EFFECTIVE APPROACHES TO THE DEVELOPMENT OF ASSET MANAGEMENT PROGRAMS FOR SMALL SCALE LOCAL GOVERNMENTS

by

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(Under the Direction of Stephan Durham)

ABSTRACT

Infrastructure asset management is an important topic at all levels of government. Determining the necessary attributes of a guide for asset management for small local governments is an important uncovered topic as they are responsible for managing a significant amount of the state's infrastructure. This study evaluates whether the American Public Works Association (APWA) guide to asset management is effective for small governments or if there needs to be additional asset management resources for these governments. Results from interviews and surveys conducted with government representatives in Georgia as well as a case study where the APWA guide was followed indicate that small governments have different priorities and access to fewer resources than larger governments. Based on this evidence, a decision tree for software and a supplemental document with a breakdown of the asset management system implementation procedure was created and recommended for use to supplement the APWA guide in local governments with limited resources.

Key Words: *asset management*, *infrastructure*, *local government*, *pavement management*

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1.0 | INTRODUCTION

Asset management is an important tool utilized by local government management throughout the US. The term "local government" refers to incorporated city and county entities. Existing guides for asset management typically include sections on policy, objectives, and day-to-day activities. These guides are meant to direct local governments to create strategic plans describing how infrastructure will be managed and services provided to citizens. In 2018, the American Public Works Association (APWA) published the *Guide to Successful Asset Management System Development* for the use of local governments in its network. This study analyzes the current level of asset management in local governments in Georgia using surveys and interviews. An analysis of the APWA guide was completed in order to identify areas of weakness within the guide in relation to local governments of different sizes. Recommendations to improve relevance and applicability for small scale governments in Georgia are provided in later sections of this report. Specific challenges encountered by stand-alone cities with a population of less than 20,000 and by counties with similar levels of resources are addressed in the recommended modifications to the APWA guide. An asset management plan was then implemented following the APWA guide in a small local government. The implementation of the asset management plan is evaluated to determine problems encountered and the processes that were successful for the local government.

1.1 | Defining Assets

An asset is anything that has value as defined by the municipality. This study focuses on assets related to infrastructure. There are different categories within infrastructure assets. Assets graded by the American Society of Civil Engineers (ASCE) in their Infrastructure Report Cards are as follows: aviation, bridges, dams, drinking water, energy, hazardous waste, inland waterways, levees, parks and recreation, ports, rail, roads, schools, solid waste, transit, and wastewater [ASCE,

2017]. This is a national grading system for infrastructure assets that communicates the need for attention in certain asset categories. Not every city or county provides all these assets and services to their citizens, so the asset management system specific to each local government only contains the assets they manage. Assets are valued by their monetary value along with the importance of the service they provide to a municipality. For instance, according to the American Road and Transportation Builders Association, one mile of 4-lane highway in rural or suburban areas costs approximately $4-6 million to construct. Rural 2-lane undivided roads cost approximately $2-3 million per mile. It costs approximately $1.25 million to mill and resurface a mile of a 4-lane highway. The Florida Department of Transportation also created a report detailing the cost of road construction and repair. These values are likely similar to those in Georgia. The cost of a new undivided 2-lane rural road with 5 ft paved shoulders is approximately $2.2 million per mile in Florida. The cost of milling and resurfacing this type of road is approximately $500,500 per mile. The cost of a new undivided 3-lane rural road (center turn lane) with 5 ft paved shoulders is approximately $2.7 million per mile. The cost of milling and resurfacing this type of road is approximately $710,000 per mile. These specific types of roads have less traffic and are the most commonly managed by small local governments. Major highway departments normally do not manage them [Florida Department of Transportation, 2019]. Highways possess other stakeholder value in addition to monetary value. For example, low levels of traffic are a form of value lacking a dollar amount. A local government must assess the desired levels of service of the community so that projects of high importance to the community are appropriately prioritized.

1.2 | Defining Asset Management

As discussed previously, an asset is anything that has assigned value or worth to an organization. The management of infrastructure assets is generally entrusted to government entities, but this can

be a complicated undertaking if there is no defined management system. Asset management is defined by the International Organization for Standardization (ISO) as, "the financial, operational, maintenance, risk, and other related activities of an organization to realize more value from its assets" [ISO, 2018]. An asset management plan is a guiding document that connects future plans as well as daily action in the maintenance of assets to policies and overarching goals of the organization and appropriate stakeholders. Asset management plans are used to ensure that the budget and employees of an organization are used efficiently in the maintenance and progress of their assets.

1.3 | Importance of Asset Management

Asset management is becoming more important in governmental settings. This is necessary because governments operate uniquely from other organizations as there are many checks, balances, and politics involved in the management and distribution of a specific budget. However, at the national level, asset management faces major obstacles caused by a funding deficit of approximately $4 trillion. This deficit continues to increase yearly. According to ASCE, this funding gap not only affects local governments but also trickles down and affects families at an average amount of $3,400 per year (that's $9 a day) [ASCE, 2016]. Generally, asset management guides specifically for infrastructure are published by software companies like AssetWorks and government related associations. The Institute of Asset Management (IAM) is an international organization that provides resources concerning asset management to members and others who visit their website. This organization is meant to be a resource for a diverse group of organizations like businesses, tech companies, and any other organization that owns or manages assets. Additionally, APWA provides service and resources specific to local governments in America.

1.4 | Summary of Thesis Components

This thesis contains eight chapters that analyze and evaluate asset management in Georgia and apply the results to asset management resources for Georgia. Asset management plan implementation on general and specific levels in Georgia are studied in this thesis. Chapter 2 introduces challenges of asset management and the importance of asset management in the nation and state of Georgia. Chapter 3 covers current asset management methods, associated software, and ways to evaluate the data that is collected. Chapter 4 introduces and explains the research objectives and significance. These are the guiding force behind the study as a whole and give reasons for the methodology presented in the following chapter. Chapter 5 presents the methodology for each step of the research process. Because both qualitative and quantitative data is analyzed, the different methods for the analyses of these data are discussed. Chapter 6 follows the same structure as Chapter 5, connecting research findings to research methodology. Chapter 7 discusses the results and conclusions concerning asset management in different types of local governments, as well as discussing how the findings can be implemented into practice. Finally, Chapter 8 reviews final recommendations from the study and the future work that should be done based on the study.

2.0 | BACKGROUND

2.1 | Challenges of Asset Management

The United States focuses primarily on building new and improved infrastructure while the degrading infrastructure of the past is often overlooked. Putting money into the maintenance of existing infrastructure is not glamorous or exciting causing most elected officials to naturally steer toward flashy projects that easily garner votes and community support. This is often a costly mistake. In an article that the Brookings Institution published called *The Case for Spending More on Infrastructure Maintenance*, one expert discusses how repairing damaged cars as a result of poorly maintained roads would cost the equivalent of 50 cents to $1 tax per gallon of gasoline.

The United States does not invest in its infrastructure at the level that other countries are investing. According to the article *The State of U.S. Infrastructure,* "On average, European countries spend the equivalent of 5 percent of GDP on building and maintaining their infrastructure, while the United States spends 2.4 percent. Other countries, including Australia, Canada, France, and the United Kingdom have also developed national infrastructure frameworks that allow the central government to direct and prioritize projects in a way that the United States' more decentralized system has struggled to do" [McBride, 2018]. Where other countries have nation-wide approaches to developing and managing infrastructure, the United States is not united in this area. Canada and the Republic of South Africa are both focusing on an integrated approach to infrastructure management that emphasizes clear communication and complete understanding of roles and responsibilities. The United States needs to make changes in the way it builds and maintains infrastructure, or it will continue to degrade and cause safety issues.

When encountering the task of managing assets, local governments are challenged with barriers. A large portion of Americans have false impressions about where their tax money goes

when it comes to infrastructure and who is responsible for infrastructure management. Improved communication between the local government and the communities they govern could increase approval of a local government which could lead to better funding and increased productivity.

2.2 | Current State of Infrastructure

This section reviews the current state of infrastructure in the United States and how it compares to other countries.

2.2.1 | State of Infrastructure in the United States

Infrastructure in the U.S. is aging and deteriorating. According to the ASCE Infrastructure Report Card for 2017, the U.S. received a D+ for the overall infrastructure grade. This rating reflects an overall poor state of infrastructure that is at risk of failure. The article explaining how the grade was determined states that there have been "decades of underinvestment" in the infrastructure that will require monumental steps to overcome [ASCE, 2017]. The awareness of the American people is not enough for real change. The deteriorating assets will and have already cost billions of dollars to the U.S. economy. According to an article posted by the Council on Foreign Relations, "investing in new infrastructure and current maintenance would positively impact the economy" [McBride, 2018]. **Figure 1** shows the history of the grades for each type of infrastructure in America since 1988. The grade has remained stagnant at a D or D+ for the past 20 years, but the funding gap has steadily increased, putting further stress on the economy.

CATEGORY	1988*	1998	2001	2005	2009	2013	2017
Aviation	B-	C-	D	D+	D	D	D
Bridges	–	C-	C	C	C	C+	C+
Dams	–	D	D	D+	D	D	D
Drinking Water	B-	D	D	D-	D-	D	D
Energy	–	–	D+	D	D+	D+	D+
Hazardous Waste	D	D-	D+	D	D	D	D+
Inland Waterways	B-	–	D+	D-	D-	D-	D
Levees	–	–	–	–	D-	D-	D
Ports	–	–	–	–	–	C	C+
Public Parks & Recreation	–	–	–	C-	C-	C-	D+
Rail	–	–	–	C-	C-	C+	B
Roads	C+	D-	D+	D	D-	D	D
Schools	D	F	D-	D	D	D	D+
Solid Waste	C-	C-	C+	C+	C+	B-	C+
Transit	C-	C-	C-	D+	D	D	D-
Wastewater	C	D+	D	D-	D-	D	D+
GPA	**C**	**D**	**D+**	**D**	**D**	**D+**	**D+**
Cost to Improve**	–	–	**$1.3T**	**$1.6T**	**$2.2T**	**$3.6T**	**$4.59T**

Figure 1: ASCE Report Card History [ASCE, 2017]

Figures 2 and **3**, taken from the Global Built Asset Wealth Index 2015, portray how the monetary values of built infrastructure in each country compare. **Figure 2** is generally biased towards larger countries, but **Figure 3** is the value of built assets per capita in each country. The

U.S. does well when the total stock of built assets is considered (**Figure 2**) but fails to enter the top ten when this value is calculated per capita (**Figure 3**). Countries often get caught up in "progress", building bigger, better, more intricate, more impressive "new" infrastructure while neglecting the built assets from the past. This index discusses how the U.S. is failing in its built asset wealth pointing out that, "There is increasing concern about the negative impact an underperforming built environment has on the economic prosperity of U.S. cities" [Cayet and Cavalla, 2015]. There is a vast gap between the investment required to bring the infrastructure in the US from where it is to "ideal conditions," and it is far too wide to be covered by funding from the public sector [Cayet and Cavalla, 2015]. Additionally, there is a demand to prepare for future disasters as they grow in intensity with climate change. Ultimately, the US needs to make changes.

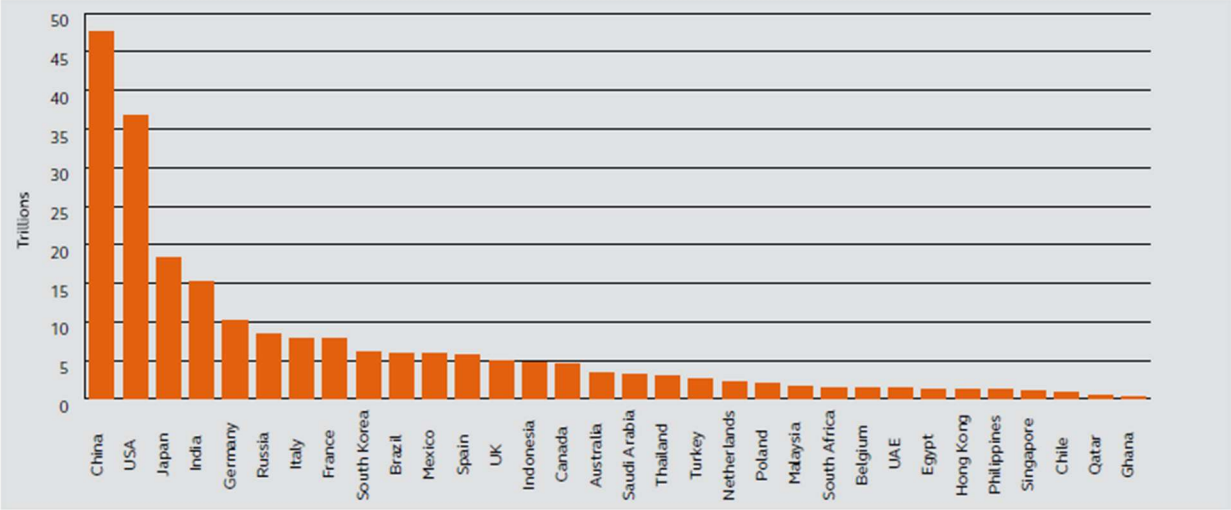


Figure 2: Stock of Built Assets, 2014, US$ [Cayet and Cavalla, 2015]

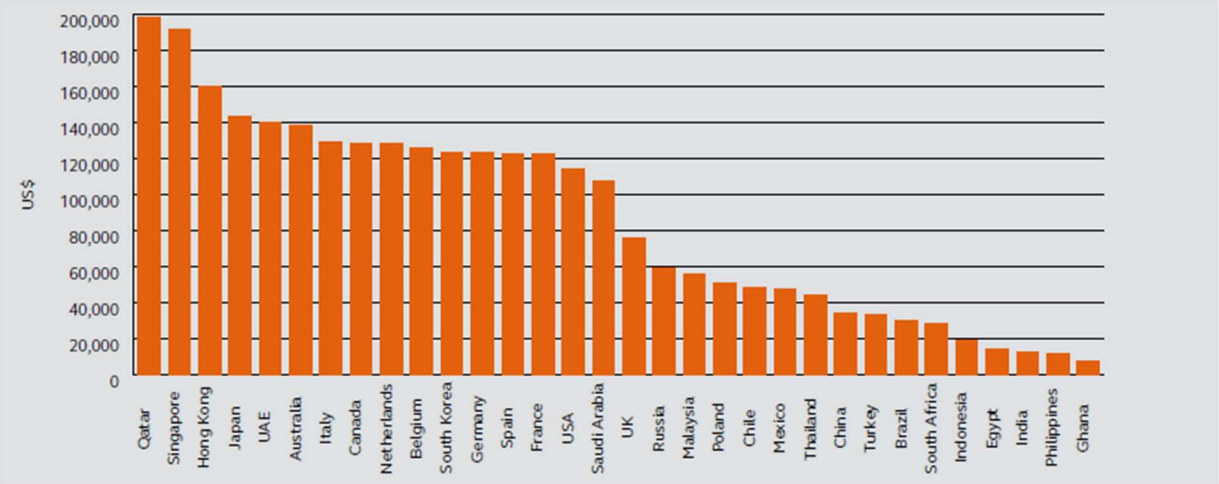


Figure 3: Built Assets Per Capita, US$ [Cayet and Cavalla, 2015]

2.2.2 | State of Infrastructure in Georgia

The most recent ASCE Georgia Infrastructure Report Card is from 2019. Based on this report, the Georgia infrastructure received a cumulative grade of a C+, which is a slight improvement from the preceding 2014 grade of C [ASCE Georgia, 2019]. **Figure 4** shows the changes in individual infrastructure grades for Georgia between 2014 and 2019. Even with some improvements, Georgia has a long way to go as its population is continuing to grow putting an increased stress on the existing infrastructure. As most of the population and population growth is focused in and around Atlanta, most of the state's funding flows into this area's infrastructure. This creates more strain on the smaller local governments located in areas of the state not affected by the growth of metro-Atlanta. For instance, Georgia's transportation funding produced by the state motor fuel tax is not sufficient to cover the costs of repairing and replacing all of the deficient bridges in Georgia. ASCE reports that most deficient bridges in Georgia were not included in a report to the Federal Highway Administration (FHWA) because "these off-system bridges are owned by local governments such as cities and counties" [ASCE Georgia, 2014].

The grade increase can largely be attributed to the Georgia Transportation Funding Act of 2015 (TFA), which "provided nearly $1 billion in additional revenue for Georgia's transportation system each year, which included the 14,863 bridges and culverts across the state" [ASCE Georgia, 2019]. Georgia has reduced the percentage of structurally deficient bridges by approximately half by implementing state mandated asset management programs. However, local governments still struggle to prioritize bridge maintenance even with the Transportation Investment Act because it has not been approved by many regions throughout the state. While the state is repairing and replacing bridges, local governments are not motivated to give attention to their bridges. ASCE recommended that expanding asset management implementation in local governments is needed [ASCE Georgia, 2019].

The infrastructure report card provides five solutions that are intended to raise Georgia's infrastructure grade in the future. One focus is that water-related utilities in Georgia are "consistently underfunded", which creates significant potential future problems that have not been addressed yet [ASCE Georgia, 2019]. There is a similar lack of funding for ensuring that private dams in Georgia are safe. Another recommended solution is that the Atlanta region needs to implement a transit strategy for the whole area it effects. ASCE of Georgia states that the ongoing Savannah Harbor Expansion Project will raise the infrastructure grade as it will "require improved rail and truck freight transportation networks to efficiently get goods to and from the port" [ASCE Georgia, 2019]. The final "Key Solution" for raising Georgia's infrastructure grade is that landfill owners increase their fees for out-of-state waste because it will lower the amount of waste generation per capita in Georgia. The Key Solutions solve large scale problems that affect the state as a whole in many different ways.

GEORGIA			
Category	2014	TREND	2019
Aviation	B+	↔	B+
Bridges	C-	↑	C+
Dams	D-	↑	D
Drinking Water	C+	↑	B-
Energy	B	↔	B
Parks & Recreation	D+	↑	C-
Ports	C+	↑	B-
Rail	B	↔	B
Roads	C-	↑	C+
Schools	C+	↑	B
Solid Waste	C+	↓	C
Stormwater	D+	↑	C-
Transit	D-	↑	D+
Wastewater	C	↓	D+
Overall	**C**	↑	**C+**

Figure 4: Comparison of 2014 and 2019 Grades [ASCE, 2019]

As mentioned, the TFA has increased the funding for roads in Georgia. Significant improvements have been effective because of the Georgia Department of Transportation (GDOT), which is funded by the state. Additional improvements to the road grade recommended by ASCE is that local governments utilize new funding made possible by House Bill 170, but this requires a vote on an additional sales tax [ASCE Georgia, 2019]. Successful adoption of local Special Purpose Local Option Sales Tax (SPLOST) funding requires local governments to communicate with citizens about the need for asset management and investing in local infrastructure. An important part of asset management programs is determining community priorities. Additional funding is created by the SPLOST Programs, but these programs only authorize additional sales

tax for specific projects, so they are not a solution for all the deterioration of the infrastructure. It is often difficult for areas in Georgia to adopt TSPLOST (transportation specific SPLOST) funding projects because they are voted in by regions or counties. The areas in Georgia that have TSPLOST funding in place as of 2018 are shown in **Figure 5**.

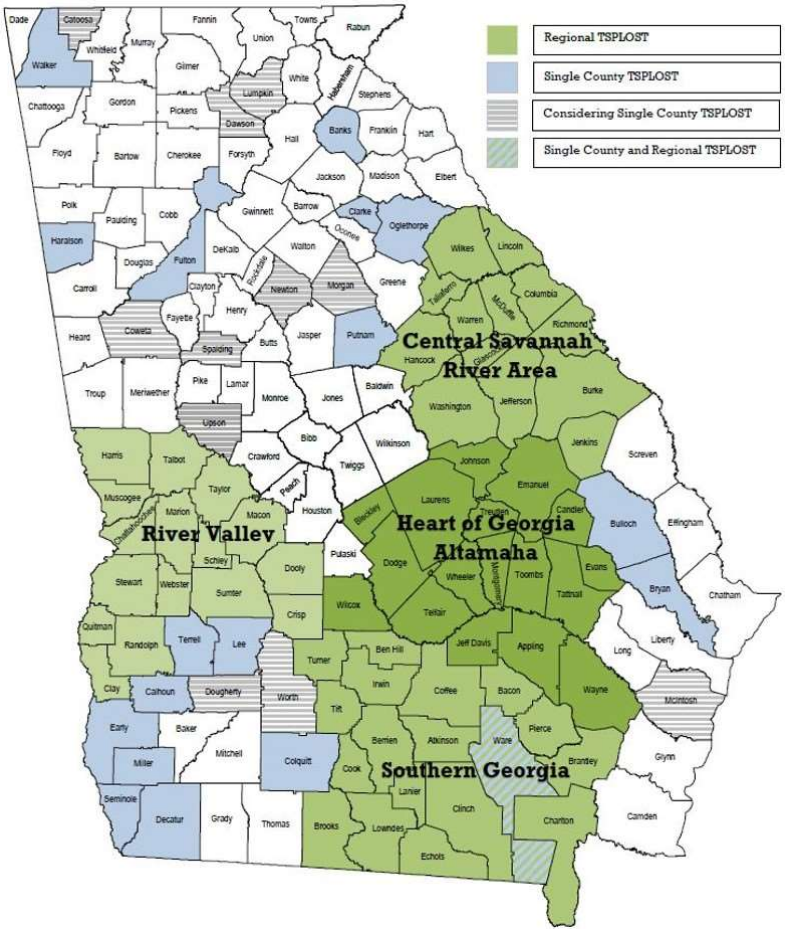


Figure 5: TSPLOST Funding in Georgia [Wickert, 2018]

Georgia is the eighth most populous state in the United States. There are 159 counties with 535 incorporated municipalities. There is no designation between cities and towns, meaning that there are many "cities" with less than 100 people in population. In comparison to other states Georgia is making significant progress on its infrastructure. As shown in **Figure 6**, Georgia was

one of only two states to receive a C+. 12 states received a grade of C, and 16 received a grade of C-, with the remaining states getting either a D+ or no grade.

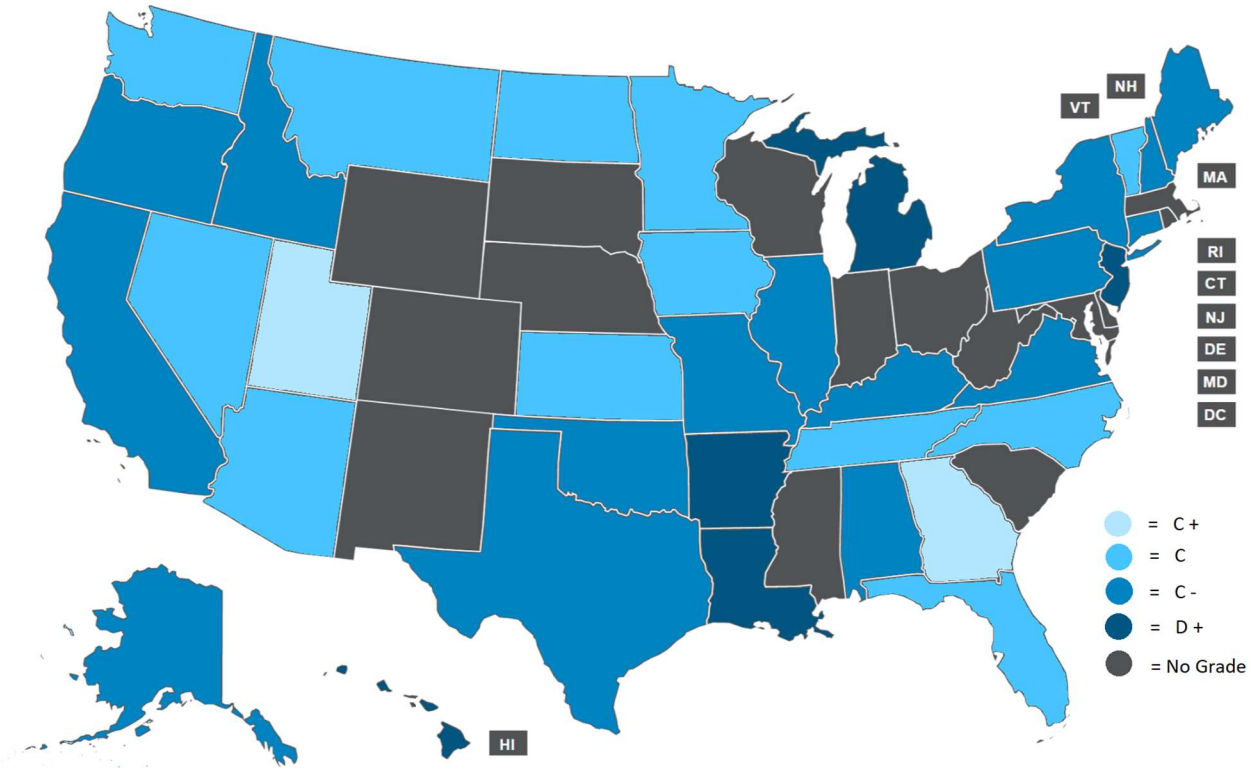


Figure 6: State by State Infrastructure Grades

3.0 | LITERATURE REVIEW

3.1 | Overview

Communities expect proper asset management from their local government. In the United States, money to fund new infrastructure or maintenance on existing infrastructure generally comes from the local or state governments. This model contrasts to other countries who nationally invest more money in their infrastructure than the U.S. There is often a disconnect between citizens' priorities, the work that government officials prioritize, and the work that engineers prioritize which leads to misunderstandings and public unrest. The infrastructure in the U.S. has begun to age and deteriorate, and the funding needed to repair and replace all the existing assets currently does not exist. Programs need to be implemented at local levels in order to address specific needs of the community and infrastructure. Asset management programs vary depending on size of municipality, budget, and a multitude of other factors. This literature review examines tactics for managing infrastructure assets within municipalities with different resources and priorities, and it reviews software used for the management of infrastructure.

3.2 | Developing an Asset Management Plan

When developing an asset management plan, there are factors that need to be considered first. Every local government entity is different, but generalized steps can be tailored to fit the specific needs, priorities, and limitations of certain types. An important first step in any asset management system, emphasized by the APWA, is that every local government, regardless of size, create an inventory plan to understand what assets a particular local government holds and their condition. Creating a detailed inventory helps local governments to understand the status of their infrastructure and what is most pressing to prioritize. Performing an inventory and assessment is the beginning of a long road to a successful asset management system; therefore, developing a

standardized approach to asset management for various governmental entities (national, state, and local) has been attempted by multiple organizations. The difficulty is that not all local governments are able to approach asset management the same way. Each local government will likely have different priorities, different budgets, and access to different resources.

The Department of Provincial and Local Government (DPLG) in the Republic of South Africa is adamant about the importance of clear roles and responsibilities. Their approach to the management of municipal infrastructure is addressed in the booklet: "Municipal Infrastructure: Roles and Responsibilities of National Sector Departments, Provincial Counterparts, and Municipalities". The DPLG emphasizes cooperation between different sectors and departments within the government with its objective to work toward common goals together. In his published work, Mahmoud Halfawy supports the DPLG saying, "There is a broad consensus in the industry that adopting integrated multidisciplinary approaches is a key requirement for implementing efficient, sustainable, and proactive asset management programs" [Halfawy, 2008]. Infrastructure has become increasingly intricate and therefore more segmented in its management. As a result, inefficiencies in the management of infrastructure in local governments are not uncommon.

3.2.1 | Existing Infrastructure Maintenance Methodologies

The asset management task force, created by APWA, created a generalized solution that addresses many problems that municipalities have when considering asset management. In their packet, the APWA Task Force includes multiple tools for local governments to use when attempting to establish an asset management system.

First, APWA's "Asset Management Road Map for Success", depicted in **Figure 7**, provides guiding questions to consider when thinking of asset management. Some of the most important 'stops' on the road map where municipalities should spend time are: "1) What do our

customers value most about our services? 2) Asset Inventory 3) What is [the Asset] worth? and 4) Current Budget & Spending" [APWA, 2018]. It's important to know what citizens will care about and invest in, otherwise they will not "buy into" these ideas and there will not be money to fund asset management. In some cases, it'll be necessary to learn to communicate the importance of maintaining certain assets to the people investing because the full impact of maintaining certain assets may not be apparent (such as underground pipes -- water/sewage maintenance is important!).

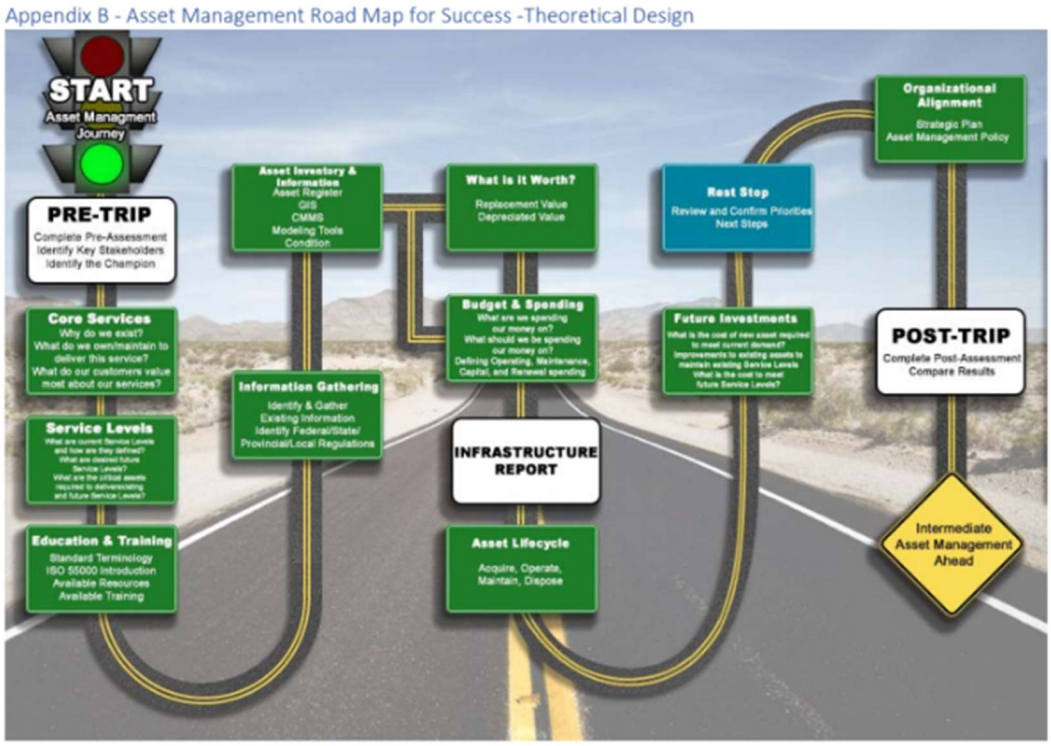


Figure 7: Road Map to Success [APWA, 2018]

Next, an example Agency Infrastructure Report is included for reference. This document stresses the importance of defining assets, determining rating systems for each type of infrastructure and rating them, and then understanding the infrastructure funding. An example rating system is depicted in **Figure 8**. This creates a basis to build upon. Taking these initial steps

in learning the state of current infrastructure assets helps with determining next steps and prioritizing assets.

Infrastructure	Asset	Rating System	Scale
Drinking Water	Pipes	International Water Assn – Infrastructure Leakage Index (ILI)	1-8 scale; Very Bad = >8, Poor = 4-8, Good = 2-4, Excellent = 1-2
Roads	Pavement	Pavement Condition Index (PCI)	0-100 scale; Very Poor = 0-25, Poor = 26-40, Fair = 41-54, Good = 55-70, Very Good = 71-85, Excellent = 86-100
Parks	-	Facility Condition Assessment	Poor = >1.0, Fair = 0.10-0.05, Good = <0.05

Figure 8: Rating Methodology Example [APWA, 2018]

The *Guide to Successful Asset Management System Development* is designed to be beneficial for any sized organization when learning to manage their assets. This is a fairly inclusive guide that contains much direction for creating asset management systems. The entire guide is divided into four main parts, or, as stated in the guide, "The following are the fundamental asset management system components that are recommended for each organization that is charged with managing public infrastructure assets" [APWA, 2018]: Asset Management Policy, Asset Management Objectives, Strategic Asset Management Plan, and Asset Management Plan(s) (depicted in **Figure 9**).

Figure 9: Guide to Asset Management Subcategories [APWA, 2017]

The first step in this development guide is to address policy that is already in place so that the existing goals of the local government are not overlooked but built upon. After determining overarching asset management goals and policy that the local government already has in place (e.g. a principle declaring the local government's focus on sustainability), the next step is to determine asset management objectives. These objectives should be "specific enough to minimize confusion on expectations" and "general enough to apply to all physical infrastructure assets being managed" [APWA, 2018]. Thus, the objectives could cover timeframes of when assets will be added to an asset inventory, what standards of sustainability the newly built assets will be expected to meet, how often assets will be inspected, etc. The next step is to begin a Strategic Asset Management Plan (SAMP) which outlines parameters that need to be met for the implementation of a plan that aren't included in the objectives. The SAMP should include items such as stakeholder needs/expectation, time parameters of certain responsibilities, budgeting, engineering, necessary resources, communication needs, training and certification requirements, etc. The final step in this guide is making one or more asset management plan(s). This should be a specific plan built on all

the considerations in the first three steps. It should be clear that everyone involved knows their role and what needs to happen at the present and in the future. There should be a plan for data collection and for what to do with the data. Some other things that should be considered with building an asset management plan are life cycles of assets, time parameters, establishment of inventory, cost of ownership, quality control procedures, financial impacts of varying maintenance levels of service, prioritization, etc.

As discussed, other countries have asset management approaches such as the Republic of South Africa's DPLG paper on Municipal Infrastructure. This booklet approaches phases in the asset management system from the national level all the way down to the local level. The following is stated in the booklet, "Since the delivery of municipal infrastructure involves all spheres of government and a whole range of sector departments, there is a strong need for both co-operative governance and cross sector collaboration. The principles are designed to ensure an enabling institutional environment for the delivery of municipal infrastructure, which institutionalizes a collaborative approach" [DPLG of Republic of South Africa, 2006]. This encapsulates one of the most important ideas to be gained from South Africa's approach to infrastructure management which focuses on establishing roles for each facet of the government and making sure they integrate the responsibilities with each other.

3.2.2 | Infrastructure Management for Urbanized Areas

Urban areas have high and dense populations. The U.S. Census Bureau defines areas with 50,000 people or more as "urbanized areas" and areas with populations between 2,500 and 50,000 as "urban clusters" [Ratcliffe, Burd, Holder, and Fields, 2016]. In the same document, urban areas are meant to have a population density of at least 1,000 people per square mile (ppsm) with lower density mixed use land areas having between 500 and 1,000 ppsm. This section covers

infrastructure management practices in urban areas. As it is more straightforward to find information on urban cities, rather than counties, this section presents practices of cities.

