Los Angeles County Vote Center Site-Selection: Facilitating Decision Making with a Web Application

by

Alexander Holt

A Thesis Presented to the
Faculty of the USC Graduate School
University of Southern California
In Partial Fulfillment of the
Requirements for the Degree
Master of Science
(Geographic Information Science and Technology)

May 2019

To my Mother, Father, and Ashley-Rose

Table of Contents

List of Figures vi

Acknowledgements vii

List of Abbreviations viii

Abstract ix

Chapter 1 Introduction 1

1.1. Progression of Election Systems 1

1.2. Senate Bill 450: Vote by Mail Voting and Ballot Discussions 2

1.3. Motivations and Project Goals 8

Chapter 2 Related Work 10

2.1. Voting Locations effect on Voting Decisions 10

2.2. Constituency and the Voting Process in Los Angeles County 11

2.3. Voter Participation and Turnout 12

2.4. Other Jurisdictional Approaches to Applying the Voter's Choice Act 12

2.5. Other LA County Projects Related to VSAP 17

Chapter 3 Data and Methodology 19

3.1. Web Application Design and Structure 19

3.2. Potential Vote Center Site List 23

3.3. Voter Registration and Turnout Toolset 26

3.4. Potential Vote Center Service Layer through Vehicle Accessibility 30

3.5. Initial User Feedback 34

Chapter 4 Results 35

4.1. Overview of Functionality for the Application 35

4.2. Application in Use 43

4.3. Feedback from reviewers 47

Chapter 5 Future Work and Conclusions 50

5.1. Current Status of the Application 50

5.2. Future Improvements to the Application and Fixing Bottlenecks 51

5.3. Final Findings 54

5.4. Conclusion 55

References 56

List of Figures

Figure 1 LA County Infographic Summarizing Changes for SB 450 3

Figure 2 LA County's VSAP Project Time line 5

Figure 3 Los Angeles County New Voting System Prototype 7

Figure 4 Percentage of Eligible Residents Not Registered to Vote in Sacramento County 15

Figure 5 Priority Ranking Map Sacramento County 16

Figure 6 CCEP Vote Center Siting Tool..... 17

Figure 7 SQL Query through Registered Voter Database to Acquire Voters by Age Class 29

Figure 8 Splash Screen Display 36

Figure 9 Default Layers of the Web GIS Application 37

Figure 10 Icons of the Main Tools..... 37

Figure 11 Demonstration of the "Filter by City/Community" Tool 38

Figure 12 "Select Vote Center Location Type" Tool 39

Figure 13 Selectable Registered Voter and Election Turnout Layers..... 40

Figure 14 Registered Voters by Age Class 18-29 Relative to the Countywide Mean..... 40

Figure 15 General Election 2016 Turnout by Registered Voter 41

Figure 16 Opening the Service Area Site Tool and Entering the Service Area ID 42

Figure 17 Running the Service Area Site Tool Displaying a 5-minute Drive Polygon, Voter count, and Business Count..... 42

Figure 18 Demonstration of Selecting an Election Precinct with a Younger Age Demographic of Registered Voters. 45

Figure 19 Inglewood Continuation High School Service Area 46

Figure 20 Inglewood High School Service Area 46

Acknowledgements

I would like to thank my thesis advisor Assistant Professor and Director of Graduate Studies, Dr. Robert Vos of the Dana and David Dornsife College at the University of Southern California. Dr. Vos never gave up on me when I struggled to define my topic or worried about being able to make enough time in my schedule to complete the thesis. He pushed me through the difficult times by meeting with me every week, giving me countless hours of thoughtful insight, and helping direct my thesis into a product that I feel very proud of. I would also like to thank the GIS staff of the Los Angeles County Registrar-Recorder Office for giving me direction on how to aggregate the large voter datasets that were used in this thesis and letting me have access to all the tools that were required to complete the web GIS application.

List of Abbreviations

AdCom	Advisory Committee (for the VSAP project in LA County)
CCEP	California Civil Engagement Project
CSV	Comma-separated values
Esri	Environmental Systems Research Institute
GIS	Geographic information system
LA County	Los Angeles County
RRCC	Los Angeles County Registrar-Recorder Office
SB 450	Senate Bill No. 450: California Voter's Choice Act
SSI	Spatial Sciences Institute
UCLA	University of California Los Angeles
USC	University of Southern California
VBM	Vote by Mail
VCA	California Voter's Choice Act
VSAP	Voting Solutions for All People Project

Abstract

Elections are a pinnacle of modern democracy. Fair elections have been a key pillar to the success of representative democracy; yet, many of the age-old problems still exist. One of these problems is voter turnout and making voting accessible to every member of that democracy. In today's elections, we are at an interesting crossroads of technology and convenience. California has recognized both trends and is implementing the Voter's Choice Act (VCA) or SB 450 to guide the future of voting in the state by allowing people to vote over a multi-day period and at any location of their choosing. With this change, new voting locations will play a more critical role to the process than ever before. This paper discusses the design and implementation of a web GIS application that will assist Los Angeles County stakeholders and elections officials in choosing these new voting locations by providing tools for analysis. The tools developed are designed to assess potential site locations and their relationship to voters and businesses, voter age demographics, and voter turnout. The initial version of web GIS application documented here was reviewed by county officials. It will likely be provided to local stakeholders by the Los Angeles County Registrar-Recorder office and used in the first round of site-selection for these new voting locations.

Chapter 1 Introduction

The purpose of this thesis is to assist in determining vote center locations for Los Angeles County's new voting system through a multi-step spatial analysis process. Currently the Los Angeles County Registrar-Recorder/County Clerk office is undergoing a redesign of their entire voting system called the "Voting Systems for All People" or VSAP. Under a new 2016 California Senate Bill titled "SB-450 Elections: Vote by Mail Voting and Mail Ballot Elections" or the "California Voter's Choice Act," many new requirements were created to equitably distribute voting locations across all voting areas. This thesis conducts various spatial analysis techniques and presents the results in a Web GIS application to assist in accomplishing the goals of this bill in choosing new vote center locations for Los Angeles County.

1.1. Progression of Election Systems

Elections within the United States have had a dramatic evolution over the last two hundred years, since the inception of one of the world's oldest and most stable democracies. In coordination with rapidly evolving technology of the 21st century, new election systems are being tested and implemented. Figuring out the best way to apply these new technologies in cohesion with new rules and regulations, as well as appeasing all participants in the system is a long process that requires constant input. Understanding past technologies and the progression of the elections is essential in being able to determine the best path forward.

The progression of voting technology has had a slow evolution due to sensitivity of elections and their role in politics. Before the 1800s voting was typically done by voice, in a public setting (Troy 2016). Paper ballots, a variation of the technology most of the country uses today, eventually got phased in as the American government grew and political factions rose to power. Paper ballots were described by King (2016) as being, "…easy to count and hard to

falsify, but the system was better suited to smaller elections" (34). Not until the 19th century, when controversy in American politics began to rise due to the civil war and subsequent limitations on voting rights, did the voting process enter a stage of secrecy. The term "vest-pocket" was coined for people who would show up to vote with the ballots hidden, which in turn also created mass voting fraud by false ballots. As the number of technical issues grew, new technological solutions were developed to thwart voting fraud. Lever machines were created to help count ballots in 1920, and in 1965 the punch card technology was invented (McGerr 1984). This was the general technology used for the latter half of the 20th century. A variation of that voting machine called the "Votomatic" is still in use in a few counties today. The progress at which both regulation and legislation govern voting equipment has been slow to keep up with modern technology. This in turn has limited access to voting and voter turnout has suffered.

1.2. Senate Bill 450: Vote by Mail Voting and Ballot Discussions

To improve election systems, in 2016 California passed Senate Bill No. 450 titled "Vote by Mail Voting and Mail Ballot Elections," written by state Senators Ben Allen and Robert Hertzberg. The bill was specifically designed to guide and improve the implementation of elections conducted in California. The bill was made up of four parts: (1)requiring all counties to mail registered voters a VBM (vote-by-mail) ballot; (2)replacing the regular polling places with a new type of voting location called a vote center; (3)creating a new time window of ten days before the election during which voters can vote; (4)and requiring every jurisdiction to create its own plan to implement these new changes while receiving input from the public (Los Angeles County 2017). The final bill was passed into a law on September 29, 2016, outlining the framework for jurisdictions to implement an entirely new voting system.

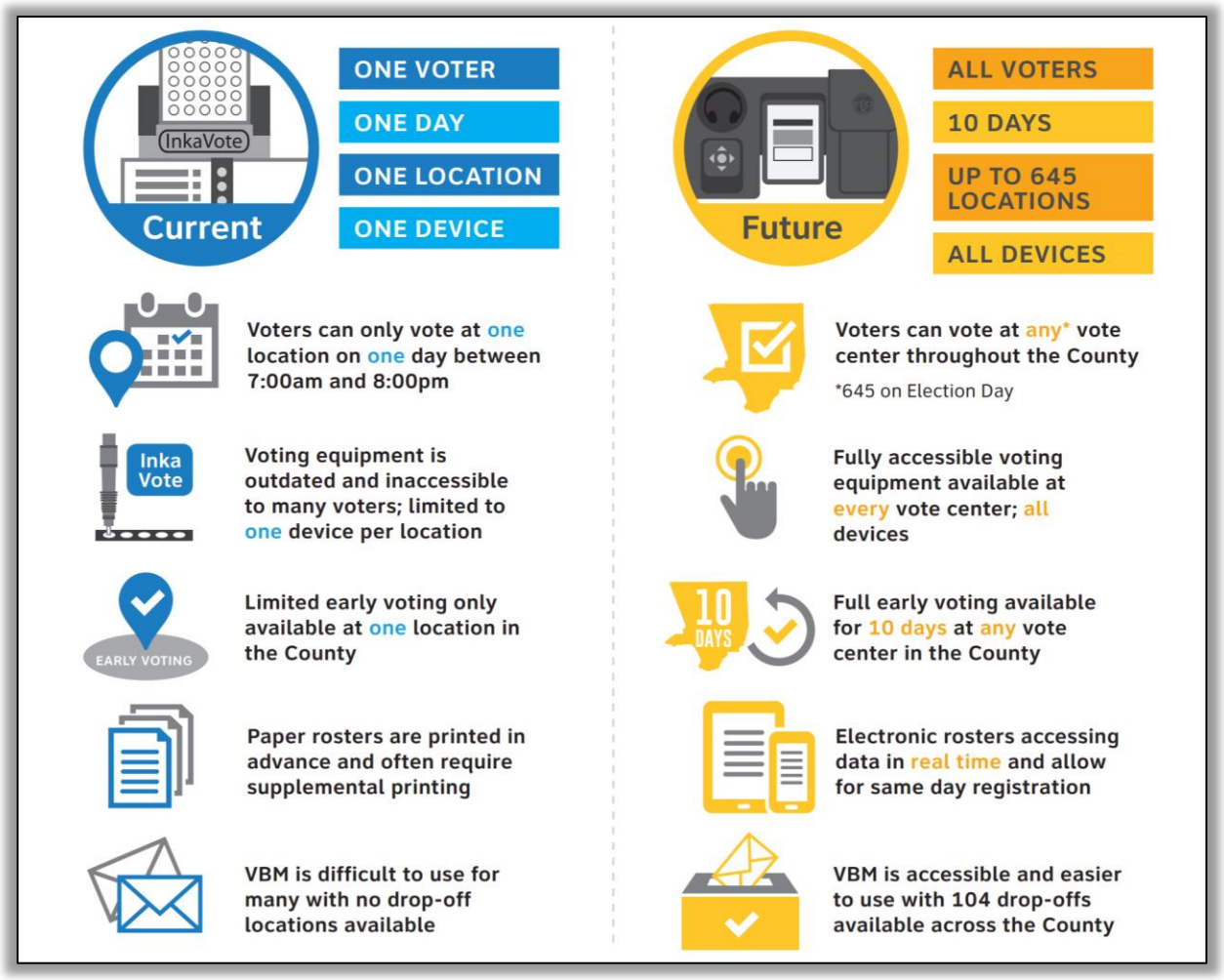

Figure 1 LA County Infographic Summarizing Changes for SB 450 (LA County 2017)

Figure 1 summarizes many of the critical changes SB 450 will have on Los Angeles County's current voting system. One of the major components of the bill is to open the time frame for voting. Instead of elections being on a single day and each voter having a specific poll location to go to, voters will have ten days and be able to use any vote center. The official terminology of the location where participants are going to vote is also being changed from "polling place" to "vote center."

The primary objective of the bill is for technological innovation to improve the voting process and create optionality for larger counties like Los Angeles County, by laying out an

easier framework on how elections should be conducted. As the law itself states, “This bill would, on or after January 1, 2020, authorize the County of Los Angeles to conduct any election as a vote center election if certain conditions are satisfied, including conditions related to ballot drop-off locations and vote centers” (SB 450 2016). This verbiage allows LA County to work with local elected officials to create a proper set of conditions to be used in deciding the location of vote centers and drop-off locations. The following is a minimum set of conditions that the bill requires:

> The county elections official, when developing the draft plan for the administration of elections conducted pursuant to this section, considers, at a minimum, all of the following:
> (i) Vote center and ballot drop-off location proximity to public transportation.
> (ii) Vote center and ballot drop-off location proximity to communities with historically low vote by mail usage.
> (iii) Vote center and ballot drop-off location proximity to population centers.
> (iv) Vote center and ballot drop-off location proximity to language minority communities.
> (v) Vote center and ballot drop-off location proximity to voters with disabilities.
> (vi) Vote center and ballot drop-off location proximity to communities with low rates of household vehicle ownership.
> (vii) Vote center and ballot drop-off location proximity to low-income communities.
> (viii) Vote center and ballot drop-off location proximity to communities of eligible voters who are not registered to vote and may need access to same day voter registration.
> (ix) Vote center and ballot drop-off location proximity to geographically isolated populations, including Native American reservations.
> (x) Access to accessible and free parking at vote centers and ballot drop-off locations.
> (xi) The distance and time a voter must travel by car or public transportation to a vote center and ballot drop-off location.
> (xii) The need for alternate methods for voters with disabilities for whom vote by mail ballots are not accessible to cast a ballot.
> (xiii) Traffic patterns near vote centers and ballot drop-off locations.
> (xiv) The need for mobile vote centers in addition to the number of vote centers established pursuant to this section (SB 450 2016).

