric mapping explains how census blocks and population were translated to parcels and used in the analysis.

3.2 Dasymetric Mapping

The completion of dasymetric mapping gave a count of how many residents were located in each parcel. To complete population mapping depended on three datasets: parcels, ACS, and census block groups. The census block groups had to be downloaded from the Census Bureau website. Dasymetric mapping is needed so that the population can be factored into the evaluation of proper accessibility to parks within the community. The only parcels used in dasymetric mapping were land-use codes: 100, 101, 102, 103, 106, 107, and 211. According to the U.S. Census Bureau, the average persons per household in Redan is 2.85. Based on the parcel dataset land-use category field, parcels that were labeled as residential single families or single residential townhomes had an average building square footage of 1748.

The goal of dasymetric mapping is to have the total residential parcels within each census block track equal to the estimated population of that block group (EP). Dasymetric mapping began by multiplying the number of units in each parcel by the number of bedrooms. This is called the Initial Population of the Household (IPH).

If the total IPH of all parcels within a block group is not equal to the EP, then there needs to be an evaluation of IPH within that block group. If the total IPH exceeds the EP, the parcels with the highest IPH were reduced. The reduction in population starts with the parcel having the

highest population to the value of the average person per household in Redan. If the total IPH is below EP value, then parcels with low IPH values are updated to the average persons per household to a value of 3. The building square footage of a unit determines which IPHs changes. The updates are made starting with the largest square footage parcels of the smallest IPH value. This was done until all the total IPH are equivalent to the EP.

For example, if the total IPH of a block group exceeds the EP. Parcel 16 027 01 002 has one unit with six bedrooms, but since total IPH exceeds EP then the IPH of this parcel is reduced from 6 to 3. The value of 3 was used because the average persons per household in Redan was 2.85. Larger IPH values decrease, so the total IPH of parcels within the census block accurately represents the EP.

Apartment parcels could not use the same method to map population as the single-family and townhome parcels because units in an apartment complex are not split individually. For more accurate and detailed information, the website Apartments.com was used as a reference. The site information included the number of stories of each structure in the complex, number of units in the complex, and number of bedrooms per unit. The number of bedrooms used at apartment complexes was the average number of bedrooms of all the units on the property. If an apartment complex sits on two parcels, then the number of units in that complex is split in half between the two parcels. As mentioned in apartment complex parcels, the number of bedrooms is an average of the total bedrooms per unit at the complex. This average would then be divided between the parcels. For example, the average number of bedrooms at the Reserve at Stone Creek is 2.5, so the first parcel has a bedroom value of 2, and the second parcel has a bedroom value of 3.

If a parcel is sitting on two block groups, then the population of that parcel should be counted in one group or the other. This decision was based on the IPH of the parcel and the group it would best be included is based on the EP. In order to make that decision, a new field was added to the parcel shapefile called Census Block Group. Using the Select by Location tool in ArcGIS Desktop, each parcel was given a value of the block group name that it was within. This was successful for the majority of parcels, but there were a few instances were a parcel would cross two block groups. Comparing the total IPH of each section to the EP of each block, the parcel would be labeled under whichever group it would serve best to equalize IPH and EP values.

The mapping of the population at the parcel level using dasymetric mapping allowed for an accurate account of the estimated population. Mapping the population is useful in Chapter 4 of the manuscript as the results of GIS analysis determine what areas are accessible and comparing accessibility among residents.

3.3 Network Analyst Tool

Using the ArcGIS applications, network analyst enables users to run a spatial analysis for assessing accessibility and routing problems. The network analyst tool (Service Area) is available on ArcGIS Desktop as an extension, ArcGIS Pro, and ArcGIS Online. The access point of the service area, as mentioned above, represents the entrances at each park. Based on the placement of the access points at each park, the network analyst tool creates service areas buy creating a network from accessible streets. Service areas can be based on time or distance. For this project, service area analysis on roads are based on distances of ¼ mile, ½ mile, 1-mile, and 2-mile breaks. Each park has separate polygons with the Multiple Facilities Option. The four

polygons created from running the spatial area analysis are the layers added to the web application.

Some studies on parks have used buffer analysis to determine the service areas of parks. The change from using the buffer tool to the network analyst derives from the limits of the buffer tool. The buffer tool creates a buffer or zone around the park site. The zone is determined by choosing a straight-line distance or radius such as 1-mile. This straight-line distance does not account for roads, bodies of water, or other structures that limit travel. The buffer analyst tool was helpful in the past, but the network analyst tool is a more accurate measurement of traveling distance and time based on road networks. The change from buffer analyst tool to the service area in network analyst is a major factor in improving park accessibility research. Using the four breaks to create service areas, the analysis on the accessibility of parks in Redan is discussed further in chapter 4.

3.4 Web Application Design

3.4.1. Design

Once the techniques used to evaluate park accessibility of Redan were completed, such as dasymetric mapping and service area analysis, the next step was to add the subsequent layers to ArcGIS Online. The web map contains the following layers: parcels, which includes population, parks, service areas, access points, DeKalb streets, Redan boundary, and vacant sites. All shapefiles must be zipped separately and uploaded to the content page of the creator, especially if layers are to be referenced in other web maps or applications.

The parcel layer added to the web map represents only the parcels that hold residents of Redan. The vacant sites and access point layers are turned off by default to limit the clutter in the web map, but users can turn on the layers at any time. The symbology of the service areas layer

was changed in ArcGIS Online to show the four different breaks based on the distances mentioned earlier. A customized color ramp was used to show how access decreased to residents the farther they were away from park entrances. The service areas layer was set to a high transparency level so that the streets and parcel layers are visible to users. ArcGIS Online web maps have a default feature for all layers called pop-ups. Pop-ups are a box that holds information on the layer and appears whenever a feature on the map is clicked. By right-clicking on the layer in the "contents tab", pop-ups can be turned off or configured to the creator's preference. Pop-ups were turned off for the service areas layer because the symbology gave enough information. The park layer was configured so that if a user clicks on a park, a pop-up appears, displaying the name, address, acreage, and a picture of the park. Park amenity information is available through the query widget tool discussed in the following section. Pop-ups for the parcel layer were configured to show the land use category, acreage, and number of residents. Additional parcel information is available through the screening widget tool discussed in the next section. Using cartographic principles, the color schemes and symbology of each layer were chosen for visualizing and comprehending the content within the map.

Once the web map was created, the application was designed using the Esri Web AppBuilder. The web application used a basic template made available through Esri. The layout selected for this application was chosen to complement the structure and design of the web map. The web application is accessible through any browser and most electronic devices that have internet access. Besides the web map, the application has a legend to clarify the features within the web map. There is a toolbar on the web application that holds several tools that users can use to operate and manipulate the web map and data within it. The tools on the toolbar were selected specifically for this project and are listed in the following section. The application is embedded

in a story map, and the story map will help users understand the goal of the application and its overall purpose in enhancing park accessibility. The template of the story map comes from the Esri Story Map Gallery.

3.4.2. Tools and Techniques

An essential part of this application are the tools, also known as widgets, available to the user so that they can engage with the web map. The first three widgets are simple and give the user basic controls of the web map. The *Basemap widget* changes the base layer of the web map to whatever the user prefers. The *Legend widget* represents what layers are within the web map. The bookmark widget keeps a record of the scale and view of the current extent of the web map and saves it as a bookmark. The *Print widget* is available for users who want to share analysis or details pulled from the web map. The next few widgets are a little more complex and are designed for users conducting analyses. The *screening widget* is a tool available to users that allow for analyses on parcel layers. Under the Draw tab, a user can identify an area by using a point, drawing a line, polygon, or selection by a rectangle. Under the Place name tab, a user can identify a location on the map by inputting the name of the place. In the configuration of this widget, the parcel shapefile was used as the layer to analyze data based on the selected location. The population, acreage, building square footage, and land use category are listed. There is an option to select a buffer distance that shows what parcels fall in the range. For this project, a ½ mile buffer distance was set as the default. The option to download the parcel information that is reported from the screening widget was selected. Users are able to download the data based on the buffer distance of the identified location. Once the analysis is complete and the users are satisfied, the restart button returns to the web map to the default scale.

The *Query widget* is a tool used to search the facilities within an existing Redan park. In the configuration of this widget, the park shapefile was used as the layer in the query. The parameters set included symbology and the ability to export results. The facilities listed in the query are a customized list based on the fields available in the layer. The last parameter for this widget was selecting the option to turn off query results when the widget is closed. In the widget, users select a single park from a dropdown list of parks. A list of facility details is presented to the user, which can be used in analysis or exported for further work.

The next tool is meant to allow users to turn vacant land parcels into new park sites. By using a customized version of the editor widget, users would have the means to show what parcels they think would be the best place to add a new park. The goal of this tool is to add parcels to the park layer that were initially labeled vacant sites so that when a service area analysis is re-run, the change would reveal new service areas.

The last tool gives users the ability to add park entrances to park sites. The park entrance layer is used in the service area tool as the reference point. The service area tool uses the access points to determine what areas are serviced based on the distance(s) set. This tool allows users to add additional park entrances to the layer. This tool is not ready for use, and details of this tool are explained in the conclusion chapter.

Chapter 4 Results

When park directors and local government officials decide what facilities or parks are needed in the community or a specific neighborhood, it is ideal that park information and analysis be made readily available to all. This chapter outlines how tools are used in the web application and the types of analysis that can be derived through the user-interface. This web application can allow each user to see the impacts of existing parks, gather data to support an argument, run real-time analysis, and present the effects of proposed new park locations. This technological advancement is meant to assist in helping local government officials plan for future parks and help reduce inaccessibility to parks.

4.1 Web Application Features

The default template of the map shows the active layers. Figure 3 presents what a user sees when opening PFR for the first time. Users can pan across the map and view how park accessibility changes throughout the community. Basic operations buttons are located on the left of the application, such as zoom in and out. The home button returns the web map embedded in the application to the default scale. Once the user feels comfortable with the layout of the map, the toolbar on the top right-hand side of the application gives more abilities for change and individual manipulation. The legend, bookmark, and print tools are the first three widgets on the toolbar. These tools do not shape the map but allow users to inform themselves on the symbology of features, save the scale and layout of the web map for future work, and print the web map as shown. The symbology of closest to farthest service areas are reflected in a steady gradient color scheme from white to tan to red. White polygons are nearest the access points, and red polygons are farthest from the access points.