Infrastructure in areas with high and dense populations is generally subject to more stress than smaller cities. Urban cities typically have an asset management system or asset management practices in place for their infrastructure. Because there is generally more infrastructure, more governmental divisions, a higher budget, and access to more resources in cities with larger populations, there are likely multiple asset management plans already in place. The purpose of this discussion is to examine potential differences that cities of varying sizes encounter when implementing asset management systems.

Large cities like San Antonio, Texas, have created infrastructure management programs (IMPs). The "Adopted Rolling 5 Year Infrastructure Management Program" is broken into categories including the following categories: Drainage, Streets, Sidewalks, Traffic Signal Program, Alley Maintenance, Pavement Markings, Advanced Transportation District (ATD) Improvements, and School Pedestrian Safety [City of San Antonio Department of Transportation & Capital Improvement, 2006].

The drainage maintenance program for San Antonio "addresses debris removal within [their] Natural Creeks and restores the shape of constructed channels to ensure proper water flow" [City of San Antonio Department of Transportation & Capital Improvement, 2006]. They have certain criteria in place for projects to be placed on the drainage maintenance plan.

The city created an interactive map connected to GIS that shows where and when work will be done with respect to the IMP so that the work can easily be navigated. There is an interactive map on the City of San Antonio's website that describes all of the current and future work that will occur as a part of this management plan. The map utilizes GIS data for the city to

create an accurate depiction of work. GIS implementation is an attainable goal that most municipalities should be able to achieve as a part of their plans.

This IMP is very intricate and encapsulates many areas of infrastructure. Asset management plans of this scale are only possible with a large budget.

The city of Denver, Colorado, began the Better Denver program in 2007 in response to the population growth of the city. Denver determined that they "should spend around $25 million more every year to maintain" the new facilities and existing infrastructure [City and County of Denver, 2019]. Denver historically had a problem of deferring major maintenance of assets for up to ten years at a time, which lead to the city struggling to catch up with the funding and maintenance gap. The Infrastructure Priorities Task Force (IPTF) was created in 2006 to address the growing issues and create goals to help direct the changes in Denver infrastructure spending. This is a feasible step for a local government of any size to take. Creating an asset management task force that will develop a plan for the city could be beneficial when attempting to change a city.

3.2.3 | Infrastructure Management for Small Local Governments

As previously mentioned, the U.S. Census Bureau defines areas with populations between 2,500 and 50,000 as "urban clusters" [Ratcliffe, et al., 2016]. Areas that are not encompassed by either the definition for urbanized area or urban cluster are considered to be rural. The National League of Cities (NLC) defines small cities as "one[s] with 50,000 people or less" [National League of Cities (NLC), 2019].

The size of a community has a large effect on what sort of management plans can be implemented. There are advantages and disadvantages to larger and smaller local governments. One important advantage for larger cities or counties is the access to more money. An advantage of smaller communities is that the community goals for their tax dollars are easier to assess.

Because there is a smaller group of people to gather opinions from and communicate with, the process for figuring out priorities for the management and future infrastructure of the city or county can be easier. The NLC makes the point that there is "frequent contact between local officials and the people they serve" [NLC, 2019]. This makes it more straightforward for officials to understand what effects their work has on the community. Smaller (and especially growing) local governments still need to focus on putting infrastructure management programs into place. These entities with less infrastructure to manage often do not prioritize maintaining them. However, these smaller communities can use the advantage of "fewer bureaucratic hurdles" to implement asset management practices more quickly than many larger communities would be capable [NLC, 2019].

Infrastructure management is a problem especially for cities and counties that begin to grow and expand their population. The Mid-America Regional Council (MARC) created a toolkit for small cities based on the growth around Kansas City. This is a smaller and more specific approach than the APWA guide for asset management that focuses on community, neighborhood, street, and site design that addresses more specific localized issues faced by growing small cities around Kansas City [Mid-America Regional Council, 2018]. The issues addressed in this document are often faced by small communities. As a local government grows and develops, the pressure of new infrastructure is in direct conflict with that of existing infrastructure. Therefore, the management plan must consider the existing infrastructure such that it does not become unsafe with neglect and deterioration over time. If existing infrastructure is not maintained well, adding to this infrastructure will only create additional problems. The Environmental Protection Agency (EPA) has resources for growing small cities and towns as well. The EPA tools focus on planning for growth and the economic development of growing small cities (Environmental Protection

Agency, 2019). The tools provided by these organizations do not encompass everything that an asset management plan will cover and may be useful only when implementing an initial asset management plan.

Currently, research on infrastructure management on the smaller scale that include existing adjustments for forming management plans in cities and counties with fewer resources does not exist. The opportunity to create a system that uses the strengths of a small city to create a unique approach to asset management is undiscovered territory. There are studies that have tested infrastructure asset management tools and techniques meant for larger cities on smaller cities to determine how they function (e.g. Smart Cities), but this does not create a valid understanding of small cities and asset management because the research money used to institute these plans is not readily available to local governments of most small towns. It has not been determined whether infrastructure asset management systems should be approached differently by small local governments. Information on this area of asset management is sparse, and research will be beneficial for the future of small cities and counties.

3.3 | Software and Asset Management

There are many software options available on the market in terms of infrastructure and asset management. However, there are not many options that incorporate all types of assets. Many of the existing technologies used in city or county management are not efficient when combined with other technologies. In the article *Municipal information models and federated software architecture for implementing integrated infrastructure management environments*, Mahmoud Halfawy states, “Infrastructure management decision-making typically involves the integration of a multitude of data, processes, and software systems, and requires a collaborative multi-disciplinary approach” [Halfawy, 2008]. This is true for local governments, no matter the size. As

local governments tend to vary in their access to finances, it is difficult to recommend specific technologies. Because there are not many affordable software systems available for managing all assets at once, the prioritized assets must be determined and then a software decision can be made from there.

While discussing the inefficiencies often encountered in government infrastructure management, Halfawy states that software has been created in hopes of simplifying the task of infrastructure management, but instead oftentimes created more fragmentation "by creating information gaps between [the] processes" [Halfawy, 2010]. If a municipality does not have a plan for how the data collected by a software will be used or does not understand all the data collected, inefficiencies can be found. If misinformation about software occurs, multiple software could be used to obtain the same information, or data could be collected and not used which is an inefficient use of funds. Halfawy comments on this by saying that, "Data and process fragmentation can be largely attributed to the use of proprietary data models and formats, which impede software interoperability and the ability to access and exchange infrastructure information" [Halfawy, 2010].

3.3.1 | Costs Associated with Software

According to the public budgets of multiple cities, municipalities in Georgia do not typically budget specifically for technology that will be used by the government. If there are departments, they usually must determine if the cost of a software would benefit the department and consequently the city. For example, the public works budget in Gainesville, Georgia comes from the General Fund [Perry, Hutcherson, & Hamby, 2017]. The public works department of Gainesville decided that it wanted to use more technology in traffic control and traffic studies. They proposed to the city council their plan for implementing cameras in more intersections of

congested areas in town and created a T-SPLOST for this project. Because they didn't directly have the funding available, they had to find a different source of funding for implementing a large new project.

Software is normally priced based on the size of the organization or capacity of information it is expected to gather and analyze. **Figure 10** shows a pricing method for the commonly used road management software called StreetSaver. This particular software pricing is based on the quantity of roads that a municipality is responsible for maintaining.

Tiered pricing for StreetSaver

Centerline Miles	Sections	StreetSaver Pavement Asset	SS+ (excludes Parking Lots)
(whichever is greater)		Annual Cost	
< 20	< 200	$750	$375
21 - 200	201 - 1000	$1,500	$750
201 - 500	1001 - 2000	$2,500	$1,250
501 - 1500	2001 - 5000	$3,500	$1,750
1501 - 3000	5001 - 10k	$5,000	$2,500
3001 - 5500	10k - 18k	$7,000	$3,500
>5501	>18k	Request a Quote	
Consultant	N/A	$2,000 More Information	

Figure 10: Pricing Table for StreetSaver [Metropolitan Transportation Commission, 2019]

3.3.2 | Asset Management Software

There are many options available for cities and counties to use as a part of their asset management system. While software is not the main purpose of an asset management plan, having a system in place will help guide the decision for choosing a software that is beneficial and cost effective for

the municipality. HiperWeb is a work order software program that has prorated payment by the amount of their services used. With a software that manages work orders, it is important that a municipality can use it alongside any other software in place. There are other options such as Cartegraph, another work order program, that could be more cost effective depending on the municipality. Different asset management software often integrates better with other technologies used by governmental agencies. Software like Cartegraph is moldable to the specific necessities of the local government but can be time demanding to implement. While it makes sense for a government with enough techno-savvy employees, this software is not recommended for a local government with a limited quantity of employees. The choice of an asset management software should be driven by efficiency and effectiveness within the specific local government. Otherwise, it could create more hindrances than solutions.

There are asset specific software packages that provide solutions for a certain type of infrastructure. An asset specific software package focuses on a single asset class like roads, bridges, stormwater, etc. StreetSaver is a common asset management software used for road management. This software provides GIS mapping, condition assessments, and more. There are other street specific asset management options including MicroPaver. A trial period is often suggested when implementing new software, so a local government does not feel trapped with a software that does not meet its needs and is costly. Community involvement software packages like SeeClickFix provide an app for citizens to be involved in asset management. **Table 1** presents a few asset management software systems that are commonly used with targeted infrastructure elements incorporated in each. Generally, software which covers additional assets and/or tasks incorporates additional modules which cost extra. Depending on the organization's current and

future plans for use of the software system, a significant amount of information is required to make an educated decision on the software used.

Each software package is unique. The most important thing in the long term for any local government is to find a software that benefits them by increasing productivity, sustainability, and efficiency and reducing expenses in asset management in the long term.

Table 1: Asset Management Software and Associated Assets

Software	Mapping	Work Orders	General AM	Aviation	Bridges	Dams	Drinking Water	Energy	Parks & Rec	Rail	Roads	Solid Waste	Storm-water	Transit	Waste-water	Notes
Hiperweb	•	•	•	•	•		•	•	•		•	•	•	•		Specific software available for specific infrastructure. Pay for what you use.
Cartegraph	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	Not specific to software, but will track every infrastructure asset in one place. Option available to build custom assets.
CityWorks	•	•	•													
AgileAssets	•	•	•										•			
StreetSaver	•										•					Non-pavement assets can be integrated into system.
CityReporter		•							•		•					Facilities, Fire Prevention, Workplace Safety, Timesheets
MuniLogic	•						•				•		•		•	Created for full government use.
MicroPaver	•										•					

3.4 | Qualitative Research and Evaluation

As a part of this study, surveys and interviews provide qualitative information about cities and counties in Georgia and their relationship with asset management. This section focuses on proper ways to collect and analyze qualitative information based on the book *Qualitative Research & Evaluation Methods: Integrating Theory and Practice* [Patton, 2015].

Close-ended questions are considered quantitative data, and open-ended questions are considered qualitative data. There were both quantitative and qualitative data gained from the survey, while the interviews produce qualitative data that is intended for use to understand different sizes of municipalities in Georgia and their use of and thoughts on asset management. Asset management programs are not standardized enough for them to be rated on a specific scale and

measured exclusively quantitatively. Therefore, qualitative data was gained from open-ended questions on the survey, interviews, and finally the observations of the city as the asset management program is implemented.

There is a specific approach to evaluating the implementation of programs. Program evaluation is defined in the text as the "systematic collection of information about the activities, characteristics, and outcomes of programs to make judgments about the program, improve program effectiveness, and/or inform decisions about future programming" [Patton, 2015]. As this study is mainly focused on implementing asset management programs in local governments, specific qualitative data is useful when evaluating if this process helps a city or county with obtaining the goals it wants to reach.

Although the qualitative information gained from the surveys and interviews may not apply to a large majority of the population of Georgia cities and counties, the information can "produce a wealth of detailed information about a much smaller number of people and cases" [Patton, 2015]. The design strategy that was used for this study was purposeful sampling because choosing selective cases provides richer information for a larger variety of local governments. Purposeful sampling was important in this research because the city or county must be willing and able to put an asset management plan in place. Patton (2015) discusses that it is typical to focus on small samples (even as small as one) for the purpose of qualitative studies such that the full depth of a program can be understood. The situation analyzed was considered a dynamic system, and the data was collected with this in mind. Because the system is dynamic, attention to process is required while assuming that change is ongoing within the focus area.

There was both quantitative as well as qualitative knowledge gained from the survey that was needed for the analysis of Georgia asset management. The quantitative data retrieved from the

survey focused on a larger sample, so that the data is more generalizable. The quantitative data consisted of categorical or numerical data whereas the qualitative data consists of "quotations, observations, and excerpts from documents" [Patton, 2015], as required in the textbook.

A process of program evaluation as opposed to quality assurance was used to assess the implementation of an asset management program in a city. These two qualitative evaluation processes are closely related with some of the significant differences being that program evaluation was focused more on program processes and outcomes with goals-based judgement because the information was intended for decision makers, while quality assurance was focused more on individual processes and outcomes with professional-based judgement because the information was intended for clinical staff [Patton, 2015]. One of the influential first steps of evaluating a program is evaluating its implementation. If a program cannot be fully implemented within an organization, the program itself cannot be evaluated or creates false results when evaluated. Patton (2015) states, "It is important to know the extent to which a program is effective after it is fully implemented, but to answer that question it is important to learn the extent to which the program was actually implemented." As there are guidelines provided by the APWA, the program implementation was determined by evaluating the level of progress based on the guidelines set, answering questions like the following: Are the goals of the community stated clearly? Is an infrastructure inventory in place? Is infrastructure rated? Is there an action plan? These sort of questions that help with evaluating the implementation of an asset management program will lead to understanding the development of a program and what differs from the original plan of implementation. Patton states the following in the qualitative research textbook:

> "If a process of ongoing adaptation to local conditions characterizes program implementation, then the methods used to study implementation should correspondingly

be open-ended, discovery oriented, and capable of describing developmental processes and program changes. Qualitative methods are ideally suited to the task of describing such program implementation." [Patton, 2015]

This indicates that qualitative methods are relevant for this study as asset management plans are not meant to be implemented the same way in every local government.

3.5 | Transportation Asset Management Study

A similar study was conducted by Mildner (2018) for the state of Georgia. This study analyzed transportation asset management in the state of Georgia. The main goal of this study was to "identify knowledge and resource gaps relating to transportation asset management" based on literature concerning transportation asset management practices at the federal, state, and local levels and a survey sent to city representatives in Georgia about transportation management (Mildner, 2018).

Mildner focused on the transportation management section of asset management, discussing a lack of resources and guidance which are both needed for appropriate management of transportation infrastructure. Mildner's category of interest are local governments in Georgia.

Mildner discusses asset management in general, as well as the Federal Highway Administration's (FHWA) transportation asset management framework. The framework that Mildner presents is similar to the APWA *Guide to Successful Asset Management System Development*. The transportation asset management flow chart includes the following items: Goals and Policies (Reflect Customer Input), Asset Inventory, Condition Assessment and Performance Modeling, Alternatives Evaluation and Program Optimization, Short- and Long-Range Plans (Project Selection), Program Implementation, Performance Monitoring (Feedback), and Budget/Allocations (Mildner, 2018). These items can relate to the APWA sections: Asset

Management Policy, Asset Management Objectives, Strategic Asset Management Plan, and Asset Management Plan. Both plans involve defining policy to guide decision making, creating inventories, rating infrastructure's existing conditions, specifying tangible performance measures like objectives, and then both frameworks establish a specific plan from there. One large difference in these guides is the step in the FHWA's guide to take available budget and select projects for short- and long-term plans.

An inventory is an important aspect of both plans. Mildner states that, "An effective inventory includes infrastructure assets by type, condition, location, function, and value" (Mildner, 2018). For smaller communities, transportation assets could be inventoried with their other assets because it may not make sense for all asset management to be broken into sections. This may just be a separate part of the same document for some local governments rather than a separate division.

Mildner states that transportation asset management documents are typically directed toward state agencies and there are not many resources specifically for local governments. This is a similar phenomenon to that with infrastructure asset management in general. Mildner discusses the fact that Georgia's population and demand for better infrastructure is growing, which is an important factor in the necessity of these types of programs being implemented at the local level.

A survey was distributed to counties and cities in Georgia for this study. The survey was distributed to all counties in Georgia with the assistance of GDOT (Mildner, 2018). Out of the cities and counties in Georgia, 56 cities and counties received and began the survey. 40 survey responses were used in the analysis (23 from counties and 17 from cities). The survey that Mildner sent out consisted of 35 questions, thus making complete responses less likely. According to multiple suggested approaches for surveying, surveys should be short and simple in order to collect more complete responses from a variety of respondents. Of the 56 responses Mildner obtained,

only 60% of respondents answered the last question (in other words, 60% completed the survey). This indicates that many of the responses were not complete and any inferences from this survey may be invalid because of the response rate. From the data that Mildner collected, generalizations were made about the size of local governments and that effect on their transportation asset management programs are potentially invalid because of the response rate. Mildner's study was used as a reference for the survey created in this study.

3.6 | Castle Rock - A City with a Plan

Castle Rock, Colorado, is home to Dan Sailer who is the chair of the Small Cities and Rural Communities (SC/RC) committee for APWA. He was a member of the task force that created the APWA guide for asset management. With his help, the city of Castle Rock developed a Strategic Asset Management Plan (SAMP) based off of the guide that the APWA created. This section of the literature review discusses the specifics of the guide that the city of Castle Rock created. Castle Rock developed the plan referencing documents already in use by the city as well as financial policies in place as guidance. The SAMP was then used as direction for the implementation of individual asset management plans. **Figure 11** shows the influences that existing documents have on the SAMP and the influence that the SAMP has on future decisions.

As part of the SAMP overview, the public works department states that they have a desire to "unify the formal activities of the Department associated with asset management" [Castle Rock, 2018]. The Public Works Department of Castle Rock defined the budgets that they must work with as constraints to their plan. Because asset management is concerned with maximizing the value obtained from assets in the most efficient and effective way possible under the constraints of the municipality, it is important to have a definition of what is considered to be value gained from an asset. The Castle Rock Public Works Department defined what value means for all assets and for

specific assets (Castle Rock, 2018). This is not an area specifically outlined in the *Guide to Successful Asset Management System Development*, but it is good to be able to communicate what value is being maximized for the stakeholders involved. This was the first step that Castle Rock took prior to defining policy principles and objectives as is the first instruction in the APWA guide.

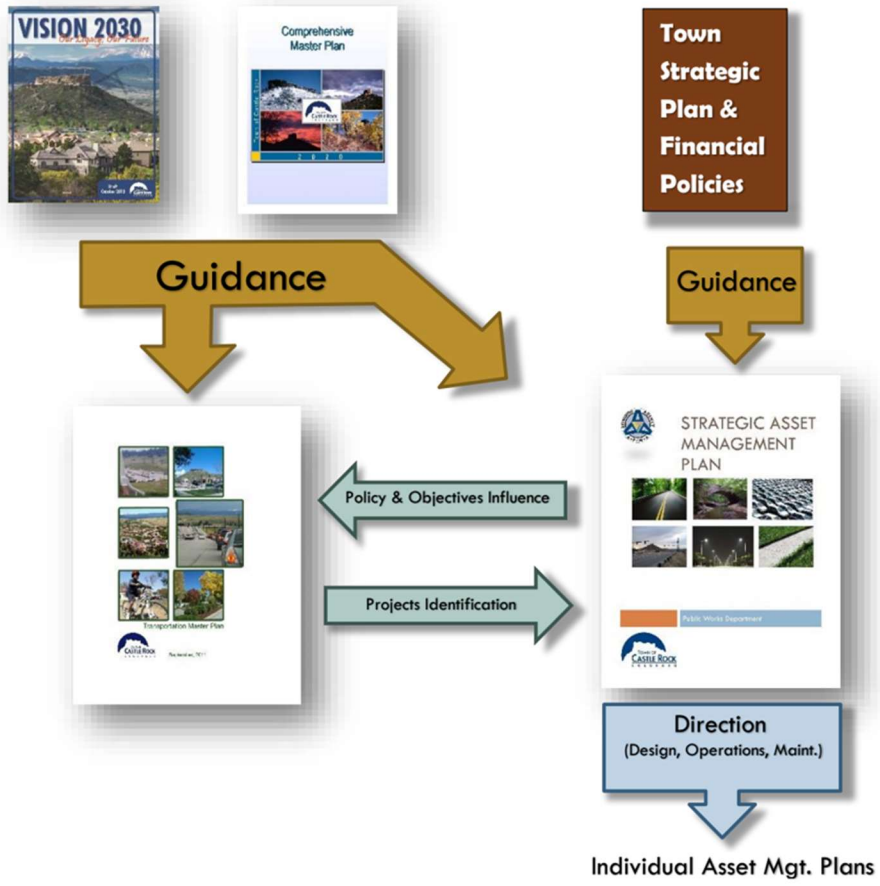


Figure 11: Relationships of Influence for SAMP [Castle Rock, 2018]

In the 'Department Policy Principles & Objectives' section, the principles and objectives are broken into categories including general, design phase, construction phase, inventory, condition rating, operations and maintenance, and reconstruction/replacement. The policies are overarching for the area where applicable. An example of a policy principle in the general category is: "Individual Asset Management Plans (AMP) will be established for each physical asset class that provide comprehensive direction as to how each asset class is to be efficiently managed in

alignment with this SAMP" [Castle Rock, 2018]. An objective that aligns with this policy principle is as follows: "Individual AMPs will include quantitative Levels of Service (LOS)" [Castle Rock, 2018]. It is important for policies and objectives to align.

Once all necessary policies and objectives for the city of Castle Rock were determined, an action plan was created. This action plan includes specific activities and target dates for activities to be completed. The actions can be connected to the policies and objectives defined earlier in the SAMP. This connection is an important aspect of strategic asset management plans as the main purpose is creating actions from goals.

Castle Rock published a transportation infrastructure report card. This is useful for explaining the importance of the transportation infrastructure and why funding needs to go to certain areas over others. The Castle Rock *2018 Transportation Infrastructure Report Card - Nutshell* (**Figure 12**) which is an overview of the transportation infrastructure report card is pictured below. The transportation system is broken into four main "asset classes" which are each given a rating out of 5 stars and a risk rating associated with maintaining the current service levels. There is also an overall rating and risk rating for all the transportation infrastructure.

In the full report card, the explanations of the cumulative rating and each asset class rating are given. The executive summary of the report card assigns value applicable to each asset class. Value associated with all transportation infrastructure assets as defined by the Castle Rock Public Works Department are as follows:

- "Lowest total lifecycle cost (total cost)
- Reliability
- Low downtime
- High safety value

- Low environmental impacts" [City of Castle Rock Public Works Department, 2018]

There are more specific values assigned to each asset class. This is a common suggestion within asset management plan guides because well-defined value is necessary to guide the management toward maximizing value.

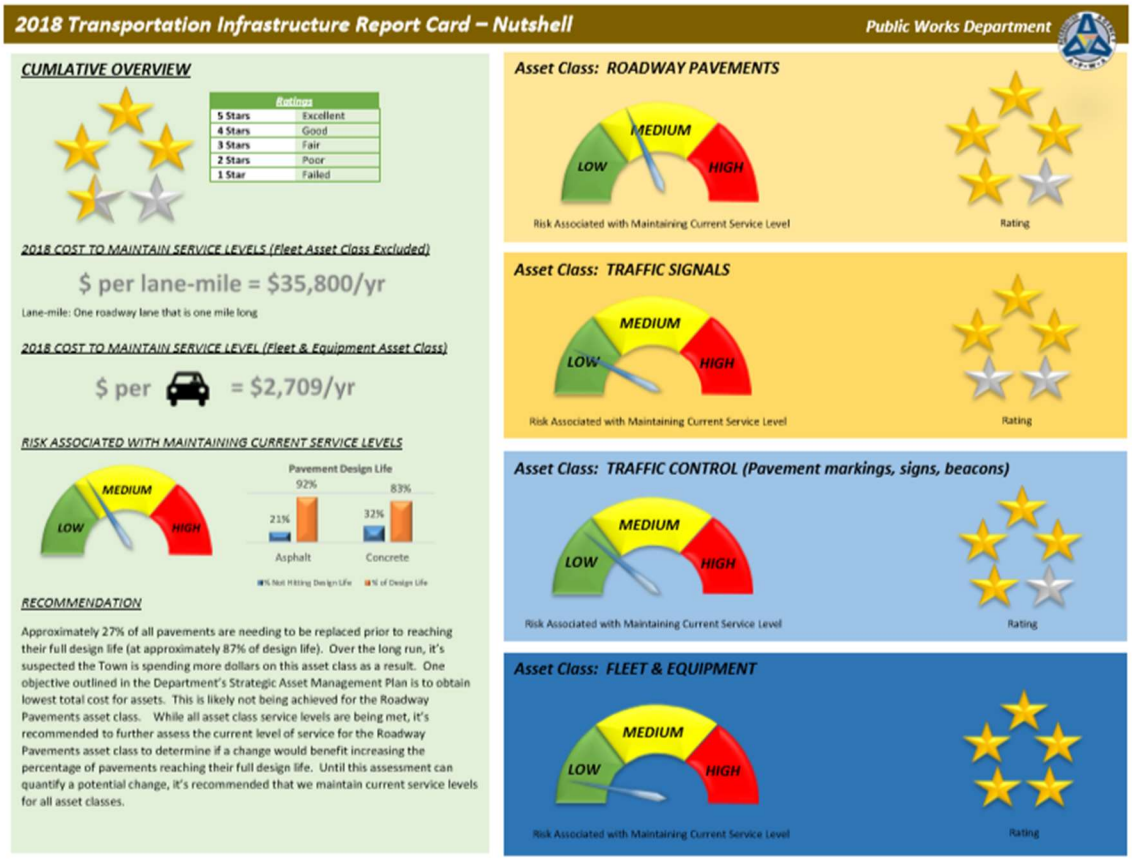


Figure 12: Castle Rock 2018 Transportation Infrastructure Report Card - Nutshell [City of Castle Rock Public Works Department, 2018]

Each asset class was then given a weight depicted in the chart in **Figure 13**. The purpose of this weight was to create a balanced rating that was appropriately influenced by the importance of each asset class. Higher weighted asset classes have a higher effect on the safety of the community and costs associated with their failure. The asset class weight is applied to the asset class rating to determine the score in relation to the other assets.

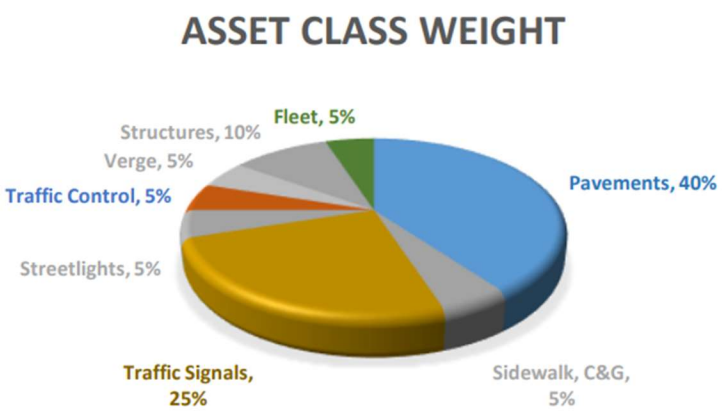


Figure 13: City of Castle Rock Asset Class Weight Chart [City of Castle Rock Public Works Department, 2018]

The rating for each asset class was determined in different ways. Road ratings translate the Pavement Conditions Index rating grade to a star grade. The grade scale is shown in **Figure 14**. The translation of all rating systems to a single rating is necessary when final ratings are meant to be shared with the community. It is important to make communication as simple as possible when providing an overview of the asset conditions.

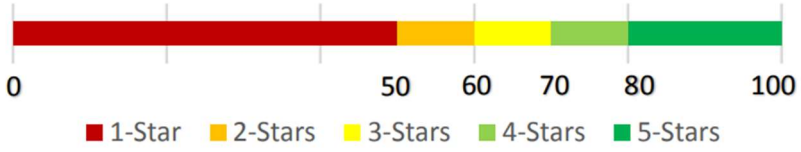


Figure 14: City of Castle Rock Road Grading Scale [City of Castle Rock Public Works Department, 2018]

4.0 | PROBLEM STATEMENT

This section is dedicated to analyzing the purpose of this study and the desired outcomes. It gives a general direction and significance for this research.

4.1 | Research Objectives

The main objective of this study was to determine effective approaches to the development of asset management programs for small scale local governments and decide whether a more specific plan or supplementary direction is necessary for these entities. An additional framework will be recommended if it is thought to be useful.

This research involved assessing how large local governments differ from small local governments in their current relationship to asset management and the development and implementation of asset management plans. The differences between these types of governments and their knowledge of and relationship to asset management is investigated using both surveys and interviews. A survey is sent to local government representatives that contains questions related to asset management to determine a tentative estimate of the proportion of cities and counties that already have asset management plans, the proportion of cities and counties that have funding available for asset management, and other related questions that were used in this study.

A valuable takeaway is the information gained from developing an asset management system utilizing a general guide in a small local government in Georgia. This began by looking at the APWA *Guide to Successful Asset Management System Development*, which helps determine the qualifications a local government should possess to be chosen for the implementation of an asset management plan. Once the local government was determined, an asset management system based on the APWA *Guide to Successful Asset Management System Development* was initiated. The program implementation and program itself was evaluated to determine if it was or will be

successful in the future for maintaining infrastructure for the selected local government. If determined to be necessary or useful, supplementary resources for small local governments were created to suggest for use with the APWA guide.

4.2 | Research Significance

The degradation of infrastructure comes at a cost to citizens. It is expected that the current state of infrastructure in the United States as a whole costs each family approximately $9 a day, that's $3,400 a year [Economic Development Research Group, 2016]. This indicates that infrastructure in distress is a cost to the community it affects. Steps to improve the management of infrastructure have positive effects on the community as a whole. This is true for communities on smaller levels of government as well.

Asset management is an important topic in local governments. The sustainability of a significant portion of the nation's infrastructure depends on the ability of local governments to maintain and plan infrastructure efficiently. There is currently a large gap in the condition of infrastructure and the standard that infrastructure should meet. This is true for the nation as a whole and thus true for most local governments. Local governments tend to allow infrastructure to degrade to a dangerous level before replacing or repairing it.

This research provides insight into the current state and awareness of asset management systems in Georgia's local governments. The implementation of an asset management plan in a small city is observed and analyzed to test if the American Public Works Association's guide for implementing asset management systems works for a small local government. This establishes further research on the development of asset management plans in different sized cities to determine whether there should be supplemental information or different guides for different sized cities.

5.0 | RESEARCH METHODOLOGY

Prior to collecting information, it was determined that data collection from cities was the least complicated in the case of Georgia. The information for cities in Georgia was more clearly separable from the surrounding effects and influences of other local governments and the state government. They can be classified in terms of population and population density in a more straightforward manner as they cover less area.

Georgia cities were split into three size categories based on population: small (less than 20,000 people), mid-sized (between 20,001 and 75,000), and large (75,001 or more). These city sizes were determined based on Georgia city populations. Variation may be attributed within the size categories (especially small) as there is no population requirement for a town to become incorporated. 486 of the 535 incorporated municipalities in Georgia are designated as small using the definition in this study. Of those 486 small municipalities, 324 have populations of 2,500 or less. Rural cities are likely underrepresented in this study. As mentioned in section **3.2**, the US Census Bureau defines urban areas as areas with more than 50,000 people and population densities of 1,000 ppsm or 500 ppsm where there is mixed use land [Ratcliffe, et al., 2016]. Because four of the ten largest municipalities in Georgia are consolidated city-county governments, the population densities of these areas did not always reflect the 1,000 ppsm rule. Thus, the population was considered when determining the size in relation to other local governments in Georgia.

Tables 2-8 list the populations and most recent general fund budgets of cities in each size category. General funds typically contain the budgets for the day-to-day operational costs of the city in question for the year. **Tables 2**, **3**, **5**, and **7** provide populations and general funds for the top and bottom five cities by population in each category. **Tables 4**, **6**, and **8** provide populations and general funds for ten randomly selected (using a random number generator) cities in each size

category. Data for the general funds of small and rural cities is not as easily accessible as larger cities and, in some cases, could not be located. The size categories are the same as defined earlier in this study with the addition of the rural category for municipalities that have fewer than 2,500 residents because it is expected that not many cities this small are represented in the survey results. The cities were originally broken into categories using the populations of Georgia cities. The large cities, listed in Table 2, were defined as 75,000 or more because of the 10,000-person gap in populations between the tenth and eleventh largest cities in Georgia. Reasons for cutting the category at 75,000 are as follows: Atlanta is a major metropolitan area; four of the top ten municipalities are consolidated city-county governments; five of the top ten cities can largely attribute their size to Atlanta's growth. These criteria effectively remove a portion of the cities in Georgia that are expected to have more funding and resources than the average Georgia cities.