These conditions require an extensive site selection process that Los Angeles County is currently undertaking. The spatial web application developed through this project will allow local

stakeholders to assist and guide the site selection process. Spatial analysis and the development of a proper site selection system is essential for helping meet all these conditions and fulfilling the purpose of SB 450.

The passing of SB 450 prompted Los Angeles County to go on a decade-long journey to optimize the entire voting system through a project titled "Voting Systems for All People" or VSAP. The current system, which was originally implemented in the 1960s, is aging, the cost to replace and maintain the old equipment is increasing, and the efficiency/performance of the entire operation is deteriorating. These factors prompted the head of Los Angeles County's Registrar-Recorder's Office, Dean Logan, to initiate a five-phase project in September 2009 as shown in Figure 2 below (Los Angeles County 2017).

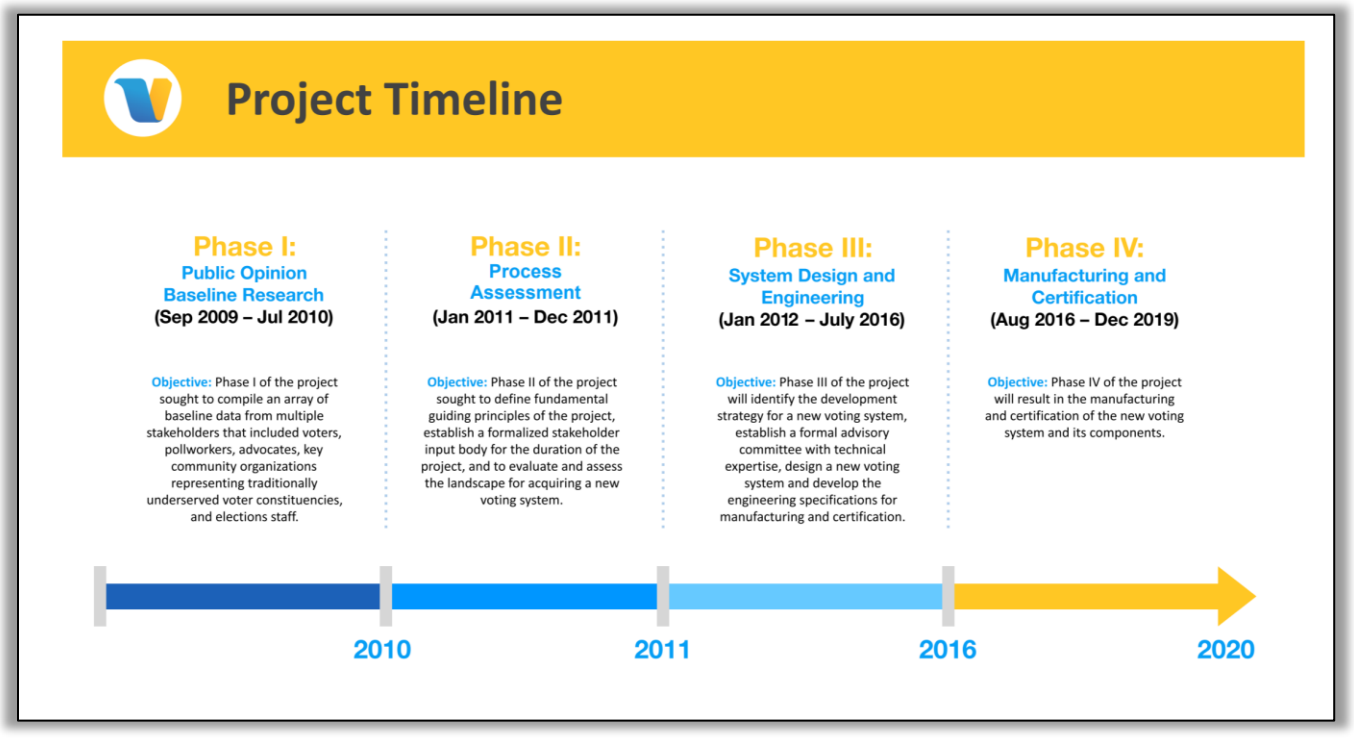

Figure 2 LA County's VSAP Project Time line (LA County 2017)

Phase I and Phase II were the preliminary stages of the project. Election stakeholders from different groups with various expertise were chosen to provide input. The stakeholders are identified as: "…. voters, poll workers, advocates, key community organizations and elections staff" (Logan 2017). Research was then conducted to evaluate the current election system and receive feedback from the various stakeholders. This data was compiled, organized, and used to guide the second phase of the project. Phase II took a deeper dive into the main concerns that were addressed by these stakeholders by creating a VSAP Advisory Committee or AdCom, designed to guide the process of creating a new voting system and ensure the "voice of the voter" was respected throughout its implementation. The two main hurdles in this part of the project were assessing the voter systems markets and the regulatory environment (Logan 2017). A research team from UCLA Luskin School of Public Affairs played a key role in the implementation of Phase II, by providing research on which systems would meet all the goals that were set in Phase I and outlining the key regulatory problems that would need to be overcome to reach those goals. The new system would have to be designed with the legislature to help accommodate all these needs, thus Los Angeles County played a prominent role in the creation of SB 450. Phase III set out to fulfill all the request that were outlined in the first two phases and move from research to development and design.

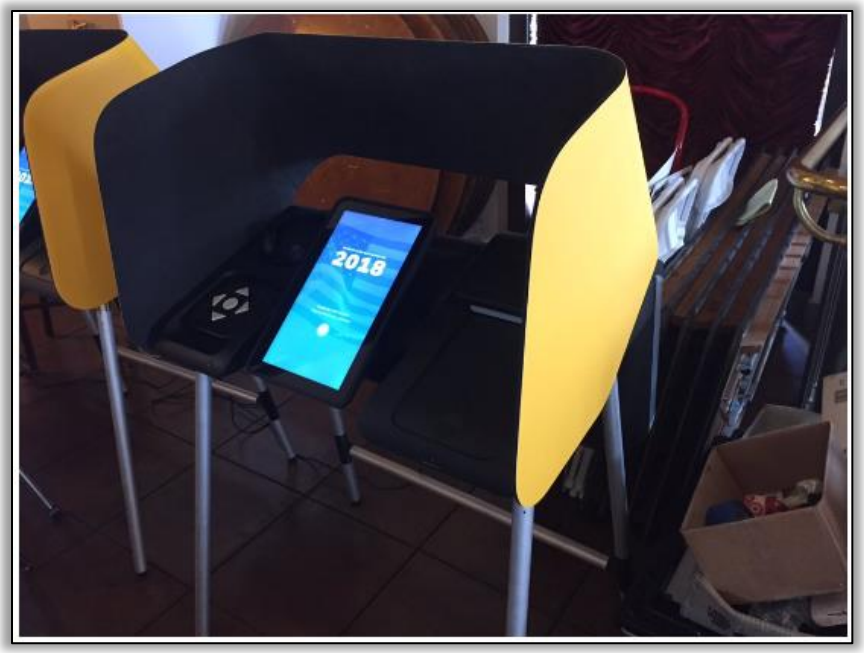

Figure 3 Los Angeles County New Voting System Prototype

The voting system prototype was designed by an award-winning global design team named IDEO. The idea behind this voting system was to allow easy access to every resident of Los Angeles County whether English was a second language, a voter had a major disability, or getting to the polls was an issue. Creating easier accessibility to voting and easing the process are major drivers for the VSAP project, which focuses on the voting procedure itself. From 2012 to 2016 this voting system was critiqued through the steps outlined in Phase III. The outcome of this process was the new prototype shown in Figure 3 above. The new mobile and easy to use system was designed to change and vastly improve the interaction of voting, thwarting problems of the past. Phase IV is where the process sits as of 2018. Deciding where to locate these new voting systems within vote centers is the next major task of the VSAP Project.

1.3. Motivations and Project Goals

The discussion surrounding the creation of a better voting process has been a hotly-contested one and become even more relevant as of late with the greater polarization the U.S. has gone through. To create the best, most fair election process possible, an entire new voting structure had to be created, and this led to the VSAP project.

After a very chaotic 2016 Presidential election, the public eye has become keen on watching every election. Hackers, voter suppression, election fraud, and an increasing number of other issues are creating new problems on top of the existing ones within our election process. This is causing municipalities of all sizes to move ever quicker to calm these worries (Wines 2017). Generally, the strategy is to show that election officials are addressing all potential threats, but coming up with solutions to problems that are consistently arising in the face of an ever-changing world is difficult.

Los Angeles County is one of the largest and most diverse voting populations in the country and has many contentious issues that derive from its sheer size (Census 2016). Ensuring that all residents have an equal right to vote in a fair and secure election is at the pinnacle of its democracy. The many immigrants that live in Los Angeles County have moved here to be a part of a better system. America prides itself on having a long standing and balanced democracy, which is becoming increasingly threatened as the integrity of voting is questioned. Improving this process and making sure it is always at its best is something that must be done to ensure the continued success of our country.

Spatial analysis on elections is wide spread, conducted on many scales, and essential in figuring out trends. Even the smallest details can help with understanding the results of an election. This all starts with the casting of each ballot. Figuring out the details and story of the

voting process using the tools GIS offers can give an interesting insight into what has the biggest impact on these elections. These tools can offer insight for decision makers and those who will be playing integral roles in the VSAP project. A custom web GIS application with special tools to address the needs listed out in SB 450 will be a great addition to the immense amount of work that has already gone into Los Angeles County's VSAP project. This thesis will discuss the creation of that web application, the data used to create the custom tools used in the application, and the functionality of the final product.

Chapter 2 Related Work

To improve the current election systems, California passed Senate Bill No. 450 titled, "Vote by Mail Voting and Mail Ballot Elections," written by state Senators Ben Allen and Robert Hertzberg in 2016. The bill was specifically designed to guide and improve the implementation of elections conducted in California, and the law is being implemented county by county throughout the state. Comparing Los Angeles County to others and using studies of other large counties that have implemented similar voting procedures can prove to be valuable in assessing how to implement the new vote center system. Since the implementation of SB 450, many counties in the state have begun planning to run elections following the requirements of this mandate. According to SB 450, 14 counties are currently allowed to conduct elections under SB 450 rules. These include Calaveras, Inyo, Madera, Napa, Nevada, Orange, Sacramento, San Luis Obispo, San Mateo, Santa Clara, Shasta, Sierra, Sutter, and Tuolumne. The rest of California must practice elections under the Voter's Choice Act by 2020 (Padilla 2018). Los Angeles County is planning to have completed the implementation of the Voter's Choice Act by 2020.

Understanding the importance of both the process of voting and the Voter's Choice Act are essential in making it as fair and organized as possible. Whether voters participate and the act of voting itself can be influenced by the location where citizens vote. Previous studies discussing these influences need to be studied by those making the decisions on where polling locations will be.

2.1. Voting Locations effect on Voting Decisions

The designation of voting locations and the requirement of having a specific polling location assignment for each voter can influence voter's decisions. Berger et al. (2008) analyzed

this phenomenon. Situational context is how environmental contexts influence the decisions and choices people make. This is especially relevant in the process of voting, which is one critical choice people make in a democracy. When people are assigned to a polling location, the type of polling location can influence how they vote. One example of this would be if a voter is assigned to a school, the voter could be biased to vote for school-related funding initiatives (Berger et. al 2008).

The study is especially relevant to SB 450 because the bill abolishes designated voting locations by creating the vote center (in which all voters can vote at any location) and opening vote by mail to the entire constituency. The vote center location designations should be delegated in a way to prevent these situational bias scenarios, even subtle ones. This is inevitably impossible in all scenarios, but probable when there are equally suitable voting locations offered as options to voters. For example, offering both a church and a public library as equally suitable voting center options for citizens in each city might at least randomize the influence that would occur on ballot items related to library funding or religious freedom. This is where GIS becomes valuable by helping to identify a wide variety of possible sites to select for polling locations. Various GIS systems can be deployed to give decision makers a valuable tool to guide the vote center location decisions.

2.2. Constituency and the Voting Process in Los Angeles County

Los Angeles County currently uses the InkaVote voting system, in which voters physically mark ballots for each contest during the election. Not only is this process tedious, it creates problems in counting votes. In some election races, ballots are not counted, these are called a “residual vote.” There are many reasons ballots turn into residual votes, including a

voter selecting too many candidates or not filling in the ballot in an appropriate amount of time. In a 2004 Caltech study based on Los Angeles County, the research concluded that voters with lower educational backgrounds and who speak English as a second language tend to cast more residual votes (Sinclair 2004). In a county as diverse as Los Angeles County, having fewer legitimate ballots can have huge impacts on elections, especially in smaller elections. This also makes certain populations within a constituency feel under represented knowing that these problems exist. Eliminating these problems and easing the access to vote is the best way to help engage communities that have felt underserved by the problems of residual votes.

The Los Angeles County VSAP project will reduce these residual ballot issues. The creation of a simpler and more effective voting system, through electronic booths prevents residual ballots and eliminates the possibility of having ballots cast improperly. This in turn can create a better voter turnout and more accurate elections, especially for voters from different linguistic backgrounds. This is an important aspect that can be addressed with GIS, by laying out where minorities groups are, and areas that have had significant residual voting problems in the past. Using GIS, regions with residual votes can be identified and decision makers will evaluate these regions when deciding where to put the vote center locations. Through time, these problems can be reduced with new technologies implemented by the VSAP project and properly locating vote centers.

2.3. Voter Participation and Turnout

The backbone of SB 450 and its main purpose is to increase voter turnout. Voter turnout is a problem that is becoming increasingly prevalent in elections. According to the Pew Research Center in a 2018 report, the U.S falls behind most developed countries in voter turnout. As a representative democracy since its founding, the U.S. needs to have an active voting

constituency, especially Los Angeles County with its diversity and high population density. Bringing in new technology and changing the process of where voters will vote are the two best ways to achieve a better voter turnout and are the two most important themes of Los Angeles County's VSAP project.

Participation and accessibility typically relate to the distance a voter must travel to his designated voting location. Removing voting designations eases the travel distance by creating a more flexible system by allowing voters to choose where to go vote. A 2003 study by J.G Gimpel titled, "Political participation and the accessibility of the ballot box" concluded that the physical distance a voter travels has a direct effect on the voter's likelihood of voting. The study also states that making the voting location as accommodative as possible will also increase voter participation. This includes following compliance with the Americans with Disabilities Act (ADA), having enough space at the voting locations for voting machines, and assessing traffic and road conditions. The conclusion and overall theme of the article states that physical accessibility to a polling place is one of the major factors that contributes to voter turnout.