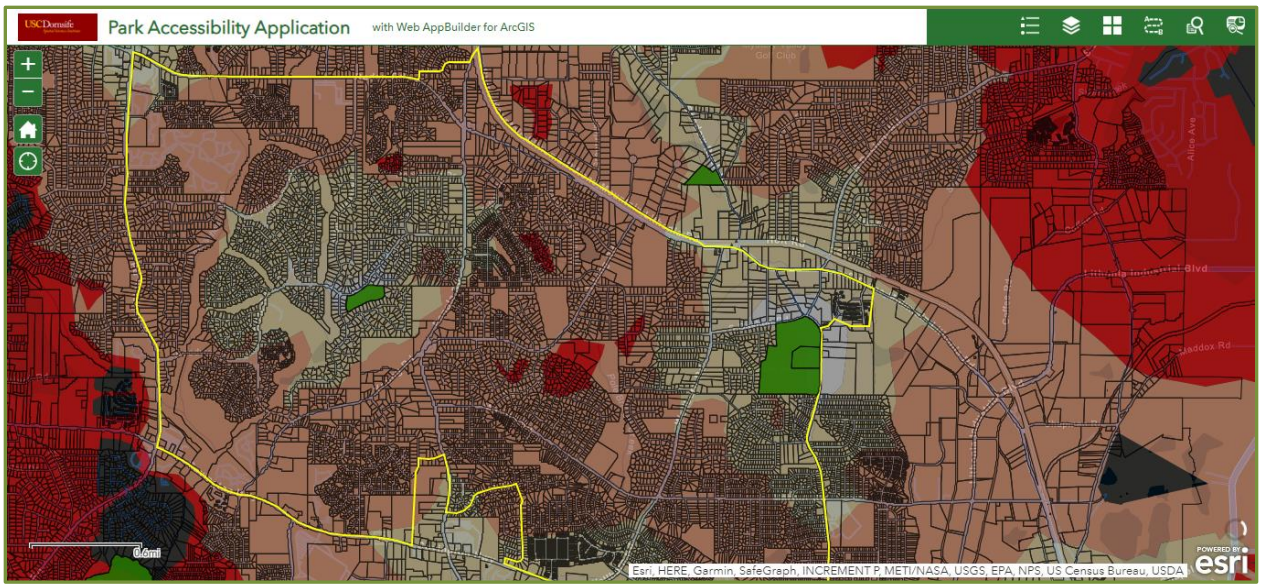

Figure 3 Park Friendly-Redan App Accessed April 20, 2020

The next tools on the PFR toolbar allow users to change the design of the web map within the application. If a user does not like the default layout of the web map, there are two widgets that allow updates to be made. The layer tool opens a column on the right-hand side of the screen, and users can turn off or on any layer within the web map by clicking the check-box next to the name of the layer. Depending on the objective or interest of the user, some layers may be more useful than others. In the default layout, vacant sites are not shown, but this vacant site information may be of interest to stakeholders. According to Esri, the basemap layer is the background imagery that geometrically references the web map. The basemap gallery widget allows users to choose which map would best serve in the examination of Redan.

When the user has made the desired changes to the web map, the customized query and screening tools allow users to collect park amenities data and run a spatial analysis. Figure 4 shows that the Parcel Analysis tool is used to evaluate the area surrounding Biffle Park in central Redan. Under the Parcel Analysis tool, the draw tab was selected, and users can pick from a variety of tools to select an area on the map. In the figure, the rectangle tool was used as the draw

mode, and a box was drawn around Biffle park. Based on the configuration of the widget, a ½ mile distance was drawn around the rectangle producing the red boundary shown in Figure 4. When the user clicks the report button at the bottom of the widget, a report on parcels is generated (shown in Figure 5). Link to the application, PFR, is available in the refence section.

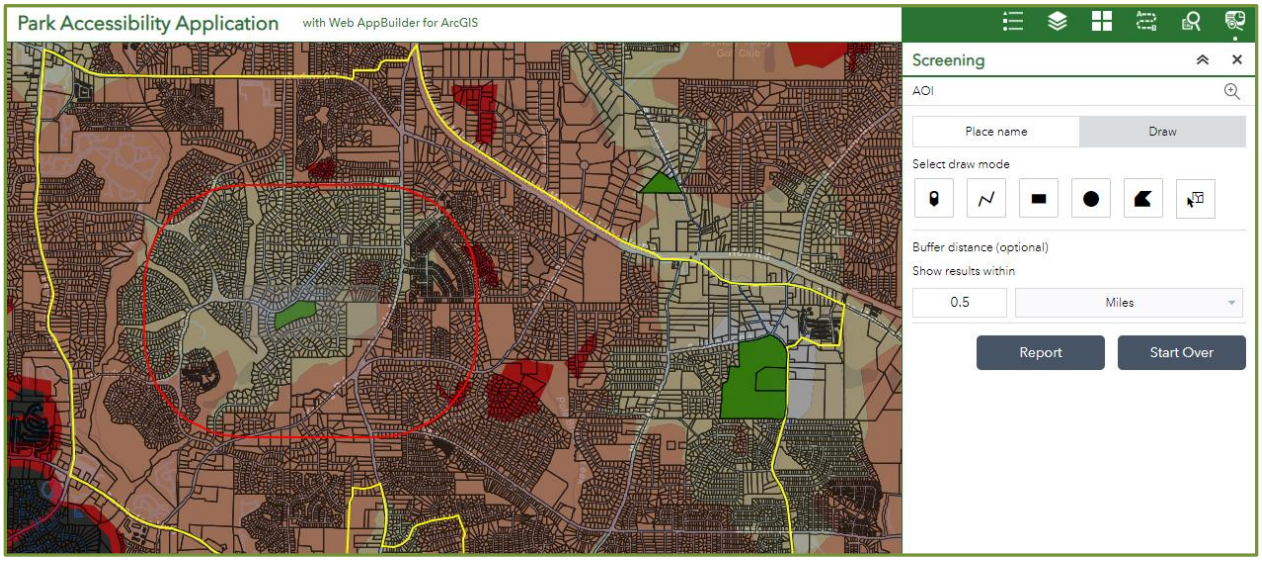

Figure 4 Using the Parcel Analysis Tool to Assess Parcels at a ½ Mile Distance

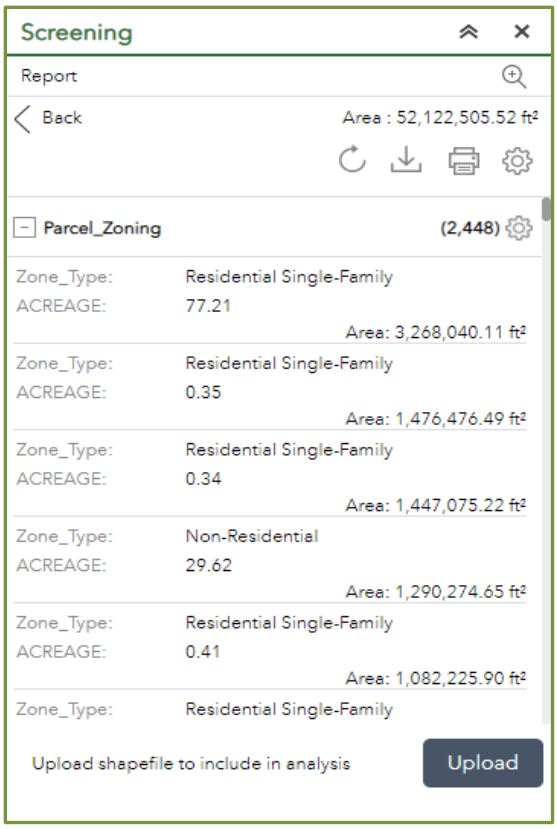

Figure 5 Report on Selected Parcels

The Facilities and Amenities Tool is used to verify the number of facilities available at each park site. In the application, the Redan Park was selected under the drop-down list of parks. When a park is selected, the name, address, acreage, facilities, and pictures are shown at the right-hand side of the application, as shown in Figure 6. The amenities of a park are listed for all users to see with a few clicks of the mouse. Making this information readily available helps show what facilities are available to the community and reports which facilities are lacking overall.

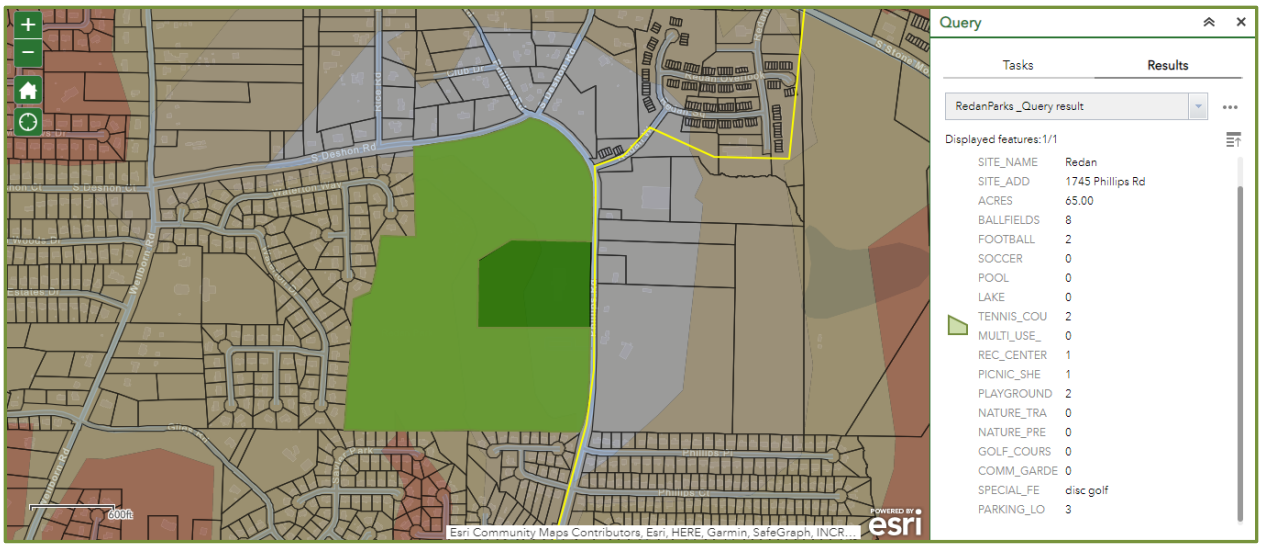

Figure 6 Operating the Facilities and Amenities Tool for the Redan Park

4.2 Example Park Recommendation Scenario

This section reviews a unique function where users can select new park locations from the vacant land sites and see how accessibility changes for residents based on those proposed locations. The goal of the web application was to provide users with park data and allow for spatial analysis through the user-interface. The parcels selected to become proposed park locations are completely dependent on the user's interest. In this example park recommendation scenario, five user-selected parcels known as the proposed parks, were selected from the 441 parcels that are considered vacant according to the tax digest provided by the DeKalb County Tax Appraisal Department. These vacant parcels were selected for several reasons. The five vacant sites chosen were within the boundary of Redan and contained at least nine acres making them large enough to hold several amenities. The five proposed parks, in the example park recommendation scenario, neighbored large communities such as an apartment complex or large subdivision, and the proposed park locations are in an area of Redan that did not have a park in the desired distance of a ½ mile. The ability to see the impact of proposed parks is an additional benefit of PFR.