Table 2: Ten Cities in the Large Size Category

City	Population	General Fund ($)
Atlanta	486,290	661,300,000
Augusta-Richmond	197,166	162,054,620
Columbus-Muscogee	194,058	150,604,260
Macon-Bibb	152,862	149,472,000
Savannah	146,444	199,943,286
Athens-Clarke	125,691	134,294,822
Sandy Springs	106,739	95,959,885
Roswell	94,786	13,106,724
Johns Creek	84,350	63,183,891
South Fulton	83,205	65,080,926
Averages	**167,159**	**169,500,041**

Table 3: Five Largest and Smallest Cities in Mid-Sized Category

City	Population	General Fund ($)
Warner Robins	74,854	43,950,167
Albany	73,175	61,378,703
Alpharetta	65,799	72,588,199
Marietta	61,048	59,738,151
Smyrna	56,685	51,537,655
Sugar Hill	23,180	11,583,070
Griffin	22,770	11,813,287
Acworth	22,698	14,677,638
Union City	21,370	29,290,801
Cartersville	20,978	44,363,130
Averages	**44,255**	**34,938,314**

Table 4: Ten Random Cities in Mid-Sized Category

City	Population	General Fund ($)
Warner Robins	74,854	43,950,167
Valdosta	56,085	38,380,000
Acworth	22,698	14,677,638
Brookhaven	53,518	36,503,529
Union City	21,370	29,290,801
Stonecrest	54,471	18,346,800
Hinesville	33,140	19,987,205
Tucker	36,130	10,492,875
Sugar Hill	23,180	11,583,070
Douglasville	33,675	30,748,299
Averages	**40,912**	**25,396,038**

Table 5: Five Largest and Smallest Cities in the Small Size Category

City	Population	General Fund ($)
Forest Park	19,823	22,217,739
Snellville	19,738	13,426,874
Suwanee	19,549	13,366,910
Milledgeville	18,575	13,868,442
Thomasville	18,515	17,172,575
Thunderbolt	2,660	2,806,600
Reidsville	2,660	
Pembroke	2,569	
Royston	2,569	2,397,122
Donalsonville	2,551	6,246,919
Averages	**10,921**	**11,437,898**

Table 6: Ten Random Cities in the Small Size Category

City	Population	General Fund ($)
Blackshear	3,516	
Alamo	3,370	
Cordele	10,726	
Montezuma	3,078	2,084,427
Cleveland	3,896	3,385,581
Morrow	7,473	
Camilla	5,030	7,901,400
Fitzgerald	8,721	
Unadilla	3,532	
Stone Mountain	6,368	4,186,359
Averages	**5,571**	

Table 7: Five Largest and Smallest Cities in the Rural Size Category

City	Population
Sylvania	2,452
Homerville	2,400
Georgetown-Quitmar	2,358
East Dublin	2,355
Mount Vernon	2,258
Tarrytown	85
Gay	83
Talking Rock	69
Rest Haven	66
Edge Hill	24
Average	**1,215**

Table 8: Ten Random Cities in the Rural Size Category

City	Population
Dillard	369
Blairsville	611
Warwick	397
Waleska	890
Toomsboro	431
Meigs	1,032
Davidsboro	1,732
Edge Hill	24
Patterson	747
Ray City	1,068
Average	**7,301**

Upon completing a survey, it was determined that further breakdown of counties categorized by population and a definition specific to county sizes was needed because the city definition had not been confirmed to apply well to counties. As mentioned above, there are 324 cities that can be defined as rural cities by population in Georgia, which are defined by the United States Census Bureau as "all population, housing, and territory not included within an urbanized area or urban cluster" [Ratcliffe, et al., 2016]. This is important because the cities in Georgia with less than 2,500 people are much less likely to have representatives in APWA because of the associated membership costs and are therefore less likely to have organized asset management plans in place. Counties generally cover more land area and have higher populations than cities. Because county populations are concentrated in some areas and sparse in others, there tends to be a lot more variation with defining counties as rural or urban. Following the reception of responses from the survey, different county categories were created based on population density. Counties in Georgia were defined as rural if the population density was less than 50 ppsm. They were defined as small if the population density was between 50 and 500 ppsm. They were defined as somewhat urban if the population density was between 500 and 1,000 ppsm. Finally, counties were defined as urban if the population density was greater than 1,000 ppsm. Based on these definitions, there are 66 counties that are considered rural, 77 counties that are considered small, 11 counties that are considered somewhat urban, and 5 counties that are considered urban.

Further research on asset management in counties is recommended following this study. It is recommended for other states to compare their population areas and city and county sizes by population and population density to definitions given by the US Census Bureau. It is important to note that other states likely have population limits for cities to become incorporated.

The basic steps to this methodology of research included first interviewing representatives from each of the size categories from cities to gain insight concerning their in-depth relationships with asset management. Then a survey was distributed to representatives of cities throughout the state which was used to collect a more general view of Georgia local governments and their relationships with asset management. Following this survey, a few local governments were identified as potential partners for implementing an asset management plan for program evaluation. Site visits were conducted with each of the potential cities, and a decision was made about which city to perform a case study in which an asset management plan was created for the road system using the APWA guidelines.

Following all the data collection, the information was analyzed using multiple methods. The analysis methods are primarily based on the type of data collected and the specific research questions relating to the data. The statistical software JMP 14.0 was used to analyze the quantitative data collected from the survey and resources such as the Georgia Department of Transportation. Qualitative methods of analysis were used when investigating qualitative data. Based on the information gained, it was determined whether small local governments can successfully use the APWA *Guide to Successful Asset Management System Development*. If small local governments were determined to require further resources, recommendations were provided. The following subsections review the methodology of the research areas in more detail.

5.1 | Interviews

Interviews were conducted with four individuals with various experiences in public works and asset management. The interviews were conducted to obtain a better understanding of the question types to ask in a survey sent to many different city representatives. These interview processes

helped with developing an in depth understanding of specific differences between cities of various sizes and their resources and services.

Interviews with three local government public works employees from cities in Georgia of different sizes were conducted in order to understand current asset management processes in Georgia as it relates to size categories of cities. These interviews provided both insight into specifics of what cities in Georgia manage on a day-to-day basis and information to base later investigations on a broader scale in surveys to Georgia cities as well. The three interviews were performed for each designated size of local government defined in this study: Small, Mid-sized, and Large. Some of the data that was gleaned from interviews include the most important aspects of asset management in their experience, problems faced, software used, etc.

The selection of people to interview came from connections within APWA and the Carl Vinson Institute of Government (CVIOG), who provided funding for this project. Each Georgia city representative worked in public works. The fourth interview, with Dan Sailer, was originally conducted to understand his perspective on small cities and asset management because of his position with the APWA Small Cities/Rural Communities (SC/RC) committee. However, he was also the assistant public works director in Castle Rock, Colorado, which has successfully implemented an asset management program, so the process of this as well as a small city perspective were discussed.

The interviews with the large and mid-sized representatives were conducted in person, and the interviews with the small representative and Dan Sailer were over the phone. All the interviews were recorded with consent of the interviewee except for the small local government interview where the recording device did not function correctly. Each interview began with a basic introduction of this study's research in the area of infrastructure asset management and local

governments, then the interviewee was free to discuss their thoughts and experiences with related topics within their city or area of expertise. Guiding questions were posed throughout each interview primarily to encourage the interviewee to cover areas of management, funding, construction, community involvement, prioritization, etc. as they related to infrastructure.

5.1.1 | Small Local Government Interview

Jason Spencer, Public Works Director in Oakwood, Georgia (population 4,148), was interviewed for a small city perspective. The city of Oakwood is in Hall County, Georgia, and has a residential population of 4,148 and a daytime population of approximately 30,000. Oakwood straddles I-985 in Georgia and is 48 miles from Atlanta. It is home to Lanier Technical College and a campus of the University of North Georgia. With the proximity to the interstate, Oakwood attracts a significant amount of industry because trucks are easily routed through the city. These factors influence the significant increase in daily transient population. The information obtained through this interview are presented in section **6.1.1**.

5.1.2 | Mid-Sized Local Government Interview

Chris Rotalsky, Director of Public Works for Gainesville, Georgia (population 40,359), was interviewed for a mid-sized city perspective. The city of Gainesville is the county seat of Hall County, Georgia, and is approximately 50 miles northeast of Atlanta. Five major state routes pass through Gainesville as well as U.S. Route 129. Gainesville is a business hub for northeast Georgia and has a residential population of 40,359. Gainesville is widely known as the "Poultry Capital of the World." It is home to a significant portion of the Northeast Georgia Health System, as well as a Kubota plant. These and other industries provide employment to a large amount of the residents of Gainesville. In addition, economic growth and development is promoted in this city that is

considered part of metropolitan Atlanta. The information obtained through this interview are presented in section **6.1.2**.

5.1.3 | Large Local Government Interview

Drew Raessler, Director of Transportation and Public Works in Athens-Clarke County (ACC), which has a population of 125,691, was interviewed for a large city perspective. ACC is one of the smallest counties area-wise in the state of Georgia. ACC is a unified government and all projects in the city of Athens and Clarke County have been combined since 1990. The unified government is approximately 60 miles northeast of Atlanta, Georgia. ACC is home to the University of Georgia (UGA), a public university with 29,680 undergraduate students and 9,041 graduate students totaling 38,652. A significant amount of resources and economic development is produced and sustained by the amount of college students in and around ACC. The university's main campus covers 767 acres in ACC. As a land-grant institution, UGA receives tax exemptions in areas that could significantly benefit the ACC unified government. Athens-Clarke has a residential population of 125,691. The median age is estimated by ACC to be 26.2 years old, which is likely skewed by the presence of college aged (18-23) students. It is estimated by WelfareInfo.org that 34.4% of individual residents are impoverished. This is more than twice the poverty rate of 16.9% in Georgia. Athens has the 19th highest population of all 159 counties in Georgia and the 5th highest population of all 535 cities in Georgia. The information obtained through this interview are presented in section **6.1.3**.

5.1.4 | Small Cities and Rural Communities Interview

The last interviewee was Dan Sailer, Assistant Director of Public Works for Castle Rock, Colorado and Chair of APWA's Small Cities and Rural Communities (SC/RC) Committee. Sailer was interviewed for his knowledge from the SC/RC committee through APWA as well as his

experience establishing a strategic asset management plan in the rapidly growing city of Castle Rock.

The city of Castle Rock is the county seat of Douglas County and is a suburb of Denver. It is located approximately halfway between Denver and Colorado Springs. Many young professionals and other residents commute to jobs in the Denver metro area (approximately 30 miles north) or Colorado Springs (approximately 20 miles south). Castle Rock has an estimated residential population of 62,276, which is over triple the population in the year 2000 [U.S. Census Bureau, 2017]. Because of its location there is a lot of growth and economic development in the area.

The Small Cities and Rural Communities Committee's purpose is to support public works professionals working in communities with fewer than 100,000 residents. They basically provide resources for small communities and promote awareness of the challenges these communities face. Though the communities supported by this committee include a larger range of populations than the focus of this study, the defined small local governments in this study fit into the SC/RC definition. The information obtained through this interview are presented in section **6.1.4**.

5.1.5 | Qualitative Analysis of Interviews

The interviews are important for understanding in depth differences between local governments in regard to asset management. No local governments manage their assets in exactly the same way, even if two local governments are of similar type and size. Obtaining first-hand knowledge about asset management in local governments (specifically cities) is a beneficial aspect of the interviews as they provide information about real world experience. As mentioned in the literature review, qualitative information is an important part of researching the implementation of an asset management system because it is continuous and growing and depends on people in many

government agencies. Knowledge gained from experienced individuals is an informative resource in the asset management field. Experiential information is extremely useful when there are a multitude of moving parts affecting outcomes. This information is valuable for determining any modifications or additions to the APWA guide.

Qualitative analysis can be a complicated task for researchers who are accustomed to analyzing qualitative information. Though not as straightforward to analyze, qualitative information is beneficial and necessary when results are not quantifiable. Asset management plans are meant to enhance efficiency and productivity, which are measurable results, though difficult to quantify. However, one purpose of this study is determining a manageable way for small local governments to implement asset management plans. The results of this question are more subjective in nature.

Each interview completed for this study was analyzed for information that can be connected to asset management in small local governments and how they differ from larger local governments. As the interviews were all recorded or notes taken during them, the transcripts of each were reviewed for this information. Similar topics were covered in each interview and are compared. The knowledge gained from interviewees' experiences over their careers working with local governments is used. This analysis and information are presented in section **6.1.5**.

5.2 | Survey

A survey was sent to local government representatives in Georgia to create a more inclusive and comprehensive observation of how local governments are managing their assets. The questions in this survey were meant to provide information that informs decision-making about asset management in Georgia. The creation, distribution, and evaluation of the survey and its responses are discussed in this section.

The local governments that the survey was distributed to were broken into size categories based on population guidelines stated at the beginning of this section. The survey link was shared with 615 representatives of 92 cities and 41 counties in Georgia. This was not representative of the whole state which contains 535 incorporated municipalities and 159 counties. As discussed in the beginning of this chapter, the number of rural cities in Georgia are likely underrepresented. Additionally, the county responses from the survey are assumed to introduce a slight skew in the data. Because the responses were kept anonymous, the specific distribution of responses from cities and counties cannot be determined.

Recognized bias in the survey was potentially introduced from multiple representatives from the same local government providing responses. To adjust for this, responses were examined to determine if any two complete survey responses were similar in both open- and close-ended questions. If two survey responses were similar and from the same IP address, one response was discarded. If the responses were similar, but determined to have significant differences, both responses were retained for analysis. Additionally, the survey results included voluntary responses from members of the APWA Georgia Chapter. These responses primarily came from persons employed by cities or counties who are members of the APWA and are potentially more likely to be actively working on bettering their infrastructure because they are a part of an organization that emphasizes this topic.

A copy of the survey is included in **Appendix A**. The survey consists of 14 questions concerning information about the respondent's city or county and information about asset management. The survey categorizes the responses based on one of the three size categories; Small (20,000 or less), Mid-Sized (20,001-75,000), and Large (75,001 or more). A significant amount of the analysis relies on the size of the local governments. All the population densities and populations

of counties in Georgia were reviewed and the quantity of counties that fall into each category are presented in **Table 9**. As stated, the survey was sent to local government representatives from Georgia including 41 counties. Some of the responses from counties could be placed in population categories that don't reflect their population densities. In the survey, counties have the potential to be placed in a higher population category than population density category. This was determined to be acceptable as most counties, even ones with low populations and population densities, have more infrastructure to maintain than cities with limited resources.

Table 9: Counts of Counties by Population and Population Density

		Population Density Categories (People Per Square Mile)			
		Rural (<50 ppsm)	Small (50-500 ppsm)	SW Urban (500-1000 ppsm)	Urban (>1000 ppsm)
Population Categories	Rural (<2,500)	2			
	Small (2,500-20,000)	54	14		
	Mid (20,000-75,000)	10	49		
	Large (>75000)		14	11	5

In an effort to gain information from more local governments in Georgia than Mildner's "MCRP Option Paper" (discussed in section **3.5**), a more concise survey was created and distributed to more local government representatives. The responses were kept anonymous to allow for an even greater response rate. This could potentially create issues because if multiple responses came from the same local governments, it is more difficult to rule them out. The process for taking out answers thought to be from the same local government is explained above. Because of the anonymity, information cannot be directly tied to cities or counties which would be useful for further research, but non-anonymous responses would have worked against the current goals of the study.

The survey responses were analyzed using common statistical methods. The quantitative analyzation methods were performed using JMP 14.0. This is an observational study because facts were gained about current practices and awareness of a certain group of local governments without making the participants undergo any treatment. The responses were not random because there was no control over which cities or counties answered, and the survey was sent to a large portion of the population of local governments in Georgia. Since it was more likely that local government representatives who are more involved in asset management plans would give more complete responses, some local governments were less likely to be represented in the survey.

The first question with quantitative responses provided the first variable for the study: the size of the local government, which, as stated earlier, was a categorized set of population ranges. The other quantitative (categorical or numerical) variables considered for this analysis were the answers to questions two (number of employees in public works), three (selection of services), four (asset management plan(s) or not), six (funds for asset management or not), seven (awareness of funds), eight (inventory or not), ten (lane miles of road), eleven (outsource for road rating), and twelve (asset management software or not). There were multiple hypotheses tested using the survey:

1. There would not be a relationship between the local government size and the completion of the survey.
2. There would be a relationship between the local government size and whether there is an asset management plan in place.
3. There would be a relationship between local government size and whether there is an asset inventory.

4. Larger cities or counties are more likely to have an asset management plan and inventory in place.
5. Larger cities or counties have more employees in their public works departments.
6. Cities and counties that are responsible for maintaining more road mileage are more likely to have asset management plans.
7. Local governments of different sizes are responsible for different quantities of road miles.

5.2.1 | JMP Analysis of Quantitative Survey Results

The conditions and figures for each statistical test are outlined in **Appendix B.**

In order to determine if the data collected was equally representative of local governments in Georgia a Chi-squared test was completed to determine if there was a relationship between local government size and the completion of the survey. Local government size and a 60% survey completion (meaning respondent answered 60% or more of questions) are both categorical variables, therefore, a Chi-squared test would be appropriate. The null hypothesis being tested is that there was no relationship between local government size and the completion of the survey.

A Chi-squared test was conducted to determine if there is a relationship between the local government size and if there is an asset management plan in place. Local government size and whether there is an asset management plan are both categorical variables; therefore, a Chi-squared test would be appropriate. The null hypothesis being tested is that there is no relationship between local government size and if there is an asset management plan in place.

It was important to verify that there was a significant difference between the average number of employees for each local government size. Local government size is a categorical variable while the number of employees is a quantitative variable, therefore, a one-way ANOVA was appropriate. If the p-value was indicative of significance, the null hypothesis was rejected,

and a Tukey Test was performed in order to determine which groups were different from one another. In summation, the ANOVA test was used to determine whether there is a significant difference in the average number of employees in any of the city size categories, and the Tukey Test was used to illustrate how they differ if the ANOVA was positive. It was expected that there is a relationship between the two variables as they are likely dependent on each other.

A two-sample t-test for the road mileage in cities with and without asset management plans was performed to determine if cities that are responsible for more road mileage are more likely to have an asset management plan in place. It was expected that cities with more road mileage are more likely to have an asset management plan in place because of the challenges that are faced with more infrastructure.

It was important to determine if there is a significant difference between different city sizes and the mean road mileage. City size is a categorical variable while the road mileage is a quantitative variable, therefore, a one-way ANOVA was appropriate. If the p-value is low, the null hypothesis was rejected, and a Tukey Test was performed in order to determine which groups are different from one another. It was expected that the larger cities will have more road mileage on average to maintain.

5.2.2 | Analysis of Qualitative Survey Results

The open-ended questions were less likely to be answered by the respondents as they take more time and effort. The answers were expected to come from city or county representatives who were more interested in the topic at hand. Selected answers were reviewed in context of the jurisdiction size and their relation to asset management. The responses to the open-ended questions were compiled based on the size selection and then compared within their respective size categories and

to responses from the other size categories. As the data taken from the open-ended questions is qualitative, the information does not need as much analysis and can be applied more directly.

5.3 | Site Visits

The second part of this research was to identify and assist a small jurisdiction in developing an asset management system. A series of site visits were conducted to determine a local government for the case study. The first meeting focused on general information about the local government and information specific to asset management. Because this involved working with a local government that is on its own time schedule and has predetermined tasks at hand, scheduling was an important step in the process of this research. Additionally, time was allotted in each meeting discuss the APWA *Guide to Successful Asset Management System Development* and how it would be used while beginning the processes of creating an asset management system for the local government in question. Any questions or concerns were recorded. The information gained from the initial discussion was used when determining if there need to be modifications to the APWA guide for small cities.

There were some qualities that make a local government more or less likely to be considered as a potential jurisdiction for the implementation of a plan. The desired size of a jurisdiction needed to be in the small category (population of 20,000 or less). This jurisdiction must be willing to participate in this study and initiate the implementation of an asset management system. Because there was not sufficient time for an asset management system to be fully developed and implemented, the asset management policy, objectives and strategic plan were created for the public works department, and an asset management plan specific only to roads was created. It was necessary that the jurisdiction did not already have an asset management program in place. If they had a rudimentary system in place with no significant structure or documentation,

a more structured and efficient program could be developed. After communication was established with a few cities and counties, one local government was chosen to continue work with the asset management system implementation process.

The six jurisdictions visited were Catoosa County, the City of Covington, the City of Hartwell, the City of Perry, the City of Saint Marys, and the City of Sandersville. Sandersville and Hartwell are both cities that are involved in the Archway Partnership program through the University of Georgia. In this partnership, UGA provides resources to cities to help them complete projects and strengthen their communities as a whole. The other four local government entities have representatives who are involved in the APWA. Because these communities are already involved in activities and organizations that help further the well-being and success of their jurisdiction, they are more likely willing candidates to follow through with the case study after the site visits.

As previously stated, each of the site visits began with discussing general information about the local government. This included confirming the population, defining any trends in growth, analyzing the budget, and accounting for public infrastructure assets managed. Asset specific information was then discussed including inventory, condition, and priority of different types of infrastructure. The current management system for work orders and management was then explained, including a discussion of software. Policy that affects asset management was the final topic discussed in the site visit before an explanation of future steps.

The expected steps for the case study were reviewed during each site visit to determine whether the local government would have the availability and interest level to complete the study. The future steps included future meetings with the researcher to complete a strategic asset management plan and one individual asset management plan for one asset class. The case study is

preferred to happen in a local government that has qualities better suited to the work that is planned. A local government that would welcome a road specific asset management plan was preferred as road management is widely applicable. Another factor influencing the selection of a case study location was the proximity of the local government to metropolitan areas. A community that could be defined as separate from large metropolitan areas was preferred for this study. Additionally, a local government with a population of significantly less than 20,000 people was defined as more representative of the challenges of local governments in the "small" population range.

5.4 | Case Study

As previously discussed, the APWA *Guide to Successful Asset Management System Development* was created to help guide local governments of any type or size through implementing an asset management system. To determine its effectiveness in local governments with limited resources, the guide was tested in a small local government in Georgia with the creation of an individual asset management plan.

First, information was accumulated from the existing documents and processes that guide decision making in the local government. Existing documents available online were reviewed prior to the first meeting. Then, meetings with the selected local government were scheduled for the development of a portion of an asset management system. Following the APWA *Guide to Successful Asset Management System Development*, the policies and goals that the local government finds to be important were clearly defined to ultimately drive the day-to-day actions of local government employees. This is important for the local government's identity and the community's satisfaction with the government's work. Explicit guiding reasons behind the activities of the government are beneficial to have when communicating with citizens and elected officials. Documents for both the strategic asset management plan (SAMP) and a road specific

asset management plan were created for the selected local government in the case study. This section covers the plan for each of the case study visits and the development of parts of the system.

5.4.1 | First Case Study Visit

During the first case study visit, the public works director was asked to discuss the goals, policies, and any existing plans established by the local government. The topics discussed during the site visit were reviewed, meaning that the current processes of the government toward managing infrastructure were clearly understood before any changes were discussed. This meeting served as a deep dive into the past management and spending on roads, as well as any new expected funding or projects. Software in use were discussed, specifically the software and/or process used for road rating system (outsourcing or not). Any other road specific management activities and concerns were mentioned in this meeting. The processes that a government uses to communicate information and get from start to finish on different tasks were reviewed. A layout of decision-making processes was created. It was important to gage the community involvement level at this stage as well.

Between meetings and after defining overarching goals, the APWA guide was followed to create a strategic asset management plan (SAMP). A strategic asset management plan is a multi-faceted plan that involves many different governmental departments. This SAMP was created for the public works department of the selected local government. Building a SAMP requires knowledge of the policy and goals of the local government in question, information from the discussion during the first meeting as well as any information gained from budget documents, comprehensive plans, etc.

5.4.2 | Second Case Study Visit

During the second case study visit, the SAMP created between the meetings was discussed. Any concerns or questions were addressed and worked through. The SAMP was designed to be beneficial for the entire public works department, aligning all the value and expectations within the department. It was determined that a meeting with department heads from each section within the public works department should be scheduled for the final case study visit. To align with this thought, a meeting time and place was determined in the second case study visit. This meeting was scheduled for the final day of the last site visit, which was to be three days long.

Additionally, the second visit involved tying road management activities to sections within the SAMP. This includes activities such as patching, resurfacing, crack-sealing, etc. The purpose of reviewing management practices and activities with the street department is to create an understanding of the current practices. An understanding of current processes is necessary for building an appropriate asset management plan for the roads and knowing the most appropriate methods to rate them in an efficient and effective manner.

5.4.2.1 | Development of Road Rating System for a Small Local Government

It was determined that an initial starting point for the road specific asset management plan would be rating the street system of the selected local government. The technique used to rate the roads needed to be straightforward and easily repeatable for future ratings to more accurately depict the changes in the state of the roads over time. This section describes the process that was followed to build the road rating system and how to use the system.

Road rating methods used by GDOT, FHWA, and other state departments of transportation were reviewed to create a simplified plan for the selected city. A reference spreadsheet (located in

Appendix C) was created that shows the qualifications for each type of rating. It contains the following categories (each of these categories is a distinct column within the spreadsheet):

- Distress type - this category contains all the surface distress types that can be visually inspected on asphalt pavement. It includes surface defects, surface deformations, cracking, and patching & potholes.
- Description - this includes a description of each distress type and what is expected for different levels of rating. For example, the description for raveling is, "Loss of pavement material from the surface down. Slight to moderate raveling includes loss of fines from the surface (rated 1-2). Sever raveling includes loss of coarse aggregate (rated 3-5 depending on the size of the affected area)."
- Resulting problems - This defines the problems that result from the associated distress type. For example, the resulting problems associated with raveling are "loose debris" and "decreased skid resistance." Additionally, possible underlying problems are included when they are relevant. Underlying problems are considered relevant when the surface problems require further investigation before restorative actions can be taken. For example, depressions in the pavement surface can be indicative of subgrade settlement which should be investigated prior to repair [Pavement Tools Consortium, n.d.].
- Prevention/remediation tactics - This describes approaches that can be taken to either prevent further similar damage to the pavement or to repair the pavement from the damage that has occurred. For example, the prevention/remediation tactics suggested for raveling are, "Should be investigated before repairs are made. Sealcoat or thin overlay can protect against further raveling. If in localized areas, remove and patch. If spread significantly throughout road surface, remove and overlay or mill and repave."

- Pictures - example pictures of each type of surface defect are shown.

The spreadsheet and information within the spreadsheet were compiled based on information gathered from Pavement Interactive, which is an online resource for pavement information "developed by the Pavement Tools Consortium, a partnership between several state DOTs, FHWA, and the University of Washington, as part of their effort to further develop and use computer-based pavement tools" [Pavement Tools Consortium, n.d.].

As part of the road specific asset management plan, a spreadsheet for each type of distress that asphalt pavement can undergo with rows for each road in the local government was created. Using the spreadsheet, a visual rating of all the roads for the selected local government was performed. Each distress type was given a severity rating range of either 0-5 or 0-10 depending on the severity of the root causes of the distress (whether the problem is solely a surface problem, or a problem caused by sections underneath the asphalt layer). The spreadsheet calculates the condition rating for each road using *Equation 1.* This spreadsheet is included in **Appendix C**. The rating system was designed to be simple enough to rate the entire road system in two days or less and provide the local government a basis for future independent assessment upon completion of this study.

$$Condition\ Rating = ((85 - Sum\ of\ Defect\ Ratings)/85) * 100 \qquad \text{(Equation 1)}$$

The road rating process included driving the road network in the city and visually determining the distress types present on each roadway section. The inspector assigns the distress types observed on the road a severity rating. For the first iteration of this rating system, pictures were taken along each roadway so that the distress types and intensity levels can be referenced for future ratings. This supports the consistency of rating the roads in the same manner each time.

5.4.3 | Final Case Study Visit

The first portion of this visit was dedicated to visually inspect and rate the roads. The road rating system created as per section **5.4.2.1** was used for this task. The rating process was explained in detail to the person responsible for roads in the local government. Complete understanding was confirmed so that the local government can repeat the process. All the roads in the local government were driven and visually inspected with the person responsible for road rating, maintenance, construction, etc. All the documents created for and used during this process were shared with the appropriate representatives of the local government.

The second and final portion of this visit was used for a meeting with all representatives of public works infrastructure as chosen by the public works director. This meeting was used to discuss the SAMP that was created for the public works department. A review of all parts of the plan was completed with questions and concerns discussed. SAMPs are meant to direct all departments within public works, thus it is important to review the contents and confirm that it is feasible for all departments to use. The dates within this plan are also decided by the departments and either changed or confirmed by the public works director and city or county manager. This is beneficial for all departments and for the completion of the asset management system as a whole. It gives everyone a vested interest in the success of the system.

5.4.4 | Development of Road Specific Asset Management Plan

Because of the complexity of local government asset management and time constraints, an asset management plan solely for the road system was established. The road system was chosen as the focus in this study because it is expected that most local governments are responsible for maintaining roads. This ensures relevance for other local governments. Additionally, the road asset management plan provides an example for asset management plans for other infrastructure assets.

An asset management plan for roads included an inventory, a rating system, an inspection schedule, and an action plan based on ratings and requests from citizens. The inventory included the length, location, and type of roads, the number of households and businesses directly affected by the roads that the city manages, as well as the rating for each road. The inspection schedule sets the frequency for when roads should be inspected and what special cases require re-inspection. The action plan defines the repairs, replacements, re-inspections, or additions that occur based on the ratings of roads or requests of citizens.

5.5 | Development of Additional Asset Management Resources

After the case study was completed, the APWA *Guide to Successful Asset Management System Development* was evaluated and additional resources were created for local governments with limited resources. The supplementary resources were designed using information from the survey results, interview analyses, and case study.

As presented in the literature review, the first step of developing an asset management plan according to the APWA guide is to develop policy principles related to asset management. These asset management policy principles are intended to be built on high-level plans that are already in place for the local government. This becomes an obstacle if an organization does not have previously defined policies or guiding plans in place, or if the current policies and plans are not viable or desired by the local government. Small local governments are less likely to have updated comprehensive plans in place for their jurisdictions. Small local governments often do not even have a document defining the direction in which the jurisdiction is moving. The websites for multiple Georgian local governments, e.g. the City of Alto and Lanier County, were visited to search for guiding documentation, and there was generally either an absence of guiding

documentation or minimal budgetary documentation. Many incorporated cities do not have websites at all.

An asset management system could help incentivize a small local government to establish a direction, though the problem exists of determining policy principles for asset management without any direction. For this potential problem, a section could be added to the APWA guide for creating asset management policies without direction from other plans and goals. This section could include direction from agencies like the Environmental Protection Agency (EPA) that have created resources specific to small local governments. Once the direction and policies are defined, objectives can be defined.

The remaining sections of the APWA guide are not expected to create issues for a small jurisdiction as they are generalized for any local government. However, this indicates that the APWA guide is possibly too general. This study provides evidence that small local governments face challenges that are different from larger ones. Based on the information gained from small local governments in Georgia, this study could prove that it is beneficial to add sections that provide further insight and direction specifically for smaller local governments.

Other areas where small local governments may need extra guidance are revealed with research specific to them. The data from the survey is more generalized and can indicate areas of focus for small local governments in Georgia specifically. For instance, if smaller cities and counties have less employees in public works but similar quantities of road mileage to mid-sized local governments, modifications to the daily activities for road management should to be made. A larger government may have an entire division for streets, whereas small ones must determine how to maintain infrastructure with less employees and less resources. An additional section for managing with less resources could be created.

An addition to the APWA guide could include a focus on operation with lower budgets and fewer resources. One potential change is to add an asset management training phase in the plan as smaller cities tend to have less employees to inform and train. This would include a training session about asset management, managing smaller budgets, and the resources available to local governments at this size. There are specific government programs and grants that are designed to help smaller communities, but they cannot be relied upon as a consistent resource. Thus, a small local government will need to consider how they can operate at an appropriate level with the budget and resources they consistently have available.

The desired approach to maintaining the infrastructure of a local government must be defined before considering software. Certain software is more useful and cost effective for smaller local governments. An additional section that discusses approaches to choosing software for governments of smaller sizes would be beneficial to include. This would provide a review process for software that are appropriate for specific services and for the specific local government.

As Georgia's population increases, many small local governments are experiencing a significant amount of growth, especially the cities located near Atlanta. A section for small cities that are expecting significant growth may be a beneficial supplement to the guide. This section could focus on how to plan new residential areas and continue growing in population while maintaining their small-town identity. The APWA guide does emphasize defining values and goals of the community, such as maintaining a walkable downtown or a focus on sustainability. The future plans of a local government are important to understand in order to maintain and build on existing infrastructure in a way that approaches the future strategically.

6.0 | RESEARCH FINDINGS

This section presents and reviews the results from the research conducted within this thesis. Both quantitative and qualitative analyses of results are presented.

6.1 | Interview Results

As described in the previous section, four interviews were conducted in order to understand current asset management practices for cities of different sizes in Georgia.

6.1.1 | Small Local Government Interview

As outlined in section **5.1.1**, Jason Spencer, Public Works Director of the City of Oakwood, Georgia, was interviewed for a small city perspective on asset management. Spencer was asked to discuss asset management and infrastructure in the city of Oakwood, Georgia. Spencer stated that Oakwood does not have an asset management plan that is generalized to all assets, but they do have tools for managing specific assets. Each section of infrastructure that Oakwood is responsible for was reviewed in the interview. The information obtained from Spencer's interview is presented in this section.

According to Spencer, the city of Oakwood uses StreetSaver for the management of its 20 centerline miles of pavement infrastructure [Spencer, 2019]. StreetSaver is not commonly used in cities as small as Oakwood. Despite this fact, Spencer found this software to be user friendly, providing not only road ratings, but also treatments for different scenarios taking budget and external influences into account [Spencer, 2019]. The city of Oakwood pays an annual fee (covered in the General Fund for the city) of approximately $1500 based on the lane miles of road. This fee covers inspections, treatments for expected scenarios, and lifecycle analyses of the roads. Spencer recommended use of this software over MicroPaver for pavement management because it is more user friendly to non-engineers [Spencer, 2019]. Spencer advised that a local government should

know what infrastructure it is responsible for, know the life cycles for that infrastructure, and have a rehabilitation process for it as well [Spencer, 2019].

The City of Oakwood uses the software program Hiperweb for work orders. This was a recent change from the old system where the office would receive a phone call, fill out a work request over the phone, send work request to the appropriate individual, note work location using tacks on a corkboard, and complete the work when able. After the work order was completed, the individual would then fill out completion documents and file it in a 3-ring binder [Spencer, 2019]. This binder was the official documentation of work orders for the year and would be reviewed at the close of the year. As an upgrade from this old system, Oakwood was testing Hiperweb for stormwater, roads, and sewer. The annual cost for the three modules is $12,000, and the annual cost for the complete five module package is $20,000. Spencer stated that the city of Oakwood tried Cartegraph but was unsatisfied with the length of the implementation process compared with Hyperweb's implementation taking only three days [Spencer, 2019]. Oakwood shares the Hall County geographic information system (GIS) which saves the small city money while not sacrificing the use of maps. Both Hiperweb and StreetSaver work with GIS.

Specific challenges encountered by the city of Oakwood were reviewed. With the daytime population exceeding six times the live-in population, there is more strain on the infrastructure that the city of Oakwood maintains than the population would suggest. Specifically, the added strain on the road system in Oakwood is not reflected in funding received from the state. Local Maintenance and Improvement Grant (LMIG) funding from GDOT is calculated based on centerline mileage of roads and the population of the local government which does not consider the daytime population. In addition, the live-in population was approximately 80% renters, making community involvement even more challenging than it is for most cities. There are additional

challenges because the newly elected city officials were more focused on growing the residential sector of the community versus the previous council that focused on growing the commercial sector of the city [Spencer, 2019]. This can be a major issue for small cities. Because of limited resources, changing the direction of the city's goals and identity with every new elected official is not feasible. Defining a long-term direction of infrastructure that the city will hold true to is an important step for many small cities. Both a comprehensive plan and an economic development plan are in place within the city. These are both extremely beneficial guiding documents for the city, though the daily activities of the public works department are not proven to align with the long-term plans. With only three full-time employees and a growing population, the city of Oakwood faces many challenges in the future of their infrastructure.