One of the more prolific books written about elections titled "Contemporary Democracies" by G. Bingham Powell (1982), is a frequently referenced literature among academics that study election systems and voter turnout. The importance of his work centers on trends that affect voter turnout. At the crux of the discussion on voter turnout, Powell discusses the influence of the social and economic environment. A paper on this topic by Blais and Dobrzynska (2008) discusses how the socioeconomic environment influences turnout, by stating that there is significant evidence that shows turnout in economically prosperous areas will be higher. This influence has been downplayed through the years, but significant evidence in recent studies show how prevalent it really is. Blais and Dobrzynska (2008) state that it relates to all

scales of societies from countries all the way down to the municipal level. This is important to understand for Los Angeles County's VSAP program during the decision-making process for determining vote center locations in lower socio-economic areas that have low voter turnout. These areas should have more rather than fewer voting centers to bring the act of voting to the forefront in these communities.

2.4. Other Jurisdictional Approaches to Applying the Voter's Choice Act

Since the Voter's Choice act is a statewide initiative, understanding the approach other Counties have taken can be useful for Los Angeles County's implementation. Sacramento County's GIS department went on to conduct an analysis of the county to determine optimal locations to put the new vote centers required by the Voter's Choice Act (VCA). The team, led by Sacramento County's GIS analyst Steve Demers, studied different criteria that the bill mandated, creating various spatial layers primarily through National Census Bureau data and locally collected data.

Choropleth maps were created from the census data to identify language minority communities, voters with disabilities, communities with low rates of household vehicle ownership, low income communities, communities of eligible voters who are not registered to vote, and an assortment of other maps related to the criteria listed in Voter's Choice Act (VCA). The maps were then imported into an Esri Story Map, which is a collection of maps that is sourced on the Esri website and is readily available for the public to view online. Figure 4 shows an example of how one of these maps was displayed for the public using Esri's Story Map software.

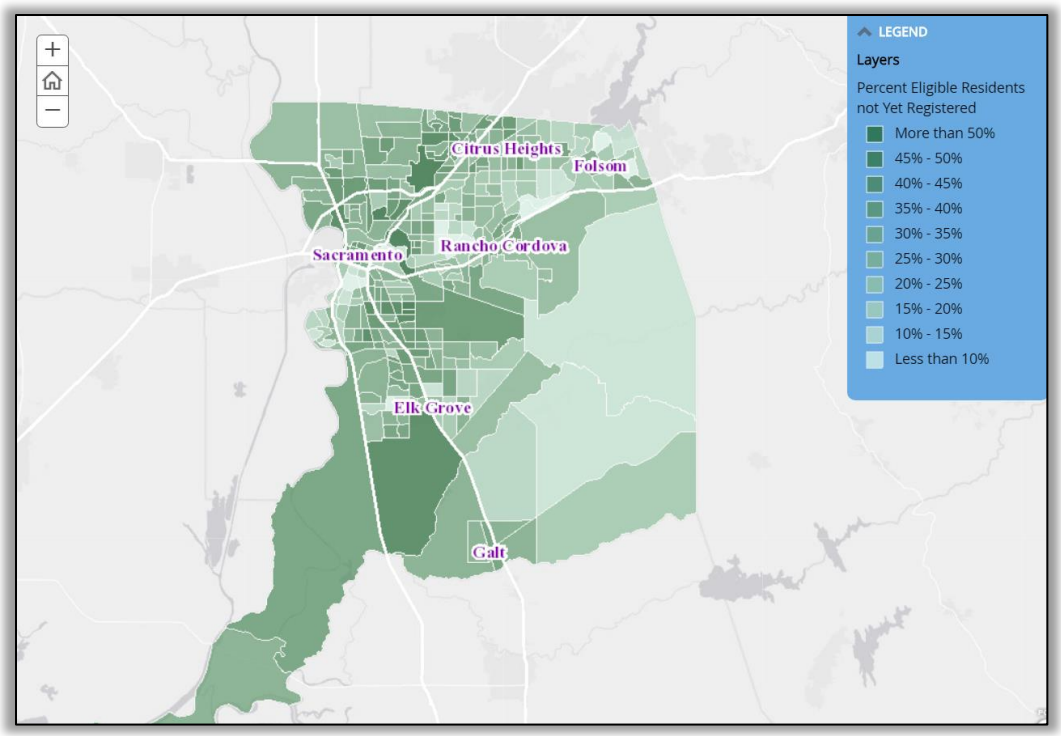

Figure 4 Percentage of Eligible Residents Not Registered to Vote in Sacramento County (Sacramento County GIS 2017)

Once the team finished working through all the relevant Census Bureau data that applied to the Voter's Choice Act, they then moved on to procuring other data sources that could help with the analysis. Proximity data sets were created to determine population centers, public transportation routes, and walking distances from resident's homes (Sacramento County GIS 2017). Figure 4 shows an example of how the population density was visualized using the Esri story map software to suggest desirable areas to locate voting centers. After creating data layers with all the publicly available data the team could use, they combined the data converting it all into raster layers and used the "weighted sum" approach to distribute equal weight to each criterion. The final map prioritized each census tract with a different priority ranking, this ranking distinguishes areas that would be ideal for vote center locations.

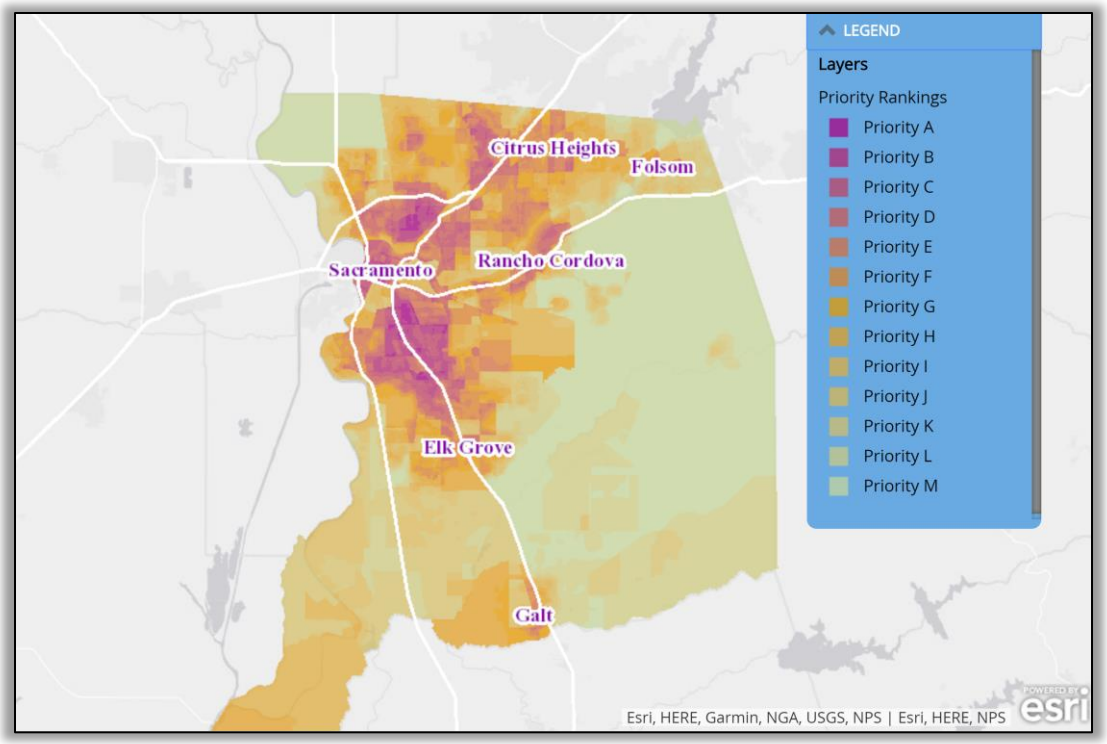

Figure 5 Priority Ranking Map Sacramento County (Sacramento County GIS 2017)

The final layer (Demers 2017) is being implemented through the California Civil Engagement Project (CCEP) with the following participating counties: Madera, Napa, Nevada, Sacramento, and San Mateo. Each of these counties went through a similar process as Sacramento county and created a spatial layer that identifies optimal locations for vote centers through the Voter's Choice Act. The CCEP, which is hosted at USC's Sol Price School of Public Policy in Sacramento, is a research project that is designed to inform policy and give decision makers more advanced tools to reduce disparities in opportunity for civic participation (CCEP 2018).

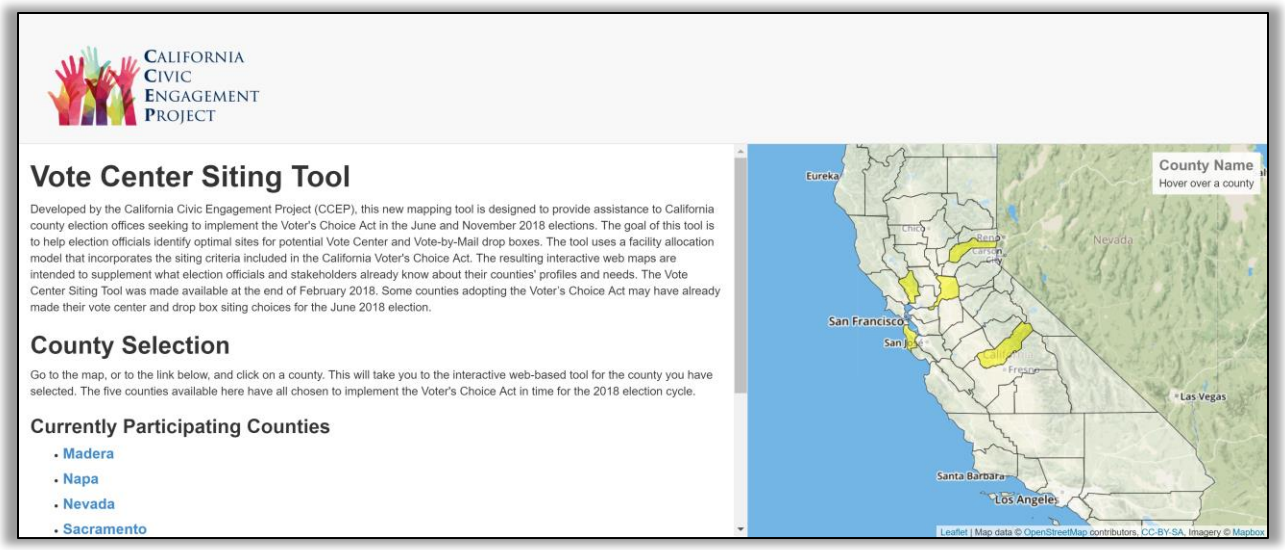

Figure 6 CCEP Vote Center Siting Tool (CCEP 2018)

2.5. Other LA County Projects Related to VSAP

A consulting firm by the name of PlaceWorks is charged with supporting the site selection process for the VSAP project in Los Angeles County and validating every potential site that is chosen. They have a weighted site-suitability process, like the CCEP projects discussed above, that ranks which areas will be better suited for vote centers. Through this site-suitability analysis Los Angeles County will quantify the number of vote centers each city or community will be allocated by its weighted score from the raster layer that PlaceWorks developed (PlaceWorks 2018). A third party conducted this analysis to reduce controversy and potential lawsuits regarding the placement of vote centers and to ensure Los Angeles County is in line with the all the statutes set forth in the Voter's Choice Act (VCA). Most of the site-selection work will be field work, or "ground truthing" as they have deemed it, in which they will visit the facility. PlaceWorks will also conduct community outreach to find sites that best serve each community. They have been given access to the web GIS application developed for this thesis

project, so that they may integrate it with their site suitability analysis and to aide them with their public outreach efforts.

Chapter 3 Data and Methodology

The purpose of this study is to design, create, and fully explain a specialized web GIS application intended to help Los Angeles County decision makers in choosing vote center locations for the VSAP program in accordance to California's Voters Choice Act. The entirety of the data used in the web application is fully accessible to the public and located within the public domain, propriety data was not used. In Chapter 2, the approach of various other counties located in California were analyzed to discover their solutions in using GIS tools to help decision makers choose vote centers.

This chapter lays out in detail the methodology of creating this web GIS application, as well as how the data was extracted and manipulated. The approach taken in designing this application is specialized for Los Angeles County. A different more comprehensive approach is required for Los Angeles County because of its size and scale. The first part of the chapter discusses the components of the web application and how the design is specifically geared to help satisfy the requirements set out in the Voter's Choice Act (VCA), as well as an outline of the technical structure of the application for those who would like to recreate and understand the back end of the application. Next, each of the specific tools is explained thoroughly from the collection of the data to the implementation of the datasets into their associated tools. The end of the chapter provides a discussion on how the final application was tested and by whom.

3.1. Web Application Design and Structure

Most of the data that was collected comes from various Los Angeles County public offices. The datasets that are related to elections and voter information come from tables, reports, and spreadsheets on elections archived by the Los Angeles County Registrar-Recorder's office. These tabular datasets were manipulated and converted into geospatial datasets using ArcMap

and ArcGIS Pro. The spatial datasets were then uploaded online to an ArcGIS online hosted server provided by Los Angeles County. The GIS web application was created using ArcGIS Online web application toolsets and the spatial data uploaded to the server. The entirety of this project was conducted within the Esri suite of software and access to Esri products would be required to recreate and edit the application as discussed below.

The design of this application is intended to be easy to use by GIS and non-GIS professionals alike. The application is intended to be flexible so that it can answer a multitude of important questions in relationship to placing vote center locations. For example, questions might come from city officials who would like more vote centers in their district or from election officials as part of the initial site selection team who is choosing the locations for the initial roll out in the 2020 General Election. This is a notably aggressive timeline for such a large jurisdiction to be implementing these vote centers: the VCA specifically allows Los Angeles County a longer deadline than any other county for this reason, as described in Chapter 1 (VSAP 2018). The value and importance on where and how many vote centers will be implemented in each area of the county is something stakeholders are taking very seriously. This new system is one of the biggest changes in the history of elections in California as stated by Mindy Romero, who is founder and director of the California Civic Engagement Project, a non-partisan research group (Lyon 2018). All this was taken into consideration when designing the application to make sure that it is simple enough for non-expert users, yet effective in communicating key information about the decisions on where to locate vote centers.