It was imperative to design an application that park planning officials and directors can visualize accessibility from existing Redan parks and proposed sites. The service areas ran in ArcGIS Pro are updated to reflect the proposed locations. From the example scenario, the change in residents impacted are substantial. Figure 7 is a map of existing Redan parks with service areas discussed in chapter 3, highlighting the travel distances from parks. These are the same service areas used as a layer in the web map. A major takeaway from this map is that the majority of residential parcels in Redan are outside of the 1-mile travel distance to a park. Figure 8 is a map of Redan parks and the selected vacant sites that were chosen as proposed parks. With

five new parks, most members of the community would be within a 1-mile travel distance of a park entrance.

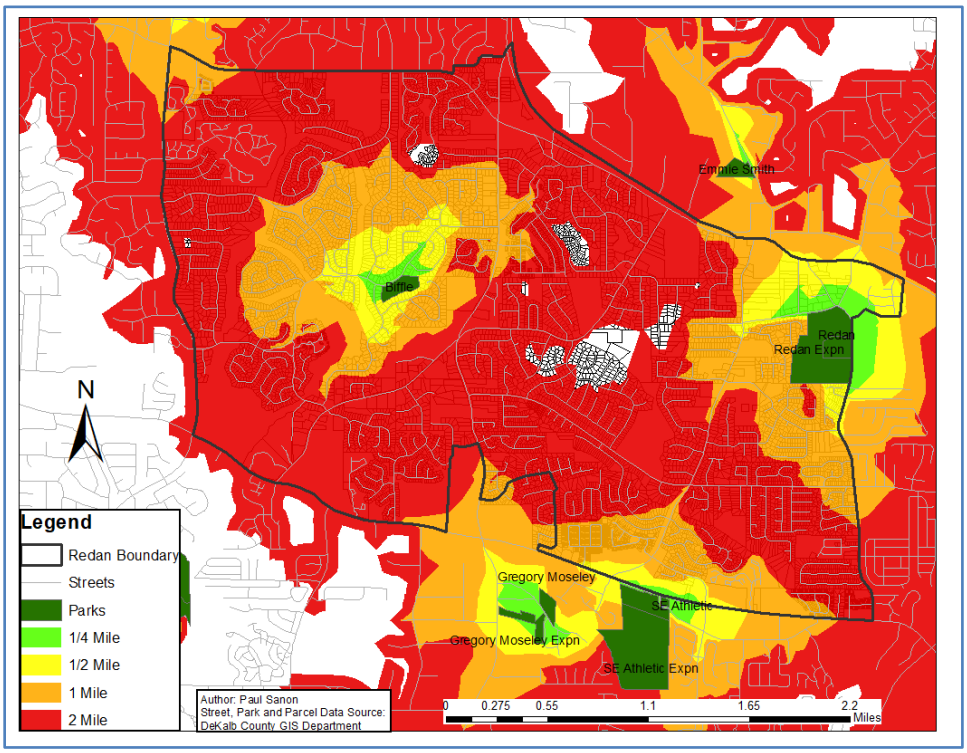

Figure 7 Service Areas Based on Existing Parks

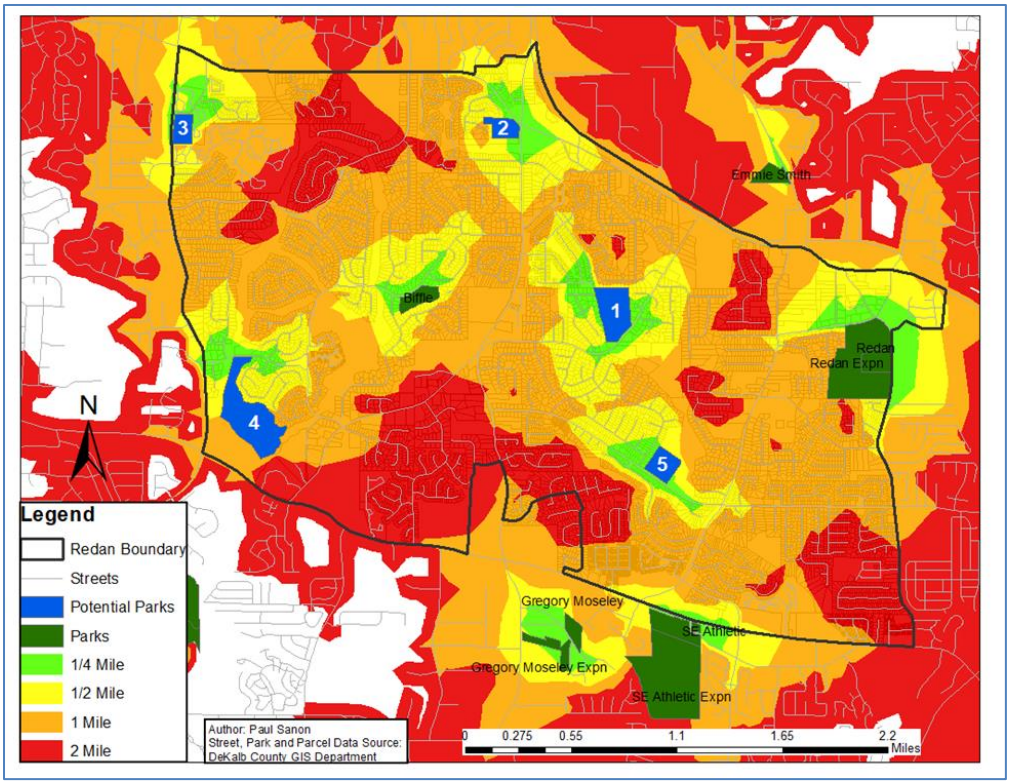

Figure 8 Service Areas Based on Existing Parks and Proposed Parks

Based on the service area breaks at a ¼ mile, ½ mile, 1-mile, and 2-mile, two maps were created for each break. One map shows the parcels within the set distance of existing parks. The second map shows parcels within the set service area of existing parks and proposed parks. The objective of this scenario is to show the capabilities of the web application when it is complete. All analysis completed in this scenario was done in ArcGIS Pro.