Though implementing an asset management system that directs their infrastructure would be beneficial, it is another large undertaking that may not seem feasible for one of the three full-time public works employees to create. With funding levels present in cities of this size, it is likely not feasible for Oakwood to hire a consultant to design an asset management system either. The APWA guide provides an approach that is general enough for any size or type of government, which is potentially so general that it could be overwhelming to small governments who already have too many tasks for their employees.

6.1.2 | Mid-Sized Local Government Interview

As outlined in section **5.1.2**, Chris Rotalsky, Director of Public Works, from Gainesville, Georgia, was interviewed for a mid-sized city perspective on asset management. There are eight divisions of the Gainesville public works department including airport, cemetery, vehicle services, street maintenance, solid waste, engineering, public lands and buildings, and traffic [Rotalsky, 2019]. Further, there is a separate department of water resources which manages water and sewer.

Rotalsky discussed all of these, software, budgets, and challenges during the interview. This section presents the information obtained from the interview with Rotalsky.

With eight divisions in public works, there was not "an official asset management tool or process for each" [Rotalsky, 2019]. However, like Oakwood, the city of Gainesville used Hiperweb as their work order and asset management software. This software was used across multiple divisions for work orders and inventories. Rotalsky discussed outsourcing to Roadbotics for road inspection and ratings. For $10,000 (pricing based on population) they provide a road rating system divided into segments with an online map of the segments, and pictures of the roads every 10 feet [Rotalsky, 2019]. This was a significant improvement from how the road rating process was previously performed. In the past an individual would "physically go out, look at each segment, write down and rank that segment, bring it back, and put it into another software that would then rate it out. Based on this information a list of road needs would be generated" [Rotalsky, 2019]. This process would take an individual almost the whole year as Gainesville has approximately 150 miles of road. Rotalsky noted another benefit of outsourcing to Roadbotics was the standardized system that won't vary as much as a rotating individual producing this information. He recommended Roadbotics as a consulting firm especially for local governments that are growing.

Rotalsky commented on the importance of relationship building among departments and sections within the government. He believed this to be an important part of accomplishing tasks smoothly. Rotalsky detailed that SPLOST and TSPLOST funded projects are based on community needs or desires. Because they vote the tax in or out, the projects must be appealing to the public. Note that glamorous projects are not always an option for local governments with limited resources

that are just trying to stay afloat. Education of the community concerning the projects is necessary to get the tax voted in for less glamorous projects.

As Gainesville is a growing city with many resources available, APWA representation, solid relationships between departments in public works, and organized high-level guiding documents in place, it is feasible an asset management system could be developed based on the APWA guide and implemented within a year. This is a general estimate based on the fact that Chris Rotalsky has significant knowledge about asset management and the organization of the guiding documents of the city. However, he was skeptical of the breakdown of asset management "where rubber meets the road" because, he said, "Gainesville is a decent sized city, but I don't have the resources to just have one asset manager" [Rotalsky, 2019]. Even with his skepticism, there was a comprehensive plan in place, thorough budget documentation, an urban redevelopment plan, a software system that is beneficial, employees who are not completely overwhelmed with tasks, and solid relationships between departments. All these factors would benefit Gainesville in the process of building an asset management system.

6.1.3 | Large Local Government Interview

As outlined in section **5.1.3**, Drew Raessler, Director of Public Works, from Athens-Clarke County (ACC), Georgia, was interviewed for a large city perspective on asset management. In his interview, Raessler discussed the budget document that Athens-Clarke approved for the 2019 fiscal year as it relates to public works and the assets maintained by the local government. Raessler provided insight into using TSPLOST funding to focus in improving the pavement infrastructure in Athens. The ACC transportation system has become more advanced in recent years.

The case of ACC is different from many local governments as it is a consolidated government. This means the entire population and area of Clarke county is managed by what used

to be the city of Athens. There are more employees available for working on different tasks. The departments relating to infrastructure assets in ACC are as follows: Public Utilities Department that provides water and sewer services, Solid Waste Department that provides collection and disposal services, the Sustainability Office that promotes policy and practices that are environmentally conscious, the Transit department that provides and manages public transit in ACC, and the Transportation & Public Works Department that constructs and manages the road system, traffic operations, sidewalks, and drainage systems.

Raessler explained performance benchmarking and prioritization system that ACC has in place for determining road repair and replacement. They plan to outsource for automated road rating for all roads every 5 years and for arterials and collectors every 2.5-3 years [Raessler, 2019]. Raessler explained that this would inform the prioritization system. He stated that with two people in their paving section, 1200 lane miles of road was "too much for them…to look back at our condition, look forward at our paving program, and all the while mess with punch lists and everything else that comes with managing a contract" [Raessler, 2019]. This is a more advanced system than what local governments with smaller budgets have in place. Typically, small local governments have limited employees as well as limited funding and other resources. This system was implemented after the TSPLOST was voted into action increasing funding for transportation from "$2.5 million a year to $7.5 million a year" [Raessler, 2019]. With the advances in funding and resulting boom in road construction, Raessler said their paving season increased which put strain on the rating system and caused them to begin to contract out for the road rating. The two new systems for roads, as well as the implementation of CityWorks, were made necessary and possible by the increase in funding from TSPLOST. Because TSPLOST is not guaranteed for the future, this could become a problem.

ACC was in the process of building a report card like the ASCE Infrastructure Report Card. Raessler did not mention the template that APWA created for this very purpose, so it was assumed that he was not aware of its existence. He did mention that their mission was responsible construction and maintenance of transportation which they work down from. Raessler said there was not a specified document that defines the goals and policies of asset management and walks through how day-to-day activities reflect those. However, there were many components of an asset management system in place. For example, Raessler said, "Each department has a mission statement that supports those larger normative goals and then that mission statement is supported by performance measures and then each of those performance measures are backed by some sort of action" [Raessler, 2019]. Raessler mentioned that they have room for improvement in defining the asset management practices within their government structure, but they seemed to be on the right track. Raessler gave a piece of advice based on his experience to smaller local governments for outsourcing to manage citizen concerns and questions about road maintenance and replacement:

> "By [obtaining road ratings] through [automated rating], and smaller cities may benefit from this from a capacity standpoint not having the knowledge or the time to do it themselves, we can say, 'Look, we didn't generate this, some random engineer from somewhere else didn't generate this, this was done based on industry accepted technology that came in, rated the roads, didn't care rich neighborhood or poor neighborhood. It just came in and looked at the roads and generated this list based on maintaining asphalt in perpetuity.'" [Raessler, 2019]

The problem for many small local governments is that they do not believe they have funding available for outsourcing ratings, however, completing ratings once every few years minimizes the impact on the budget. Instead, the outsourcing can be entered into a longer-term plan.

6.1.4 | Small Cities and Rural Communities Interview

As outlined in section **5.1.4**, Dan Sailer, Director of Public Works in Castle Rock, Colorado, and chair of the SC/RC committee was interviewed for an administrative small city perspective on asset management.

Sailer explained that one of the initial goals of the APWA Asset Management Committee was to "get a base education out to [the APWA's] membership so we can start talking some of the same language" [Sailer, 2019]. He discussed how asset management is an often-misunderstood topic for all kinds of organizations. Specifically, he mentions how many local governments are under the impression that an asset management system is just a software, when a software should be seen as an element of the whole system. Moving on to discuss the SC/RC committee, Sailer summed up the general problems for small local governments as follows:

> "For smaller cities, typically the staff is asked to wear many hats and do as much as they can with the small amount of financial resources. That tends to be the biggest challenge that smaller communities deal with is just how to get the biggest bang for the dollars that they have. That's what we hear from most communities nationwide is how to get more out of the resources that they have." [Sailer, 2019]

With that in mind, Sailer emphasized the importance of having good protocols for tracking necessary data for making decision within a local government. This was thought to be more important than having a sophisticated program for collecting data.

Next, Sailer discussed his experience working long-term with a local government in building and implementing an asset management system. The City of Castle Rock, Colorado had a population of approximately 17,000 when Sailer began his career in public works there in 2000. They have since grown to a population of approximately 70,000. This kind of rapid growth is generally a problem for local governments in the sprawling and expanding metropolitan areas of large cities. Sailer mentioned how Castle Rock moved from a day-to-day, more reactionary form of management to a "wholistic" and "more forward-thinking" approach [Sailer, 2019]. Sailer said they did this by taking time to take a step back and consider their day-to-day operations considering their comprehensive plan and other long-term goals. The Sandersville Public Works Department implemented a Strategic Asset Management Plan in approximately 2017 to focus on maximizing the value received from their physical infrastructure. Sailer said it's important to "really try to understand what it is [local governments] are trying to maximize from their infrastructure assets" as a starting point especially for smaller and rural communities [Sailer, 2019]. He repeatedly emphasized the importance of having at least one "Champion" for asset management who takes on the role of pushing for education and implementation of asset management related systems, ideals, and practices. This person would act in a similar role that Sailer played in Castle Rock, working on educating staff as well as politicians (city councils, city and county managers, etc.).

Sailer then discussed some tactics used to define value and important goals within the community of Castle Rock as well as tactics for educating necessary stakeholders on asset management. He emphasized the importance of being able to define the story behind the need for an asset management just as it is important to be able to tell the story of the reasoning behind funding. They perform community surveys every two years where they ask stakeholders what is important to them community wide, which helps to understand "high level value they want from

[the] infrastructure" [Sailer, 2019]. This high-level value desired by the community helps to build the story behind the need for an asset management system and influenced the goals and policies relating to asset management. Sailer said he used information he learned from APWA and his community to educate the department director and town manager to understand his thoughts and form a common vision between them. He stressed the importance of effective and clear communication of the effects of different funding levels and different practices so that the budget decision-makers know exactly what they are choosing to give funding to or take funding from. Once the importance of an asset management system was communicated to the appropriate people, the SAMP was built and used, per the APWA guide, to build specific asset management plans for infrastructure.

As a part of the committee that built the *Guide to Successful Asset Management System Development*, Sailer answered a few questions about the guide itself and the applicability he sees it having for different local governments. He stated the following:

> "I think the underlying principles associated with that guide are not specific to small cities or large cities…It's a good introduction to those high-level fundamentals that hopefully get organizations thinking to get out of the [day-to-day] and say 'Okay, are we really using our resources in an efficient manner?'" [Sailer, 2019].

Sailer thought this organization of focus within a local government of any size would be beneficial for setting and fulfilling expectations. He reemphasized that money and software aren't the true factors affecting asset management, but what is done with those resources. Finally, he offered to send the SAMP created for Castle Rock for reference when building one for a case study.

6.1.5 | Interview Analyses

Many of the practices in ACC and Gainesville were on similar levels of sophistication. This is likely because of different levels of funding from residents. Even though Gainesville has approximately half the population of Athens-Clarke, the demographics of taxpayers is significantly different. The unemployment rate in ACC is significantly lower than in Gainesville which likely has a large effect on the funding for public infrastructure maintenance. Although, based on the ACC SPLOST website and the interview with Drew Raessler, the recent funding increases from SPLOST increased the construction of public infrastructure which put more stress on the limited employees.

The city of Oakwood was significantly different in their management of activities as the number of divisions within the public works departments of Gainesville and ACC outnumbered the quantity of employees. Though Oakwood had the ability to implement software including Hiperweb and StreetSaver, this was a recent development and is not expected in many other governments of similar size. Both Gainesville and ACC outsource for road rating and have software packages that assist with the maintenance of infrastructure. The city of Oakwood does not have the ability to outsource for road rating consistently, but instead the department rates the roads and inputs the ratings into a software themselves. This is time consuming for a limited staff. Small local governments are often significantly affected by surrounding populations. This is not a problem that either Gainesville or ACC experiences on the same level as Oakwood. While Gainesville and ACC are both experiencing growth from the expanding metropolis of Atlanta, Oakwood has more immediate and significant effects on their infrastructure from their daytime population.

All three of the cities interviewed practiced infrastructure management tactics, though none had an asset management system in place. If an asset management system were attempted, Gainesville and ACC have the advantage of better funding and more employees while Oakwood has the advantage of fewer bureaucratic fences to jump. The knowledge and importance of implementing an asset management system are not high enough for any of the three Georgian cities to be planning to implement a system in the near future. The task of creating and implementing an asset management plan often seems too large to commit.

Sailer provided perspective from the other side of asset management system development. The recommendation he stressed the most was to find an asset management champion within the government. Sailer, as the Champion of his own city, emphasized that having at least one or two people dedicated to the completion of the system was instrumental in the implementation of a successful system. For all types and sizes of government, Sailer said having a plan for data use is essential for the effective collection of data. Thus, the software package does not matter as much if there is not direct action using the collected data. He suggested the use of less expensive tactics for managing infrastructure in local governments with limited resources, e.g. software like Excel to manage an inventory. Finally, Sailer called the APWA guide a "good introduction" to asset management systems and ideals [Sailer, 2019]. Though the guide is helpful for high-level thinking, it can be a looming trek for local governments who do not know where to start logistically.

6.2 | Survey Results

Survey responses from local government representatives in Georgia on the APWA Georgia Chapter contact list were collected through the Qualtrics website. A total of 101 survey responses were received including 34 respondents from large (by population) local governments, 37 respondents from mid-sized (by population) local governments, and 39 respondents from small

(by population) local governments. This is a 16.4% response rate from the 614 recipients of the survey. This indicates that larger local governments have a stronger presence in APWA than smaller local governments because 18.9% of the counties and 1.9% of the cities (or 5.8% of local governments) in Georgia classify as large by population while 28% of the survey responses are from large local governments.

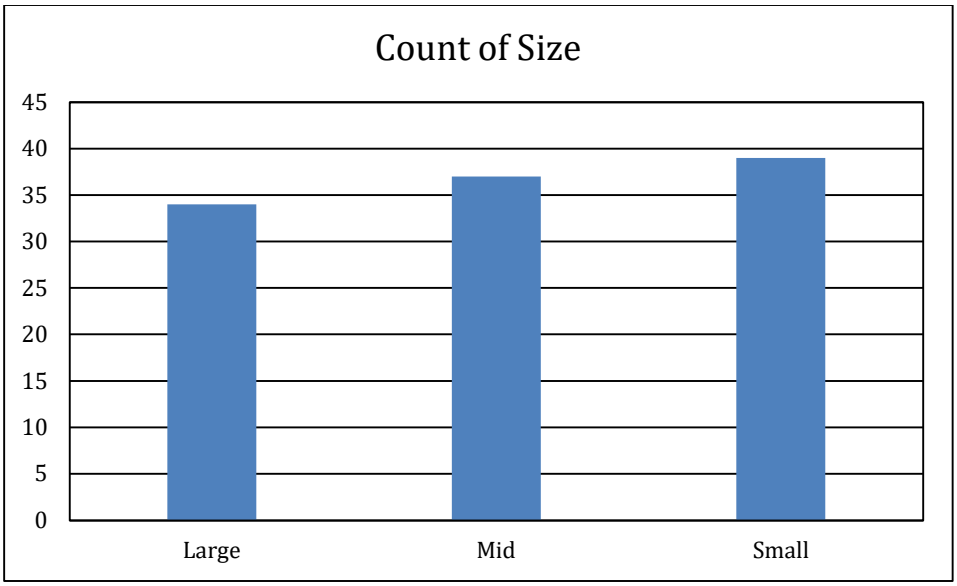


Figure 15: Distribution of Responses by Local Government Size

The distribution of the number of employees that each participating local government has in their public works department is shown in **Figures 16**, **17**, and **18**. Respondents from small local governments answered that they have from 0 to 75 employees in public works. The center of this distribution is at 5 employees with a mean of 13 employees. The majority of respondents from small local governments reported less than 10 employees in their public works department. Respondents from mid-sized local governments answered that they have from 7 to 250 employees in public works. The center of this distribution is at 36.5 employees with a mean of 53 employees. There is only one response from a mid-sized local government representative for over 150 employees in public works. Respondents from large cities answered that they have from 21 to 1900

employees in public works. The center of this distribution is at 100 employees with a mean of 364 employees. The majority of respondents from large local governments reported less than 300 employees in their public works department.

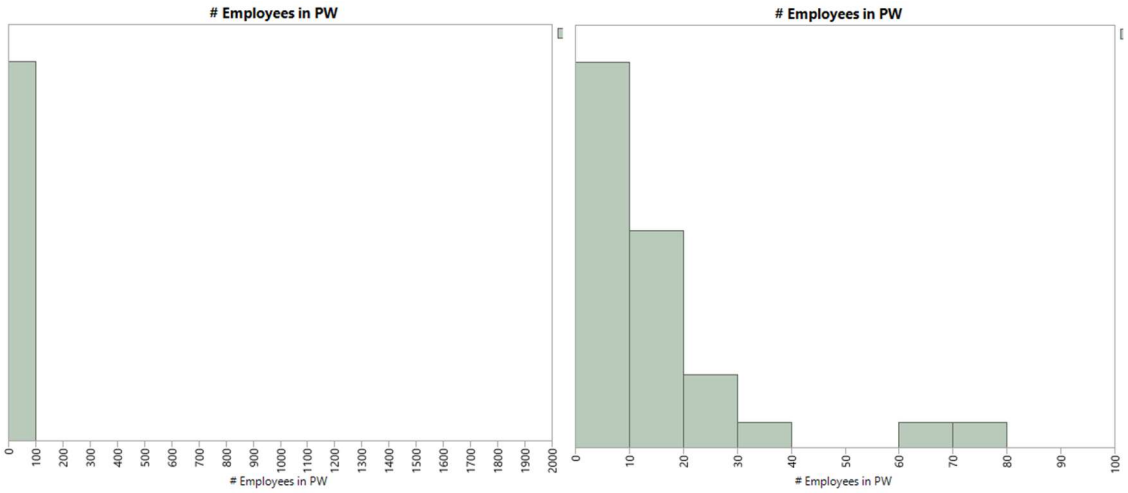


Figure 16: Distribution of Number of Employees in Public Works for Small Local Governments

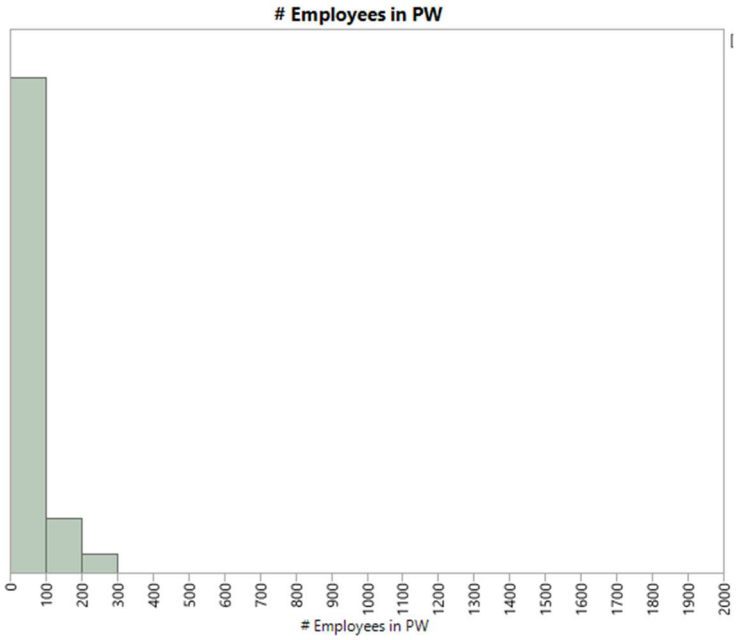


Figure 17: Distribution of Number of Employees in Public Works for Mid-Sized Local Governments

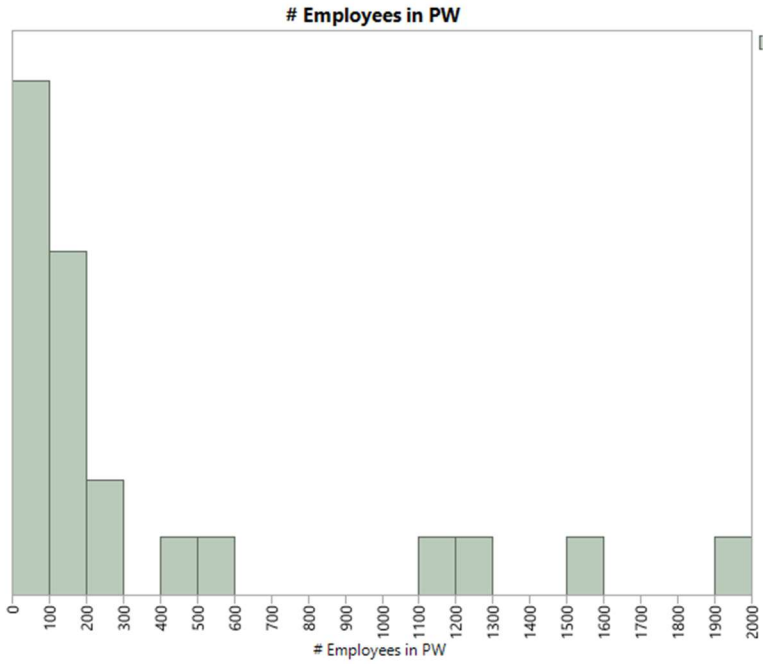


Figure 18: Distribution of Number of Employees in Public Works for Large Local Governments

The second question that the recipients answered was "Which services does your local government provide for citizens? Select all that apply" with a list of services that are rated by the ASCE Report Card for the states. **Figure 19** shows that almost all the local governments that responded to the survey chose roads as an option. 81% of small local government respondents, 80% of mid-sized local government respondents, and all the large local government respondents answered that they are responsible for maintaining road infrastructure. The figures show that the top assets across all local government sizes are roads, stormwater, solid waste, parks and recreation, and drinking water. 60-100% of respondents from each city size answered that they are responsible for maintaining infrastructure involving roads, solid waste, and stormwater. These percentages show that the majority of various sized local governments in Georgia manage these three infrastructure systems. Smaller local government representatives' responses include the assets mentioned previously, drinking water, parks and recreation, and wastewater. Medium sized local governments are indicated to be more likely to maintain bridges than small ones, while most

of the large local governments have bridges to maintain. When comparing the results for each local government size from **Figure 19**, the large local governments have higher representation in aviation, bridges, dams, rail, and transit than the other two sizes.

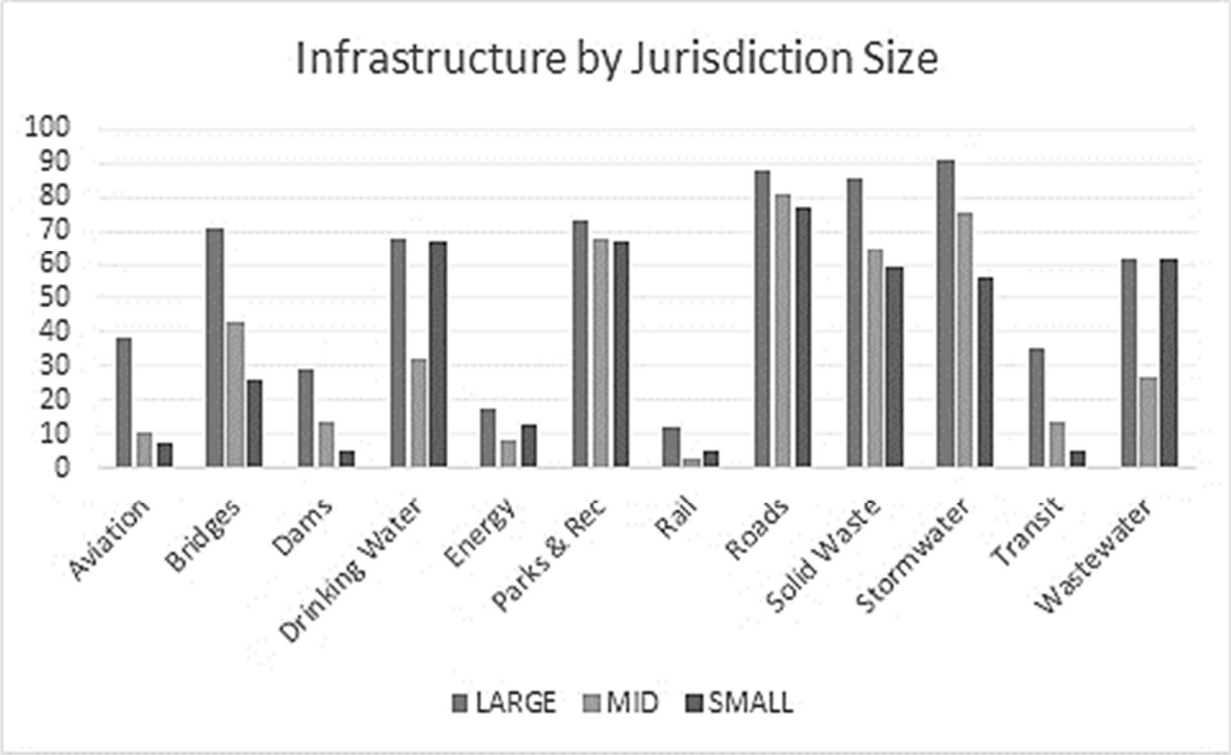


Figure 19: Responses for Infrastructure Managed by Local Government Size

Based on the 2014 and 2019 ASCE Infrastructure Grades (**Figure 4**), dams, transit, and wastewater are rated the lowest with grades of D, D+, and D+, respectively. The next lowest grades are stormwater and parks & recreation with grades of C-. These infrastructure asset classes are the farthest from a desirable grade and are often managed by small local governments. Because the most typical infrastructure found across all local governments is roads, this will be the focus of the asset management plan implemented in the chosen city. The ASCE road grade for Georgia has improved significantly because of a state initiative to improve roads. This initiative largely focuses on roads maintained by the state and roads in Atlanta. ASCE recommends that local governments "utilize the HB170 provision that allows counties, either alone or in groups if they have common

projects, to ask voters to fund local transportation projects with an additional sales tax up to 1 cent" [ASCE, 2019]. Many local governments are struggling to obtain the votes they need for this funding opportunity. Community education is often an important part of asset management system implementation, especially when votes are involved. Since 2014, the solid waste grade has fallen from a C+ to a C grade. Initiative for recycling and waste reduction could be a focus section for new asset management systems. The stormwater grade has improved since 2014. ASCE recommends that planning for stormwater, wastewater, and water be integrated for future infrastructure. In small local governments where asset management plans are new, an emphasis on integrating the management of water infrastructure is thought to be beneficial.

The distribution of road miles provided by the survey respondents from each participating city is shown in **Figures 20**, **21**, and **22**. Respondents from small local governments answered that they have from 1 to 500 road miles to manage. Based on the survey, on average most small local governments had 39 employees to manage 142 miles of roads. The majority of respondents from small local governments reported less than 50 road miles. Respondents from mid-sized local governments answered that they have from 80 to 940 road miles to maintain. The center of this distribution is at 284 employees with a mean of 358 miles. This distribution has a larger variance than that for small local governments. Respondents from large local governments answered that they have from 320 to 2000 road miles to manage. The center of this distribution is at 971 miles with a mean of 862 miles. The majority of respondents from large cities reported between 500 and 1500 road miles.

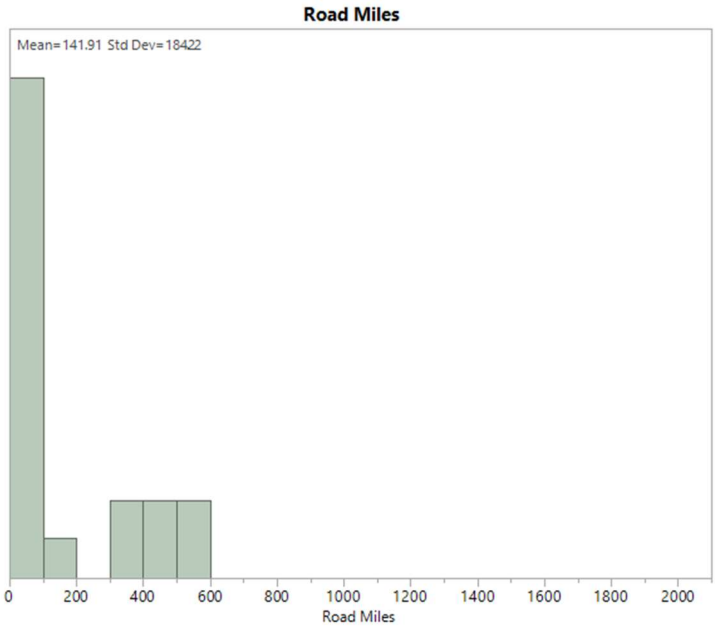


Figure 20: Distribution of Road Miles for Small Local Governments

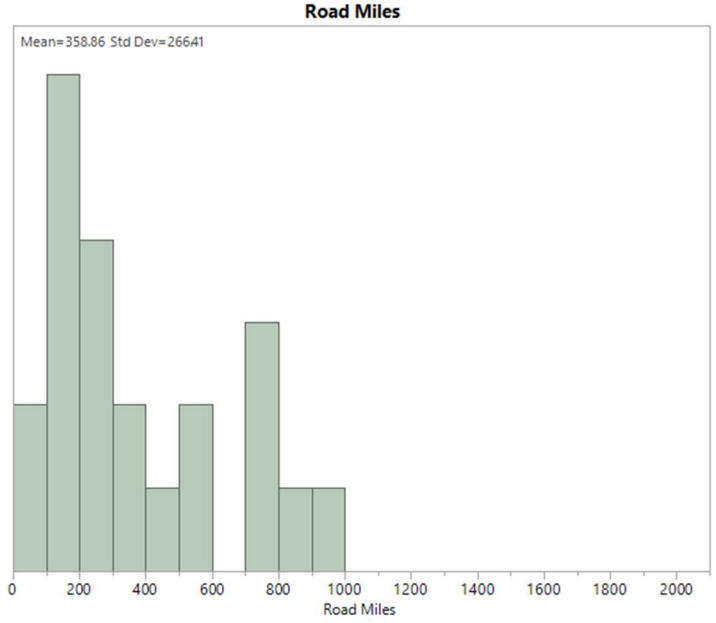


Figure 21: Distribution of Road Miles for Mid-Sized Local Governments

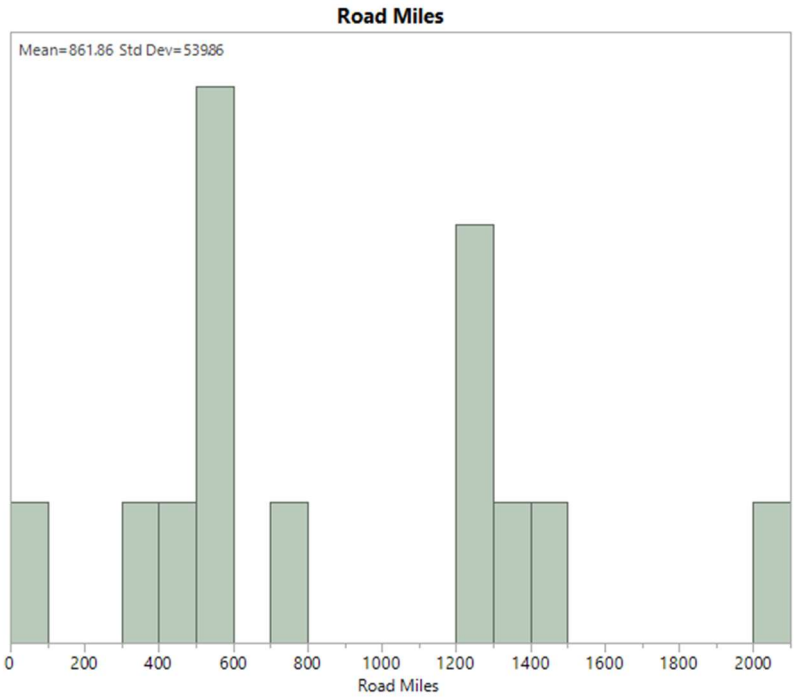


Figure 22: Distribution of Road Miles for Large Local Governments

6.2.1 | JMP Analysis of Quantitative Data from Survey

The data collected from the survey is a mixture of quantitative data and qualitative data. The quantitative data is a mixture of categorical and numerical data. There are specific statistical methods used for mixed types of data collected. The statistically detailed explanation of each JMP test is provided in **Appendix B**. A discussion of the results for each JMP test is provided in this section.

6.2.1.1 | Chi-Squared Test for City Size and Completion of Survey

To determine if there was a relationship between the size of the city and the completion of at least 60% (8 questions) of the survey, a Chi-squared test was completed. This test and results are shown in the corresponding section in **Appendix B**. The p-value resulting from the test does not indicate a significant relationship between the respondent's city size and whether they completed the survey. This means that the individuals who responded to the survey show similar completion rates

no matter what size city they represent. This shows that the responses are representative of the population questioned.

6.2.1.2 | Chi-Squared Test for City Size and Asset Management Plan

Another Chi-square test was completed to determine if there is a relationship between city size and whether there is an asset management plan in place. The results for this test are presented in **Appendix B**. The p-value resulting from this test indicates that there is a significant relationship between the size of a city and the presence of an asset management plan. Small cities have the lowest proportion of cities with asset management plans in place. The proportion of mid-sized cities with asset management plans is between the proportions of small and large cities. This leaves large cities with the highest proportion of asset management plans. This was the expected outcome of this test because larger cities with more assets and resources are more likely to need a plan to manage the assets.

6.2.1.3 | One-Way ANOVA for City Size and Number of Employees in Public Works

A one-way analysis of variance was completed to confirm that there is a significant difference in the number of employees in public works departments in cities of different sizes. The results for this test are presented in **Appendix B**. The p-value resulting from this test indicates that there is a significant difference in an average number of employees in public works for at least one city of different sizes. A Tukey Test was then completed to confirm that the smaller cities have significantly fewer employees in public works on average than mid-sized cities, which have significantly fewer than large cities. This supports the discussion regarding the distributions shown in section **6.2**.

6.2.1.4 | One-Way ANOVA for City Size and Road Miles

Another one-way analysis of variance was completed to confirm that there is a significant difference in the amount of road miles maintained by cities of different sizes. The results for this test are presented in **Appendix B.** The p-value resulting from this test indicated that there is a significant difference in at least one average road mileage for specific city sizes. A Tukey Test was then completed to determine where the significant difference is located. The results of this test indicate that large cities are responsible for maintaining significantly more road miles than both mid-sized and small cities. However, there is not a significant difference present between the amount of road miles that small and mid-sized cities are responsible for maintaining.