The web application is composed of three tools that were created and implemented to be used with each other to answer important questions that stakeholders will ask while conducting the site-selection process for vote centers. The first tool consists of a joined, feature class layer of

points intended to show all potential vote center locations within Los Angeles County. Such points include public facilities, past polling locations, and commercial locations. This helps give a base layer for decision makers to choose from and use the next two tools to help determine new vote center locations. Since there is a large reduction in the number of sites during this transition from polling places (around 4000) to vote centers (around 1000), spatially viewing this distribution is a key part of the site selection process. The data sources and creation of this layer are described further in this chapter below.

The second major component and tool of the web application is designed to show the many dimensions of voter turnout and voter registration demographics by creating various layers that can be used together to determine turnout by precinct and can also be aggregated by age class. This is useful in finding districts that have low voter turnout overall by registered voters and targeting vote center locations within these areas. It can also be used to find areas that have high voter turnout among different age populations, which can help define what type of vote center will be useful in those regions, which is especially useful if one's objective is to increase voter turnout among a certain age population.

The final tool examines the service area regions for each of the potential vote center locations that were created in the first tool. These service areas are determined by various drive times to each potential location. This assists with helping decision makers in choosing accessible vote center locations and comparing the accessibility of potential locations. Each service area that is generated for every potential vote center location will have a count of total businesses within a 5-minute drive time and a total registered voter count calculated for each feature. How the data was collected and manipulated will be discussed further in this chapter. With all these tools within one application a multitude of questions can be answered about locating a vote

center location for a specific area, whether one is targeting a younger demographic because of poor turnout or would like to determine the accessibility by vehicle of a potential vote center. The process of determining vote centers is going to be a long arduous one, even after the preliminary site list is created, each site will continually be critiqued, new sites will be added, and this application will continue to be relevant. It is designed to be useful for the entire process and long into the future after the initial site list is made.

The decision to make a web application was made to give GIS analysis tools to a broad and varied audience. If a city council is concerned with their current polling locations and would like to reassess the new locations of the vote centers, Los Angeles County employees could provide them with this application to help them decide on where they would like to put their vote center, as the application covers the entire county. Also, the application is hosted by Los Angeles County and will be continued to be updated and improved by its staff in the future. For the first round of site selection, the main decision makers will be Los Angeles County employees and managers. Creating the best set of resources for choosing these sites is in their best interest and having useful GIS applications for site selection is an essential resource.

The web application will be made available to the public, as it will be located on the ArcGIS Online environment. It is hosted by Los Angeles County, on their ArcGIS Online account. This ensures that the public will have access to the web application and the datasets that were created for this application will be made available to every Los Angeles County ArcGIS user within the county, so they can continually update or recreate the application. The servers that host the web application are provided by Esri and rented by Los Angeles County to store the data that feed the application and the tools that will be run on it.

3.2. Potential Vote Center Site List

The spatial layers that are generated for this tool come from a few very large datasets. These large datasets were manipulated to create a final point feature class that is labeled as the "Potential Vote Center Master Site List." Each of the spatial layers created in this data set can be selected individually or combined in the web application to be viewed when using the other tools.

The first major dataset was commercial and business data located within Los Angeles County. This dataset originally was formatted as a comma-separated values (CSV) and was provided by the Community Development Commission of Los Angeles. The layer contains over 720,000 businesses across Los Angeles County and contains attributes related to location, type, and size. The spatial layer was created by geocoding coordinates from addresses in CSV file that was processed. Each of the individual businesses had a Standard Industrial Classification (SIC) code associated with it. SIC codes were used to separate the commercial addresses into different categories. Business locations are essential in helping determine where voters work and where they frequently visit and can potentially be used as a vote center location.

Using the SIC code identifiers, a layer was created for Eating and Drinking Places, which uses SIC code number 58. Finding popular locations such as a Starbucks, which is classified within this SIC code, would be a potential target if the commercial center where it is located has the capacity to hold a vote center. This was the only point layer from this dataset that is included in the final potential vote center site selection layer. Two other layers were generated from this dataset as well using the SIC code identifiers: business services and commercial stores. The three layers together were used to create a count feature attribute labeled "major business count" in the last toolset of the web application: the service area accessibility spatial layer. The process and

use of these layers will be described later in this chapter, when discussing the service area accessibility tool.

The next layer used to create this tool is previous polling locations provided by the Los Angeles County Registrar Recorder's Office (RRCC). In this layer, there are over 4,000 polling locations used in the last election. Since these fit the criteria for previous polling locations, they are a solid base of potential locations that may fit the criteria for the new vote center locations. The final vote center location count is aimed to be about 1,000 locations across all of Los Angeles County (VSAP 2018). Previous polling locations include: community centers, schools, fire department, recreation centers, religious centers, private residences, parks, and other public facilities.

Since the VSAP program will give multiple days to accept ballots and may have a higher influx of voters due to the reduced number of voting locations, many of these prior polling locations will prove to be inadequate to serve the new needs of vote centers. All private residences where removed from this layer, as they will no longer be able to accommodate a multi-day voting period. This layer had a field labeled "Location1" which identified the type of polling place, all residences were selected and deleted from this field. All other previous polling locations were left in because places such as schools and fire departments, may be able to accommodate the new requirements set forth by vote centers depending on the size of the site. The vote center must not impede the day-to-day operations of many of these public services. But the only real way to determine that is through field verifications, which will need to be conducted on every site before it is selected. The staff that will be doing these field verifications will be sent to each selected site and answering many questions related to the facility such as the

size of the parking lot, whether the facility is a willing host, how busy the facility is during business hours, and a host of other questions related to the fitness of the site.

The final layer added to this potential vote center site layer was collected from the Los Angeles County GIS Data Portal, titled "Locations/Point of Interest" or commonly known as the Location Management System (LMS) data. This dataset includes over 73,000 locations which include 63,000 public locations. The dataset is split up into three categories (cat1, cat2, cat3) which are in order of specificity and used as identifiers for the dataset. The "cat2" identifier was used to separate the data that was joined to create the potential vote center site layer tool. The following attributes were selected using this identifier: churches, city halls, community organizations, community services, county offices, farmers markets, fire stations, libraries, parks and gardens, park and ride locations, public high schools, public middle schools, recreation centers, recreations clubs, recreation programs, shopping centers, and sports complexes. A new layer was created with these locations and joined to the other layers. The GIS Manager of the Los Angeles County Registrar Recorder Office, Elio Salazar assisted in selecting these location identifiers within this layer, based on the methodology used for the previous polling location site selection process, and what he deemed to be the most appropriate potential sites (LAC RRCC 2018).

Once all the data was cleaned and merged together, a final spatial layer was created that included all the potential vote center locations, as well as a layer for each individual feature class type. The layers were uploaded to Los Angeles County's ArcGIS Online environment through ArcMap as hosted Feature Layers. These Feature Layers were then input into ArcGIS's Web AppBuilder online software by adding the layers to the web map linked to the web application and using the Filter widget tool to select between the features. Each of the different categorical

features are selectable within the application and the process of how the filter tool is used will be discussed in Chapter 4.

3.3. Voter Registration and Turnout Toolset

The next tool created for the web application was designed to show voter turnout by election precinct, which are defined election areas within a city. The purpose of this tool is to give decision makers access to a visual and manipulatable representation of previous election turnout results and assist them with looking for patterns related to voter turnout. This is essential in choosing vote center locations in order to ensure that areas that have low voter turnout for specific age groups or demographics will be covered adequately by vote centers. As described in the VCA, by targeting these areas, decision makers can choose to place vote centers in locations that can most suitably serve these groups of potential voters by giving them easier access to voting.

The elections result data that was used in creating this layer was collected from previous elections results published by the Los Angeles County Registrar-Recorder Office (RRCC) online and accessible to anyone, and all the other data was provided from the RRCC's GIS division. This data can be acquired by downloading it off the RRCC's website (lavote.net) or can be requested by going to the headquarters of the RRCC in Norwalk, CA and filling out the proper paperwork and paying a small fee. On the RRCC's website, they publish detailed spreadsheets of every major election labeled as "Statement of Votes Cast." This dataset is released for each major election and is formatted in a Portable Document Format (PDF) and a zipped Excel worksheet. The zipped folders contain a list of every single voting contest that was conducted during the election that was selected. The contest size varies from small municipal elections to statewide contests.

For this tool, turnout was evaluated from county-wide contests to allow comparisons by precinct across the entirety of Los Angeles County. This data originated in the form of an Excel spreadsheet organized by the following columns: precinct, ballot group, registration, ballots cast, and votes for each candidate or measure. The data that was kept in creating the spatial layers for this toolset were the precinct, registration, and ballots cast. This data was then joined with a spatial layer provided by the RRCC, which is a polygon layer of the election precincts for each major election. The registration column gives us the number of registered voters per precinct, and the ballots cast gives us the number of votes casted for each precinct. Dividing ballots cast by precinct and multiplying that by 100, gives us the percentage of turnout of registered voters for that precinct. This final calculated column was used to describe turnout within the tool.

The next step in this process was to change this tabular data into a spatial format by conducting a join by election precinct with the spatial player provided by the RRCC. Between each major election cycle election, precincts within city boundaries change for a variety of reasons, whether a new development occurred or there were changes to population in specific regions. Each election precinct has around 1,000 registered voters to help balance jurisdictions and properly structure elections.

For each election, the RRCC's GIS section creates a spatial layer of election precincts which also includes registered voters by precinct. Using the precinct number, the data on registered voters was joined with the election dataset to create a spatial layer with voter turnout by precinct for each election. This process was done for major elections in 2014, 2016, and 2018. Age classes were included in the calculations, but other demographics such as language, ethnicity, and sex are not fully comprehensive among the registered voter databases, so they were not being included within this tool because of missing data.

Once the layers were properly joined and formatted within ESRI's ArcMap, they were published as an ArcGIS Online service onto Los Angeles County's ArcGIS Online environment as a hosted Feature Layer, which is necessary to publish the web application county-wide and for public use.

The next step in the design of the tool was to create a layer that shows the distribution of active registered voters by age class. This dataset was created by querying through the RRCC's registered voter database, which is available to the public by requesting for the voter history files from the main office. The voter history files are records that are kept on every single election containing information on everyone who voted in that election.

```
SELECT SE.ElectionPrecinctCode
      ,SAC.[age_range]
      ,Sum(SAC.[VoterCount]) as VoterCount
  into [RRCC_Layers].[dbo].[ElectionPrecinctAgeClass]
  FROM [RRCC_Layers].[dbo].[SubprecinctAgeClass] as SAC
  inner join [GIS_Election].[dbo].[VWSubprecinct_Election] as SE on SE.Label=
SAC.[Subprecinct] and  SE.ElectionOID='9AAF5242-8676-484E-912D-A680DB77A2A8'

  Group by SE.ElectionPrecinctCode, SAC.[age_range]
  order by SE.ElectionPrecinctCode, SAC.[age_range]
With A
  AS
   (select ElectionPrecinctCode as ElectionPrecinct,
                ISNULL([Under 18],0) as AgeUnder18,
                ISNULL([18-29],0) as Age18To29,
                ISNULL([30-39],0) as Age30To39,
                ISNULL([40-49],0) as Age40To49,
                ISNULL([50-59],0) as Age50To59,
                ISNULL([60-69],0) as Age60To69,
                ISNULL([Above 70],0) as AgeAbove70
    from [RRCC_Layers].[dbo].[ElectionPrecinctAgeClass]
       PIVOT
          (SUM(VoterCount) for Age_Range in ([Under 18],[18-29],[30-39],[40-49],[50-
59],[60-69],[Above 70])) as PIV
   )
   Select A.*
   Into ElectionPrecinctAgeClassPivot
   from  A
   Order by A.ElectionPrecinct
```

Figure 7 SQL Query through Registered Voter Database to Acquire Voters by Age Class

Figure 7 shows the SQL query that was used to segment the voters in each precinct by age class. These layers were uploaded as hosted feature layers to ArcGIS Online through ArcMap. The different age class ranges were 18-29, 30-39, 40-49, 50-59, 60-69, and 70 and above. For purposes of visualization in the web GIS, each of the six age classes in the voter turnout classifications was sorted by standard deviations (SD) away from the mean across the county. This shows how different from the mean the presence of any given age class was in influencing voter turnout in a particular precinct. The six groups included those: 1.) from the minimum to 1.5 SD below the mean, 2.) from 1.5 to 0.5 standard SD below the mean, 3.) from 0.50 SD below the mean to 0.5 SD above the mean, 4.) from 1.5 SD to 2.5 SD above the mean,

and 5.) from 2.5 SD above the mean to the maximum. This will be useful in the many questions decision makers will face about voter turnout when deciding vote center locations. Examples of the types of questions that will be asked are discussed in the next chapter.

Once all these layers were created, the final tool was built by including the election turnout results for three election cycles (2014, 2016, and 2018) and the registered voter data distributed by age class. The primary intention of including these layers is to show turnout by precinct for each major election in an easily selectable way and to make a simple tool to toggle between turnout and the different years, as well as the distribution of registered voters by age class to compare the voter turnout layers with.

3.4. Potential Vote Center Service Layer through Vehicle Accessibility

The final part of this web map application was the creation of the vehicle accessibility to potential vote center service layer and tool. The purpose of this tool is to show the drive distance to each potential vote center and the number of businesses and registered voters within the proximity of any chosen vote center. ArcGIS Pro and its Network Analyst extension was used to create the layers needed for this tool. This extension helps in creating drive times around all the potential vote centers that were created within the first tool. Various drive times were assessed from 5 minutes to 15 minutes, and service area polygons were formed around the potential vote centers. Each of the service areas also includes a count of businesses using the business layers that were generated and explained in Section 3.1 above, as well as a count of registered voters.

There are multiple ways to go about creating these layers and several were explored in the creation of this tool. The first method is to generate all the service area polygons in ArcGIS Online. This was practical because the data layers that were needed to create these service area polygons were already generated and uploaded to hosted feature class layers in the design and

implementation of the first tool. Also implementing this newly created service area layer into the vote center site-selection web application would be seamless if it is done in ArcGIS Online. To create this layer with this method, one must use the map viewer web application in ArcGIS Online. There is a simple analysis toolset that includes a "Create Drive-Time Areas" tool. This uses Esri's "Living Atlas Analysis Layer" and can use real time traffic data to create service area polygons around each point. This tool is ArcGIS Online credit driven, and for the thousands of potential vote center sites, it was not feasible to run the analysis on because of the expense. However, doing a small sample did give a solid direction on how to conduct the analysis and what was required to generate the service area layers that were needed through another more cost-effective approach.