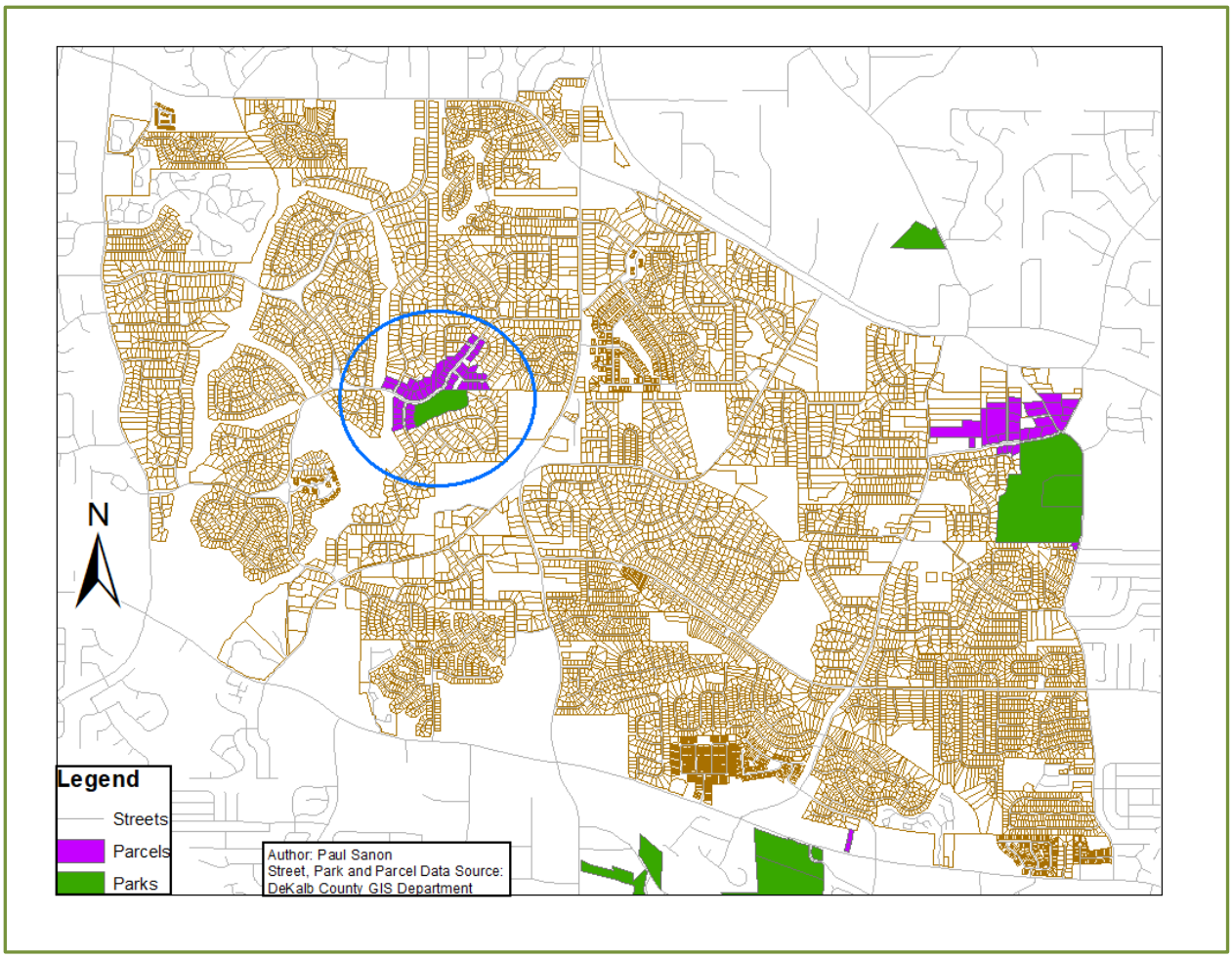

Figure 9 Parcels Within ¼ Mile Network of Existing Parks

Based on the ¼ mile service area of existing parks, 96 out of the 9826 parcels are covered within the distance. There are 308 residents that live within a ¼ mile of a park representing 1 percent of Redan's population, these are the residents considered to have adequate accessibility in Redan. The parcels on the north side of Golfcrest Road back up to the fields at Biffle park. This is a prime example of how a more in-depth study of park entrances would benefit service area analysis. If there is a park entrance between parcels, then houses on the south side of Biffle park would also have adequate access.

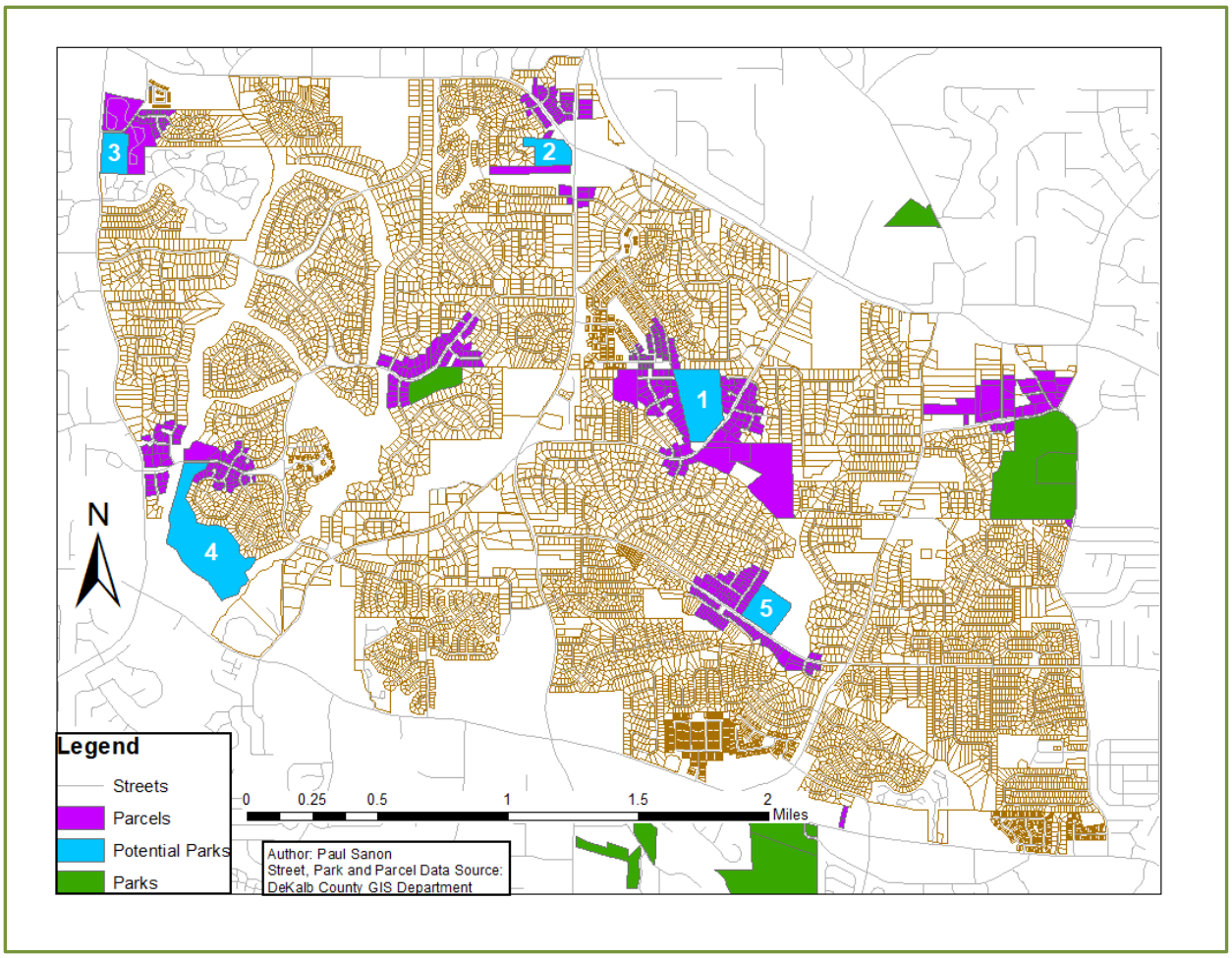

Figure 10 Parcels Within ¼ Mile Network of Existing Parks and Proposed Parks

By adding five potential park locations, the number of parcels within the given service area increased from 96 to 531. Thus, increasing the number of Redan residents that have access to a park within ¼ mile of their home to approximately 6%. With this recommended scenario a total of 1941 residents would be within distance.