6.2.1.5 | Two-Sample T-Test for Road Mileage in Cities without Asset Management Plans

A two-sample t-test is performed to determine if cities with asset management plans in place have more road mileage to maintain. The results of this test are presented in **Appendix B**. The p-value resulting from this test does not indicate a significant difference in the road mileage that cities with asset management plans are responsible for maintaining from cities without asset management plans. It was expected that cities with asset management plans would be responsible for maintaining more road mileage. This was expected because larger cities typically have more road miles to maintain and are more likely to have asset management plans in place.

6.3 | Site Visits

Six site visits were completed for this study. The purpose of these visits was to determine the local government to be used for a case study. The visits included discussing general information about the local government, infrastructure asset specific information, the current infrastructure management process, and any policy in place that affects asset management.

6.3.1 | City of Perry Site Visit

The City of Perry was the first local government visited. Perry is a city with a population of 16,684. It is the county seat of Houston County, Georgia. Perry is 30 miles south of Macon, Georgia and approximately 105 miles southeast of Atlanta, Georgia. With a population of 16,684 and an expectation to break 20,000 in the next census, contributing factors to Perry's projected growth include the Warner Air Force Base, interstate 75, Frito-Lay, Perdue Farm, and CEMEX Inc. The stormwater management division within the public works department was in the process of deciding on a new software for work order and asset management. Communication between departments was not as prevalent as is desired. Because the city was already in the process of adopting an asset management system for an area of infrastructure, it was expected to be challenging to change the course of the decision-making process by introducing the APWA guide.

6.3.2 | Catoosa County Site Visit

Catoosa County was the second local government visited. Catoosa County is in Northwest Georgia, only 20 miles from Chattanooga, Tennessee. This area receives federal funding because it lies within the metropolitan planning organization (MPO) of the city of Chattanooga. The population of Catoosa County was approximately 66,550 but expected to double by the year 2055. This expected growth is attributed to the growth of Chattanooga and industry growth in Catoosa with the opening of more Shaw factories. Shown in **Figure 23** is the region surrounding Chattanooga that is included in the growth plan for the city. The General Fund covers salaries and general operation, while infrastructure maintenance and improvement projects are almost fully covered by SPLOST and federal funding. Because Catoosa is a county with a larger quantity of assets to manage and is located near Chattanooga, it was not expected to be representative of other small cities and counties in Georgia. Though Catoosa County was not the selected local

government for the case study, the site visit helped to highlight some of the differences between counties and cities in their management of infrastructure.

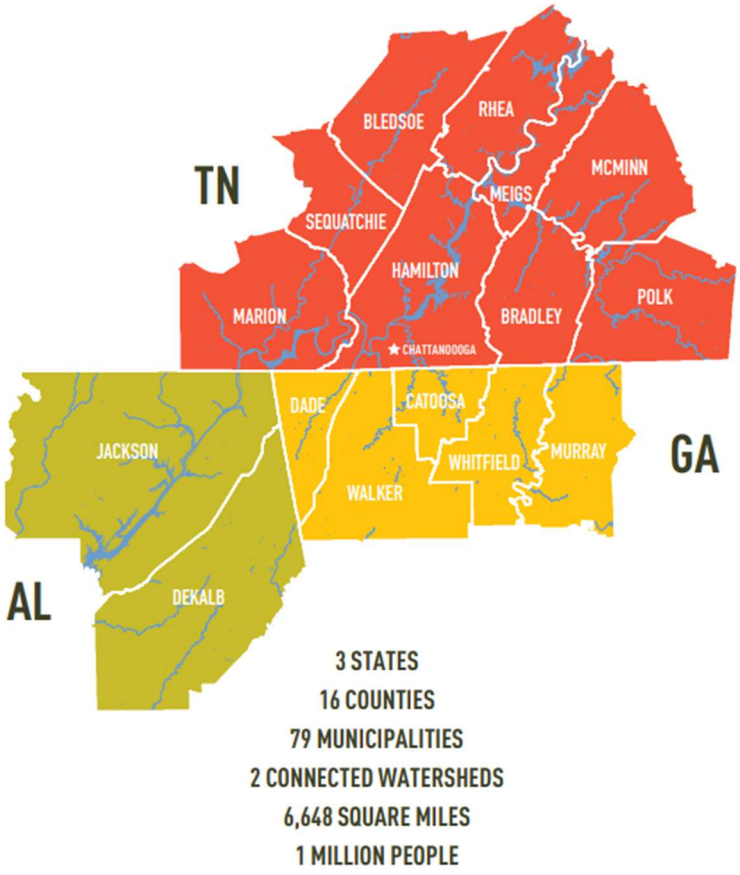


Figure 23: Thrive 2055 Region Surrounding Chattanooga [Thrive 2055, 2015]

6.3.3 | City of Saint Marys Site Visit

The City of Saint Marys, Georgia was the third local government visited in this study. This city in Southeast Georgia is the county seat of Camden County. With over 18,000 residents, the population is expected to continue growing because of the excellent school system, low crime, access to I-95, Naval Submarine Base Kings Bay, and its proximity to Jacksonville, FL (approximately 40 miles). There has been an influx of retirees, specifically, into Saint Marys because of the mild weather, proximity to Florida, and growing retirement community

development. The City of Saint Marys desired to change software from what was currently in use for the management of infrastructure. Saint Marys was revitalizing the downtown waterfront area of the city. Projects associated with this have received funding and other resources from routine maintenance and management of other infrastructure. Although Saint Marys desired to better their management system, the city was potentially too large for the case study in mind.

6.3.4 | City of Hartwell Site Visit

The City of Hartwell, Georgia was the fourth local government visited in this study. This city in Northeast Georgia is located near Lake Hartwell, the Hartwell Dam, and approximately 110 miles from Atlanta, Georgia. With a population of approximately 4,469, Hartwell has amenities that are generally not seen in cities of its size because of the traffic they receive from the popularity of the lake during the summer. While the population of Hartwell is not expected to increase, the population of Hart County is expected to increase. This likely means that the City of Hartwell will experience more traffic as it is the hub for shops, restaurants, and other attractions in Hart County. Hartwell is an Archway community. The Archway program provides resources from the University of Georgia to cities and counties in Georgia who partner with them. Thus, the city of Hartwell has experience working with the University of Georgia students on projects. Because of this, the city had an inventory project in mind that they would like to have students help with. The project that the city has in mind is related to infrastructure asset management. Though the inventory project would be affected by a strategic asset management plan, it will not be a goal of the work completed in this study.

6.3.5 | City of Covington Site Visit

The City of Covington, Georgia was the fifth local government visited in this study. Covington is located approximately 35 miles southeast of Atlanta, Georgia. It is just outside the MPO of the

Atlanta area has a population of 14,015. Because of its proximity to Atlanta the traffic received by this city is greater than most cities of its same size. Covington provides more utilities, including gas and electricity, and other services to its residents than is typical of stand-alone cities of this size in Georgia. The department heads representing gas, electricity, GIS, water/sewer, streets, and general public works were present in the meeting held during the site visit. This meeting included discussions of desires for the asset management system, asset management software, and concerns with the current decision-making process. It is likely that the City of Covington would be able to create a strategic asset management plan for its infrastructure because of available funding and a general desire for a more straight-forward plan. Additionally, Covington was in the process of adopting the asset management module within HiperWeb on top of the work order management module that is already in place. Because of the advanced state of the asset management implementation process and the fact that Covington is better equipped than most cities of its size, a case study here would not be as representative of other small local governments in Georgia.

6.3.6 | City of Sandersville Site Visit

The City of Sandersville, Georgia was the sixth and final local government visited in this study. Located approximately halfway between Atlanta and Savannah (130 miles from each) and approximately halfway between Augusta and Macon (60 miles from each), Sandersville is considered a stand-alone city that is not heavily affected by any other cities. Sandersville ("Kaolin Capital of the World") was developed around the kaolin industry. Kaolin is mined and used in many products ranging from paper to medicine. However, the kaolin industry has changed in recent years making the kaolin found in Georgia less valuable and thus causing a decline in the population of Sandersville. This is a problem encountered by many small cities that contain once thriving industry that is now no longer viable. The population of Sandersville was estimated to be

5,571 as of 2017. There are goals and objectives outlined within the city's budget document that are specific to each department in public works. These goals and objectives can be used to build the strategic asset management plan for their infrastructure. The infrastructure was not inventoried or mapped, and the software in use is not optimized. There was no road rating system in use.

6.3.7 | Case Study Decision

The case study was determined based on the population, population density, proximity to other cities, and enthusiasm about a road asset management system. Local governments were given higher priority for population that would reflect more small local governments in Georgia, location far enough from a densely populated urban area to be considered independent, and high enthusiasm about a road specific asset management plan. The six site visit locations with their color-coded potential levels are depicted in **Figure 24** with the size of their local government represented by the size of the circle.

Sandersville was determined to be the best choice for the case study. A city that is not adjacent to any larger city and has a population of 5,571 shows the challenges of a small city with the resources consistent of other small cities. Sandersville is an Archway community and has experience working with UGA on projects meant to benefit the city. The public works director agreed to be the asset management champion and help develop the asset management plan. Sandersville desired help with its roads because of the struggle to get proper funding from LMIG.

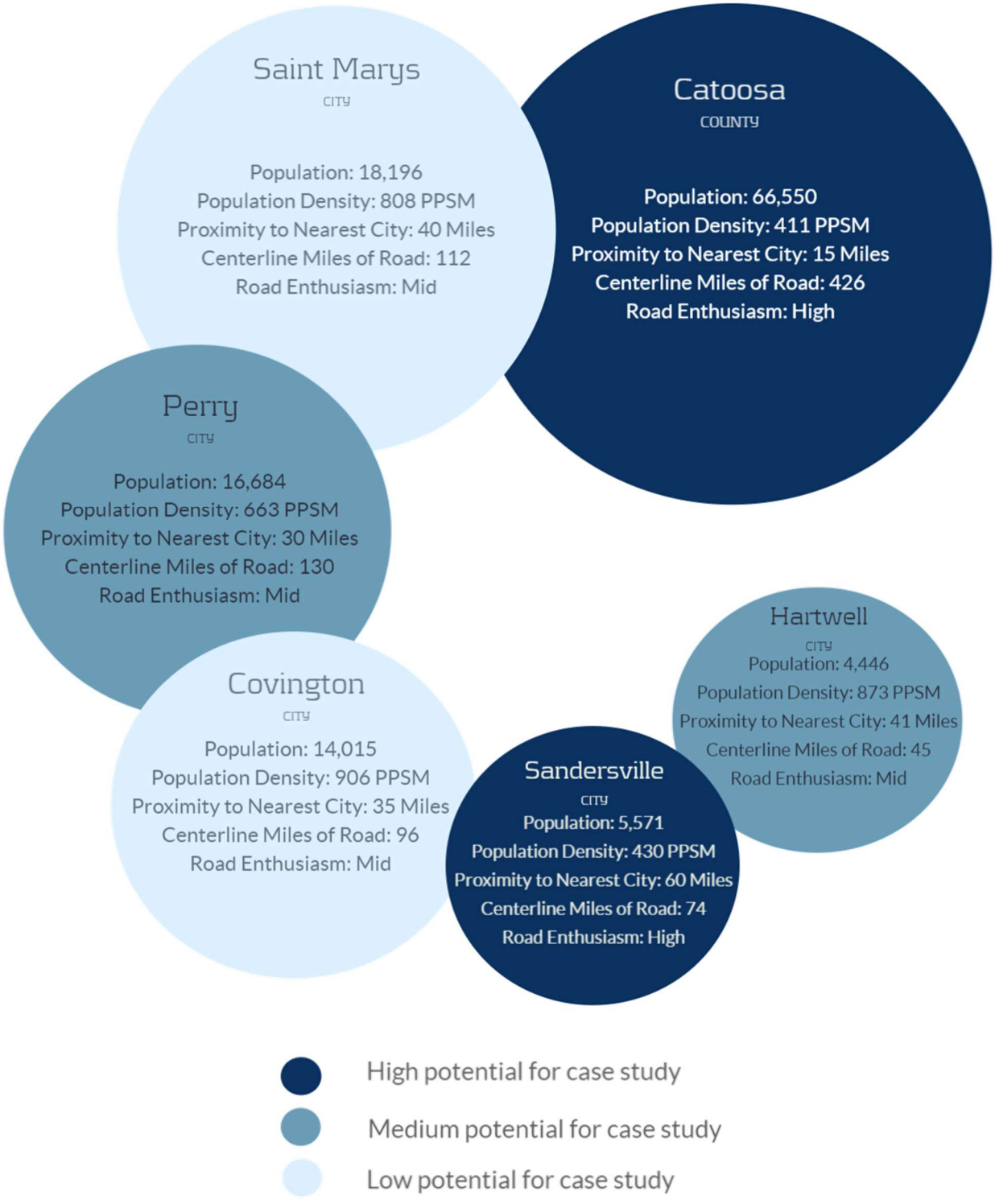


Figure 24: Case Study Determination

6.4 | Case Study

Using the APWA *Guide to Successful Asset Management System Development*, asset management policy principles and objectives were defined and a strategic asset management plan for the public works department was created for the Sandersville Public Works Department. An asset management plan was then created for the road system in Sandersville following the guide.

6.4.1 | First Case Study Visit

The first case study visit occurred on September 11, 2019. This visit consisted of a meeting between the public works director, Robert Eubanks, the city administrator, Judy McCorkle, and the Archway representative for Sandersville, Conni Fennell-Burley. Prior to the meeting, an email was sent to the three individuals containing a copy of the APWA guide and a proposed schedule of events for the case study. The original schedule planned that the case study would take approximately three and a half weeks and be completed by September 27, 2019. This schedule was ambitious and was ultimately modified in order to achieve the project objectives.

The APWA guide was explained to McCorkle, who was not in attendance during the site visit to Sandersville. She was responsible for creating the budget document for the City of Sandersville, which was practically nonexistent before she began working there. Five long-term goals are defined within the 2019 budget as follows:

I. "Protect and improve the financial integrity of the city
II. Maintain a safe and secure environment for our citizens and their property
III. Provide excellent customer service in all service areas
IV. Encourage economic development and growth in our community
V. Promote a healthy quality of life by being good stewards of our environmental resources" [City of Sandersville, 2019]

There are short-term goals defined within each department that align with the long-term goals. There are two short-term goals for the public works administration, three for the streets, and six for other public works related departments. These goals were reviewed in the meeting and confirmed as guiding principles for the City of Sandersville. It was then explained that asset management policy would be determined based on the policies and goals within the budget document. The comprehensive plan for Washington County was discussed as well, but it was determined that the goals defined within the budget document were in alignment with this plan.

The activities for the next meeting were then explained and approved by the meeting attendees. The next steps at this point were to define asset management policies and objectives using the APWA guide and the City of Castle Rock Public Works Department's SAMP as references and begin to organize them into a document that will become the Sandersville Public Works Department's SAMP. The researcher created the SAMP between the first and second meetings.

6.4.1.1 | Development of Sandersville Public Works Department SAMP

The budget long-term and short-term goals outlined within the Sandersville budget were reviewed using the APWA guide to create policy principles and objectives for the city that specifically relate to asset management. A document called *Strategic Asset Management Plan*, cover depicted in **Figure 25**, was developed and provided to the City of Sandersville's public works department. This document was written to define the asset management policy and objectives for the department. It should be used by each asset management team within the department to build specific asset management plans for infrastructure managed by the city.

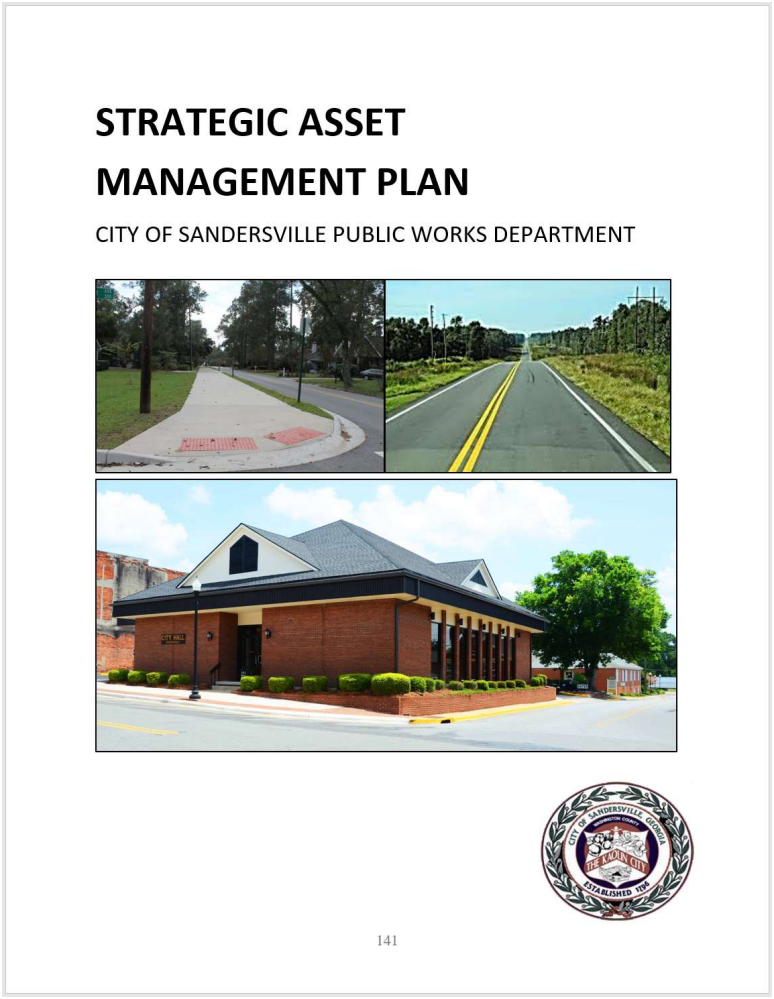


Figure 25: Sandersville Public Works Department SAMP

The SAMP first defines value that can be applied to all assets in the city. There are five value categories:

- Lowest Total Life Cycle Cost
- High Safety Rating
- Low Environmental Impact
- High Efficiency
- High Durability and Sustainability

The asset management policy principles and objectives promote the value categories as well as the long-term goals of the city. This ensures that the public works department is not wasting time and resources on activities that do not support the long-term direction of Sandersville.

Each policy principle within the SAMP can be tied to at least one of the five long-term goals from the budget document and the five value categories. For example, the first policy principle is, "Asset management plans will be created for each type of infrastructure managed by the public works department" [Dickey, 2019]. Asset management plans promote the proper management of infrastructure, increasing lifespan and efficiency, lowering total cost, and improving sustainability and durability. Therefore, this principle ties to the long-term goals I, II, and V and should promote all five of the value categories.

The SAMP should be reviewed and updated at time intervals set by Sandersville's public works department to ensure alignment within the department. A timeline should be created based on this plan outlining the expectations and deadlines for individuals and departments within public works.

6.4.2 | Second Case Study Visit

The second case study visit occurred on September 23, 2019. The main purpose of this visit was to review the SAMP created after the first meeting and discuss its influence on asset management in the street department.

The second meeting was scheduled with all three of the first meeting attendees, but only Robert Eubanks was available. This was determined to be acceptable as he would be the primary person responsible for the creation of the asset management system within the public works department. The road conditions had not been assessed for more than 3 years and was no longer useful. The previous assessment had been done by an outside source which was not repeatable by

Sandersville. The road management activities basically consisted of responding to work order requests concerning the streets when resources were available. After a brief discussion of the current state of the Sandersville road system and the asset management activities that were in place at the time, it was determined that the roads should be visually inspected for surface defects in the next visit.

A system for rating the roads was created after the second meeting. This provided guidelines for an important task in the Sandersville asset management system. The road ratings will assist with decision-making on road repairs and replacements within the department. Public works professionals in the streets department will be able to use the road ratings to assist with explanations to public officials about the prioritization of roads. Streets professionals now have the ability to reevaluate the roads in a similar manner on the determined intervals. This is an important step in the formation of a road management plan in Sandersville as they do not have a system for road rating and do not contract out for this task.

6.4.3 | Final Case Study Visit

The final case study visit began September 30, 2019 and ended October 2, 2019. The visual road rating process began on the morning of September 30th. The rating process lasted approximately seven hours on the 30th and seven hours on the 1st. A meeting between the department heads as selected by Robert Eubanks was held on October 3, 2019 to discuss the SAMP created for the public works department and future steps. This section provides detail on the road rating and the final meeting.

6.4.3.1 | Sandersville Road Ratings

The road rating criteria document and the visual inspection results can be found in **Appendix C**. The process outlined in section **5.4.2.1** was followed over two days of road rating examination in

Sandersville. The road system (depicted in **Figure 26**) was driven and assessed with the Street Department Superintendent, Wayne Johnson. The process, results, and pictures for this road rating system were shared with Johnson and Robert Eubanks. This provides Sandersville with the necessary tools to recreate the rating process in a way that will be directly comparable to the rating completed during the case study. Additionally, recommendations for the improvement of the rating system are also included in this section.

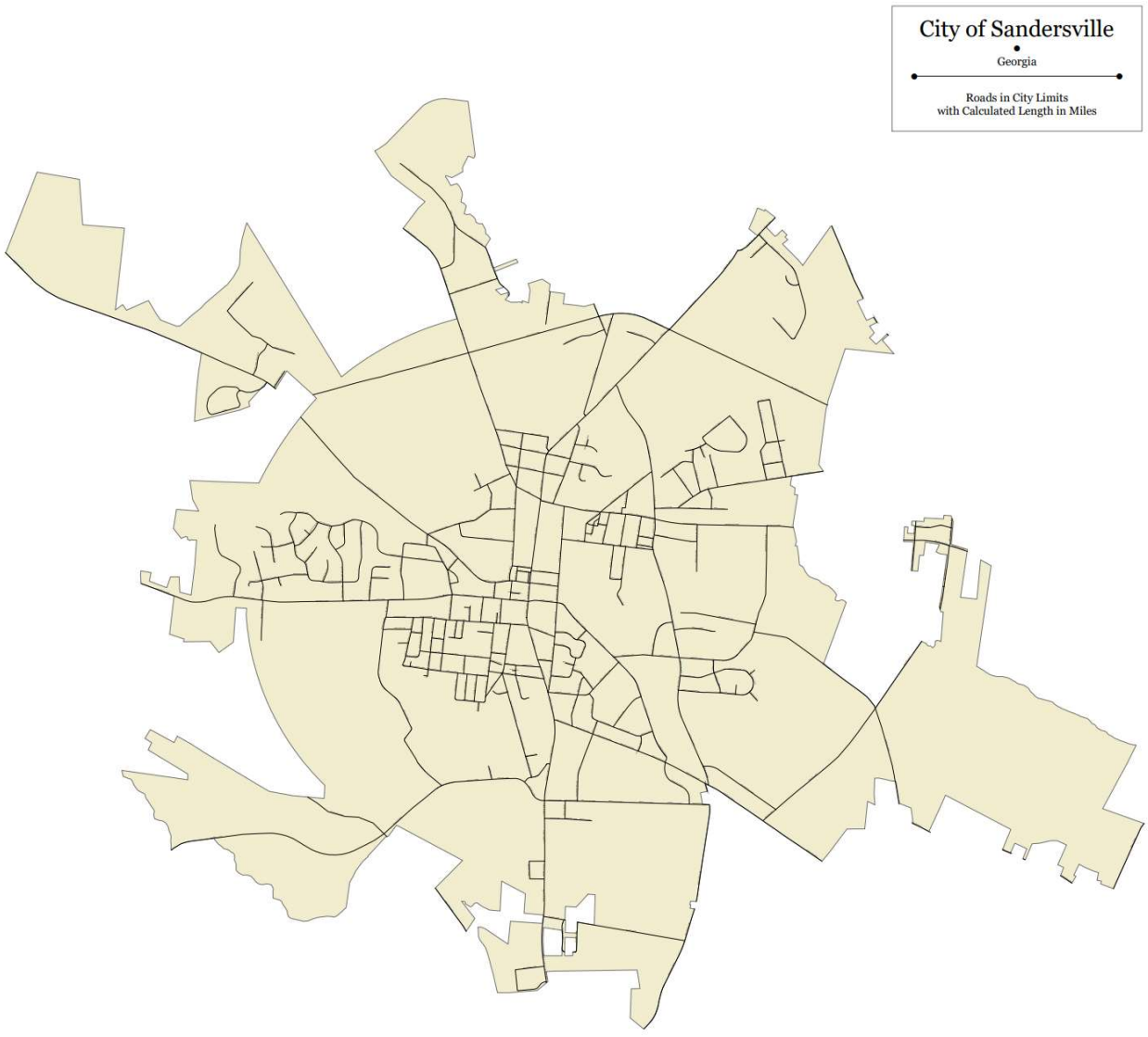


Figure 26: Sandersville Road System

The roads in Sandersville were divided into the following three categories: local, collector, and arterial. Local roads are defined as roads that carry the least amount of traffic at generally low speeds. Local roads that affect more households and businesses should be considered higher priority. Collector roads are defined as roads that collect traffic from local roads and connect them to arterial roads. Collector roads generally affect more people than local roads. Arterial roads are defined as major roads that are expected to carry large amounts of traffic. These roads should be given the highest priority in Sandersville because there is no responsibility for maintenance on freeway type roads. The roads types as freeway that pass through Sandersville are all maintained by GDOT. The average road ratings for the three different types of roads are depicted in the **Table 10**. The quantity of households and businesses directly affected by the local and collector roads were counted and the average number of each included in the table.

Table 10: Sandersville Road Rating Summary

Road Type	Centerline Mileage	Average Road Rating
Local	44.01	80.68
Collector	7.38	81.18
Arterial	9.47	86.12
Total	60.86	82.66

The average road ratings overall were higher than expected. The roads were rated based on the distress and the severity of the distress as outlined in section **6.4.3**. This simple method provides a rating basis that is helpful but can be improved to better reflect the conditions of the road system. The original method has the potential for rating a road with multiple low severity distresses and a road with one high severity distress the same rating. Some comments and pictures help account

for this with the original method. However, taking pictures requires more time, thus an addition to the method is included that will improve the system for future ratings.

The recommendations for the further development of the road rating system will reflect the distress in the roads more accurately. These recommendations were provided to the Sandersville Public Works Department. The distribution of the road ratings is presented in **Figure 27**. This shows that the distribution is close to normal with a slight left skew. With the condition of the roads in Sandersville not at an optimum state, the ratings should help reflect the true state of the roads in a way that assists public works officials in explaining their need for funding and why they perform certain tasks. The rating was determined to not accurately reflect the area of each road covered by the distress. It is predicted that if this rating was added, the ratings would be more helpful in reflecting a traditional letter grade for roads.

After calculating the road ratings and average road rating, it was determined that there should be two ratings for each distress type, one for severity and one for density or frequency of the distress. The severity rating would be the same as the rating practice in place. The additional density rating is recommended to be rated as a percentage of the road section that is affected by the distress type. This rating would be a factor ranging from 1.0-2.0 that would be multiplied to the severity rating. For example, a road with moderately severe raveling covering 50% of the road would be given a severity rating of 4 and a density factor of 1.5, thus making the total distress rating a 6 and accounting for the coverage of the distress. This would shift the distribution lower on the rating scale. Sandersville was provided with a new visual inspection spreadsheet accounting for the changes that is recommended for use in future road rating activities. The road ratings provided information that the city did not have prior to the case study. The presence of different

surface distresses was recorded, and a baseline road rating was created. This can be used in the asset management planning to create target goals and determine priorities with.

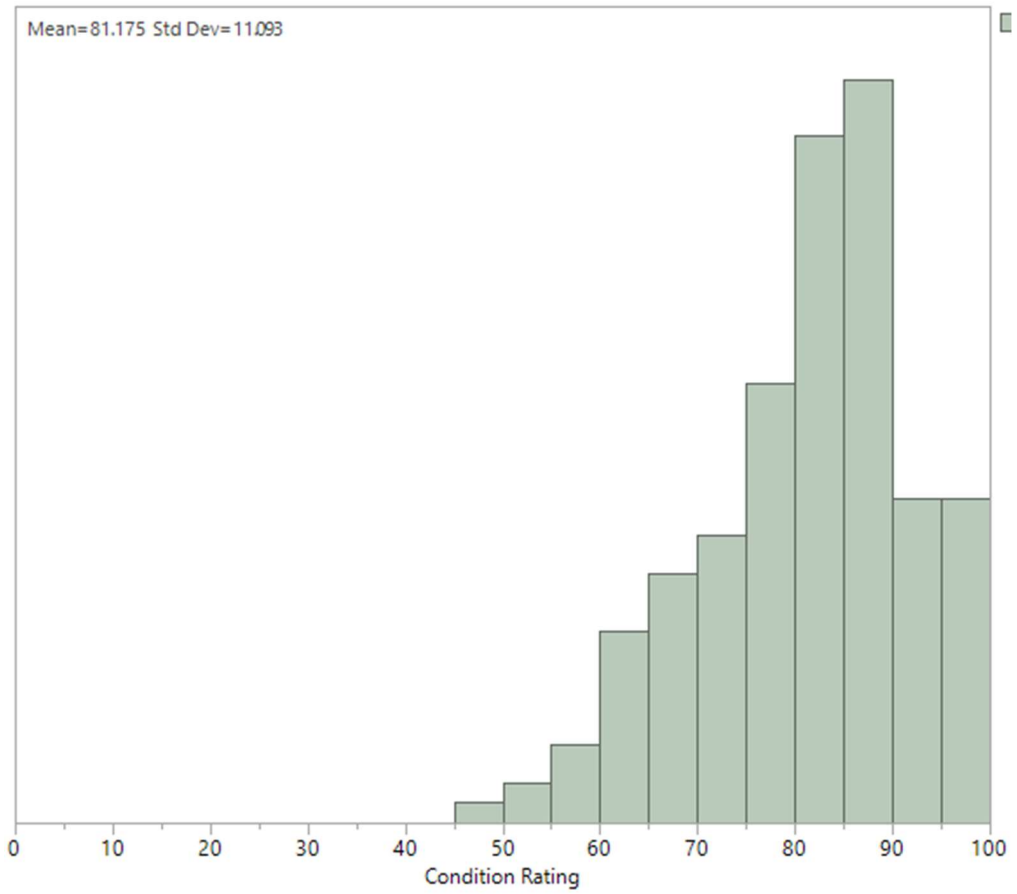


Figure 27: Sandersville Road Rating Distribution

6.4.3.2 | Final Case Study Meeting

The final meeting held with Sandersville included the directors of each department within public works as follows:

- Public Works Director - Robert Eubanks
- Public Works Administrative Assistant - Belinda Rhodes
- Street Department Supervisor - Wayne Johnson
- Street Maintenance Supervisor - Antonio White

- Fleet Maintenance Mechanic - Otis Taylor
- Waste/Wastewater Supervisor - Seaborn Street
- Electric Director - Wayne Poole

This meeting focused on reviewing the SAMP with all of the departments related to the public works in Sandersville. Eubanks compiled the inventories for each department as supplied by insurance companies for the department heads to review and update. He set a date for the final updates. Implementing an inventory for each asset class in HiperWeb was discussed. Rhodes acquired the task of scheduling a meeting with the HiperWeb representative for Sandersville to discuss using HiperWeb for inventories. This is a significant step in the asset management system of Sandersville. Each of the department heads was tasked with creating a list of the information that they would need to track in their respective inventories. It was made clear that the information collected drive action, e.g. condition ratings driving when to repair. There should be a guiding reason behind all data collected.

6.4.4 | Development of Road Specific Asset Management Plan

As previously mentioned, an asset management plan specifically for the road system in Sandersville was the only plan created because of time constraints for this study. The road specific asset management plan was created after all the case study visits were completed. The *Sandersville Street Department: Asset Management Plan*, cover depicted in **Figure 28**, is located in **Appendix E**. This plan was then shared with Robert Eubanks and Wayne Johnson for their use in Sandersville. This document is meant to be a living and changing document as factors within the government change. The SAMP should be reevaluated each time changes are made to local government's governing documents like the budget or comprehensive plan.

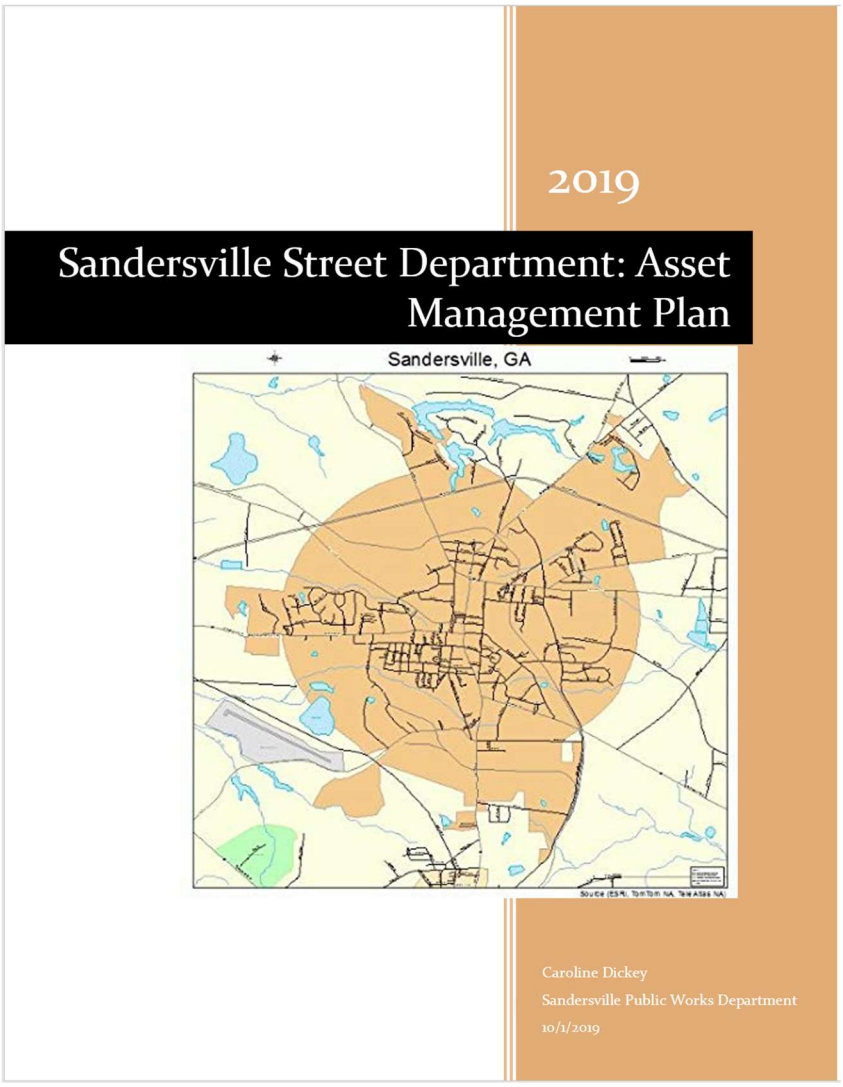


Figure 28: Sandersville Street Department Asset Management Plan Cover Page

The fourth and final section of the APWA *Guide to Successful Asset Management System Development*, **Asset Management Plan(s)**, along with the Sandersville SAMP guided the creation of the plan. The plan was created for the whole street department which manages the road system, storm drains, ditches, sidewalks, rights-of-way, and cemeteries. The plan first provides an overview of each asset and defines value for assets in each section of the department as well. The values defined in this plan build on the value defined for all infrastructure assets in the Sandersville

SAMP. The roles and responsibilities of each department are then defined so that there is no confusion about which sections of the department are responsible for which tasks.