This eventually led to using ArcGIS Pro's Network Analyst extension to conduct the full analysis on the potential vote center layer. To do this, a Los Angeles Streets Network Dataset was provided by UCLA and is available on their geoportal website (UCLA 2018). This dataset includes pre-calculated cost values for meters, miles, drive minutes, and walk minutes. The date of creation for this dataset was April 24, 2018. This enables us to use the Network Analyst extension and service area analysis on the vast potential vote center dataset layer that we created for Los Angeles County.

In ArcGIS Pro, the potential vote center point layer was input into the map to run the analysis. In the Network Analyst tool, the network data source was set to the UCLA Network Dataset. The "Make New Analysis Layer" was run, and the "Import Facilities" was loaded with the potential vote center point layer that was input into the map. The "Property" drop down was set to "Attr_Drive_Minutes," and the cutoffs were set to 5 and 15 minutes.

The next step was to set the analysis to generate polygons and make sure the polygons overlap. An overlap is necessary to make sure that each individual potential vote center point has its own service area polygon associated with it, and to ensure that each specific potential vote center location has its own 5- and 15-minute driving range.

Once the tool was run, it generated two separate polygons for each drive distance range. These polygon layers were spatially joined to the business point layer through the Spatial Join tool in the Overlay toolbox within ArcGIS Pro. This join type was a "join_one_to_one" and all target features were kept with the match option, "completely_contains." This calculates a field titled "join_count," which identifies the number of business addresses within each specific driving range for each potential vote center.

The next step was to calculate the number of registered voters within each service area polygon that was generated. The RRCC office holds a spatial database of all registered voters by street segments. Every street block in the county is drawn out in the form of a line feature with the number of registered voters on each line segment. Using the line to point tool in ArcMap a point was generated for the midpoint of each line with an attribute count with the number of voters that each of these segments contained. The "Summarize Within" tool in ArcGIS Pro was used with the service area polygon layer and the newly formed registered voter point feature. This tool calculates the numbers of points that are within each polygon and then calculates the field statistics for select attributes within the point layer. Registered voters per service area polygon were calculated and added to the service area polygons all within this single tool. The final polygon layer shows a 5-minute (or 15-minute) drive time service area that contains information on every single potential vote center (street, name, coordinates, etc.), as well as a count of businesses and registered voters within the polygon.

Once these two layers were generated with the business and registered voter count included, they were shared as a Web Map Layer within ArcGIS Pro to a hosted ArcGIS Online web profile. This feature web layer is the one used in the final tool for the web application, and once the layer has been uploaded to ArcGIS Online it is ready to be implemented into the final tool.

The Query widget within the ArcGIS Online Web AppBuilder is used to create a tool that enables a user to query a service area layer for each potential vote center. The user inputs the Service Area ID attribute that is contained within each potential vote center point feature into the Query widget. This attribute is easily obtained by clicking on the potential vote center site that the user is interested in. The Service Area ID is the key relationship between the potential vote center point layer and the service area polygon layer. Pre-generating this layer greatly improves the functionality of the application by not having to do any Network Analyst calculations on the fly. Stability of the application with the tens of thousands of features included in it was a hurdle that will be discussed further in Chapter 5. Also, using this Query widget for selection of the service areas increased the performance by not having to display the feature layer on the web application when it starts and only displaying each individual feature when queried.

Once this ID is entered into the Query widget in the web GIS, this queries the service area layer for the selected vote center and the polygon associated with it, displaying the 5-minute drive time polygon with a registered voter count, a major business data count, and information about the vote center site. More explanation on how this tool works and how it is used with the other tools in this web application is explained in the Chapter 4 below.

3.5. Initial User Feedback

Once all the tools were generated and ready for the initial release, it was made available to all Los Angeles County staff that have access to the countywide ArcGIS Online system. The initial users of the application were the GIS staff within the Los Angeles County RRCC office and IT managers who oversee the VSAP program. Also, initial users included employees of the consulting company, PlaceWorks, who working are doing field work to figure out the feasibility of each potential vote center. These groups are the most involved in the initial site selection process. Once the preliminary sites have been chosen, public meetings will be set with every city to receive feedback on the chosen sites. The web application will be one of the many tools that a city can use when they have questions about the vote centers located within their boundaries or finding additional locations to fit their needs. Most often, the stakeholders of cities will be the city clerks, who have basic computer skills and are familiar with GIS practices, thus should have no problem using this application. The web application is and will be used as a tool in every step of the vote center site selection.

Chapter 4 Results

The following chapter outlines the functionality of the application by going through how the application works and an example scenario that decision makers may go through when using the application. The city of Santa Monica is used to demonstrate the major features of the web GIS. A hypothetical scenario is illustrated for the city of Inglewood, where a city clerk has been assigned the task to help select new candidates for vote centers within their city. The chapter finishes with a discussion of the feedback received from the test users of the application.

4.1. Overview of Functionality for the Application

The application has been designed to be practical and useful for the many different types of users that will using it. Even without a GIS background, users with a few minutes with the tool should be able to understand what it does and how to conduct a simple analysis with its features. When starting the application, a splash screen is displayed, as shown in Figure 10 below, explaining in detail what each tool does and how it works.

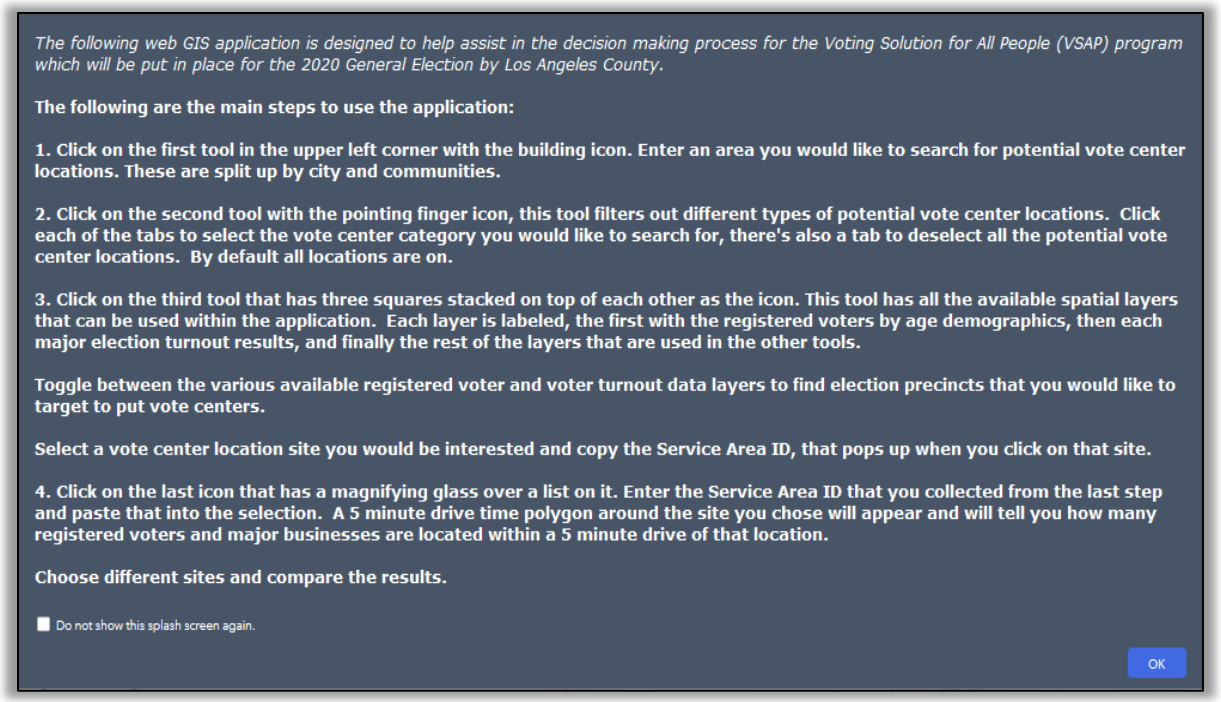

Figure 8 Splash Screen Display

The purpose of this detailed description of every tool within the splash screen is to help those who do not have experience with GIS web applications to be able to have a basic understanding of what they are able to manipulate within the application and how, as well as a reference to go back to if they need to. Also, it gives those who do have GIS backgrounds a more detailed understanding of what the application is capable of. There's an option to turn off the splash screen if the user does not want to see it again when revisiting the application.

Once in the application, the following layers are shown by default: city boundaries, Los Angeles City community boundaries, and potential vote center locations with different colors assorted by the location type that can be filtered within the "select vote center type" tool.

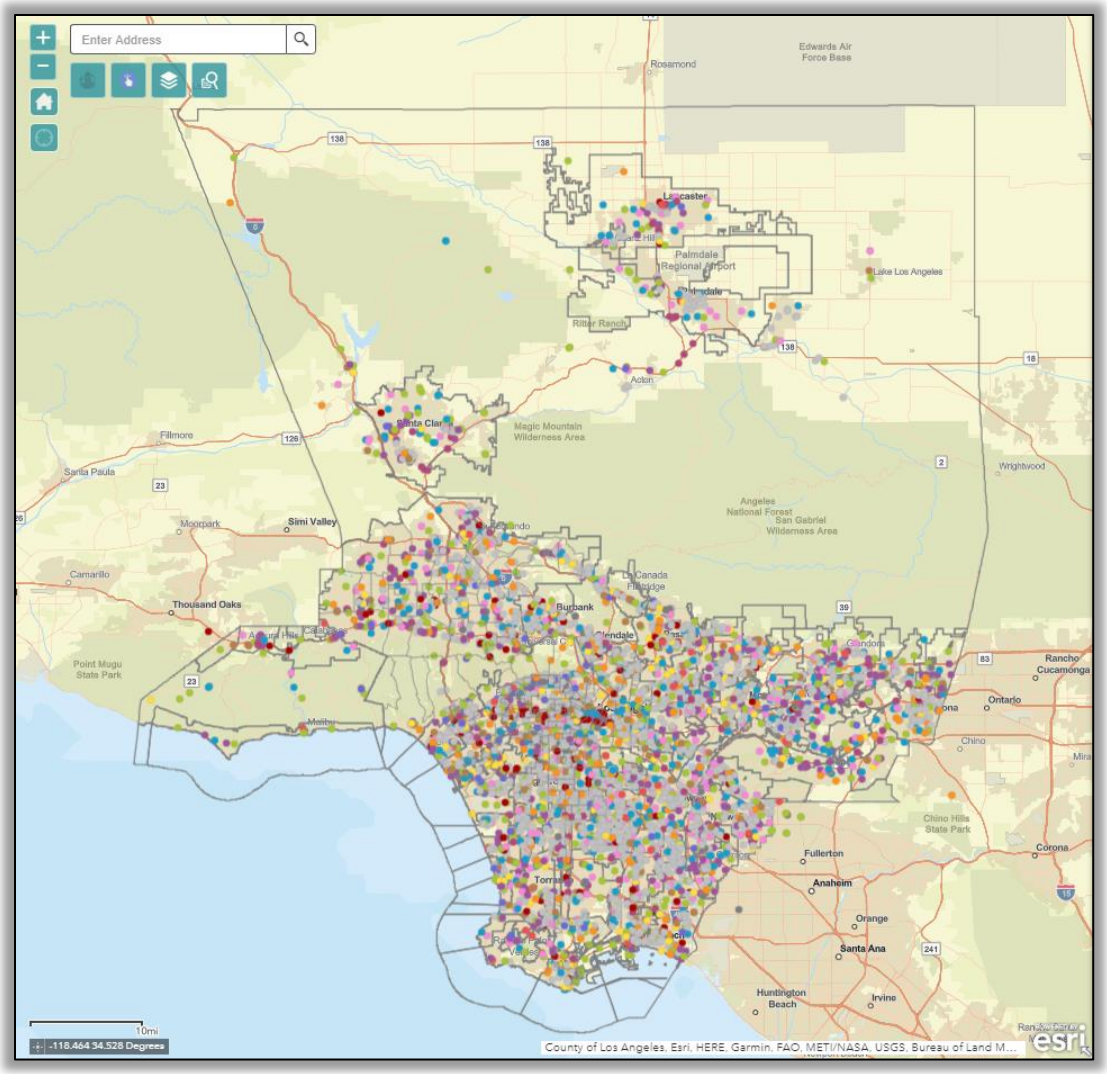

Figure 9 Default Layers of the Web GIS Application

Various default functions such as zooming in and out, the ability to go to the default extent and finding where your location is if you are within the boundaries of Los Angeles County are available in the upper left corner of the screen. The main tool sets are displayed horizontally across the top of the map in the initial viewing stage.

Figure 10 Icons of the Main Tools

The first tool is labeled “Filter by City/Community” and gives the user the ability to zoom in on an area to focus. This is intended to help decision makers find their jurisdiction instead of having to scroll in manually and shows the boundary feature for the selected city or community.