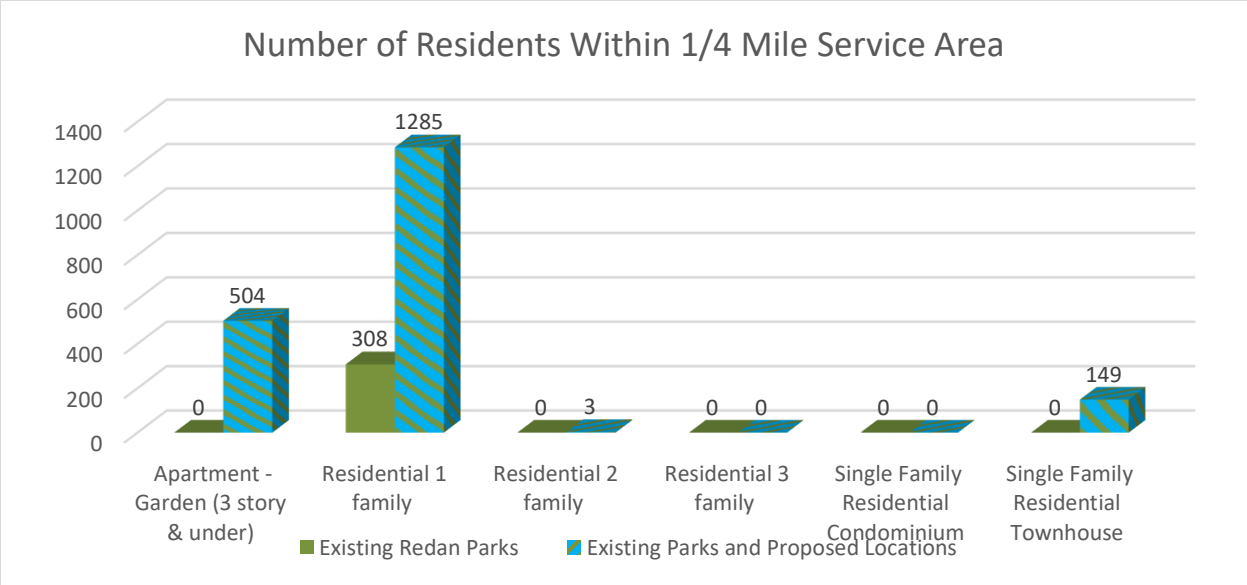

Figure 11 Comparison of Resident Accessibility at the ¼ Mile Service area

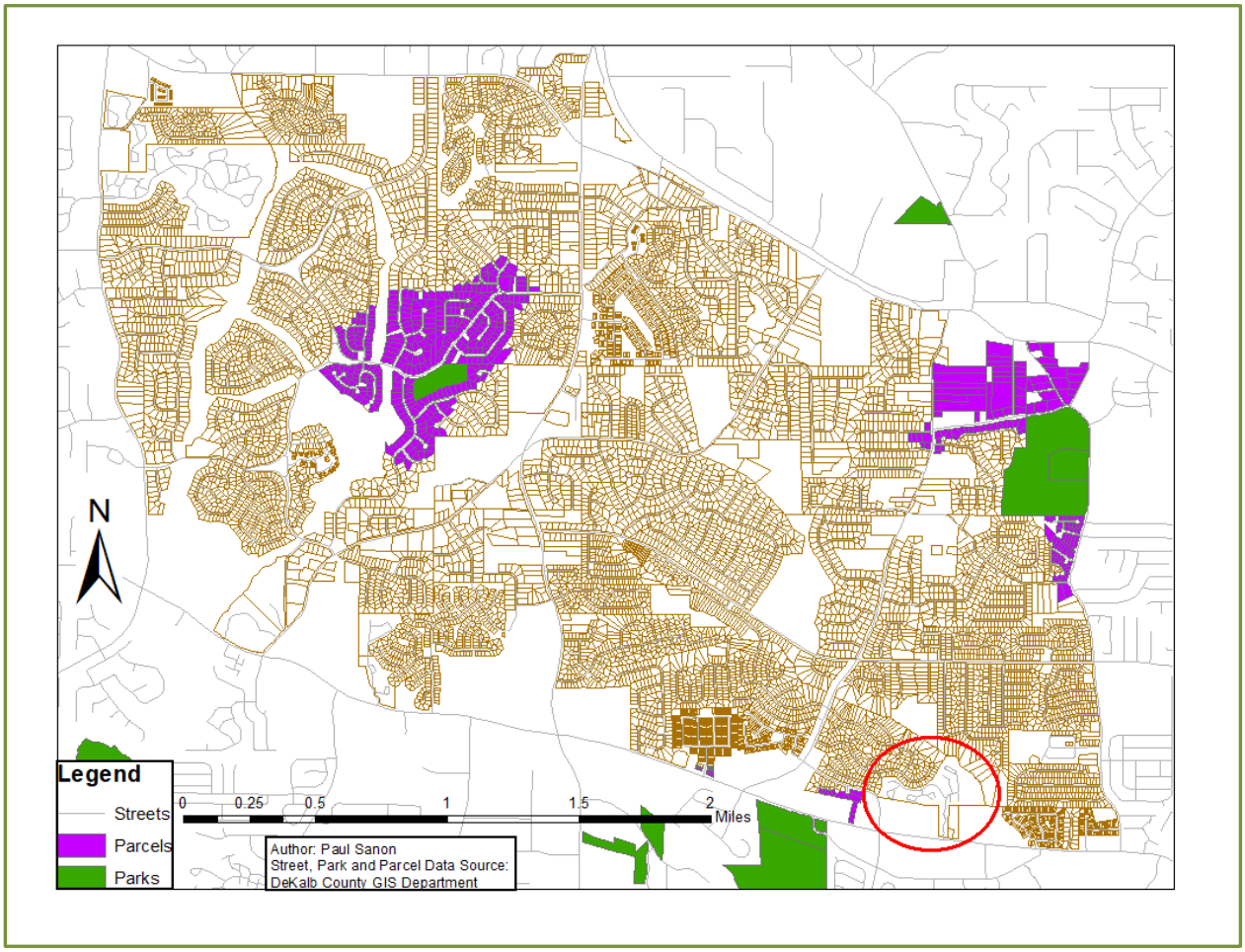

Figure 12 Parcels Within ½ Mile Network of Existing Parks

Based on the ½ mile service area of existing parks, 515 out of the 9826 (5.2%) parcels are covered within distance. There are 1640 residents that live within a ½ mile of a park. Woodcrest Village is an apartment complex on the south end of Redan. At the ½ mile service area, a small portion of this large parcel was covered by the road network service area. This parcel was not included in the ½ mile parcel count. For large parcels such as apartment complexes, the majority of the parcel needs to be covered in the service area to receive a more accurate analysis of accessibility.

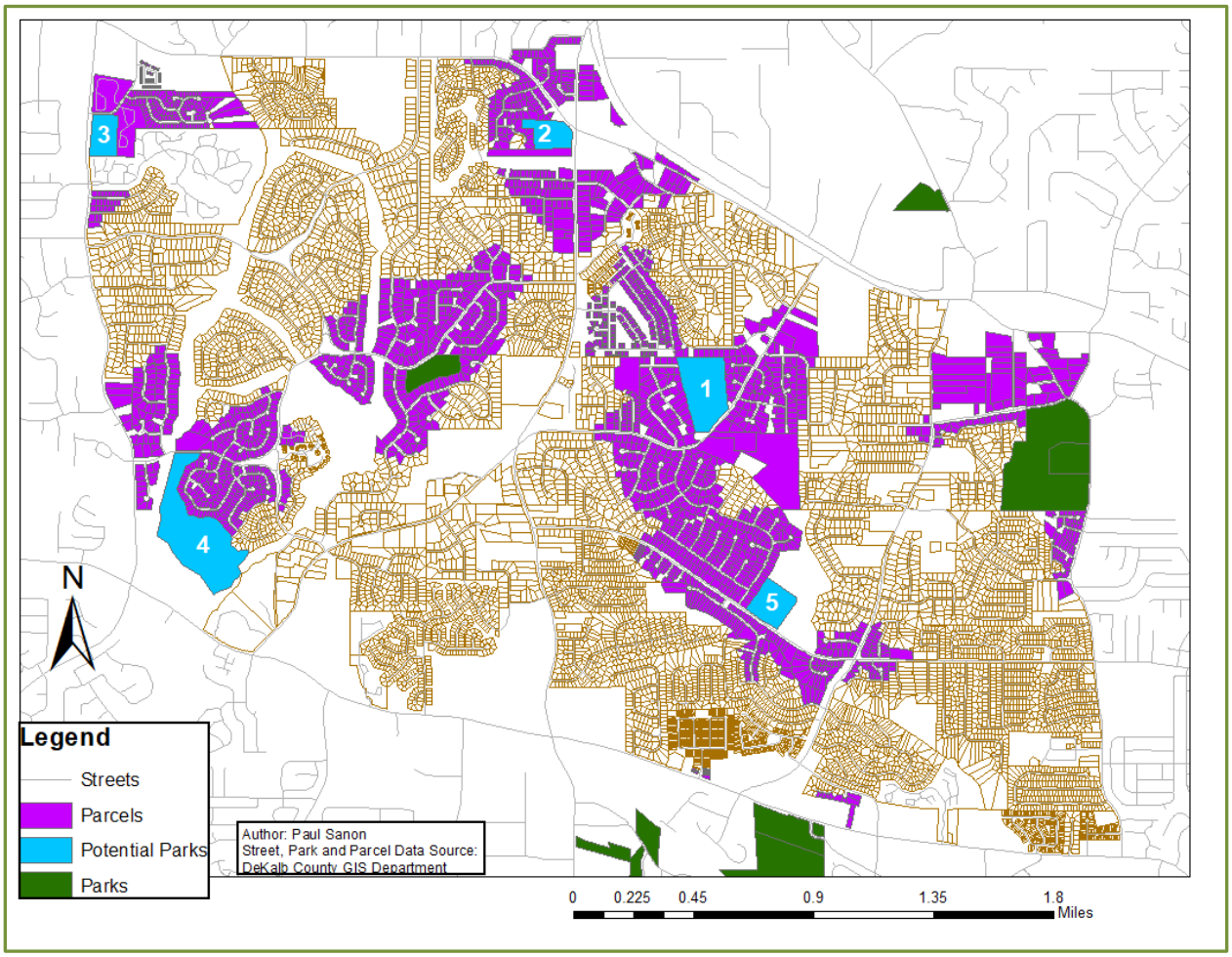

Figure 13 Parcels Within ½ Mile Network of Existing Parks and Proposed Parks

By adding the five proposed parks, the number of parcels within the given service area increased from 515 to 2536 parcels. Thus, increasing the number of Redan residents that have

access to a park within ½ mile of their home to approximately 8%. With this recommendation scenario, a total of 7479 residents would be within distance to a park.