The asset management plan then explains assigning a safety rating to each task in the street department. Safety ratings give higher priority to activities that affect the health and safety of the community. As a safe environment is the most important service a public works department can provide to its community, determining a good way of making safety the first priority is essential.

Next, the information to be collected for the inventory of each asset is defined. Each data point should be useful to the city in determining necessary qualities of the asset, providing information to appropriate authorities, or maintaining the value as defined earlier in the plan. The inventory for roads, sidewalks, and storm drains & ditches are laid out in the "Asset Inventory" section. These are subject to updates as each department determines their useful data.

The "Inspections" section of the street department asset management plan covers the rating systems for each asset class and the inspection schedule. The road rating system as defined in sections **5.4.4** and **6.4.4** is explained in this section. A conversion table, depicted in **Table 11**, for the road ratings to star ratings for a summary of the overall state of infrastructure assets is provided in this section. This method was used in the City of Castle Rock's Transportation Infrastructure Report Card to translate all the ratings performed by the transportation department to a comparable rating [City of Castle Rock Public Works Department, 2018]. There is a similar table for sidewalks and their ratings. Following the rating system definition in the document, the goal road ratings for each type of road are presented. The goal road ratings represent the desired levels of service for each type of road, with the roads subjected to the most traffic at higher levels than the local roads.

Because the Sandersville Street Department constructs and maintains assets other than streets (mentioned previously in this section), the Street Department was instructed to complete

the remainder of the rating portion of the inspection section to reflect their goals. For example, a rating system for the storm drains could include a structural adequacy rating as well as a rating for debris present. The scope of this study did not cover assets aside from the road system; thus, this task is delegated to the city.

Table 11: Conversion Table for Road Ratings

Visual Inspection Rating	Verbal Rating	Star Rating
0-30	Failing	0 Star
31-50	Very Poor	1 Star
51-69	Poor	2 Star
70-84	Fair	3 Star
85-90	Good	4 Star
91-100	Excellent	5 Star

Finally, there is the inspection schedule that is presented in **Table 12**. This schedule was determined based on Sandersville's limited personnel and presence of work orders and right-of-way maintenance which generally drive storm drain and ditch maintenance. The frequencies included in this table were determined based on suggestions from the public works director and the APWA guide. The frequencies should be updated as necessary if the wait time between inspections is too long.

Table 12: Inspection Schedule

Asset Class	Start Date	Frequency
Roads (by City)	09/30/2019	Biannually
Roads (by Engr Firm)	01/05/2020	Every 3 Years
Sidewalks	01/05/2020	Biannually
Storm Drains	01/05/2020	Annually
Ditches	01/05/2020	Annually

6.5 | Small Jurisdiction Asset Management Resources

The creation of one asset management plan in the City of Sandersville was both straightforward in the high-level definition of goals and convoluted in the logistical process of implementing the

system. The researcher in this study acted as a consultant would for this type of plan building. Large government entities contract the work of defining and implementing their plans. When resources are more limited, this is not a feasible option. The APWA guide was beneficial in the general definition of parts of a successful asset management system. However, the City of Sandersville would not have had the employee time available to dedicate to determine an action plan for the use of the guide. Local governments with limited resources to dedicate to building an asset management system in addition to maintaining their infrastructure would benefit from more specific guidance in the creation of a system. The supplemental resources for local governments with limited resources to implement an asset management system using the APWA guide were compiled into two simple documents: *Step-by-Step Asset Management* (**Appendix F**) and the *Making Asset Management Software Decisions* (**Appendix G**) decision tree.

6.5.1 | Development of Step-by-Step Approach for Asset Management Plan Implementation

The need for a step-by-step approach for asset management plan implementation was realized while working with Sandersville on the case study. This step-by-step approach is meant to be used along with the APWA *Guide to Successful Asset Management System Development* as a supplementary document for small local governments. The supplemental document, titled *Step-By-Step Asset Management* with cover depicted in **Figure 29**, was created using the APWA guide, the process of following the guide as completed in this study, and other information gained from this study. The complete document is included in **Appendix F** and was submitted to the APWA for review and potential promotion for use with the guide. There are 13 steps included in the document and it was created to be used with the APWA guide as well as the asset management decision tree presented in the following section.

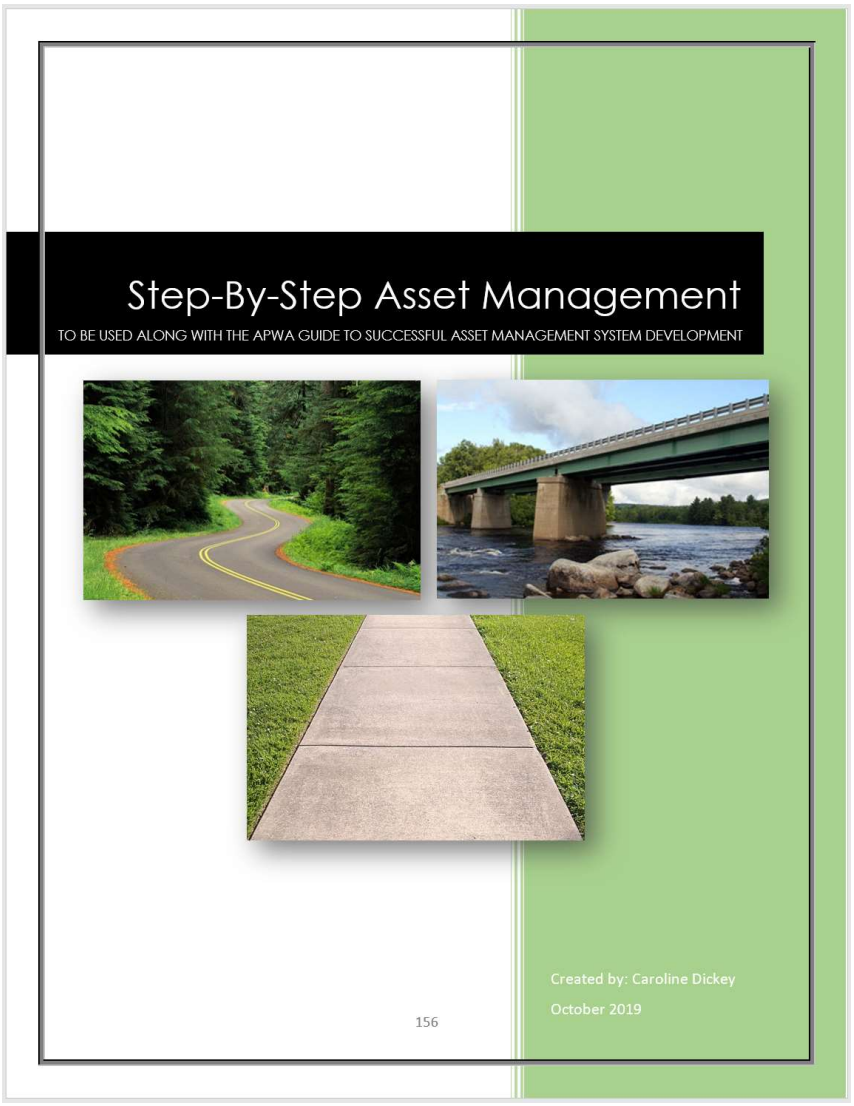


Figure 29: *Step-By-Step Asset Management* Cover

In his interview summarized in section **6.1.4**, Dan Sailer repeatedly mentioned the importance of a Champion in the formation of as asset management system. He recommended that the Champion(s) be "somewhere near the top of the organization, at least at the department level, to really have a strong understanding of the value of trying to organize those resources" [Sailer, 2019]. During the case study, the researcher acted partially in the Champion roles with Robert Eubanks, Public Works Director, acting as a secondary Champion. This was considered when creating the step-by-step document in the first step where determining a Champion was detailed.

The tasks entrusted to a Champion like setting up meetings, building the SAMP document, and delegating tasks to other departments were outlined in Step 1.

The case study in the City of Sandersville involved scheduling one preliminary meeting in Sandersville during the site visit phase of this project where information was gained about the city and three site visits during the case study. Information was gathered and reviewed prior to the first case study meeting. Additionally, a thorough understanding of public works infrastructure assets, asset management practices, and asset management systems was built before attempting to follow the APWA guide. Step 2 covers the preparation stage for the Champion to understand what they will present to other local government professionals. The ability to educate peers on this topic was emphasized in this step.

Upon reviewing the outcomes of the first Sandersville meeting, it was determined that the creation of an asset management system by the local government would require more employee buy-in. Encouraging involvement within the public works department and ensuring that ideas and concerns are considered throughout the implementation process is predicted to lead to better success of the program. Therefore, the first meeting was suggested to be scheduled with more representation from the department and focused on educating the attendees on the importance of the system.

The sections of the APWA guide were referenced throughout the document beginning in Step 4. The process for determining asset management policy for the local government was outlined in this step. As predicted in section **5.5**, additional guidance for local governments that do not have solid guiding documentation in place was determined to be beneficial. Both cases were covered in the fourth step. The use of the APWA guide was recommended for use in this step by local governments who face either case.

Local governments were directed to the APWA guide for the development of asset management objectives in Step 5. The focus of the second asset management meeting was defined in Step 6 and given a general scheduling suggestion to allow enough time for the Champion to compile asset management policy and objectives.

Next, local governments were again directed to the APWA guide for the development of a strategic asset management plan for the public works department in Step 7. The third meeting was outlined in Step 8 where the focus would be to review the first draft of the SAMP. In the APWA guide, it is made clear that there can be any number of individual asset management plans created by the local government. It was suggested that the third meeting should cover the development of asset management teams where necessary. If multiple departments are meant to work together on an asset management plan, the team would be created during this meeting.

The SAMP was recommended to be completed in Step 9, which is the time between the third and fourth meetings. In Step 10, the fourth meeting would focus on reviewing the final draft of the SAMP and determining actions based on its completion. The fourth meeting was given a scheduling suggestion that provides a shorter break than between other meetings as it should be straightforward to complete the SAMP using the APWA guide.

Step 11 was created to suggest an evaluation and approval of each asset management plan created by the asset management teams. The Castle Rock SAMP has an approval signature section that was considered as a reference for this step. This ensures that all plans align with the SAMP and create an asset management system that altogether works for the progress of the local government. This was determined to be a task that needs general guidelines and can be defined specifically by the local government.

Step 12 was used to outline the procedure for deciding on a software that complements the asset management system. The driving motives for this step was to ensure that data collected by the software is useful and to eliminate spending on software that is not beneficial for the local government. The use of the *Making Asset Management Software Decisions* decision tree was recommended for use in this portion of implementing an asset management system. Suggestions for finding a new software were made in this step as well.

The final step in the document was created to direct the local government to review and update the asset management system at a time interval of their choosing. Asset management systems should be created to change with the progress of the local government. To remain relevant and beneficial, a set schedule for updates was recommended.

6.5.2 | Development of an Asset Management Software Decision Tree

Deciding on a software is an important part of the later stages when developing an asset management system. There were multiple cases throughout this study where local governments were unhappy with their current software or looking to implement a software, but unsure where to start. A decision tree was created as a result of this study to assist with asset management software decision-making. The decision tree is titled *Making Asset Management Software Decisions* and is depicted in **Figure 30.** A larger, more legible version of the document is located in **Appendix G.** This document was submitted to the APWA for potential use alongside their *Guide to Successful Asset Management System Development*.

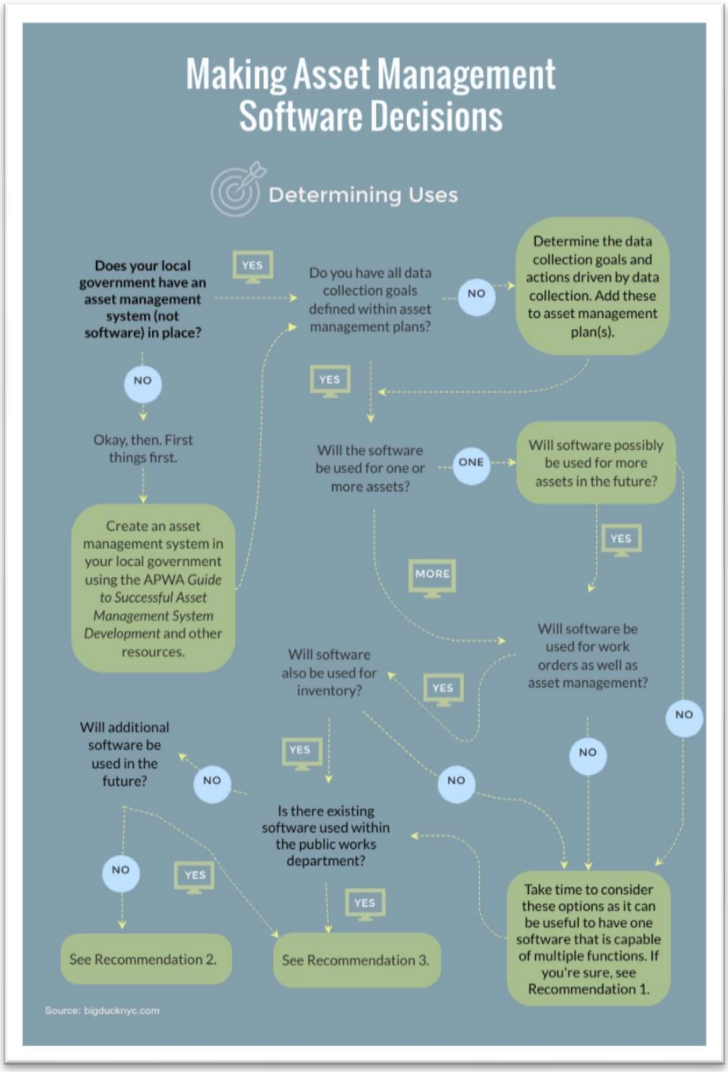


Figure 30: ***Making Asset Management Software Decisions*** **Decision Tree**

This decision tree was designed to assist local governments in defining their intentions and desires for their asset management software. If appropriately followed, the local government will thoroughly consider multiple important options for their desired software. If a software is determined to be beneficial as explained in the *Step-By-Step Asset Management* document, the local government will be directed to one of three recommendations depicted in **Figure 31** and provided more legibly in **Appendix G**. They will then be able to determine asset management

software companies to obtain quotes from based on what data they would like to collect as well as any other functions defined as useful.

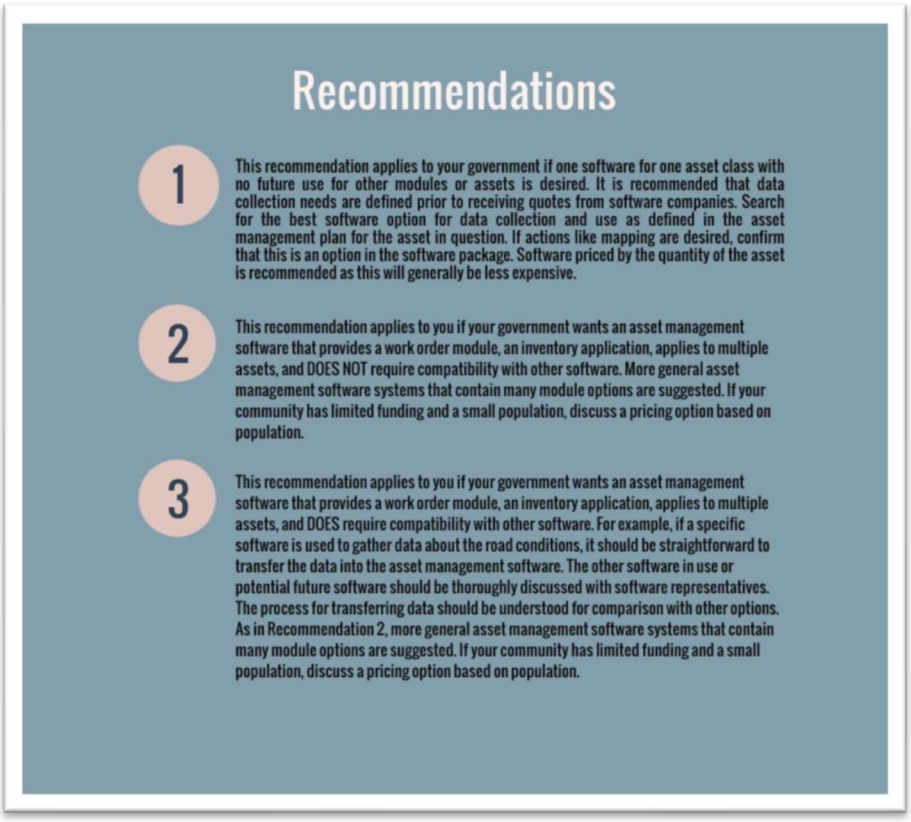


Figure 31: ***Making Asset Management Software Decisions*** **Recommendations**

The pieces of the decision tree were determined based on repeated complaints and concerns of local government officials, information gained from software company websites, and interviewee experiences with software. In casual conversations with many local government officials at APWA Georgia Chapter conferences, complaints were made about software not being appropriate or manageable for their operations. Software was sometimes adopted by one department of the local government and then spread throughout departments though not well suited for all desired tasks. If already in use, the decision tree was intended to help determine whether a software can be adapted for more effective use or could be supplemented by a small package from

another software company. The decision tree document provided a few software options to consider for each recommendation.

6.6 | Education Tactics

When performing the case study, the researcher acted as the asset management Champion for the City of Sandersville as well as a consultant with education in pavement. The researcher scheduled meetings, determined the best way to use the APWA *Guide to Successful Asset Management System Development*, defined asset management policy and objectives, developed a rating system for road assets, and created documents to be used within the City of Sandersville. Because the researcher had a background in engineering and extensively researched asset management tactics prior to building an asset management system in Sandersville, employee training would benefit many small local governments.

Asset management education could be improved upon with a training course provided specifically for local governments attempting to implement asset management systems. The course would cover the basics of asset management, defining assets, asset management, asset management plans, and asset management systems. It would then address the APWA *Guide to Successful Asset Management System Development* and how different types of local governments would best benefit from it. This course would help local governments build an asset management team within their staff and determine whether they have the ability and resources to successfully build a system by themselves or if they may benefit from an asset management consultant. The importance of asset management as well as the process for implementing a system should be made clear to local government agencies in this course. The *Step-by-Step Asset Management* document should be reviewed alongside the APWA guide to provide a comprehensive understanding of the tasks associated with implementing an asset management system.

Training for local governments that do not have staff with a background in engineering is necessary to write appropriate rating systems for different infrastructure systems. The assets with the highest presence in the state should have courses built first. A survey to assess interest in help with particular assets can be created and distributed to local government representatives. This will ensure that the appropriate areas are addressed. Based on the survey in Georgia, training modules for building rating systems and asset management plans for roads, solid waste, and stormwater would benefit the highest proportion of local governments involved in APWA at the time of this research. However, the survey in this study did not question where local governments have the highest need for assistance.

There are a few options when approaching local government training. Two ways to address the education of local governments are training conferences with class options for different areas of asset management or training videos addressing each asset management topic. As smaller local governments tend to have fewer employees and therefore less staff with engineering backgrounds, they will likely need more specific training on developing rating systems for their infrastructure. Additionally, smaller local governments with fewer resources are less likely to have rating systems in place to begin with and would benefit from something as simple as a video walking through the basics of rating each type of infrastructure. It is important to have a way to classify and prioritize infrastructure even if it is simple. The development of a rudimentary rating system acts as a foundation and springboard into better asset management in the future.

7.0 | CONCLUSIONS

Preliminary review of existing infrastructure asset management literature showed that studies comparing asset management system implementation in different types of local governments is not thoroughly researched. The majority of information on asset management assists large organizations such as state departments of transportation or sprawling metropolitan areas. Conclusions determined based on the study include:

- Education concerning the importance of asset management is often lacking. Repeatedly, local governments explained their asset management system by discussing their software use. Though software is a useful tool in an asset management system, a software should not be the strongest driving force behind actions within an organization. This and the fact that the majority of small local governments in Georgia do not have defined asset management systems in place (as determined by the survey results) show that even if asset management education is sufficient, implementation of a system is not understood or emphasized well enough to be reflected in the numbers.
- Infrastructure asset management is different for local governments with different resource levels. Local governments that cannot afford to hire consulting firms to build their asset management plans need supplemental information for their asset management system development. This is especially true for local governments with a limited quantity of dedicated employees to manage tasks on top of limited funds. Simple and straightforward direction for asset management is necessary for these local governments to be more efficient with their time spent building a system.
- This study is beneficial in determining levels of asset management in a state and what tasks need focus. As asset management in government advances and methods improve, the asset

management tactics in local governments will continue to be evaluated and improved upon. This study created tactics for evaluating levels of asset management that can be used and improved upon in future studies.

8.0 | RECOMMENDATIONS & FUTURE WORK

This section contains recommendations for APWA, the City of Sandersville, and other local governments looking to implement an asset management system.

- As the asset management field advances, the tactics used for educating local government officials about asset management systems and their importance should be analyzed and improved upon. The concept of asset management is easy to comprehend, though the importance is typically not fully realized until the infrastructure has begun to crumble and fail for lack of a system. The APWA and other organizations should continually strive for education improvements and advances. To determine if the education methods are having an effect in Georgia, a similar survey to the one in this study can be used to reassess the asset management system knowledge and use levels.
- Building an asset management system is a notable task for any size or type of local government. As mentioned in the conclusions, because smaller local governments have fewer employees available, it makes additional work difficult to assign without a clear path of what to do. The *Step-by-Step Approach to Asset Management* document and the *Making Asset Management Decisions* decision tree developed in this report are suggested for use alongside the APWA *Guide to Successful Asset Management System Development*, especially for local governments with limited resources. The APWA guide is a useful resource for local governments, however, it is providing a guide through the thought process of building an asset management system, while practically, many local governments would benefit from a step-by-step process of how to successfully manage the guide. This was determined to be true as the City of Sandersville benefited from the consultation brought by this research. The consultation supplied the step-by-step

information and direction that helped Sandersville through the beginnings of the process of building an asset management system.

- It is recommended that the APWA state chapters assess asset management knowledge and practices in their state to determine problem areas with asset management in each state. This study can be used as a reference for tactical approaches to investigate asset management in a state. Because this study was completed in an early stage of the asset management focused era, the tactics can be improved upon and streamlined for more straightforward future use. The APWA Georgia Chapter may want to assess its success in improving asset management in the state of Georgia and can use a similar survey in the future.
- As discussed in the literature review, infrastructure report cards are created on national and state levels. Recently, cities have begun to create their own infrastructure report cards. APWA has published a reference document called the *Agency Infrastructure Report*. This document provides a resource for local governments to use when creating a report card of sorts for their infrastructure system. It is recommended that use of this template is promoted in conjunction with the APWA guide as a way to assess infrastructure and locate areas which need focus.

The field of infrastructure asset management is still in its infancy. Asset management tactics and technologies have only become prevalent in the US in recent years. Major movements such as the FHWA requirement for state departments of transportation to have Transportation Asset Management Plans are beginning to push research and development in the field further. There is even a growing market for consulting firms that focus on asset management. However,

the targeted clients are generally large government entities such as large metropolitan cities and state governments. There are not many resources for asset management in local governments with limited resources. As a significant portion of infrastructure is managed by local governments, it is imperative that the importance of asset management systems is fully understood by as many government entities as possible. Proper asset management systems will lengthen the life cycles and raise the levels of infrastructure service, thus saving money. If this can be effectively shared with public works officials, there could be major forward motion in the infrastructure of Georgia and other states. Further research into the best practices and approaches to asset management of different types of infrastructure as well as the entire infrastructure system is needed to move the field forward.

REFERENCES

American City and County. (2017, September 15). Small City, Big Success: A Guide to Infrastructure Asset Management. Retrieved from https://www.americancityandcounty.com/2017/09/15/small-city-big-success-a-guide-to-infrastructure-asset-management/.

American Public Works Association Asset Management Task Force. (2018). Local Agency Asset Management Infrastructure Report. *Final Report*, 12-20.

American Public Works Association Asset Management Task Force. (2018). Asset Management Road Map for Success - Theoretical Design. *Final Report*, 11.

American Public Works Association Asset Management Task Force. (2017). Guide to Successful Asset Management System Development. *Final Report*, 21-38.

American Society of Civil Engineers Georgia Section. (2014). Georgia Infrastructure Report Card. Retrieved from https://www.infrastructurereportcard.org/wp-content/uploads/2016/10/ASCE-GA-2014-Report-Card_Full-Report.pdf.

Cayet, J. *Doing more with less: Buildings and infrastructure as drivers of economic performance* (2016 ed., Global Built Asset Performance Index, Rep.). Arcadis. Retrieved from https://www.arcadis.com/media/B/6/6/{B6614982-7686-41AA-861F-FCEA08A48DE6}Global Built Asset Performance Index 2016_002.pdf

Cayet, J., & Cavalla, A. (n.d.). *Which nations are building the strongest foundations for economic success?* (2016 ed., Global Built Asset Performance Index, Rep.). Arcadis. Retrieved from https://www.arcadis.com/media/8/1/D/%7B81DC63EB-831F-41F3-BB8E-

542031D8E3A6%7D9385_Global%20Built%20Asset%20Wealth%20Index%202015%20UPDATED%20WEB.pdf

City of San Antonio Department of Transportation & Capital Improvements. (2018). Transportation & Capital Improvements (TCI). Retrieved from https://www.sanantonio.gov/TCI/Projects/Infrastructure-Management-Program

Dawe, S. N., & Paradice, D. (2016). *A Systems Approach to Smart City Infrastructure: A Small City Perspective* (Vol. 37, International Conference of Information Systems, Research-in-Progress). Dublin, Ireland: Association for Information Systems. Retrieved from http://iot-smartcities.lero.ie/wp-content/uploads/2016/12/A-Systems-Approach-to-Smart-City-Infrastructure-A-Small-City-Perspective.pdf.

Economic Development Research Group. (2016). *Failure to Act.* American Society of Civil Engineers. Retrieved from https://www.infrastructurereportcard.org/wp-content/uploads/2016/05/2016-FTA-Report-Close-the-Gap.pdf.

Golam Kabir, Rehan Sadiq & Solomon Tesfamariam. (2014). A review of multi-criteria decision-making methods for infrastructure management, Structure and Infrastructure Engineering, 10:9, 1176-1210, DOI: 10.1080/15732479.2013.795978.

Halfawy, M. R. (2010). Municipal information models and federated software architecture for implementing integrated infrastructure management environments. *Automation in Construction*, *19* (4), 433-446. DOI: 10.1016/j.autcon.2009.11.013

International Business Machines Corp. (2007). Asset and service management for municipalities. IBM. Retrieved from https://s3-us-west-2.amazonaws.com/itworldcanada/archive/WhitePaperLibrary/PdfDownloads/asset_management.pdf. 15 October 2018.

Lijun Wei, Derek R. Magee, Vania Dimitrova, Barry Clarke, Heshan Du, Quratul-ain Mahesar, Kareem Al Ammari, and Anthony G. Cohn. (2018). Automated Reasoning for City Infrastructure Maintenance Decision Support. *Proceedings of the Twenty-Seventh International Joint Conference on Artificial Intelligence*, 5877-5879.

McBride, James. (2018). The State of U.S. Infrastructure. *Backgrounder*. Retrieved from https://www.cfr.org/backgrounder/state-us-infrastructure. 10 November 2018.

National League of Cities. (2019). Focus on Small Cities. NLC. Retrieved from https://www.nlc.org/focus-on-small-cities. 20 August 2019.

Pavement Tools Consortium. (N.D.). Pavement Distresses. *Pavement Interactive*. Retrieved from https://www.pavementinteractive.org/reference-desk/pavement-management/pavement-distresses/. 5 September 2019.

Provincial and Local Government Department of the Republic of South Africa. (2006). Municipal Infrastructure: Roles and Responsibilities of National Sector Departments, Provincial Counterparts and Municipalities. Retrieved from: http://www.cogta.gov.za/mig/docs/Municipal_Infrastructure_Roles_&_Responsibilities.pdf. 17 October 2018.

Public Works Department for the Town of Castle Rock. (2018). Transportation Infrastructure Report Card. Retrieved from http://www.crgov.com/DocumentCenter/View/19411/2018-Report-Card?bidId=. 15 March 2019.

Public Works Department for the Town of Castle Rock, CO. (2018). Transportation Infrastructure Report Card - Nutshell. Retrieved from http://www.crgov.com/DocumentCenter/View/19410/2018-Report-Card-NUTSHELL?bidId=. 15 March 2019.

Public Works Department for the Town of Castle Rock, CO. (2017). Strategic Asset Management Plan. Town of Castle Rock, CO.

Public Works Department for Town of Castle Rock, CO. (2017). Strategic Asset Management Plan. Retrieved from http://www.crgov.com/DocumentCenter/View/17459/Department-SAMP?bidId=. 15 March 2019.

Ratchata Peachavanish, Hassan A. Karimi, Burcu Akinci, and Frank Boukamp. (2006). An ontological engineering approach for integrating CAD and GIS in support of infrastructure management. *Advanced Engineering Informatics*, *20*, 71-88. Retrieved from https://doi.org/10.1016/j.aei.2005.06.001.

Patton, M. Q. (2015). *Qualitative research & evaluation methods: integrating theory and practice*: Thousand Oaks, California: SAGE Publications, Inc., [2015]. Fourth edition.

Perry, J., Hutcherson, K., & Hamby, M. (2017). *City of Gainesville, Georgia Annual Budget*. Retrieved from Gainesville, Georgia: https://www.gainesville.org/fullpanel/uploads/files/City-of-Gainesville-FY2019-Annual-Budget-and-Capital.pdf.

Ratcliffe, Michael, Charlynn Burd, Kelly Holder, and Alison Fields (2016). *Defining Rural at the U.S. Census Bureau.* U.S. Census Bureau. Retrieved from https://www2.census.gov/geo/pdfs/reference/ua/Defining_Rural.pdf.

Raessler, Drew. (2019, February 13). Personal Interview.

Rotalsky, Chris. (2019, February 14). Personal Interview.

Sailer, Dan. (2019, March 8). Personal Interview.

Spencer, Jason. (2019, February 15). Personal Interview.

The Institute of Asset Management. (2019). *Knowledge*. Resource page accessed on https://theiam.org/knowledge/.

Welfare Info. (2019). *Poverty in Athens-Clarke County unified government (balance), Georgia.* WelfareInfo.org. Retrieved from https://www.welfareinfo.org/poverty-rate/georgia/athens-clarke-county-unified-government-balance.

Wickert, David. (2018). Half of Georgia counties now pay transportation sales taxes. *Atlanta Journal Constitution*. Retrieved from https://www.ajc.com/blog/commuting/nearly-half-georgia-counties-now-pay-transportation-sales-taxes/2FBB5eYvqFjArtSHt1gOpK/#. 15 January 2019.

APPENDICES

APPENDIX A: Survey Questions

The questions included in the survey are as follows:

1. What range does the population of your community fall into?
    a. Less than 20,000
    b. 20,001-75,000
    c. 75,001 or more
2. How many employees does your public works department have?
3. Which services does your local government provide for citizens? Select all that apply.
    a. Aviation
    b. Bridges
    c. Dams
    d. Drinking Water
    e. Energy
    f. Parks & Rec
    g. Rail
    h. Roads
    i. Solid Waste
    j. Stormwater
    k. Transit
    l. Wastewater
    m. Other
4. Does your local government have one or more asset management plan(s) in place?
5. In a few words, describe the management of your physical infrastructure assets.
6. Do you have funds available for asset management?
    a. Yes
    b. No
7. Are you aware of asset management resources (funding, guidance, software, etc.) available to you?
    a. Yes
    b. No
8. Does your local government have an inventory of any physical infrastructure?
    a. Yes
    b. No
9. What does your local government's inventory of physical infrastructure include?
10. How many lane miles of road is your local government responsible for maintaining?
11. Do you outsource for road rating?
    a. Yes
    b. No
12. Does your local government use any asset management software?
    a. Yes
    b. No
13. What asset management software does your city use?
14. If you have any further comments, please use the space below.

APPENDIX B: Survey Results

The following sections align with the results sections in section 6. Each section presents the full explanation and procedure of the tests performed in the study.

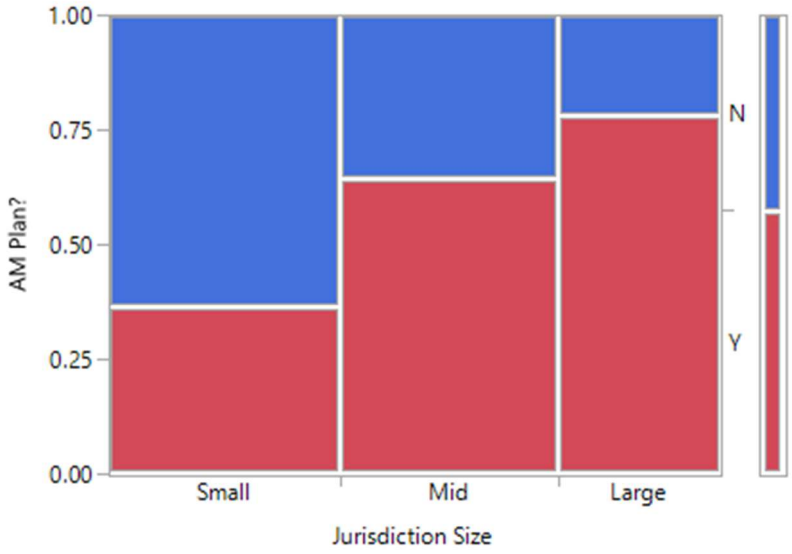
B6.2.1.1 | Chi-Squared Test for City Size and Completion of Survey

For the first Chi-Squared test concerning city size and completion of the survey, it is assumed that the responses are independent relative to what size the city is. The responses analyzed from this survey represent less than 10% of the population of cities in Georgia. It is a large enough sample size that it is expected that 80 percent of the cells had at least 5 counts. This is depicted in the contingency table for this test in **Figure 32**. The results are presented in the figure as well. Therefore, this procedure can be used. Using this procedure explains whether the following tests represent cities in Georgia well. If there is a relationship resulting from this Chi-squared test, this could mean that some size jurisdictions are underrepresented.