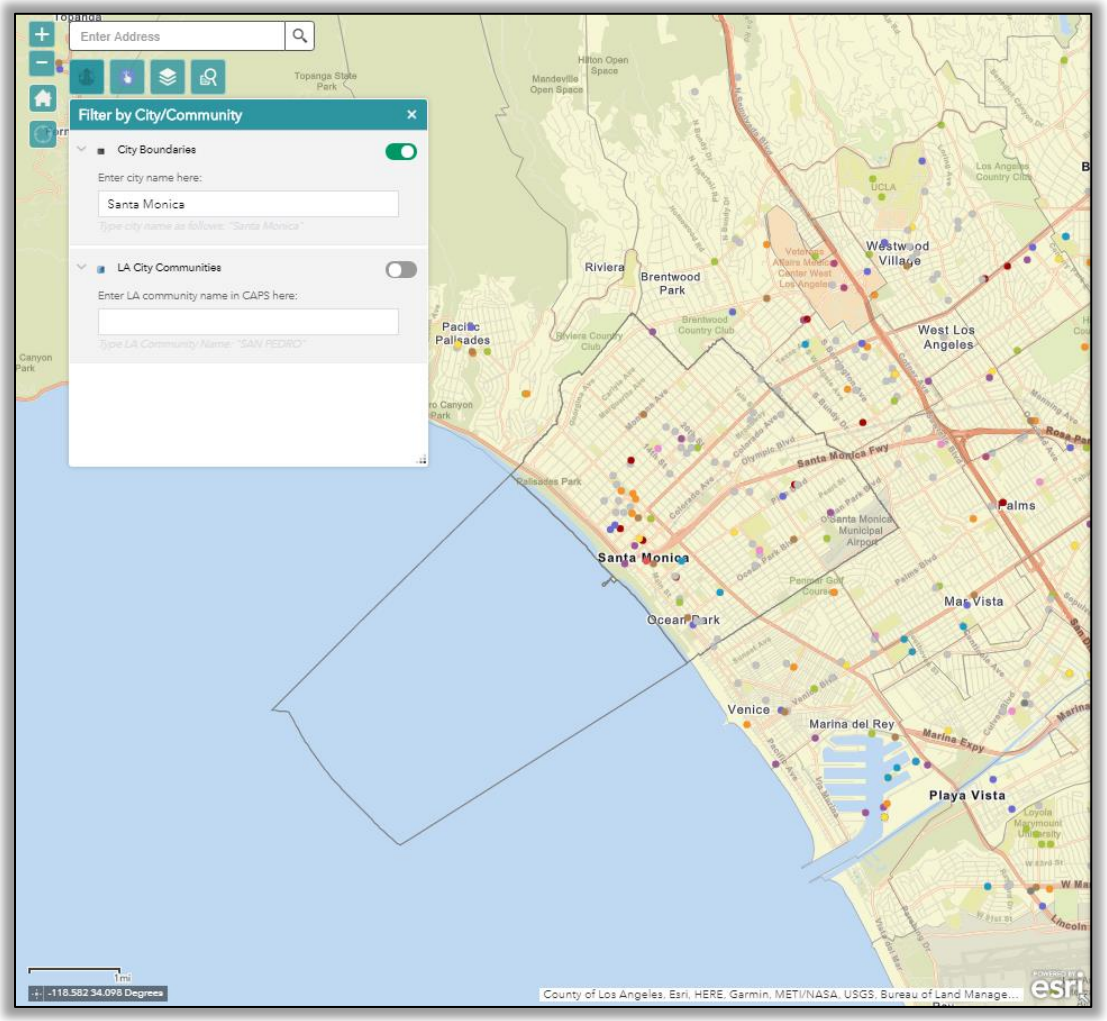

Figure 11 Demonstration of the “Filter by City/Community” Tool

Once the specific region a user would like to see is chosen, the next step is to filter out the potential vote centers that are shown. This is done with a tool in the application titled, “Select Vote Center Location Type.”

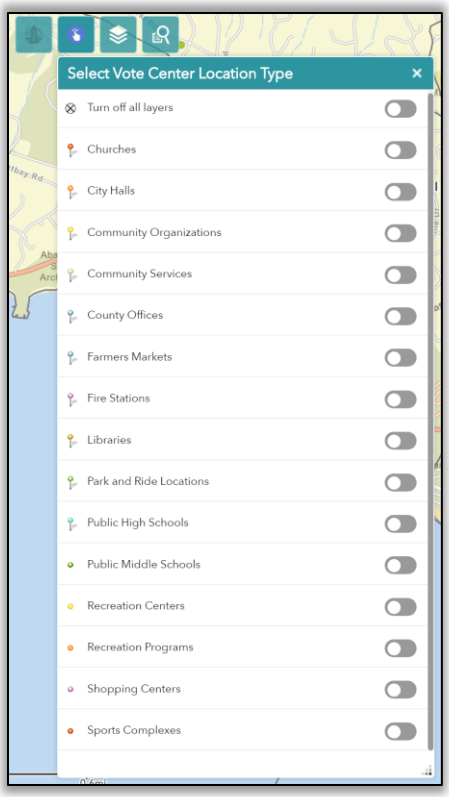

Figure 12 “Select Vote Center Location Type” Tool

By default, all the different types of vote center locations are left on when opening the application, in case the user would like to have all the sites visible when selecting a location, instead of clicking through each one to turn them on or off. A filter to turn them all off is the first option to select, and then the user can select through each of the layers listed above (see Figure 13).

Once the user has defined his desired vote center type, they can move onto the next tool. The next tool lists all the layers that are available within the application and is intended to make comparisons between registered voter and turnout data. The registered voter data is up-to-date since the last election and the voter turnout results are for the last major election in 2016. The registered voter data is aggregated by age-class, and its creation is explained in detail within section 3.3 above. The age-class layers for registered voters are aggregated by 6 different groups

with a 1 standard-deviation difference between them, organized by election precincts across the county. This helps decision makers and application users evaluate where the various age classes of registered voters are located.

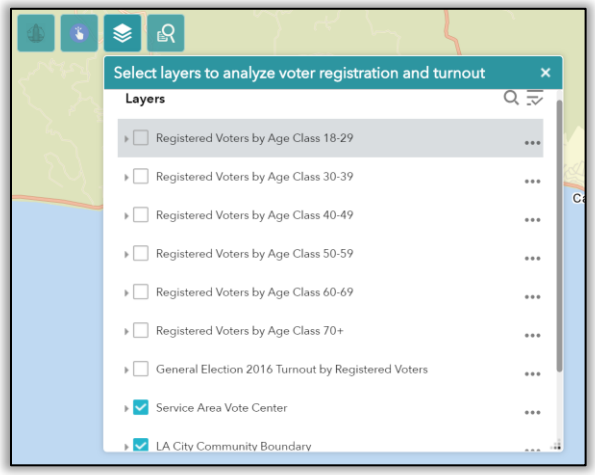

Figure 13 Selectable Registered Voter and Election Turnout Layers

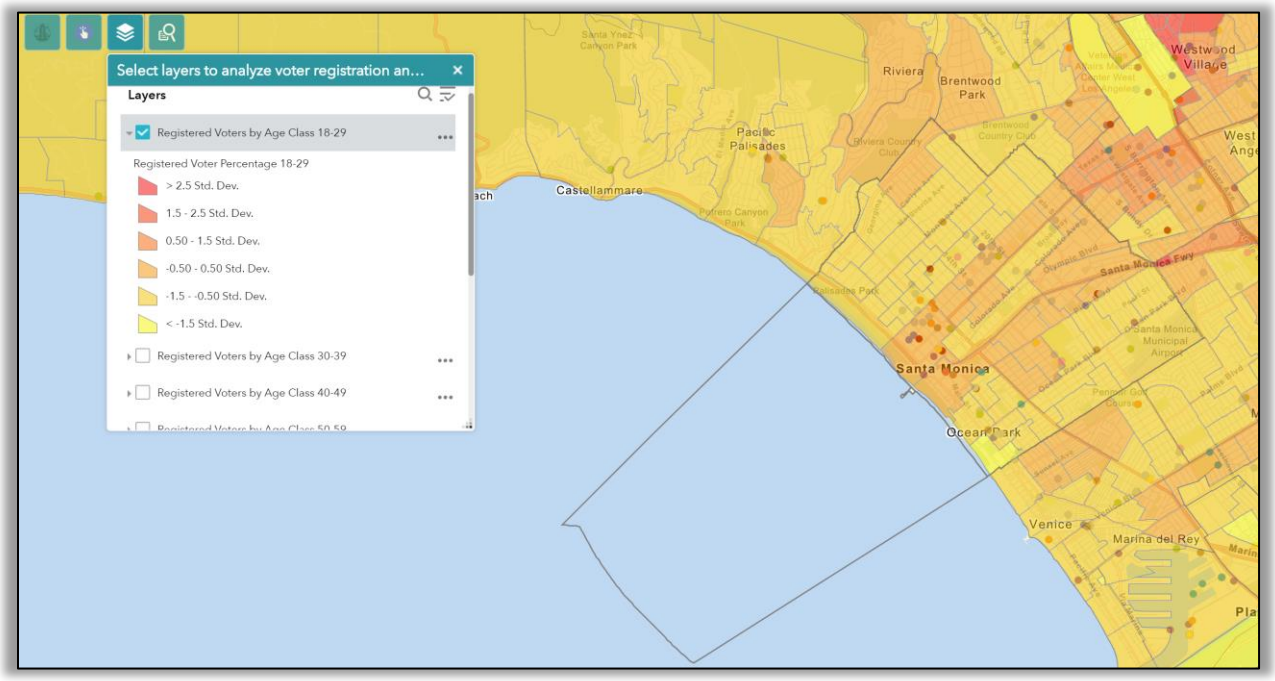

Figure 14 Registered Voters by Age Class 18-29 Relative to the Countywide Mean

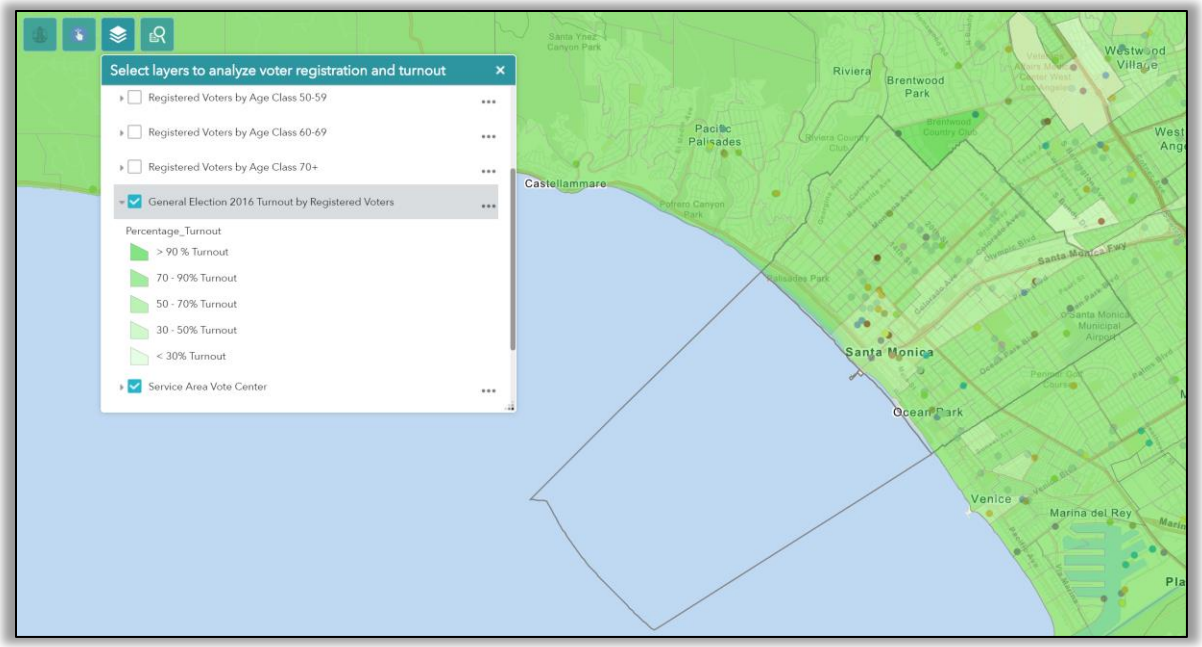

Figure 15 General Election 2016 Turnout by Registered Voter

The various examples of selecting layers (shown above) display a few interesting trends about election precincts within the city of Santa Monica. The election precincts in the center of the city, which contain a high population of young registered voters (18-29) also had a lower total general election turnout compared to the precincts surrounding it. A decision maker may choose one of these precincts to locate a vote center to target a younger demographic in an attempt to raise turnout. Finding the areas where voter turnout is poor and finding who lives within these areas is a core focus of the VSAP project to deliver the requirements set forth by California in the Voter's Choice Act (VCA).

Once the user has evaluated the Santa Monica area by selecting different layers and comparing them, he or she can then select individual potential vote center sites to get more information. By clicking on each individual site, an attribute table pops-up containing its features: Service Area ID, the name of the location, a brief description, type and the address. Entering the "Service Area ID" into the Service Area Site tool runs the final analysis of the

application. These functions are illustrated for one site in Santa Monica in Figures 17 and 18 below.