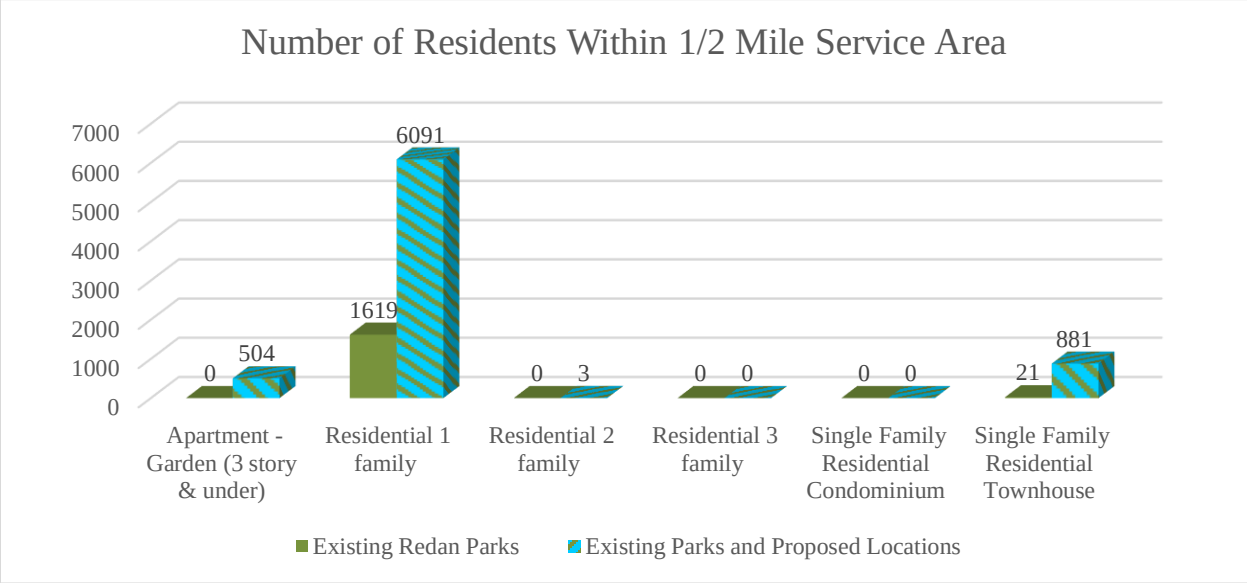

Figure 14 Comparison of Resident Accessibility at the ½ Mile Service area

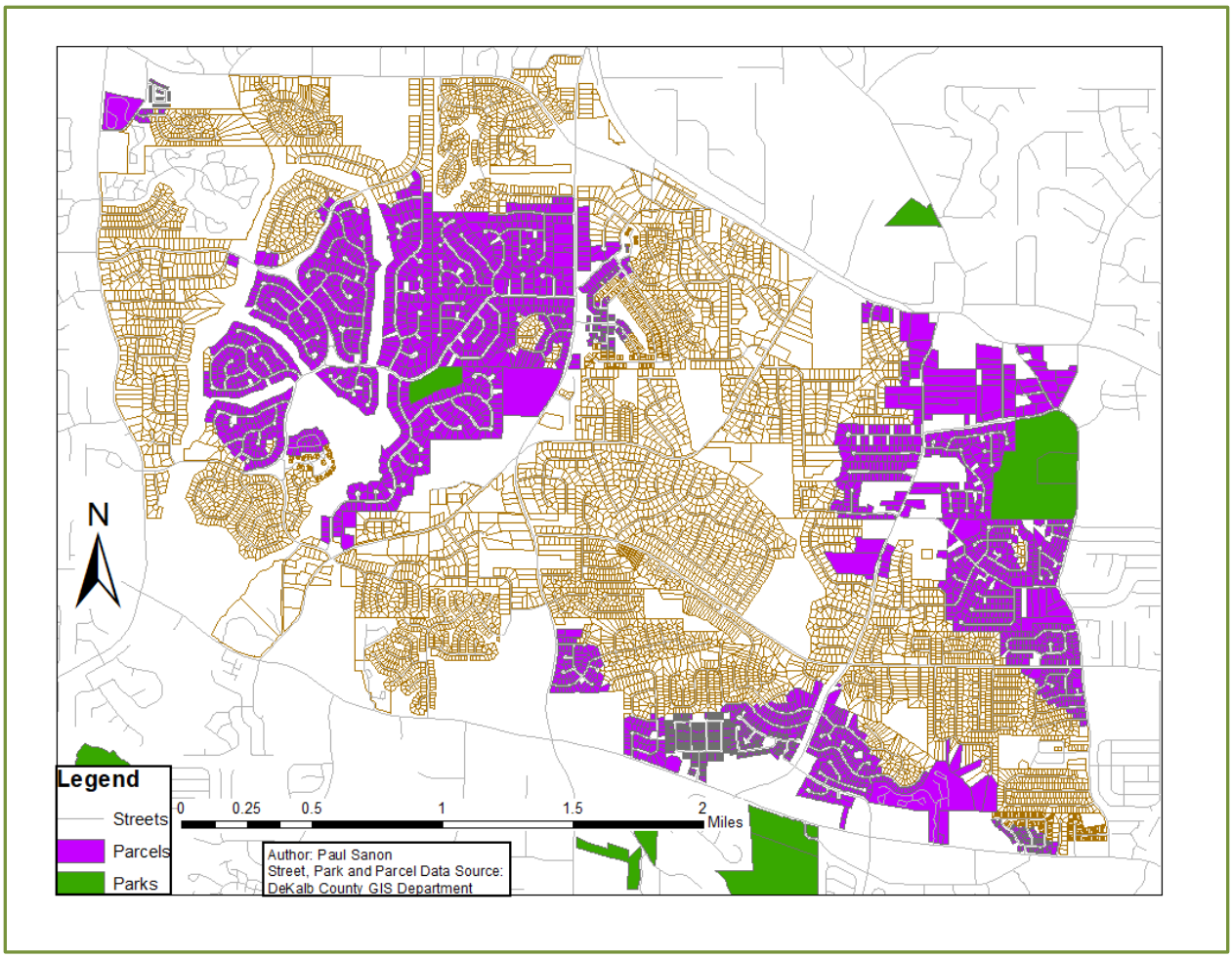

Figure 15 Parcels Within 1-Mile Network of Existing Parks

Based on the 1-mile service area of existing parks, 3511 out of the 9826 (35.7%) parcels are covered are within distance. There are 11237 residents that live within a 1-mile of a park representing approximately 37% of Redan's population.

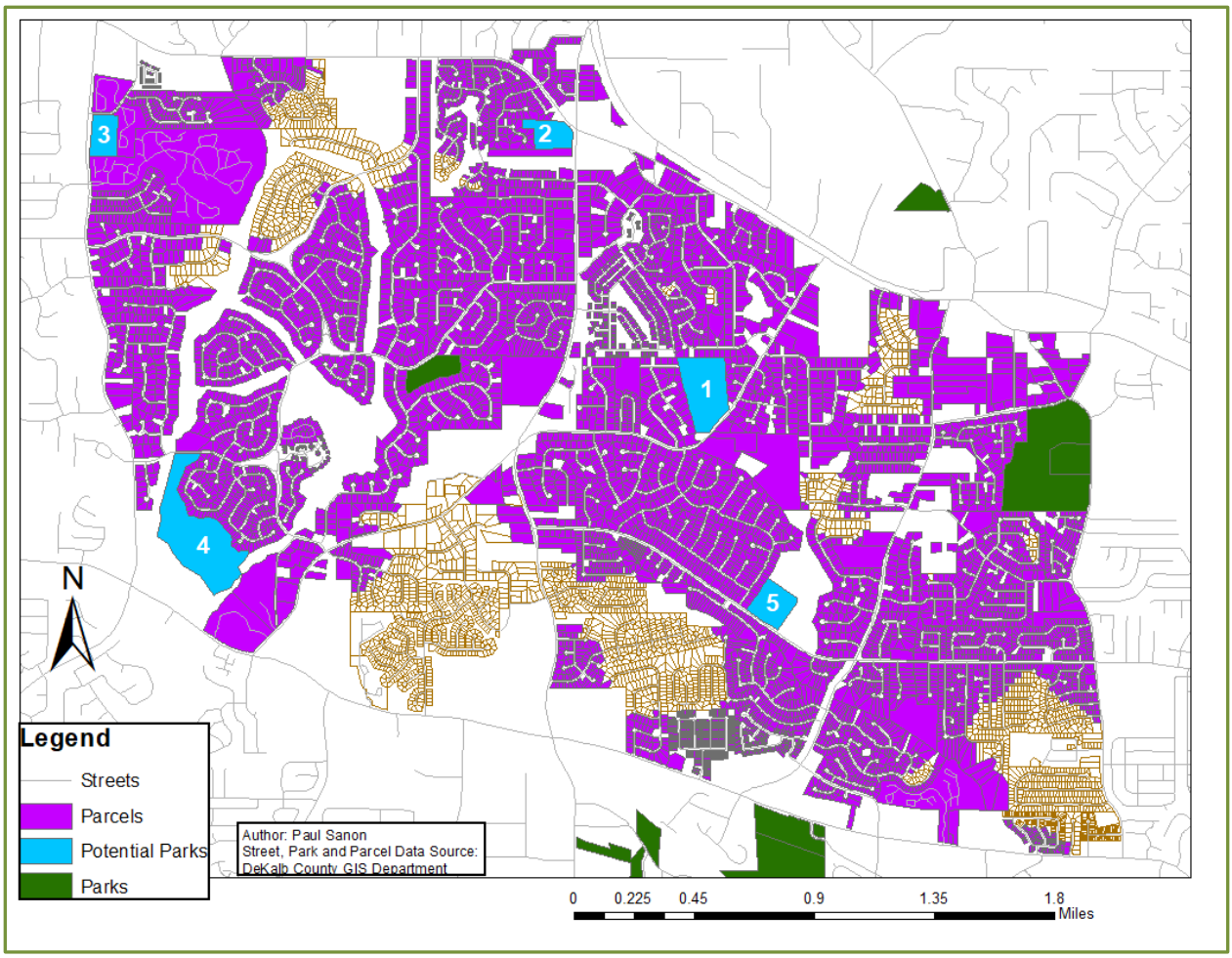

Figure 16 Parcels Within 1-Mile Network of Existing Parks and Proposed Parks

By adding five proposed parks, the number of parcels within the given service area increased from 3511 to 7656 parcels. Thus, increasing the number of Redan residents that have access to a park within 1-mile of their home to approximately 80%. Now 24,485 residents are within 1-mile of a park Adding the potential locations makes the 1-mile service area cover majority of the Redan community.