Figure 32: Chi-Squared Outputs for Completion vs. Local Government Size

B6.2.1.2 | Chi-Squared Test for City Size and Asset Management Plan

For the Chi-Squared test concerning city size and the presence of an asset management plan, it is assumed that the responses are independent relative to what size jurisdiction. The responses analyzed from this survey represent less than 10% of the population of cities in Georgia. It is a large enough sample size that it is expected that 80 percent of the cells had at least 5 counts. This is depicted in the contingency table for this test in **Figure 33** in the results section. It is expected that larger cities are more likely to have an asset management plan in place.



AM Plan?

Jurisdiction Size	Count / Expected	Y	N	Total
Small		12	21	33
		18.9655	14.0345	
Mid		20	11	31
		17.8161	13.1839	
Large		18	5	23
		13.2184	9.78161	
Total		50	37	87

N	DF	-LogLike	RSquare (U)
87	2	5.4933991	0.0926

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	10.987	0.0041*
Pearson	10.712	0.0047*

Figure 33: Chi-Squared Outputs for Asset Management Plan vs. Local Government Size

B6.2.1.3 | One-Way ANOVA for City Size and Number of Employees in Public Works

For the one-way analysis of variance concerning the jurisdiction size and the quantity of employees in the public works department, the data were not collected in a way that provides independence

between the jurisdiction sizes and the number of employees as these are dependent variables. However, the verification of this fact is desired for the study. The largest sample standard deviation (34.6) is essentially equal to twice the smallest sample standard deviation (17.2), so it was treated as though the equal variance condition was satisfied. The distribution and normal probability plot (in **Figure 34**) for Small cities show some concern about normality, however, the Large cities and Mid cities provide no evidence against normality. Therefore, this test was performed knowing this information

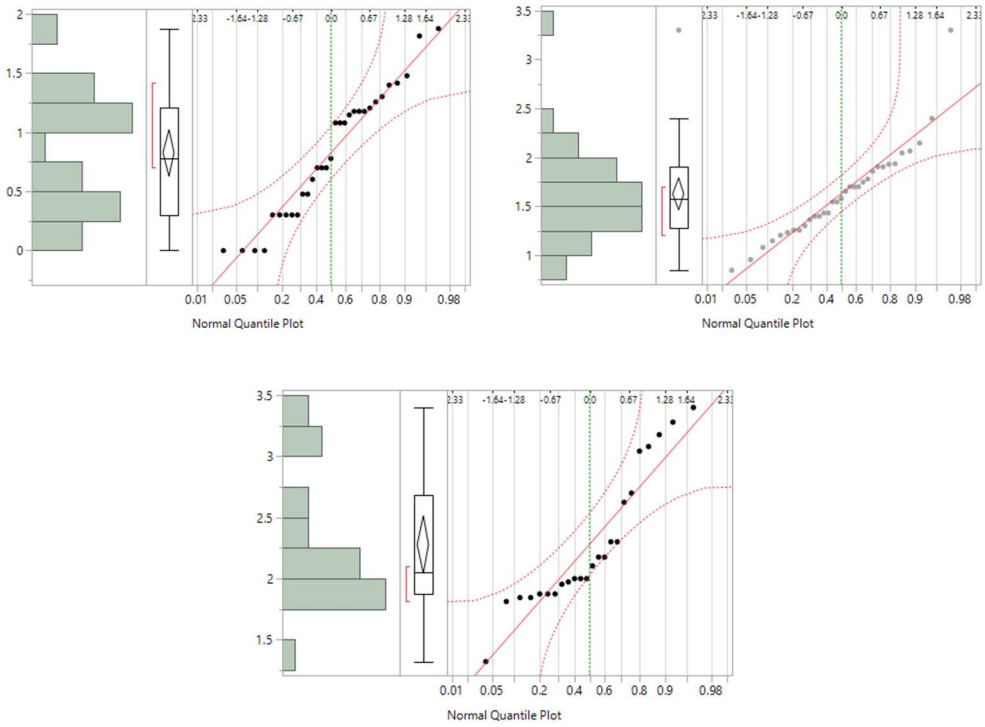
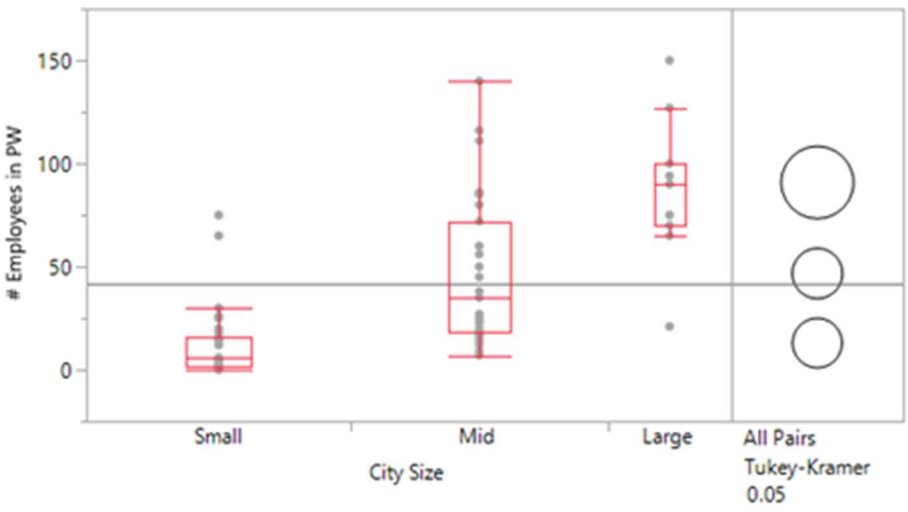


Figure 34: Normal Probability Plot for Log10(# of Employees in Public Works) for Small, Mid, and Large Sized Local Governments, Respectively



Means and Std Deviations

Level	Number	Mean	Std Dev
Small	32	12.96875	17.152982
Mid	31	46.677419	34.590352
Large	15	90.8	33.526535

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
City Size	2	63335.19	31667.6	39.0944	<.0001*
Error	75	60752.14	810.0		
C. Total	77	124087.33			

Connecting Letters Report

Level		Mean
Large	A	90.800000
Mid	B	46.677419
Small	C	12.968750

Figure 35: One-Way ANOVA and Tukey Test for Number of Employees in Public Works vs. Local Government Size

B6.2.1.4 | One-Way ANOVA for City Size and Road Miles

For the one-way analysis of variance concerning the quantity of road miles in cities of different sizes, the data was collected in a way that provides independence between the city sizes and the road mileage. The largest sample standard deviation (513.7) is greater than twice the smallest sample standard deviation (2*184.2 = 368.4), so the equal variance condition was not satisfied. However, testing was performed despite this fact. The distribution and normal probability plot (in **Figure 36**) for Small cities show some concern about normality, however, the Large cities and Mid cities provide no evidence against normality. Therefore, this test was performed knowing this information.

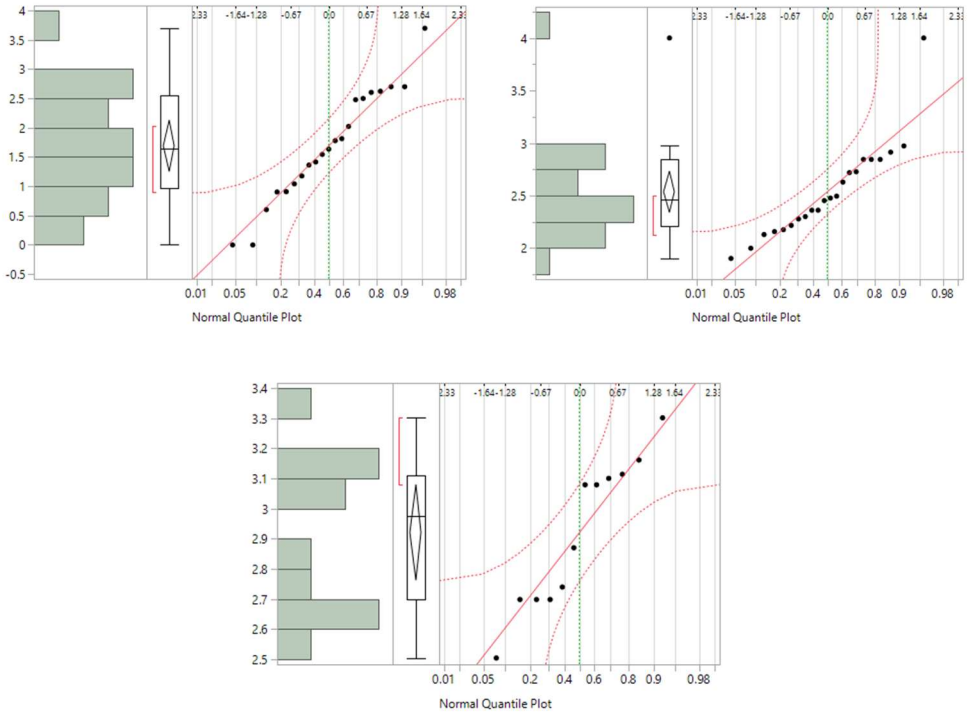
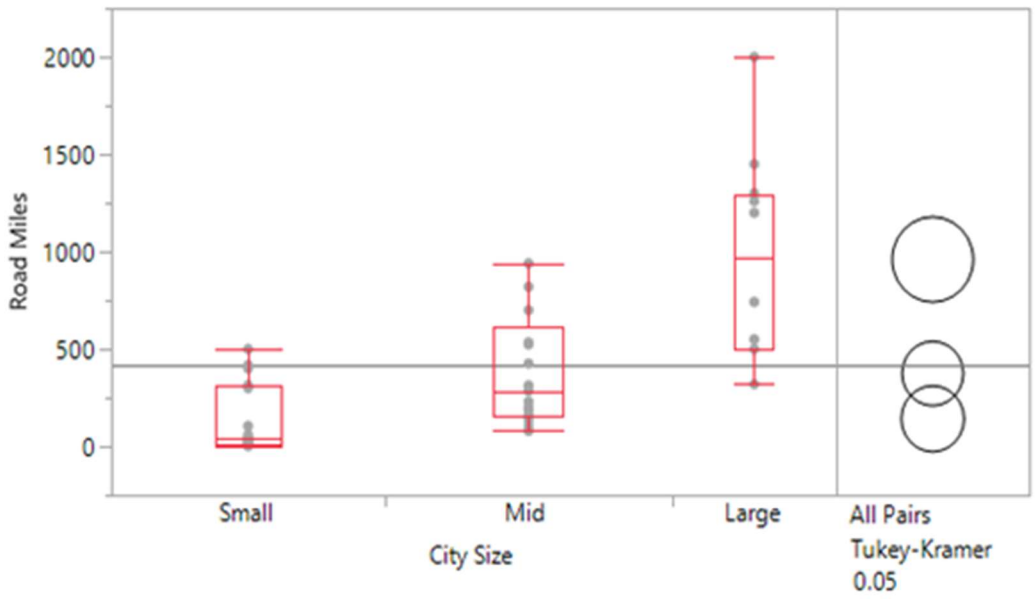


Figure 36: Normal Probability Plot for Log10(Road Miles) for Small, Mid, and Large Sized Local Governments, Respectively



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
City Size	2	5091504	2545752	25.8476	<.0001*
Error	50	4924544	98491		
C. Total	52	10016048			

Means and Std Deviations

Level	Number	Mean	Std Dev
Small	20	141.905	184.22398
Mid	21	374.52381	262.41086
Large	12	960.16667	513.67868

Connecting Letters Report

Level		Mean
Large	A	960.16667
Mid	B	374.52381
Small	B	141.90500

Figure 37: One-Way ANOVA and Tukey Test for Number of Road Miles vs. Local Government Size

B6.2.1.5 | Two-Sample T-Test for Road Mileage in Cities without Asset Management Plans

For the two-sample t-test concerning road mileage in cities without asset management plans, the data was collected in a way that provides independence between the number of road miles and if there is an asset management plan in place. The number of road miles is a quantitative variable while whether there is an asset management plan in place is a categorical variable, therefore, a two-sample t-test was appropriate. The responses to this survey represent less than 10% of the population of cities in Georgia. The normal probability plots and the distributions shown in **Figure 38** and **39** provide no evidence against the normality assumption.

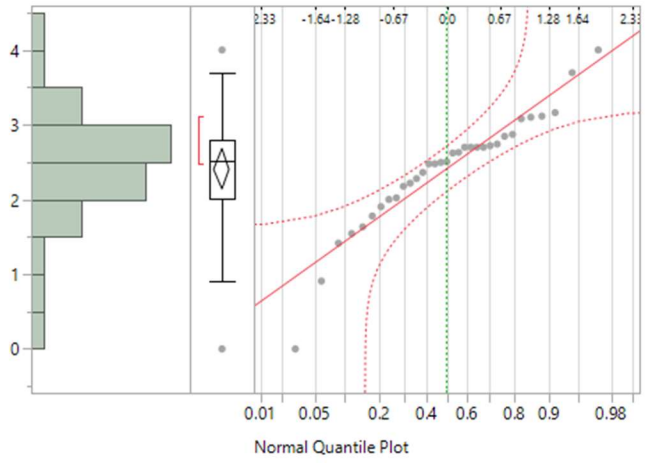


Figure 38: Normal Probability Plot for the Logarithmic Translation of Road Mileage for Local Governments with Asset Management Plans

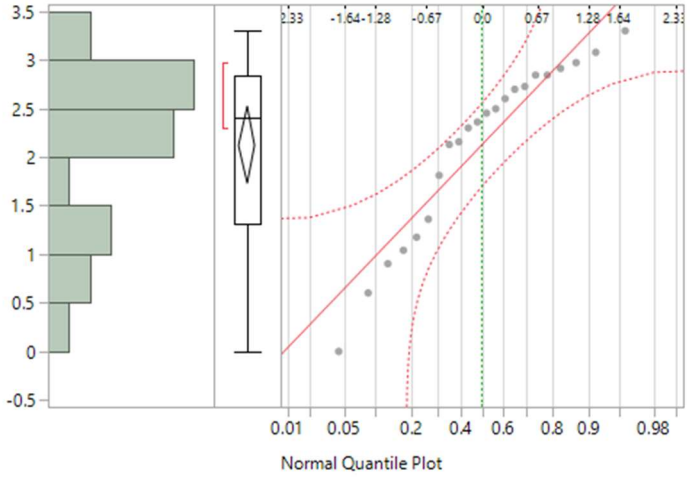
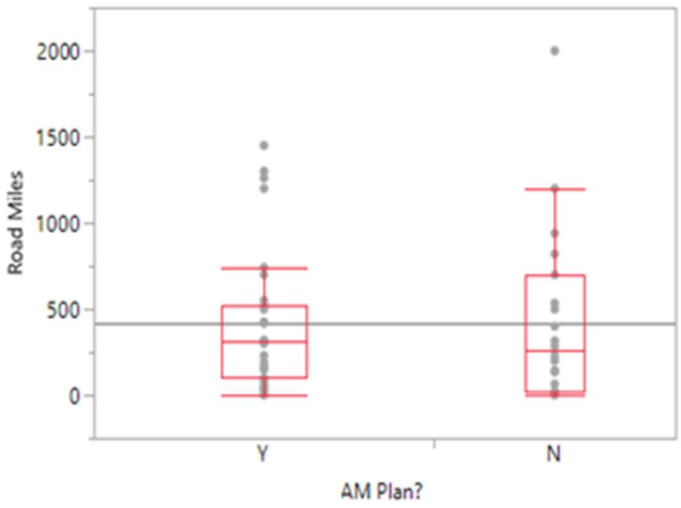


Figure 39: Normal Probability Plot for the Logarithmic Translation of Road Mileage for Local Governments without Asset Management Plans



t Test

N-Y

Assuming unequal variances

Difference	0.27	t Ratio	0.00212
Std Err Dif	127.84	DF	39.47826
Upper CL Dif	258.75	Prob > |t|	0.9983
Lower CL Dif	-258.21	Prob > t	0.4992
Confidence	0.95	Prob < t	0.5008

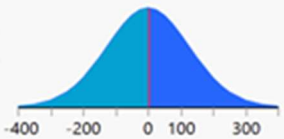
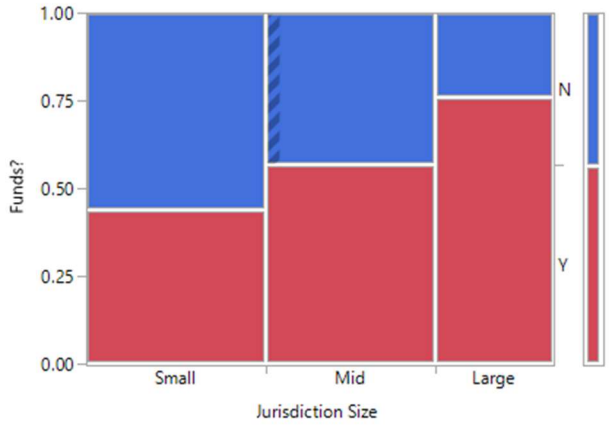


Figure 40: Two-Sample T-Test for Road Miles vs. Asset Management Plan



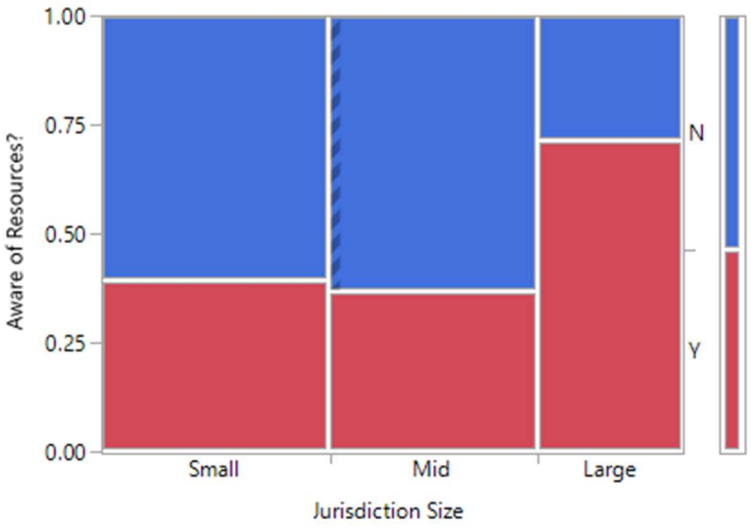
Funds?

Jurisdiction Size	Count	Y	N	Total
	Small	14	18	32
	Mid	17	13	30
	Large	16	5	21
	Total	47	36	83

N	DF	-LogLike	RSquare (U)
83	2	2.8167817	0.0496

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.634	0.0598
Pearson	5.433	0.0661

Figure 41: Local Government Size in Relation to Available Funding



Aware of Resources?

Jurisdiction Size	Count / Expected	Y	N	Total
Small	Count	13	20	33
	Expected	15.3214	17.6786	
Mid	Count	11	19	30
	Expected	13.9286	16.0714	
Large	Count	15	6	21
	Expected	9.75	11.25	
Total		39	45	84

N	DF	-LogLike	RSquare (U)
84	2	3.6057382	0.0622

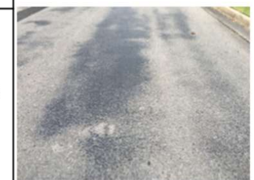
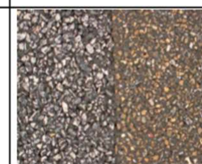
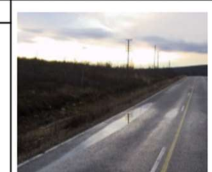
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	7.211	0.0272*
Pearson	7.083	0.0290*

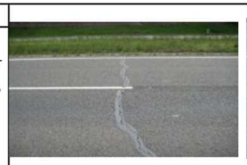
Figure 42: Local Government Size and Awareness of Resources

APPENDIX C: Sandersville Road Rating Spreadsheets

Following are the Sandersville Road Inspection Criteria.

Sandersville Road Inspection Process

DISTRESS TYPE	DESCRIPTION	RESULTING PROBLEMS	PREVENTION/REMEDIATION TACTICS	PICTURES
Surface Defects				
Raveling	Loss of pavement material from the surface down. Slight to moderate raveling includes loss of fines from surface (rated 1-2). Sever raveling includes loss of coarse aggregate (rated 3-5 depending on affected area).	Loose debris, decreased skid resistance	Should be investigated before repairs are made. Sealcoat or thin overlay can protect against further raveling. If in localized areas, remove and patch. If lots of area, remove and overlay.	
Flushing/Bleeding	Excess asphalt binder on surface	Decreased skid resistance	Blot with coarse sand if caught during construction. Major bleeding may need to be cut off or resurfaced	 
Polishing	Smooth surface areas created by traffic wearing down the aggregate	Decreased skid resistance	Sealcoat or thin overlay of skid- resistant material	
Surface Deformations				
Rutting	Surface depression along wheelpath. Can be because of subgrade or mix. Will not be able to tell based on visual inspection	Ruts pull vehicles along rut path. Can lead to excess water held on roads	Heavy rutting should be investigated before treatment. Minimal rutting (<1/3 in deep) should be fine. Deep ruts can be leveled and overlayed.	 
Distortion				
Corrugation & Shoving	Deformation in pavement surface that is exhibited by bumps or odd ripples due to traffic action in combination with other factors. Generally in intersections	Roughness in road. Damage to cars over time and driver complaints	Remove distorted areas and patch (if small). Remove pavement and overlay (if lots of damage).	 
Depression	Pavement surface areas that are lower than surrounding areas	Roughness in road, can hold water	Should be investigated to determine cause of failure. Remove pavement and subgrade and replace (patch).	

Cracking				
Transverse	Cracks perpendicular to road's centerline	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Reflection	Cracks occuring over rigid pavement joints	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Slippage	Crescent shaped cracks, generally with ends pointed in direction of traffic	Roughness in road, allows water infiltration	Remove and replace affected area	 
Longitudinal	Cracks parallel to centerline of road	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Block	Connected cracks that create rectangle shapes in cracks	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	
Alligator	Series of interconnected cracks in a pattern resembling the back of an allligator	Roughness in road, allows water infiltration, eventually turns into potholes and major structural failure if not treated	Small cracking is typically indicative of loss of subgrade support. Replace subgrade if necessary and patch over repaired subgrade. Large areas of cracking indicate general structureal failure. Overlay with strong mixture.	 

Patches & Potholes				
Patching	Area of pavement that has been replaced with new material (always considered a defect)	Roughness in road	Can only be repaired by structural or non-structural overlay	 
Potholes	Bowl shaped depression in pavement surface, end result of fatigue cracking	Roughness in road (could be serious if encountered at high speeds), allows water infiltration	Filled in or patched	 

Following are the Visual Road Rating Results.

SANDERSVILLE VISUAL ROAD INSPECTION

Note: Ratings are based on scales of 0-5 (for less serious distresses) and 0-10 (for distresses that are more likely to lead to structural failure) with a 0 meaning that distress is not found on the stretch of pavement, and the highest number reflecting seRating distresses with high frequency.

					SURFACE DEFECTS			SURFACE DEFORMATIONS		CRACKS						PATCHING/ POTHOLES		CONDITION RATING
Street Name	Total Length	Type	# Households Affected	# Businesses Affected	Raveling (0-5)	Flushing (0-5)	Polishing (0-5)	Rutting (0-10)	Distortion (0-10)	Transverse (0-5)	Reflection (0-5)	Slippage (0-5)	Longitudinal (0-5)	Block (0-5)	Alligator (0-10)	Patches (0-5)	Potholes (0-10)	((85 - Sum of Defects)/85)*100
Alfred C Carson Cir	0.0987	Local	7							3					4	3		88
Alfred C Carson Dr	0.6670	Local	45										3					96
Anderson Ln	0.0575	Local	13		2	2			3	2			2					87
Anthony Dr	0.2221	Local	3					5						2	5		7	78
Apple St	0.1542	No longer exists																
Augusta Alley	0.2139	Local	5						5	2			2	3				86
Avant Way	0.1767	Local	2		3					1			3			2	3	86
B Chapman St	0.5186	Dirt	3															
Baker St	0.1054	Local	3						3	2			2	2		2		87
Beck Blvd	0.3559	Collector	5	4	4			5		3			3	3	7			71
Betty St	0.5377	Local	38							2			2	3		2		89
Booker St	0.0442	Local	2		3			7	9	2			4	4	5	4		55
Boone Cir	0.1183	Dirt																
Briarwood Ln	0.1519	Local	4											4	8	2	7	75
Brookins Aly	0.0949	Local		3	5		4								8	3	9.5	65
Brookins St	0.0947	Local		4						2			2			2		93
Brookwood Ln	0.0144	Local	5		3			5	6									84
Camellia Ln	0.0495	Local	Unknown	1													2	98
Cardinal St	1.2144	Local	1		2		2	5	6									82
Carter St	0.0972	Local	3						7	3			4		7	2		73
Carver Annex	0.0395	Local	1		5										10	2		80
Carver St	0.8825	Local	31		2				8	2			4		8	2	4	65
Center St	0.0280	Dirt																
Clemmon St	0.3931	Local	12						3	3			3	3				86
College St	0.4813	Local	36						6	3			4	5	4	3	2	68
Commerce St	0.0653	Local		3	3				7	2			2	3	6	4	6	61
Cook St	0.0687	Local	14							1			1	1		1		95
Cooley Dr	0.1987	Local	13						4				3	3				88
Cooper St	0.3208	Local	11		2			3	8	2			4		8			68
Crabapple Dr	0.2843	Local	7					3	4	3			3		5	2		76
Creekwood Ct	0.2296	Local	8		3								3	3	7			81
Cypress St	0.1984	Local	21						7	1			1					89
Daniel St	0.2741	Local	11							3			4	2				89
Davis-Giddens Dr	0.0829							1					1			2		95
Deepstep Rd	0.8231	Arterial			1					1								98
Dennis St	0.0294	Local	1						7	3								88
Dogwood Cir	0.0219	Local	2		4				5	3			3	4	8			68
Dogwood Dr	0.2613	Local	6					4	6	3			3		6			74
E 1st Av	0.1097	Local	10						2	2			2	2				91
E 2nd Av	0.1066	Local	7	1	2				2	2			2					91
E Church St	1.3478	Arterial			3					2			2		5	3		82
E Elder St	0.0648	Local	9		2				6	4			4			3		78
W McCarty St	1.3906	Local		1				2						2	5			89
Eastlake Dr	0.1580	Local	18		3			5		3			3		7			75
Elizabeth St	0.0846	Local	10	1	3				6	4			4			3		76

					SURFACE DEFECTS			SURFACE DEFORMATIONS		CRACKS						PATCHING/ POTHOLES		CONDITION RATING
Street Name	Total Length	Type	# Households Affected	# Businesses Affected	Raveling (0-5)	Flushing (0-5)	Polishing (0-5)	Rutting (0-10)	Distortion (0-10)	Transverse (0-5)	Reflection (0-5)	Slippage (0-5)	Longitudinal (0-5)	Block (0-5)	Alligator (0-10)	Patches (0-5)	Potholes (0-10)	((85 - Sum of Defects)/85)*100
Elm St	0.1520	Local	3													1		99
Evans St	0.2572	Local	24	1				8	9	4			4	3	7	4		54
Evelyn St	0.0992	Local	10						8	3			2			2		82
Evergreen Cir	0.0403	Local	6				3		5					4	8		5	71
Evergreen Dr	1.0006	Local	67						4	3			3	2				86
Fall Line Fwy	1.4895	No Maintenance																
Ferncrest Dr	0.1746	Collector	3+Apt Complex	5	3			3		2		2	2		3		2	80
Franklin Haynes Dr	0.2388	Local	2	1				4	2	3			3	2	5	2	2	73
George J Lyons Pkwy	0.2208	Local		2	1													99
George J Lyons Pkwy E	0.1012	Local		1	1										1			98
George J Lyons Pkwy W	0.0384	Local		1	1													99
Georgetown Village Pkwy	0.2334	Private																
Gilmore St	0.1057	Local		3						2			2	2		3		89
Golden Hawk Dr	0.0476	Local							4	2			3					89
Gordon St	0.0799	Local	8		4				3	2			2			3	6	76
Grand St	0.6717	Local	23		5			5	9	3			4	4	5	5		53
Green St	0.1940	Dirt	3															
Gum St	0.1367	Local	9						6	3			3		6		7	71
Gwendolyn St	0.2020	Local	35							3			2	3				91
Hall St	0.3027	Local	12	1	2				3	2			2		3			86
Hampton Ct	0.1004	Local	8						5	2			2	3	2	1	2	80
Harrison St	0.1002	Local	22		2				5	3			3					85
Henderson St	0.8053	Local	10													2		98
Highway 24 E	0.1445	E McCarty St								3			3	2		1	4	85
Highway 242	0.1379	Riddleville Rd																
Hill St	0.0521	Local	11	1	3				3	3			2					87
Hillcrest St	0.3593	Local	17					8	5						7			76
Hines St	0.4896	Collector	72	1						3			3	3	4			85
Horton St	0.0742	Local	1							2			3	2		2	2	87
Industrial Dr	0.4727	Collector		17				5	7						7	3	6	67
International Dr	0.4391	Exist?																
Jernigan St	0.1004	Local		5					4					4	7	2		80
Joe St	0.2268	No Maintenance																
Jones Rd	0.3889	County																
Jones St	0.6841	Local		5						2			2	2				93
Jordan Mill Rd	0.5066	Collector	204	3					4				3	3	5	2		80
Kaolin Rd	0.4764	Arterial			1				4	2			2			1		88
King St	0.1014	Local	23						7	3			3	5	7	3	5	61
Kinney St	0.4427	Local	18		2				6	2			2	4	5	2		73
Kitchens Dr	0.1287	County																
Lakeview Dr	0.2750	Local	21		2		2		1	2			2					89
Lanier St	0.0929	Local	23						6	2			3	3	5	2		75
Larry Dr	0.2250	Local	2						3	2			2					92
Laurel Dr.	1.4030	Local	26		2				7	5			3	4	9		8	55
Laurel Way	0.0320	Private																
Layton Dr	0.1476	Dirt																
Lee St	0.1073	Local	9		1				4	2						3		88
Legion Dr	0.2030	Local	10						6	2			3					87

					SURFACE DEFECTS			SURFACE DEFORMATIONS		CRACKS						PATCHING/ POTHOLES		CONDITION RATING
Street Name	Total Length	Type	# Households Affected	# Businesses Affected	Raveling (0-5)	Flushing (0-5)	Polishing (0-5)	Rutting (0-10)	Distortion (0-10)	Transverse (0-5)	Reflection (0-5)	Slippage (0-5)	Longitudinal (0-5)	Block (0-5)	Alligator (0-10)	Patches (0-5)	Potholes (0-10)	((85 - Sum of Defects)/85)*100
Lime St	0.0596	Local	6		4			5	8									80
Linton Forest Dr	0.0690	Local	33		2			3	3	3					5			81
Linton Forest N	0.0572	Local	15		2			3	3	3					5			81
Linton Forest S	0.0362	Local	6		2			3	3	3					5			81
Linton Rd	2.2323	Arterial											2					98
Loos Dr	0.0728	Private			4										9		7	76
Lovett St	0.5639	Local	19						8	3			3	4	2	4		72
Lynwood Dr	0.3227	Local	16		2					3			3	2		3		85
M. Friedman Dr	0.2292	Arterial						4		3			3		4			84
Madison Av	0.1550	Local	5						7					4	8	3	7	66
Malone St	0.2225	Local		3						2			2	3				92
Maple St	0.0799	Local	18													1		99
Martin Ln	0.6389	Local	3		3				8.5						5	2		78
Martin Luther King Jr Av	0.5941	Collector	54	1					6	3			4		5	4		74
Martin Luther King Jr Ext	0.0756	Local		3					8	3			3	4	3	3	7	64
Martin St	1.0362	Local	6						7	3			4			2		81
Mathis Ln	0.3684	Local	3	1									2					98
Mayview Rd	0.1465	County																
McElrath Cir	0.2215	Local	4											3	7			88
McElrath St	0.5644	Local	39					2	5					3	6	3	2	75
McIntyre Ct	0.0376	Local	6		2				2	2				3				89
McIntyre St	0.2596	Local	26						3	2			2					92
Meadow Dr	0.9756	Local	11		2			2		3			3	3	4	2	4	73
Medical Arts Dr	0.5630	Local	2	5	3				5				3	3	7	3	5	66
Medical Arts Pl	0.0860	Not Sure Where																
Miamola Av	0.7405	Local	17										2	2		2		93
Miamola Ln	0.0815	Local	3		2			5	7				2		8	5		66
Minden St	0.1005	Dirt																
Morningside Dr	0.5526	Local	20	2						4			2	4	4	2		81
Mosley Pl	0.1007	Local	1	1	3			4	8						7	1		73
Moye Dr	0.5088	Local	21		5				5	2			2		1	3		79
Murphy St	0.0731	Local	1		3								2	2	3			88
Myrtle Way	0.0688	Local	3						5	3			3	3	8	2		72
N Anderson Dr	0.2985	Local	29		2	2			3	2			2					87
N Harris St	0.4217	GDOT (HW 15)																
N Hospital Rd	0.5496	M Friedman																
N Oak St	0.1276	Local	2	1	3				7	3			3	2	7	2	2	66
N Pecan St	0.1055	Local (Dirt)																
N Railroad Av	0.2872	Local	17	1					5	2			2	3	6			79
N Saffold Rd	0.1843	Arterial			3		3		4	3			3	1.5		2		77
N Smith St	0.7539	Collector	32	18					4	3			3	2		2		84
Newman Turner St	0.3231	Local	16		2				8	5			4	3	5			68
Newsome St	0.0697	No Maintenance																
North Av	0.1785	Local	5	1	2			5	8					4	8	2	4	61
Oak St	0.0651	Local	21		1				2	1			2			2		91
Oakland Pl	0.2235	Local	9		2		1		6									89
Opal St	0.1092	Local		4	2					3			3			1		89
Orchard Ln	0.1024	Local	7						6	1			2	2		2		85