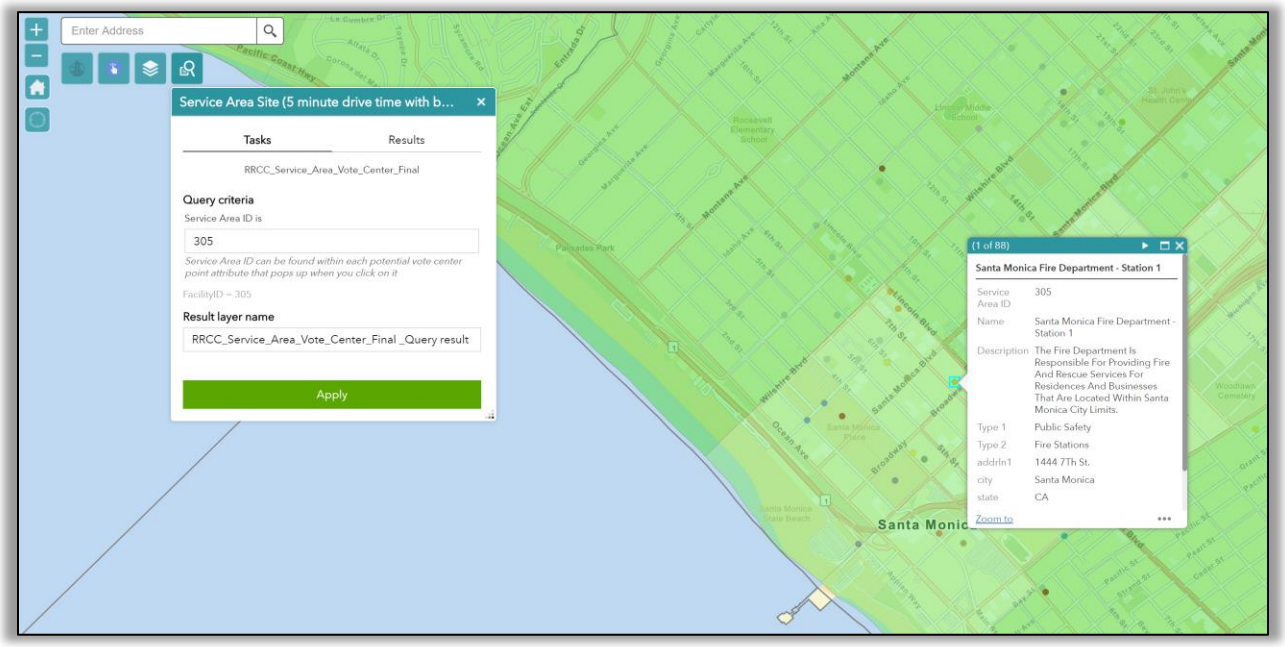

Figure 16 Opening the Service Area Site Tool and Entering the Service Area ID

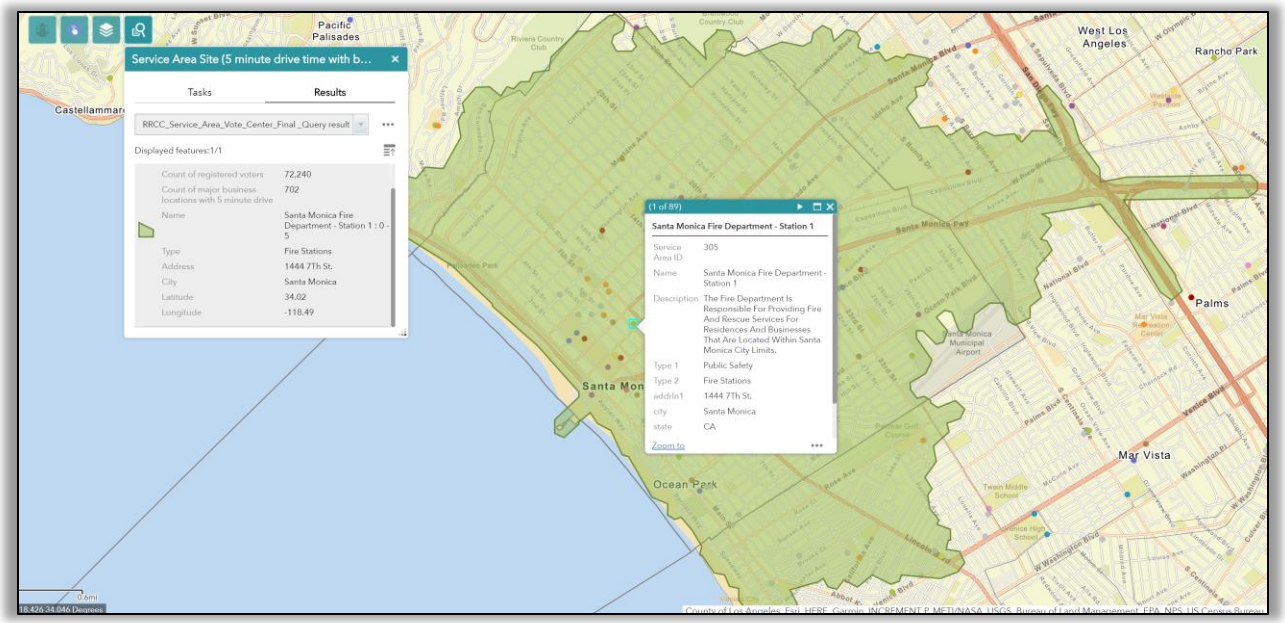

Figure 17 Running the Service Area Site Tool Displaying a 5-minute Drive Polygon, Voter count, and Business Count

When the Service Area Site tool is run, it shows a 5-minute service area for the point that was selected. It also shows a count of all registered voters and major businesses within that polygon. These can be used to compare sites of interest to see the extent of areal coverage, including the number of businesses and registered voters in each area. Registered voter data is useful to indicate where voters live and where they will likely spend nights and weekends, and major business locations can indicate areas of high traffic where the voters will be during the day. Using both counts can help the decision maker decide which vote center will have the best coverage area and can also be used by those contesting a vote center placement by showing that the vote center that was selected does not adequately support their jurisdictions needs. An example of how this will be useful will be demonstrated in the next section.

4.2. Application in Use

The application has many use cases depending on who the user is and what the user is looking for. For example, a Los Angeles county employee may just be looking for a site that has been used previously as a polling place and can now work as a vote center. The employee has been doing this selection process for years and is used to a particular way to find a voting location. Since there is going to be a decrease of about 4000 polling places to about 1000 vote centers, a reduction in the sites within each jurisdiction will inevitably cause concern to the many stakeholders from all the different scales of election, from municipal elections to competitive statewide contests.

City clerks will find this application useful by being able to request new sites if they are dissatisfied with the sites that are chosen for them, or if they prefer to choose the sites for their jurisdiction. This would most likely happen if there was an inquiry by the city council that governs the city clerk's jurisdiction. A city clerk's job is to make sure that all actions taken by

their city council fall in line with all levels (city to state) of statutes and regulations, specifically election related doctrines (Rodrigues 2017). The following scenario is an illustration using the City of Inglewood in Los Angeles County of the process a city clerk will go through to use the vote center site selection web application.

A city council member of Inglewood would like the city clerk to review where Inglewood's new vote center is going to be located. They know that every city will be provided with at least one vote center location, and since Inglewood is seeing large growth from a younger demographic moving into the city, they would like to make sure that for the 2020 general election they have the best site that will accommodate all the new residents. They see that Los Angeles County is planning to put their vote center location at a church based off a weighted site-suitability analysis that was conducted county wide, but don't think this location will provide the best turnout. They suspect it does not satisfy the requirement in the Voter's Choice Act (VCA) as well as some other alternatives. The city clerk contacts the Los Angeles County RRCC office to ask them how they chose the vote center locations and if they can have other alternative sites looked at. They tell them about their concerns with voter turnout and registration with the influx of young people moving into Inglewood. The Los Angeles County RRCC will discuss their methodology for the site-selection and reference them to various datasets and tools the city clerk can use to find a location that fits their jurisdictions needs. One of these tools will be the vote center site-selection assistance web GIS application.

The city clerk will then open the web GIS application and search his or her city as explained in section 4.1. They were advised by their city council that they did not want the vote center to be located at a church, so they deselect the church vote center type and select the rest of the site types: city halls, community organizations, community services, county offices, farmers

markets, fire stations, park and ride locations, public high schools, public middle schools, recreation centers, shopping centers, and sports complexes.

Next the city clerk begins selecting the different registered voter layers to see where younger voters are registered to vote. The clerk selects both the 18-29 and the 30-39 age class layers and finds an election precinct (290052A, shown below) that has the most younger aged voters.

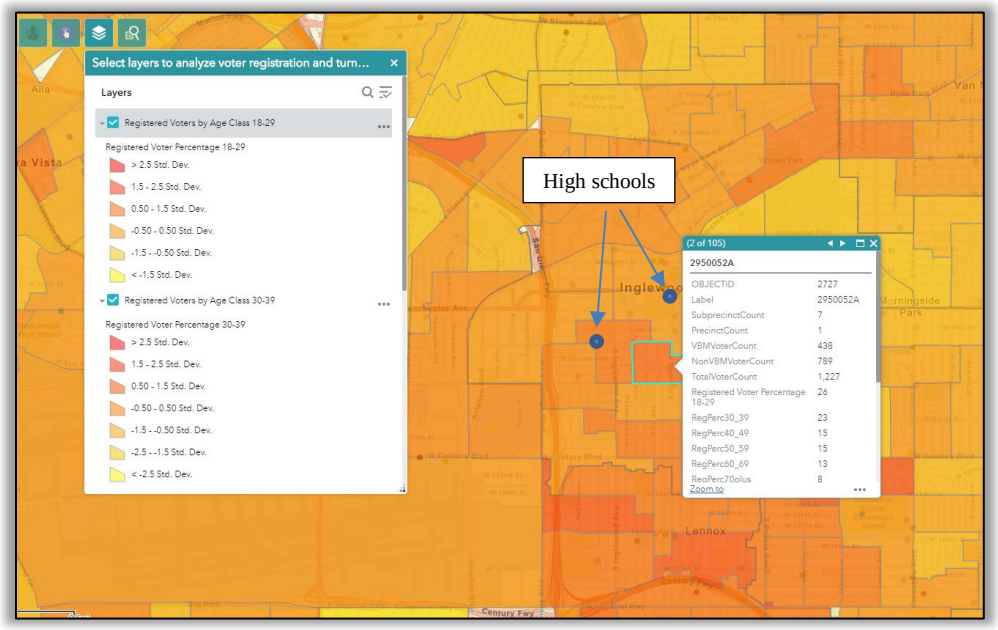

Figure 18 Demonstration of Selecting an Election Precinct with a Younger Age Demographic of Registered Voters.

Inglewood's city clerk knows the city has had poor election turnout historically by registered voters, but toggles on the 2016 general election results layers to verify the assumption. The clerk verifies this assumption and decides to choose a site in or near the election precinct 2950052A. There is a high school located just west of this precinct and another one directly north of the precinct (both shown above). Next, the city clerk checks the service area tool to see how the coverage is for both sites.

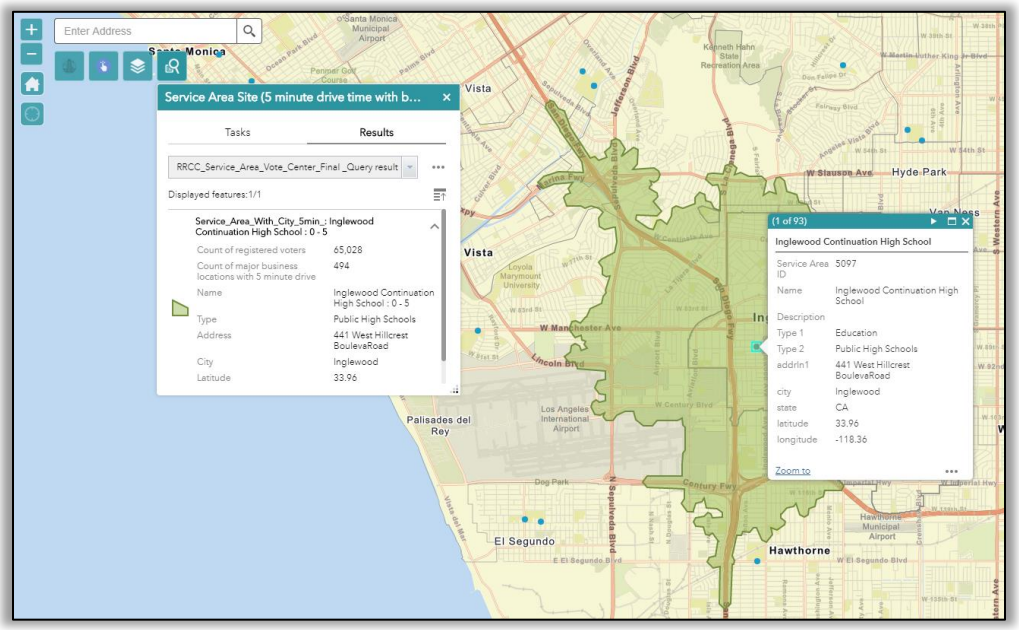

Figure 19 Inglewood Continuation High School Service Area

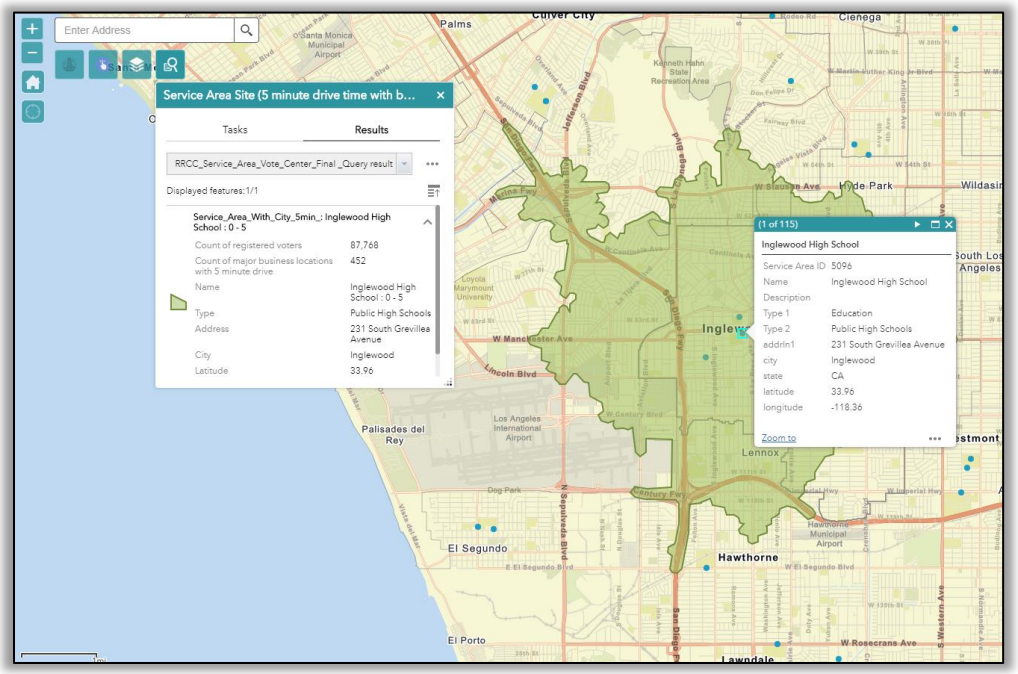

Figure 20 Inglewood High School Service Area

The city clerk realizes that the high school just north of the precinct with the high voter turnout has almost 88,000 registered voters within a 5-minute drive time and the high school to the west

only as 65,000 registered voters. They also notice that the second site with fewer registered voters has about 10% more businesses (492 vs. 452). The site with the greater registered voter count also covers more of the areal extent of the city. They decide that even though the business count is a bit lower, the large number of registered voters compared to other site makes this an obvious choice. The city clerk would then call the Los Angeles County RRCC and let them know they would like a team to conduct a field verification for this site to find out if it would be adequate to hold a vote center. They would also give the city council members who were interested in the inquiry a summary of their results and possibly access to the application to let them decide if they would like to choose another site for field verification. This is an example scenario for just one of the many stakeholders who will have access to this application.

4.3. Feedback from reviewers

The web application was given to several preliminary vote center site selectors within the Los Angeles County RRCC office who are working closely with the teams who are conducting the ground truthing efforts and the consulting firm which is conducting the county-wide site suitability analysis. They gave feedback on the application, including improvements needed before becoming available for public consumption.

A senior developer for Los Angeles County RRCC, Kamyar Miremadi, discussed his concerns with instructions for the application for those who may not be familiar with ArcGIS Online web applications. This is the reasoning for the creation of the splash screen with detailed descriptions of every tool and instructions on how to use the application. He also recommended adding more technical elements to make the service area tool easier to use by being able to instantly run the service area analysis by just clicking on a single point. This would need to be

programmed and customized carefully because of the size of the datasets involved. Overall, he thought the tool would be very useful during the site selection process.