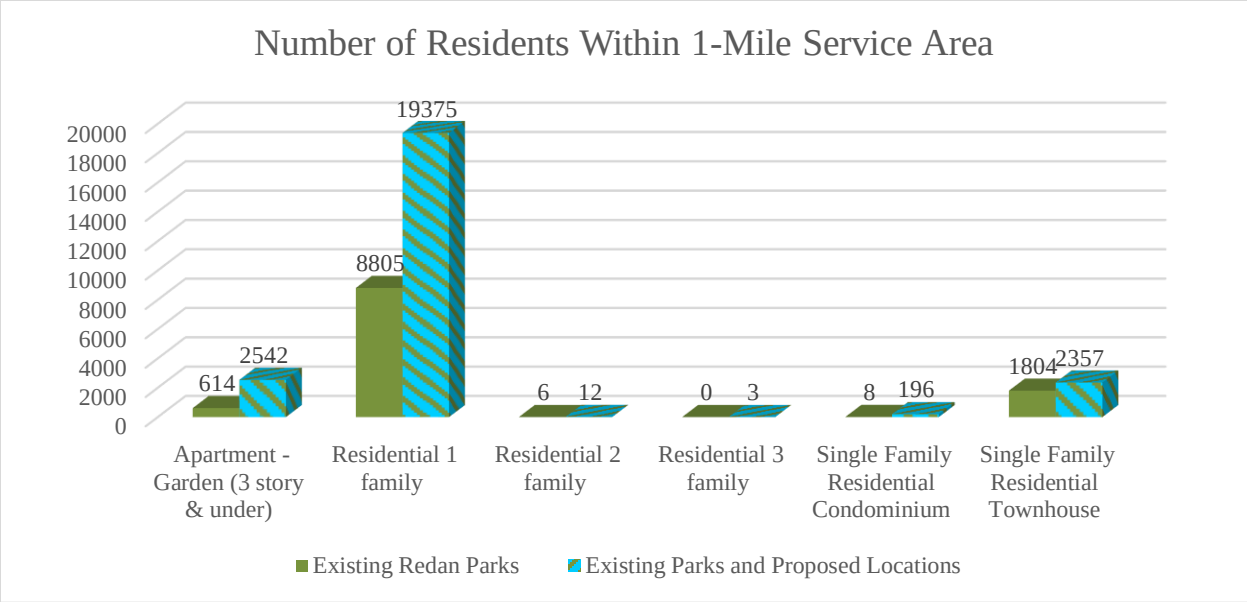

Figure 17 Comparison of Resident Accessibility at the 1-Mile Service area

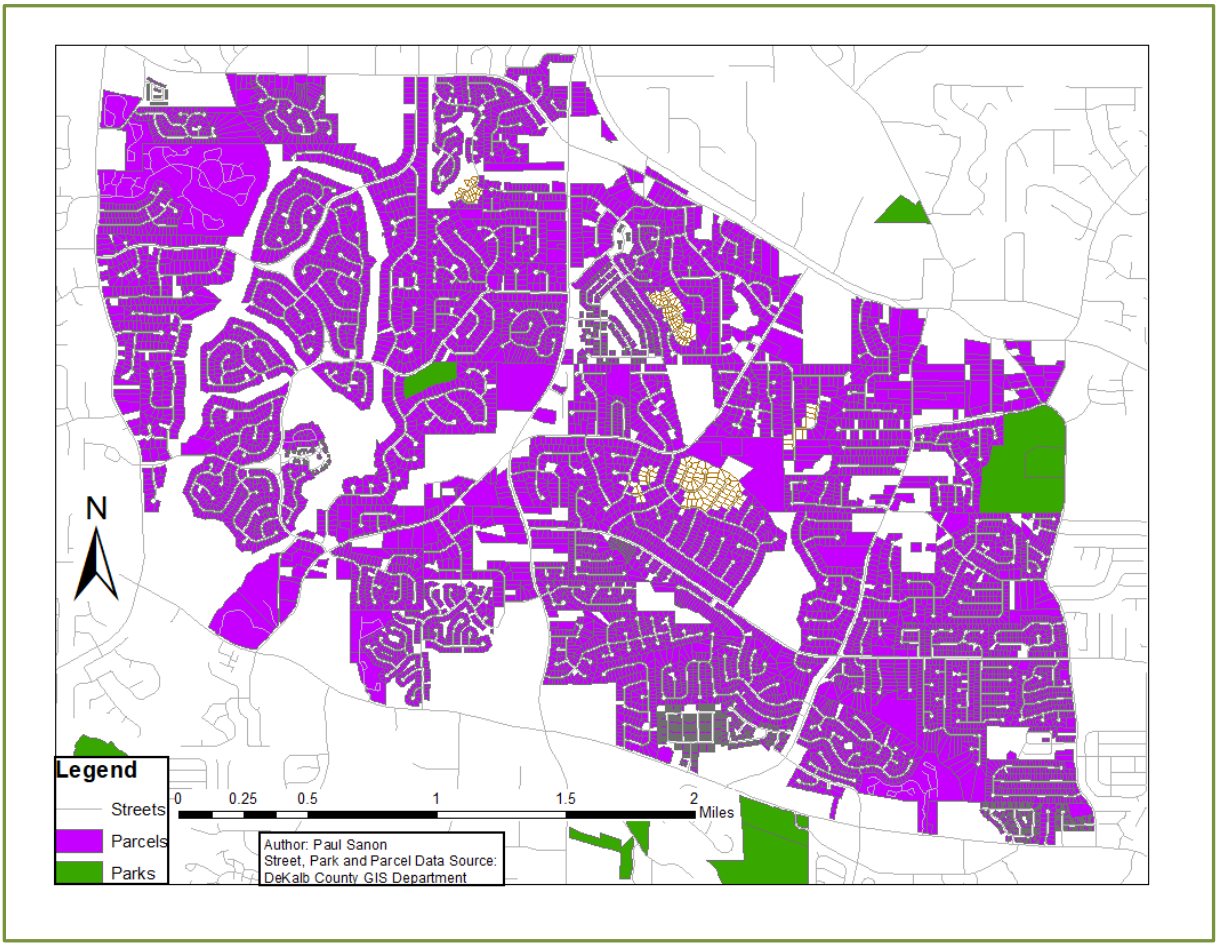

Figure 18 Parcels Within 2-Mile Network of Existing Parks

Based on the 2-mile service area of existing parks, 9679 out of the 9826 (98.5%) parcels are within a 2-mile distance. Over 30426 residents live within two miles of a park, representing 99 percent of the Redan population. The remaining areas that do not fall within a 2-mile range of a park are all parcels that are positioned at the rear of a neighborhood or at a cul-de-sac. There are 147 parcels outside of a service area and collectively they hold 341 residents, which is approximately 1.2% of the overall target population.

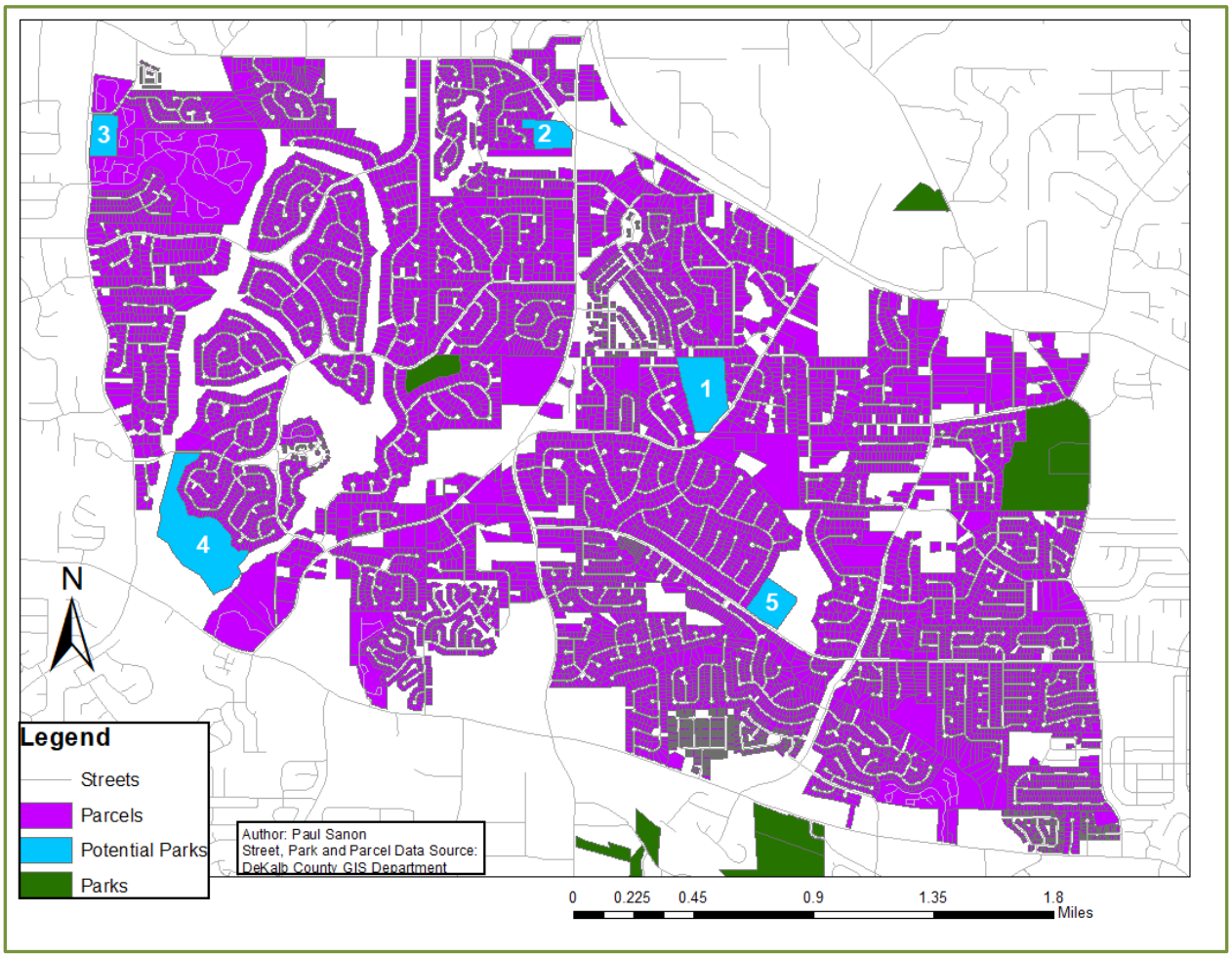

Figure 19 Parcels Within 2-Mile Network of Existing Parks and Proposed Parks

By adding the five proposed parks, the number of parcels within a 2-mile service area increased from 9679 to 9826 parcels. Thus, increasing the number of Redan residents that have access to a park within 1-mile of their home to 100%.

Figure 20 Comparison of Resident Accessibility at the 2-Mile Service Area

4.3 Discussion

The example park recommendation scenario of section 4.2 highlights an idealistic long-term plan for Redan and how more parks could impact residents of the community. By gathering the essential data on parks, parcels, population, and streets allows for an evaluation of the focus area. The results show that even one new park could have a lasting impact on residents. On the other hand, adding five potential park locations did not solve all park accessibility issues in Redan, Georgia. The analysis derived from the query tool in section 4.1 shows there is a lack of amenities at parks within Redan. The size of the park, the amenities, surrounding environment all factor into the measure of accessibility.

4.4 User Feedback of the Web Application

Park Friendly-Redan (PFR) is a web application intended to serve the community, so three members of the Redan community and DeKalb County volunteered to test the application and provide feedback on the application's practicality and usefulness. Overall, the application was very useful in visualizing Redan park accessibility, and many people were excited to see what additional benefits the application could provide with future work. This section breaks down the feedback received about PFR and how it can be tied into the future work on this project.

An analyst with the Dekalb County GIS Department was the first to evaluate PFR. Most of the data used in this project came from the DeKalb GIS Department, so they were interested in seeing the resulting web application. The GIS department was impressed with the design and functions of the application. From the comments received, the functionality and tools available in PFR surpassed that of DeKalb County's park map and many other park applications. This project was the first time the analyst has seen the use of dasymetric mapping to calculate the population and found the technique complex and useful in the County's future work. It is useful to have images of each park and find out what neighborhoods are considered to have adequate access based on service area boundaries. The only suggestion received from the DeKalb County GIS department was that PFR covers only a fraction of Dekalb County and the design of a new web application that serves a larger portion of the county would be beneficial. Overall, the department was very impressed, and the advice was to continue working on the service area tool and the ability to edit park entrance features in the web map (Interviewee 1, 2020).

A member of the Dekalb County Recreation, Parks and Cultural Affairs Department also reviewed the application. PFR was exciting to the volunteer in the hope that the application

would help generate new ideas for park management operations and scheduling neighborhood events at parks. The volunteer enjoyed the capability to see all amenities at a park by selecting a feature or running the query tool. An updated list of park amenities was shared so that PFR would have the latest specifics. There was criticism that the application lagged when loading. The default layout of the web application was overwhelming to individuals that had little experience with web applications and spatial studies. The volunteer indicated that the parcels outside of a 1-mile buffer should be in a different color other than red. According to the reviewer, red is usually associated with a negative or more extreme measure and living within 2-miles of a park in Redan is not extreme. Advice from the volunteer was to make the application more useful to residential members of the community by simplifying the analysis. A suggestion to limit the number of tools such as the query, screening, and service area tool. Overall, the Recreation, Park and Cultural Affairs Department was excited that parks were being researched with the ultimate goal of increasing park accessibility. The next steps for PFR will be to reduce the number of layers showing in the default web map so that users are not intimidated by the amount of information and features presented.

A resident of Dekalb County that lives just outside of the Redan boundary was interested in testing the application to see whether it is useful or informative for individuals on the periphery of Redan. The user indicated that PFR was both practical and informative to neighboring residents of Redan. Further, the user mentioned the symbology and design of the map was “stylish and aesthetically captivating”. Being able to view the parcel categories and levels of accessibility across the area was useful. Without instructions and no prior ArcGIS experience, the user reported that it took several minutes to understand what tools were available and how they worked. The user requested that within the Access Points layer, users be able to

place points where a proposed park entrance should be located. According to the user's feedback, it would be just as important to make park entrances accessible as it is to show proposed new park sites. Again, similar to the DeKalb County GIS department, the reviewer is interested in seeing an application that spread further across DeKalb County with park analysis. The suggestion to improve the application with instructions can be done with a Splash page, box that appears when the application is open for the first time, and this will help individuals with limited to no prior ArcGIS experience navigate through the application.

The objectives of the application were to stand apart from other web applications, provide accessible data on parks, and help improve decision making regarding park accessibility. From the feedback received, PFR is a useful web application that will be used more than once. The application is still in progress and has more work to be done. Future work on the application is detailed in Chapter 5.

Chapter 5 Conclusion

The web GIS application designed in this project was intended to serve as a tool in the design and planning of new parks and aid in analytical discussions of existing park amenities in the Redan area by park directors and local officials. The previous chapters explained the goals, studies, research, methods, and results of the web application PFR. The design and application of this project received good reviews, but the volunteers also provided recommendations for future improvements on PFR. This chapter highlights limitations that stopped certain functions, future work that could not be completed for various reasons, and goals that will enhance future park accessibility work.

5.1 Application Structure

5.1.1. Dasymetric Mapping

Dasymetric Mapping is a technique that helped display the population in Redan and its distribution within each residential parcel. This technique has been used for mapping the population in previous park accessibility literature. To improve dasymetric mapping methods from previous park literature, this project used census block groups, which are the smallest measure for population gathered by the Census. The tax digest, complete listing of parcels with details on property structures and square footage, obtained from the DeKalb County Tax Appraisal Department, provided more information not accounted for in previous park studies. Some studies used the housing unit values of each land parcel in dasymetric mapping methods (Jimenez 2016). From the tax digest, this project obtained data on land use category, the number of bedrooms in residential units, number of units, and the number of stories in a unit. Parcels that did not contain residential units were excluded in the calculations. The ability to map Redan's population was very informative and can continue to be improved for future work because

without the population it is difficult to quantify how many residents are impacted by the parks in Redan. The method of analysis used in this project will be useful for future dasymetric mapping as previous studies helped shape the methods used in this thesis.

5.1.2. Service Area Analysis

Creating service areas based on park entrances is a significant factor in park accessibility studies. The use of service areas goes beyond park accessibility research and transcends through several studies that use spatial analysis. Due to time limitations and ArcGIS Online restraints, the project has not yet provided users the ability to create service areas themselves. Additional research will be needed to customize a widget that allows users to create a service layer based on access points. In previous literature on web applications, Alexander Holt designed a web application to help local jurisdictions and stakeholders find the best locations for voting center locations (Holt 2019). In the web application, Holt used the query widget to create a service area around a single site. Based on that site, a 5-minute drive polygon was created. The methods used in Holt's vote center application can be transferred to PFR with some modifications. The difference would be that based on all Access Points, new service areas can be created. The ability for users to create new service areas within a web application will be new to park accessibility studies.

5.2 Future Work

Currently, Park Friendly-Redan does not rate the city or any parks. A future task of the application will be to add a rating for parks similar to other park accessibility research. The Trust for Public Land Organization has created the ParkServe application which gives a rating to cities based on the parks within the city. Since PFR only looks at one community, the plan is to rate the

parks instead of the city. Park ratings will be based on several factors, including acreage, number of people with access, and dis-amenities.

Park accessibility studies have looked beyond travel distance and road networks to define the term accessible. There is new research that measures the distance for the elderly and handicapped. In future work, PFR will have data on park services for handicap accessibility. The goal of all park facilities should be to have wheelchair access and be accommodating to other disabilities. The national park service (NPS) has an Accessibility Task Force that works to provide access to all members of the public. This mission of NPS should be carried out throughout all public parks. Local governments should work to promote handicap accessibility also. In future work, PFR will give parks a rating level 1-5 based on their level of accessibility for community members with disabilities, specifically handicap. A rating of 1 indicating the lowest or poor rating park and 5 being the best score. In addition to park facilities and dis-amenities, handicap accessibility will contribute to the park's overall rating.

In Chapter 2, park dis-amenities were discussed as an essential factor when evaluating the condition of a park. The use of volunteered geographic information (VGI) allows for organizations, businesses, and governments to enhance their geodatabases with the collective information of numerous volunteers. VGI platforms are typically user friendly and require limited to no GIS training. The National Map Corps (TNMCorps) completed a project working on a VGI where volunteers worked in the initial gathering of data that is published in the National Map Corps. Volunteers used the web interface to add structures including schools, hospitals, prisons, and more. The VGI prompted users to input the name, address, city, state, and zip code regarding the structure. TNMCorps (2019) found the geo-spatial data inputted by the volunteers was accurate enough to incorporate in the official database.

For future work, PFR would continue with the research done by Edgar Jimenez in examining park accessibility in Downey, California. In Jimenez's (2016) research, he put more focus on how park amenities and dis-amenities affect accessibility. When mentioning adding VGI to PFR, it has been suggested that users are able to select a park and leave comments addressing park quality, maintenance, and amenities. The objective for the VGI is to allow users to read feedback from others and provide input on park dis-amenities, park quality, and other recommendations to facilities to the list. This input will give park planners and local officials supplemental information to make informative decisions on locations and facilities for future work in the community. The stakeholders who use the park regularly should have the opportunity to express their concerns on neighborhood parks. The VGI will be embedded within the application so that stakeholders can access input and read the concerns of residents. The VGI could also serve as a social blog to design time and locations for activities in the park within the community.

As new apartment complexes are built, many owners are making sure to make amenities available within the complex as an attraction for new residents. Apartment complexes often have pools, nature trails, picnic benches, courts, fields, and playgrounds. There are five apartment complexes in Redan encompassing eight different parcels. A total of 3,177 people are within those parcels equaling ten percent of the Redan population. If there are amenities at these apartment complexes it reduces the number of people potentially going to public parks and the need to provide facilities to that neighborhood. In future work, the evaluation of apartments can add a calculation the depicts what amenities are available.

5.3 Limitations

5.3.1 ArcGIS Online Customized Widgets

Esri Web AppBuilder comes with multiple widgets to manipulate data and run spatial analysis. These widgets can be selected based on the project and several of these widgets were used in PFR. Besides the standard widgets available, many GIS professionals have customized unique widgets to create a tool that has different functions than the standard widget. Designing a customized widget in the developer edition of ArcGIS Online requires python programming experience. The time spent on training and development of customized widgets was not feasible at the current stage of this project. Of the customized widgets to be created for future use in PFR, there will be a customized tool to change vacant parcels into potential new parks for analysis. The next customized tool will update the *Access Points*. Users will be able to add more points where park entrances are proposed to be located. The updated access points layer could then be used in the query widget to re-run the service area analysis. ArcGIS Online continues to reshape and renovate how GIS data and applications are used and shared. The goal of this application is to make the latest GIS tools and features accessible and user friendly to users of all experience levels.

5.3.2. Pedestrian Access

Sidewalk research is crucial for park accessibility literature. Not all roadways can be traveled in the same manner. Without details, network analyst will not account for highways, excessive traffic, or non-walkable streets. Dekalb County GIS Department did not have information on which roads had sidewalks, which limited the accuracy of the service area. The next phase of park literature would be a more in-depth study on what roads have sidewalks.

Providing local officials with recommendations for new sidewalks can be included in future studies.

There is more than one way of measuring accessibility. Pedestrian accessibility examines sidewalks, but also roads that are bicycle-friendly. Referencing Google Maps, Redan does not have any bicycle trails, marked bike lanes on roadways, or unpaved trails. Previous park literature recommends the addition of bike paths to assist in the improvement of pedestrian accessibility.

5.4 Conclusion

The Park Friendly-Redan application designed in this project shared insight and provided directors, officials, and members of the community detailed information on park accessibility in a manner that was unique. This manuscript completed the goal of enhancing park accessibility studies by combining methods used to calculate accessibility into a web application. These methods included the evaluation of park amenities and improved traveling distance measurements. The application served to strengthen spatial science work by taking the lasted principles in park accessibility studies and combining them with the latest GIS tools such as web applications and network service areas. The application is not complete regarding all the tools available, so continued work will be required before it reaches its full potential. The ability to select vacant parcels, create new park sites, and re-run the service area tool will be unique to both spatial sciences and park accessibility studies. As discussed in the methods chapter, the design of this application can be transferred to any community around the world. A future application designer would start with gathering the latest park, street, parcel, and population datasets available. The GIS tools and applications available on ArcGIS Pro and ArcGIS Online would allow a designer to replicate the application for a community of their choosing. An

important aspect of park accessibility studies is to continue to work toward providing more residents with adequate access to parks. The more ways we can detail the irregularities and disparities of a community and make that information known to those in charge of parks, the closer we get to reaching that goal. Park Friendly-Redan will be a project that continues to evolve and work towards that goal.

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