The next reviewer was a GIS analyst with Los Angeles County, Adam Sakowicz, who is the liaison between LA County and the contracting firm PlaceWorks, who will be conducting the field work for finding the vote centers. He stated, "The network analysis is powerful. It is very useful to be able to calculate the number of registered voters within a 5-minute drive time from any vote center point on the map, and then overlay the polygons of voter turnout by groups for specific elections to do trend pattern analysis. I'll be using this application when we get to the individual site selection stage of this project." He relayed the application over to PlaceWorks, who also will also be able to use the application as a resource in their site-suitability analysis for choosing vote centers.

An IT manager with Los Angeles County, Elio Elazar, also reviewed the application. He was very positive with his overview of the application and gave a few tips on how to organize the different tools. He recommended implementing the city/community selection first in the application to help users focus on specific regions. Elio also promoted getting the application out to as many users involved in the VSAP project as possible, even those who are not involved with any of the technical work, to help give them more tools to use in the process. His approval was necessary to be able to share the application with the public on the LA County ArcGIS Online environment, and he set a date for presenting the application to the Registrar-Recorder/County Clerk, Dean Logan, in January 2019 to demonstrate the application and datasets that were created for it.

Much of feedback was positive and many recommendations were made to improve the functionality of the application as well as additional tools that could be added to enhance it. These improvements will be discussed further in Chapter 5 of this thesis for future work.

Chapter 5 Future Work and Conclusions

The web GIS application designed in this project is intended to be used through the various stages of the vote center site selection process as different sites get validated by local jurisdictions and the stakeholders, which include the managers of the sites themselves. The entire site selection process should be finished by the end of 2019. The application will be continue to be updated and improved upon by the Los Angeles County RRCC as more users have access to it, give feedback, and find ways to improve upon it.

5.1. Current Status of the Application

Currently the application is being used by PlaceWorks and the Los Angeles County RRCC as a tool to help make a preliminary site list that will be sent out to jurisdictions for them to evaluate and critique. PlaceWorks will then conduct a public outreach program with the sites they have selected with Los Angeles County to get feedback on the selection process. They are currently conducting a weighted site suitability analysis with all the criteria set forth in the Voter's Choice Act (VCA) to help assess where vote center locations should be placed. The Vote Center Site-Selection Assistance application designed and created in this project will be used as a tool to assist the various stake holders throughout the process of picking individual sites. Once PlaceWorks finishes their weighted site-suitability analysis and permission has been granted to use it by the managing staff of the RRCC, it will be implemented as another selectable layer and feature into this application to further guide the site-selection process.

Since the Los Angeles County GIS department has full access to all the layers and the web application itself, changes can continually be made to help improve upon its functionality. Los Angeles County is willing to keep the application online indefinitely and the staff of the RRCC will make sure it is maintained and updated with the feedback that is received from the

users that come across it. There will also be an effort to let election officials and other stake holders know about the existence of the application and its purpose to help guide those who would like access to more resources for selecting vote center locations.

5.2. Future Improvements to the Application and Fixing Bottlenecks

Throughout the process in the creation of this application various problems arose due to limitations from the datasets, Esri's Web AppBuilder's prebuilt functions, and various other constraints that led to decisions on how the application was built and ideas for future improvements. The biggest constraint was running processes on large spatial datasets and implementing them into the web application. A number of workarounds were implemented as well as leaving some of the originally planned functions of the application out to be added at a further date.

Since many of the feature classes that were created for the web application contain tens to hundreds of thousands of records, running geoprocessing tools on them and getting the uploaded layers to function with ArcGIS Online proved to be difficult. The Network Analyst tool that was used to create the 5-minute service area boundaries with voter count and business count was the most challenging. The service area layers had to be broken up into smaller sections when the Network Analyst tool was run on the potential vote center layer and then merged together to be able to complete the analysis. Each section had to be run over night and sometimes would fail with unidentifiable error codes. The registered voter point dataset that was used to count registered voters within the service area contained just under 500,000 points and the Summarize Within tool needed to be run on every feature to count the voters. This made it extremely difficult to create the 15-minute service area layer with voter count and business count because of how large each polygon was. Thus, the time it would have taken to create this layer was not

feasible to fit within the thesis timeline but could potentially be valuable to some users who would like to get a different perspective of each site location. The creation of a small sample 15-minute service area layer will be distributed to users of the application to see if they find it useful, and if they do it can be added to the web application with the help of RRCC's GIS staff.

Another implementation that did not make it into the initial application build was an easier way to view service areas beyond typing in the "Service Area ID" that is found within the attribute pop-up for each potential vote center. Esri's Web AppBuilder does not have an easy option to create a point and click tool to display the service area without a detailed customized programming approach. The limitation of Esri's Web AppBuilder became a constraint in the design of the application. The outline of the application and steps were designed to make sure these large layers properly functioned within the prebuilt tools of the application. Many of the reviewers of the application had similar suggestions on how to improve the application and creating an easier to use service area tool was at the top of the list. Implementing this will be a priority for the application. This will require a custom widget integrating the "Create Drive-Time Areas" analysis feature that is found within the Analysis widget and feeding it with UCLA's Los Angeles Streets Network Dataset, this is the same dataset used to generate the service area polygons that were used for the tool currently in the application. The next step is publishing the Los Angeles Streets Network Dataset as a network analyst service for consumption within the web application. This is necessary to avoid using the large amount of credits that Esri requires to conduct every drive or walk time polygon around a potential vote center when using their network datasets.

Creating this sort of custom widget for service areas would require sufficient knowledge of JavaScript and HTML, as well as using the ArcGIS API for JavaScript. The new custom

Analysis widget will have more drive and walk time service area options for users to select from, while also providing more variability in the size of scale for service areas they would like to analyze. This process would run within the web application which could also present stability issues, while the current service area tool uses a layer that was generated offline in ArcGIS Pro, which avoids any potential stability problem. The revamped toolset aims to be implemented and ready for use by the public in March 2019.

Another common recommendation to the service area tool was to create different symbology associated with registered voters for each site. One idea is to use graduated symbols for each vote center, representing the number of voters residing within the 5-minute service area. This would make it much easier to see which sites provide better coverage to registered voters without having to run the tool each time for every site. This layer could be processed offline in ArcMap or ArcGIS Pro and added as a selectable layer, but could potentially clutter the application, complicating its use.

Some other recommendations included conducting an analysis based off age and population and their relationship with vote centers. An example of this would be to show vote centers that have a higher population closer to them or vote centers that have a younger demographic. This would include partitioning the vote centers into different classes for each of the criteria that was requested. Since a filtering of the vote center list has already occurred with many of these considerations taken into account by the site-suitability analysis conducted with the contract company PlaceWorks, the layer they produce will be included in the application when it is ready for the public. This will help keep the application simple to use, instead of creating too many filtering options which could clutter the application and confuse the users.

Many of the recommendations were geared toward accommodating more compare and contrast features between the selected vote centers. The most common resolution to implement these recommendations would be to create customized widgets, that would require sufficient JavaScript knowledge. When using customized widgets with WebApp Builder, stabilization becomes a major obstacle because the environment is not designed for them, especially with larger datasets. When stabilization issues arise, where and how to host the web application also becomes a concern. For these reasons implementing many of these changes will take a great deal of time and a cost benefit analysis for which features will add the most value needs to be considered.

5.3. Final Findings

The design and final implementation of this application demonstrates how to effectively create a full functioning ArcGIS Online application making it possible for non-expert GIS users to consider alternative locations of vote centers in Los Angeles County. To accomplish this, the project made use of a full suite of Esri applications: ArcMap, ArcGIS Pro, and ArcGIS Online. ArcMap and ArcGIS Pro were crucial in organizing the large datasets. Many of the large spatial joins that included the business and registered voter datasets would not perform in one software but would perform in the other. This trial and error between the software enabled more options to help complete every task. The lessons that were learned by creating this application and an example to outline the process is useful for others trying to conduct similar analyses, especially with datasets related to Los Angeles County.

Another interesting finding that was addressed by some of the reviewers of the application is how the application has other use cases beyond site selecting vote centers. The voter registration and turnout tool is a valuable resource for many different parties associated

with elections. Determining registered voter demographics within each election precinct is valuable for those groups who want to target an increased voter turnout for their specific interest, which becomes especially important when compared with voter turnout by elections. Public outreach, special interest, and advocacy groups can use this data to know regions where young (or older) people live as this data is effectively geocoded and visualized in this tool at a much smaller scale then many publicly available datasets. Also, officials with the RRCC are interested in the service area analysis tool for other points beyond vote centers, such as locating new voter outreach locations, and mobile election stations that are put in place to help run elections.

5.4. Conclusion

The application has been a well-received addition to the current approach the RRCC is taking in implementing the VSAP program and selecting vote centers. Once the application gets dispersed to a wider user audience as the VSAP project progresses, many new features will be requested, and a bigger team will be assigned to work on the web application from the GIS department at the RRCC. This initial production of the web application will give good bearings for the decision-makers on how to use GIS when doing analysis and will hopefully open the door for more GIS use within each of the user groups. In the initial meetings where this web application has been displayed, it has been met with lots of curiosity on what the potential functions are available for this type of web GIS program. This curiosity has led me to believe that web GIS is still a widely underutilized tool that has much more opportunity when put into the right hands. As a GIS professional, the need to get more GIS tools into the hands of those that can conduct analysis, can unlock many doors to questions that would otherwise go unanswered.

References

Bailey, Trevor C., and Anthony C. Gatrell. 1995. *Interactive Spatial Data Analysis*. Longman Scientific & Technical.

Berger, Jonah, Marc Meredith, and S. Christian Wheeler. 2008. "Contextual Priming: Where People Vote Affects How They Vote." *PNAS*. July 1. http://www.pnas.org/content/105/26/8846.full.

Blais, André, and Agnieszka Dobrzynska. 2009. "Turnout in Electoral Democracies Revisited." *Activating the Citizen*, 63–82. doi:10.1057/9780230240902_4.

Bryhonda, Lyons. 2018. "Goodbye, Neighborhood Polling Places-5 Counties Switch to Mega-Vote Centers." *Goodbye, Neighborhood Polling Places—5 Counties Switch to Mega-Vote Centers*. Calmatters. April 2. https://calmatters.org/articles/blog/five-california-counties-will-trade-in-polling-places-for-vote-centers/.

Burden, Barry C., David T. Canon, Kenneth R. Mayer, Donald P. Moynihan, and Jacob R. Neiheisel. 2016. "What Happens at the Polling Place: Using Administrative Data to Look Inside Elections." *Public Administration Review* 77 (3): 354–64.

Dawod, Gomaa. 2013. "GIS-Based Public Services Analysis Based on Municipal Election Areas: A Methodological Approach for the City of Makkah, Saudi Arabia." *Open Journal of Acoustics*. July 24. http://www.scirp.org/journal/PaperInformation.aspx?paperID=35352.

Demers, Steve. 2017. "Sacramento County SB 450 Voter's Choice Act Application." *Sacramento County ArcGIS Online*. Sacramento County. https://sacramentocounty.maps.arcgis.com/apps/MapJournal/index.html?appid=7d522d534df849e58c11418566919472.

DeSilver, Drew. 2018. "U.S. Trails Most Developed Countries in Voter Turnout." *Pew Research Center*. Pew Research Center. May 21. http://www.pewresearch.org/fact-tank/2018/05/21/u-s-voter-turnout-trails-most-developed-countries/.

Elazar, Elio. 2018. "Voter Registration and Election Database." Norwalk: Los Angeles County Registrar-Recorder.

Jelokhani-Niaraki, Mohammadreza, and Jacek Malczewski. 2015. "Decision Complexity and Consensus in Web-Based Spatial Decision Making: A Case Study of Site Selection Problem Using GIS and Multicriteria Analysis." *Cities* 45: 60–70.

Kim, Jeong Hyun, and Norman Schofield. 2016. "Spatial Model of U.S. Presidential Election in 2012." *The Political Economy of Social Choices Studies in Political Economy*, 233–41.

Lamare, J. Ryan. 2010. “Union Influence on Voter Turnout: Results from Three Los Angeles County Elections.” *ILR Review* 63 (3): 454–70.

Logan, Dean. 2018. “VSAP: Voting Solutions for All People.” *VSAP*. Los Angeles County. http://vsap.lavote.net/.

“Los Angeles Network Data.” 2018. Los Angeles: UCLA Institute for Digital Research and Education.

MacGerr, Michael E. 2002. *The Decline of Popular Politics: the American North, 1865 - 1928*. Oxford University Press.

Mcmurray, Joseph. 2017. “Ideology as Opinion: A Spatial Model of Common-Value Elections.” *American Economic Journal: Microeconomics* 9 (4): 108–40. doi:10.1257/mic.20160040.

Padilla, Alex. 2016. “About California Voter's Choice Act.” *About California Voter's Choice Act*. California Secretary of State. http://www.sos.ca.gov/elections/voters-choice-act/about-vca/.

Parker, Robert Nash., and Emily Katherine V. Asencio. 2009. *GIS and Spatial Analysis for the Social Sciences: Coding, Mapping and Modeling*. London: Routledge.

Rodrigues, Kimberly. 2018. “What Is A City Clerk?” *City Clerks Association of California*. Accessed December 11. https://www.californiacityclerks.org/what-is-a-city-clerk.

Romero, Mindy. 2018. “Vote Center Siting Tool.” Computer software. *California Civic Engagement Project:* UC Davis. https://datakind.github.io/ccep_vote_center_siting_tool_beta/contact.html.

Rothschild, David. 2015. “Combining Forecasts for Elections: Accurate, Relevant, and Timely.” *International Journal of Forecasting* 31 (3): 952–64.

Sinclair, D. E. “Betsy,” and R. Michael Alvarez. 2004. “Who Overvotes, Who Undervotes, Using Punchcards? Evidence from Los Angeles County.” *Political Research Quarterly* 57 (1): 15–25. doi:10.1177/106591290405700102.

Taylor, Peter J., and R. J. Johnston. 2015. *Geography of Elections*. London: Routledge.

“Community Planning and Design, and Environmental Planning.” 2018. PlaceWorks, Inc. http://placeworks.com/.

“U.S. Census Bureau QuickFacts: Los Angeles County, California.” n.d. *Los Angeles County, California*. https://www.census.gov/quickfacts/fact/table/losangelescountycalifornia/PST045216.