					SURFACE DEFECTS			SURFACE DEFORMATIONS		CRACKS						PATCHING/ POTHOLES		CONDITION RATING
Street Name	Total Length	Type	# Households Affected	# Businesses Affected	Raveling (0-5)	Flushing (0-5)	Polishing (0-5)	Rutting (0-10)	Distortion (0-10)	Transverse (0-5)	Reflection (0-5)	Slippage (0-5)	Longitudinal (0-5)	Block (0-5)	Alligator (0-10)	Patches (0-5)	Potholes (0-10)	((85 - Sum of Defects)/85)*100
P L Braswell Way	0.0868	Local								3			4		8			82
Park Av	0.3339	Local	16						5				3			2		88
Peachtree Dr	0.1069	Local	26							2			2	2				93
Pierce St	0.2884	No Maintenance																
Pine Forest Dr	0.1367	Local	26						6				3		4			85
Pine Hill Way	0.0923	Local	6		2				8	2			2	4	7	3	7	59
Plum St	0.0815	Local	5		4			3	5	3			2					80
Poplar Dr	0.6300	Local	7	2						2			2					95
Post Office St	0.3754	Local	1	2					3	3			3	3		3	3	79
Railroad Av	0.5158	Local	7	2					5	2			2	3	6			79
Raley Dr	0.2984	Local		5	2					3			3	2	6	2	4	74
Red Bud Cir	0.1747	Local	9		2				9	3			2	3	8		7	60
Reeves St	0.1541	Local	10						6						5	2		85
Richmond St	0.1823	Local	15		2				7					3	6	3	6	68
Riddleville Rd	0.9284	Highway 242							4	2			2	2		2		86
Ridge Rd	1.3454	Collector	7	5														100
Ridgeland Dr	0.2881	Collector	55	1					4	2			2	1		2		87
Roberts St	0.0726	Local	11						5	3			3	3	3	3		76
Robin Rd	0.0736	Local	4		3				7					5			7	74
Royal Ln	0.2201	Local	24	1					5	2			2					89
S Anderson Dr	0.5089	Local	11	1	2	2			3	2			2					87
S Elder St	0.0862	Local	5		2				6	4			4			3		78
S Harris St	2.9674	GDOT (HW 15)																
S Hospital Rd	0.9062	M Friedman																
S Pecan St	0.9442	Local (Dirt)																
S Saffold Rd	0.5615	Arterial			3		3		4	3			3	1.5		2		77
S Smith St	0.8716	Collector	29	5					4	3			3	2		2		84
SES		New												3	6			89
Sparta Rd	1.4657	GDOT																
Spring St	0.5126	Local	30	1				4	6	3			4			2		78
Stacer Av	0.0307	Local		1									2	3				94
Stevens St	0.2731	Local	2							3			2					94
Summerlin Cir	0.0289	Not Sure Where																
Sunhill Rd	1.5296	Collector	80		4		2			2						3	4	82
Tanley St	0.3507	Local	15							3			3	4	5		3	79
Temple Dr	0.0076	Local	14	1					5	2			2			4		85
The Peninsula	0.1059	Local	1						2	2			2			1		92
Thompson St	0.2430	Local	1							3			2		4			89
Transylvania Dr	0.7374	Local	90					4	2	2			2		3		4	80
Triple V Cir	0.1860	No Maintenance																
Tybee St	0.3873	Local	19					7	5				3			2		80
Valley St	0.0571	Not Sure Where																
Virginia Av	0.1186	Local		1				1		2				2	2	2		89
W 1st Av	0.2802	Local	14					1	3					3				92
W 2nd Av	0.2734	Local	9	2					6	2			2					88
W Church St	1.4648	Arterial								2			2					95
W Elder St	0.3716	Local	6	1	2				6	2			2	2		2	1	80
W Floyd St	2.1065	Local	59	4				7	5	4			2	3	5	4		65

					SURFACE DEFECTS			SURFACE DEFORMATIONS		CRACKS						PATCHING/ POTHOLES		CONDITION RATING
Street Name	Total Length	Type	# Households Affected	# Businesses Affected	Raveling (0-5)	Flushing (0-5)	Polishing (0-5)	Rutting (0-10)	Distortion (0-10)	Transverse (0-5)	Reflection (0-5)	Slippage (0-5)	Longitudinal (0-5)	Block (0-5)	Alligator (0-10)	Patches (0-5)	Potholes (0-10)	((85 - Sum of Defects)/85)*100
W Haynes St	1.7613	Arterial			3			5	6				3	2	6	2	4	64
Waco Dr	0.6904	Local	8	7					7	3			2			2		84
Waco Mill Rd	0.3918	Arterial			1													99
Walden Rd	0.2301	Local	43						3	2			2		4			87
Walmart Cir	0.1463	Local		1	3					2			2					92
Warthen St	1.3795	Local	43	6				6	8				3					80
Washington Av	0.5260	Local	22	4									2			2	4	91
Wedgewood Ct	0.1022	Local	6		3		2		8	3			3		6	3		67
Wedgewood Dr	0.5193	Local	23		5		2		8	4			3	4	7	3		58
Westlake Dr	0.1430	Local	20		1			1		2			1	1	4			88
Whispering Pines St	0.1906	Local	2		5											4	4	85
Wiggins St	0.1383	Local	11		2			7	8	2			3			3		71
Willow St	0.0303	Local	2		2				5	3			4		5			78
Winchester Way	0.3290	Local	18						1									99
Windy Hill Way	0.0886	Local	18		2				3	4			3	7	8		2	66
Wise St	0.1200	Local	4		5			5	9	3			3	8	8	4		47
Woodbine Dr	0.0604	Local	26						4	3			4	8	8	3		65
Woodland Dr	0.9174	Local	21		2		2		7	4			4	3	4		8	60
	0.2827																	
Total	**74.9394**		**12**	**1**														83

APPENDIX D: Sandersville Strategic Asset Management Plan

The following pages exhibit the strategic asset management plan created as a part of this thesis for the City of Sandersville in the case study of this research project.

STRATEGIC ASSET MANAGEMENT PLAN

CITY OF SANDERSVILLE PUBLIC WORKS DEPARTMENT

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OVERVIEW, POLICY PRINCIPLES & OBJECTIVES, and ACTION PLAN Reviewed and Approved:

DATE

Recommended for approval:

_____

Public Works Director

Approved:

_____

City Administrator

OVERVIEW

The City of Sandersville, GA, manages many different types of assets. An asset is defined as anything that is assigned value. This plan focuses on public infrastructure assets such as roads, stormwater systems, public works fleet and equipment, and more. This Strategic Asset Management Plan (SAMP) contains the foundational components of the department of public works' asset management system.

This document is meant to be updated to work with any changes within the City of Sandersville and Washington County. As the two guiding documents below are modified, the SAMP will be re-evaluated to reflect any updates.

Guiding Documentation:

- Washington County Unified Comprehensive Plan
- Operating Budget and Capital Improvements Program

The activities within the Public Works Department need to be reflective of the overarching goals of the City of Sandersville. There are five city-wide long-term goals established in the Operating Budget as follows:

I. Protect and improve the financial integrity of the city
II. Maintain a safe and secure environment for our citizens and their property
III. Provide excellent customer service in all service areas
IV. Encourage economic development and growth in our community
V. Promote a healthy quality of life by being good stewards of our environmental resources

Every asset management policy created in this document will tie directly back to one of the city-wide long-term goals.

Value assigned to assets will be both monetary and value as determined by the goals of the city and stakeholders within the city. The five goals listed above direct much of the value that is defined within assets. Value that can be assigned to all assets are as follows:

- Lowest Total Life Cycle Cost
- High Safety Rating
- Low Environmental Impact
- High Efficiency
- High Durability and Sustainability

ASSET MANAGEMENT POLICY PRINCIPLES AND OBJECTIVES

The following policy principles and objectives are meant to direct asset management activities in regards to each type of infrastructure managed. Asset management plans will be built upon the principles and goals determined in this SAMP.

Policy Principle: Asset management plans will be created for each type of infrastructure managed by the public works department. (Ties to I., II., and V.)

Associated Objectives:

1. Asset management plans (combined or individual) will be created for the following asset systems managed by the Public Works Department:
    a. Streets
    b. Sidewalks
    c. Storm Drainage
    d. Fleet
    e. Parks & Cemetery
    f. Solid Waste
    g. Water & Sewer
    h. Wastewater Treatment
2. Stakeholder values specific to each asset class shall be identified within each asset management plan
3. Employees involved in asset management will have a meeting to discuss expectations and ensure understanding of plans

Policy Principle: Life spans of new physical infrastructure shall be calculated (Ties to I. and V.)

Associated Objectives:

1. The life span of each new project shall be calculated during the design phase and included in closeout documents
2. Estimated lifespan based on intended use shall be calculated for each new equipment purchase and included in associated documentation

Policy Principle: All infrastructure shall be maintained in a manner that promotes a safe and secure environment (Ties to II.)

Associated Objectives:

1. Infrastructure shall be rated according to appropriate safety standards on a regular interval that will be defined within each asset management plan

Policy Principle: Improve asset management section of Project Management (Ties to II.B.5)

Associated Objectives:

1. In addition to close-out documentation, provide best practices for maintaining finished project in an optimized manner

Policy Principle: Create a performance report providing an overview of the current state of all physical infrastructure assets. (Ties to II.C)

Associated Objectives:

1. Fleet and equipment to be inventoried by insurance company biannually
2. State of infrastructure shall be summarized in an infrastructure report card or similar document every two years

Policy Principle: Each infrastructure system shall be inventoried and regularly updated (Ties to II.C)

Associated Objectives:

1. An individual inventory shall be created for each infrastructure class
2. Attribute and location data shall be included for each asset
3. An appropriate rating system shall be determined for each infrastructure class
4. A condition assessment shall be included for each asset inventoried
5. Value shall be assigned to each asset based on monetary value and usefulness as established in each asset management plan
6. New infrastructure assets shall be added to the inventory within 5 weeks of acceptance by the city
7. Evaluation cycles shall be established for each asset inventory so that condition will be up to date and problems may be caught and fixed in an appropriate amount of time

Policy Principle: Provide education and clear explanation of decision-making process to citizens (Ties to III.A)

Associated Objectives:

1. Create clear paths from city long term goals to day-to-day activities

2. Maintain zero backlog of work orders while maintaining normal day-to-day management
3. Follow up with complaints to ensure that work is completed, or an understanding is reached regarding when work will be completed

Policy Principle: Management and maintenance of infrastructure assets shall be prioritized in a way that optimizes cost, usefulness, and longevity of assets (Ties to IV.)

Associated Objectives:

1. Maintenance shall be planned with future projects and replacements in mind
2. Maintenance techniques shall be evaluated based on cost and effect on life span of asset

Policy Principle: Replacement of any asset shall be based on total lifecycle cost, remaining useful life, safety standards, and regulatory requirements (Ties to IV.)

Associated Objectives:

1. Remaining useful life will be determined regularly and added to working inventory for each asset
2. Replacement of assets shall be scheduled when maintenance is no longer cost effective and on or before useful life ends

Policy Principle: Physical infrastructure shall be maintained in a sustainable manner (Ties to V.)

Associated Objectives:

1. Determine life cycles for all infrastructure valued at $1,000 or greater
2. Create a database that contains operation and maintenance costs of physical infrastructure within 4 months
3. Establish specific environmental goals for each physical asset class

TIMELINE

This section should be updated by the City of Sandersville to reflect the timeline expectations activities associated with fully implementing an asset management system.

RESOURCES

Guide to Successful Asset Management System Development : American Public Works Association

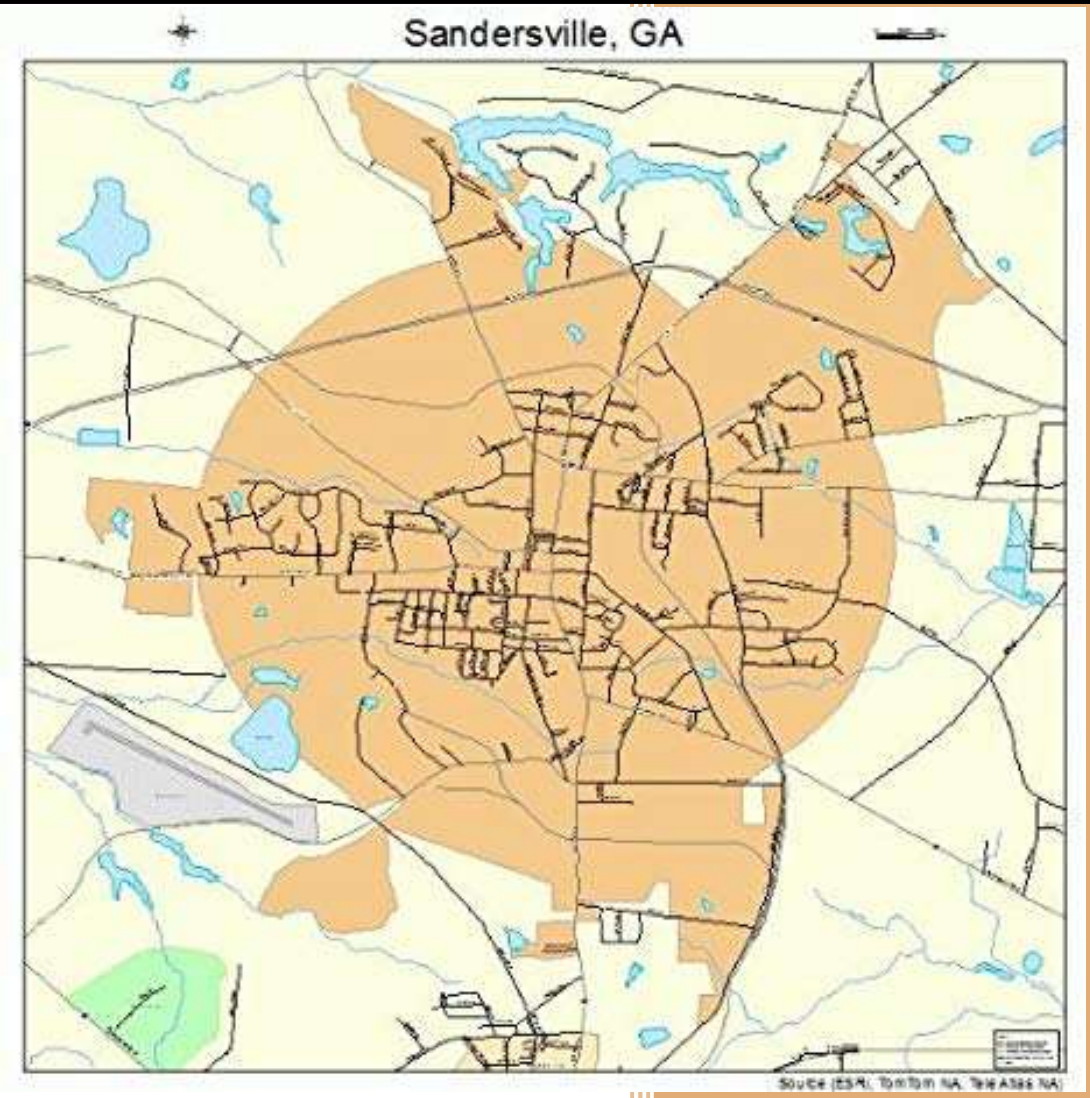
Strategic Asset Management Plan : City of Castle Rock, Colorado

APPENDIX E: City of Sandersville Street Department Asset Management Plan

The following pages exhibit the asset management plan created for the City of Sandersville Street Department in the case study of this research project.

2019

Sandersville Street Department: Asset Management Plan



Caroline Dickey
Sandersville Public Works Department
10/1/2019

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Executive Summary

Asset management is an important part of managing a city well. This asset management plan (AMP) is based on the Strategic Asset Management Plan (SAMP) created for Sandersville and is more specific to the Street Department. The details of this AMP are all meant to provide guidance for the management and maintenance of assets within the Street Department. This document shall be reviewed and updated annually to ensure that it is as useful as possible.

STREET DEPARTMENT ASSETS

Sandersville Road System:

- 74.7 centerline miles of road
- Local, collector, and arterial roads maintained by the city
- Average grade for road system: 83

Applicable value:

  - Rideability with minimal potholes and other hazardous conditions
  - Clear of debris

Sandersville Storm Drains, Ditches, Sidewalks and Rights-of-Way:

- 149.4 miles of right-of-way to maintain
- Sidewalks within city jurisdiction
- Storm drains located within city limits
- Ditches along roadways maintained by city

Applicable value:

  - Sidewalks: Accessibility – ADA compliant
  - Rights-of-way: Aesthetics
  - All: Clear of debris

Sandersville Cemeteries:

- Brownwood Cemetery
- Hall Street Cemetery
- Old City Cemetery

Applicable value:

  - Clean and aesthetically pleasing

Roles and Responsibilities

The Street Department is composed of three sections including Street Construction, Street Maintenance, and Cemeteries. The supervisor of the Street Construction Department is Wayne Johnson, and the supervisor of both the Street Maintenance and Cemeteries Departments is Ellen Salter. The main purpose of the Street Department is to maintain the roads, ditches, rights-of-way, sidewalks, and cemeteries throughout the City of Sandersville. The supervisors of each department within the Street Department report to the Public Works Director, Robert Eubanks, who ultimately leads decision-making within the department.

The Street Construction Department focuses on the development and maintenance of roads, sidewalks, storm drains, and ditches. This includes construction of the aforementioned assets minus streets which are solely maintained by this department. Much collaboration between other departments within the City of Sandersville and the Georgia Department of Transportation is necessary for the work completed by the Street Construction Department.

The Street Maintenance Department handles beautification and general lawn care of the city, keeping the rights-of-way mowed and litter free.

The Cemeteries Department is, as the name would suggest, responsible for maintaining the cemeteries in the City of Sandersville.

As multiple resources are shared by the three subsections of the Street Department, priorities need to be determined for the assignment of equipment will be efficient and effective.

DECISION MAKING PROCESS

Each work task will first be assigned a safety rating, which is the top determinant of priority. Tasks that have the highest effect on safety will have the highest priority. The safety rating qualification table is located below for use when attaching safety ratings to infrastructure assets:

Risk Level	Description	Examples	Safety Rating
Low	Presents a minimal threat to the safety and wellbeing of the community	Close to perfect condition with little to no effect on drivers or pedestrians	1
Low Mid	Presents a slightly more significant threat to the safety and wellbeing of the community	Small dip or bump in a road or minimal cracking in a road. Low levels of debris on the road.	2
Mid	Presents a significant but not immediate threat to the safety of the community	A pothole in the road, significant cracking in roads or sidewalks, mid-levels of debris on the road	3
High Mid	Presents a significant and immediate threat to the safety of the community, requiring action as soon as possible to prevent emergency situation	Extreme cracking and/or potholes in roads, indicative of failure. High levels of debris in road causing cars to swerve out of lanes.	4
High	Presents a serious and immediate threat to the safety and health of the community, immediate action (classify as emergency)	Road washout or collapse. Major obstruction of road or sidewalk. Drain blocked and thus causing major water pooling on road.	5

If tasks are in the range of 1-3, the condition rating of the asset will be assessed and compared to other upcoming tasks to determine priority levels. Determination of priority shall also include an assessment of monetary impact and stakeholder needs. This will establish a ranking system that allows for the most cost effective and beneficial decisions to be made when repairing or replacing assets. The processes and qualifications for each condition rating is presented in a later section in this report.

Current Assets

The assets managed by the Sandersville Street Department are roads, sidewalks, rights-of-way, cemeteries, ditches, and storm drains. These assets must be inventoried in an appropriate manner to account for all the assets and the value associated with them.

ASSET INVENTORY

Each asset will have attribute data recorded to be easily accessible and repeatable for the future. The attribute data will be different for each asset category.

Road Inventory

The information to be included in the road inventory are as follows:

- Road name
- Type (arterial, collector, local)
- Surface material
- Centerline mileage
- Visual road rating
- Surface defects and a description of their severity
- Number of households directly affected by road
- Number of businesses directly affected by road
- GIS map of roads managed by city with information tied to roads

As per the Public Works Department's Strategic Asset Management Plan, the road inventory shall be updated once every six months or as repairs are completed or damages are reported. For example, if crack sealing is performed on a road, the road inventory shall be updated to reflect this repair. The road rating will also be updated to reflect repairs completed or damages reported.

Sidewalk Inventory

The sidewalk inventory should include the following:

- Name of adjacent road
- Mileage of sidewalk on either side of road
- Surface defects and a description of their severity
- GIS layer added to the road map to show locations of sidewalks

As per the Public Works Department's SAMP, the sidewalk inventory shall be updated once every six months or as repairs are completed or damages are reported.

Storm Drain and Ditch Inventory

The storm drain and ditch inventory shall include the following:

- GIS layer added to the road map showing locations of storm drains and ditches
- Note shall be attached to each drain and ditch to describe debris levels at last inspection

Inspections

The roads, ditches, rights-of-way, sidewalks, and cemeteries will be inspected and given a conditions rating on a regular basis as appropriate for each asset.

RATING SYSTEM

The asset classes each will be rated with a different system and then converted into a rating system that will make an average rating for the entire department's assets possible.

Road Rating System

The roads are rated based on a simplified system developed from multiple resources. The surface defects that are rated as a part of this system are defined in Appendix A. Each defect shall be rated on a scale of either 0-5 or 0-10 depending on the severity of the underlying problem indicated by the defect. A higher rating reflects a higher severity of the defect in question. The ratings for the defects present are then summed and divided by the sum of the highest possible scores for all defects, which

equals a percentage rating for the condition of the road. The equation used is shown below:

$$100 - Sum(Visual\ Inspection\ Defect\ Rating) = Road\ Condition\ Rating$$

This rating system is not exact and should not be directly related to other road ratings conducted by other entities. It is meant to be a tool for ranking the roads in Sandersville quickly and effectively enough to make decisions about repair and replacement.

Ratings should be completed in a similar manner each time through so that the changes can be tracked well throughout time. Pictures should be taken to give support for the ratings given.

The ratings for each asset class will be translated into a rating system that can be used to compare all asset classes. Translating the ratings helps communicate the state of infrastructure to the community and other stakeholders in a simpler and more effective way. Following is the table used for translating the grades:

Visual Inspection Rating	Verbal Rating	Star Rating
0-30	Failing	0 Star
31-50	Very Poor	1 Star
51-69	Poor	2 Star
70-84	Fair	3 Star
85-90	Good	4 Star
91-100	Excellent	5 Star

The goal average ratings for each type of road is as follows:

- Arterial: Average Rating ≥ 85 (≥ 4 Star)
- Collector: Average Rating ≥ 80 (≥ 3.75 Star)
- Local: Average Rating ≥ 70 (≥ 3 Star)

When deciding which roads to repair or resurface, the priority can be determined by a combination of the road rating, the type of road, and the number of households and businesses affected by the road. The higher the overall road rating, the better condition the road is in and the lower the priority for repair or replacement. The types of roads are prioritized with arterial as the highest, collector roads next, and local roads at the lowest priority. Within those definitions, the roads that directly affect more households and/or businesses have a higher priority.

Roads shall be rated by an outsourced engineering firm once every 3 years beginning in 2020. The outsourced firm shall provide an optimization plan for which roads are

the most cost effective for repair and replacement. The rating system provided by the outsourced firm will not be directly relatable to the grades produced by the visual road rating created twice a year within the department.

Sidewalk Rating System

The value as defined for sidewalks includes accessibility, low levels of debris, and visually appealing. Sidewalks are lower priority than roads. The rating system does not have to be as involved as the road rating system because sidewalks are less of a safety concern as well and generally being used less.

The process used for rating the sidewalks is similar to the road rating system. The sidewalks should be visually observed, and the rating of each section recorded. For the first iteration of this rating system an inventory and map should be created so that future inspections can be completed in a simpler manner. Each type of surface distress is described in Appendix B. The suggested ratings are given in this table as well. The total rating for each section of sidewalk will be calculated in the same manner as the road rating using the following equation:

$$100 - Sum(Visual\ Inspection\ Defect\ Rating\ Condition) = Sidewalk\ Condition\ Rating$$

The following table represents the conversions to the 5-star rating system:

Visual Inspection Rating	Verbal Rating	Star Rating
0-50	Failing	0 Star
51-60	Very Poor	1 Star
61-70	Poor	2 Star
71-80	Fair	3 Star
81-90	Good	4 Star
91-100	Excellent	5 Star

The goal average rating for the sidewalks is > 70.

Storm Drain and Ditch Rating Systems

To be updated by the City of Sandersville.

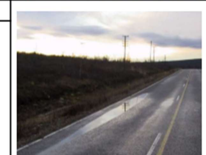
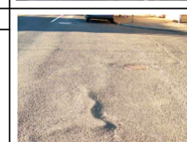
INSPECTION SCHEDULE

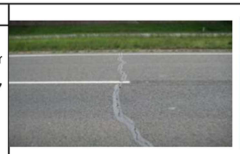
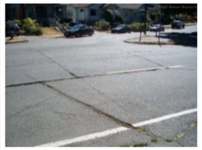
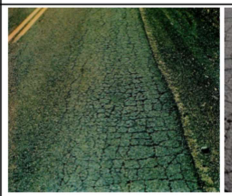
Asset Class	Start Date	Frequency
Roads (by City)	09/30/2019	Biannually
Roads (by Engr Firm)	01/05/2020	Every 3 Years
Sidewalks	01/05/2020	Biannually
Storm Drains	01/05/2020	Annually
Ditches	01/05/2020	Annually

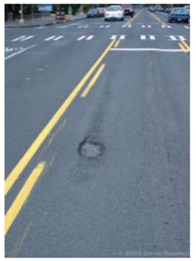
APPENDICES

A: ROAD RATING PROCESS

Sandersville Road Inspection Process

DISTRESS TYPE	DESCRIPTION	RESULTING PROBLEMS	PREVENTION/REMEDIATION TACTICS	PICTURES
Surface Defects				
Raveling	Loss of pavement material from the surface down. Slight to moderate raveling includes loss of fines from surface (rated 1-2). Sever raveling includes loss of coarse aggregate (rated 3-5 depending on affected area).	Loose debris, decreased skid resistance	Should be investigated before repairs are made. Sealcoat or thin overlay can protect against further raveling. If in localized areas, remove and patch. If lots of area, remove and overlay.	
Flushing/Bleeding	Excess asphalt binder on surface	Decreased skid resistance	Blot with coarse sand if caught during construction. Major bleeding may need to be cut off or resurfaced	 
Polishing	Smooth surface areas created by traffic wearing down the aggregate	Decreased skid resistance	Sealcoat or thin overlay of skid- resistant material	
Surface Deformations				
Rutting	Surface depression along wheelpath. Can be because of subgrade or mix. Will not be able to tell based on visual inspection	Ruts pull vehicles along rut path. Can lead to excess water held on roads	Heavy rutting should be investigated before treatment. Minimal rutting (<1/3 in deep) should be fine. Deep ruts can be leveled and overlayed.	 
Distortion				
Corrugation & Shoving	Deformation in pavement surface that is exhibited by bumps or odd ripples due to traffic action in combination with other factors. Generally in intersections	Roughness in road. Damage to cars over time and driver complaints	Remove distorted areas and patch (if small). Remove pavement and overlay (if lots of damage).	 
Depression	Pavement surface areas that are lower than surrounding areas	Roughness in road, can hold water	Should be investigated to determine cause of failure. Remove pavement and subgrade and replace (patch).	

Cracking				
Transverse	Cracks perpendicular to road's centerline	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Reflection	Cracks occuring over rigid pavement joints	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Slippage	Crescent shaped cracks, generally with ends pointed in direction of traffic	Roughness in road, allows water infiltration	Remove and replace affected area	 
Longitudinal	Cracks parallel to centerline of road	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	 
Block	Connected cracks that create rectangle shapes in cracks	Roughness in road, allows water infiltration	Crack seal for low severity (<1/2 in wide, infrequent). Remove and replace cracked layer with an overlay for high severity (>1/2 in wide, frequent).	
Alligator	Series of interconnected cracks in a pattern resembling the back of an allligator	Roughness in road, allows water infiltration, eventually turns into potholes and major structural failure if not treated	Small cracking is typically indicative of loss of subgrade support. Replace subgrade if necessary and patch over repaired subgrade. Large areas of cracking indicate general structureal failure. Overlay with strong mixture.	 

Patches & Potholes				
Patching	Area of pavement that has been replaced with new material (always considered a defect)	Roughness in road	Can only be repaired by structural or non-structural overlay	 
Potholes	Bowl shaped depression in pavement surface, end result of fatigue cracking	Roughness in road (could be serious if encountered at high speeds), allows water infiltration	Filled in or patched	 

B: SIDEWALK RATING PROCESS

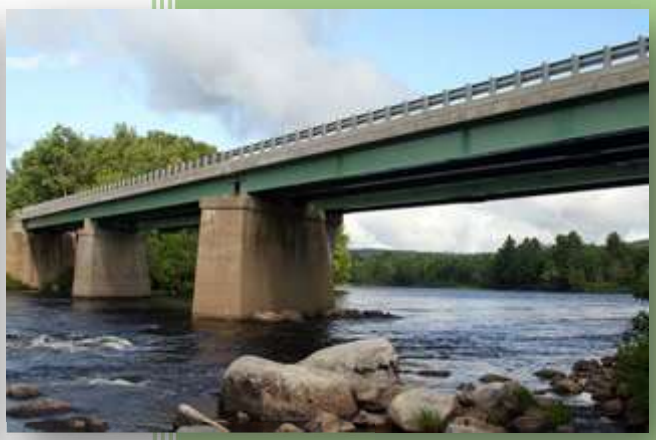
Defect	Description	Severity	Rating
Sunken Sidewalk Slab	A slab (or multiple) in the sidewalk that is sunken down lower than other sections of the sidewalk.	If sunken <1" and limited to <30% of slabs in section, rate from 0-5. If sunken >1" and/or >30% of slabs in section, rate from 6-10.	0-10
Raised Sidewalk Slab	A slab (or multiple) in the sidewalk that is raised up higher than other sections of the sidewalk.	If raised <1" and limited to <30% of slabs in section, rate from 0-5. If raised >1" and/or >30% of slabs in section, rate from 6-10.	0-10
Cracked Sidewalk Slab	A slab (or multiple) with cracking breaking the slab into multiple sections.	If cracking is minimal, rate from 0-2. If cracking is significant and there is separation between sections, rate from 3-5.	0-5
Sloped Sidewalk Slab	A slab (or multiple) are sloped to one side of the sidewalk or in the direction of walking.	If slabs are sloped where edges are <1in higher or lower than the adjacent slabs and affect <30% of slabs in section, rate from 0-2. If slabs are sloped where edges are >1in higher or lower than the adjacent slabs and affect >30% of slabs in section, rate from 3-5.	0-5
Sidewalk Deterioration	Sidewalk shows signs of wear, losing material from the surface of slabs. Deterioration will look like crumbling surface material.	Fine aggregate loss from surface of concrete, rate from 0-2. Coarse aggregate loss of significant portions of surface lost, rate from 3-5.	0-5
Gaps Between Slabs	Separation between slabs in concrete sidewalk.	Gaps <1in, rate from 0-2. Gaps >1in, rate from 3-5.	0-5
Tree Root Damage	Tree roots growing underneath the sidewalk cause deformation in the sidewalk.	Minor deformation caused by tree root damage in <30% of section, rate from 0-2. Major deformation caused by tree root damage in >20% of section, rate from 3-5.	0-5

APPENDIX F: Step-by-Step Asset Management Document

The following pages exhibit the document titled *Step-by-Step Asset Management* created for use alongside the APWA *Guide to Successful Asset Management System Development* in this research project.

Step-By-Step Asset Management

TO BE USED ALONG WITH THE APWA GUIDE TO SUCCESSFUL ASSET MANAGEMENT SYSTEM DEVELOPMENT



Created by: Caroline Dickey

October 2019

Contents

Introduction

The American Public Works Association (APWA) published the *Guide to Successful Asset Management System Development* to be used in local governments. Based on research completed in Georgia, it was determined that additional resources would be beneficial for local governments with limited resources. This document is meant to be used alongside the APWA guide previously mentioned. It provides a step-by-step process for following the APWA guide. If a local government does not have the funds to hire a consultant to help with building an asset management system, or if the local government does not have a sufficient amount of employees or resources to determine how the APWA guide should be followed, this document shall provide direct actions to take. It will promote efficiency when implementing an asset management system.

STEP 1: Determining a CHAMPION

Building an asset management system is a difficult task to follow through on. It can often be an undertaking that requires a significant amount of time and energy. Having a Champion for the local government who is dedicated to seeing an asset management system through to the end is beneficial. The Champion should be someone who understands asset management and who can commit to hold the local government accountable for creating and implementing an asset management system. Tasks that a Champion may be entrusted with:

- Setting up meetings with the appropriate people
- Compiling ideas and information concerning asset management before and between meetings
- Building a strategic asset management plan (SAMP) using the APWA guide and the information produced in meetings
- Delegating tasks of creating asset management plans (AMPs) to departments
- Holding departments accountable for completing and implementing their AMPs

It is likely that the reader of this document will either become the Champion or have someone in mind who fits into this mold. Discuss the tasks necessary with the public works director, city or county manager, or someone else invested in the wellbeing of the local government and make a final decision about the Champion for your local government.

STEP 2: Preparation for First Meeting

Once a Champion is determined, they should schedule a meeting to discuss asset management and its importance. The Champion should review the guide provided by the APWA and any other asset management resources as useful. Additionally, the Champion should understand the policies in place within the local government that have influence over asset management systems. For example, if the local government has a policy located in their budget document or

comprehensive plan that states that the government will provide an environment that promotes safety and health for the citizens, this is a principle that affects the development of an asset management system. The case where strong existing high-level plans are not in place, making asset management policy more difficult to define, is addressed in STEP 4. In either case, the information thought to be pertinent to the meeting should be pulled ahead of time by the Champion so that they can provide examples and answer questions to the best of their ability.

The Champion should decide what they feel is the best way to communicate the asset management information in the meeting. Some suggested tactics for sharing this information are as follows:

- Provide a printout of the APWA guide and appropriate sections from guiding literature for the local government with important points highlighted.
- Organize information into a slideshow presentation to share during the meeting.
- Email links to or PDFs of the appropriate documents to the meeting attendees and request that they review before the meeting.

It is imperative that the importance of an asset management system is communicated effectively. This helps the local government employees to be more invested in the development of their plan. The system created from this process affects all day-to-day activities of the local government employees.

STEP 3: First Meeting

The following are suggestions for meeting attendees:

- Public works director
- Heads of each department in public works
- City or county manager if desired
- Anyone that would have insight on software usage
- Others as determined useful by the Champion

No matter what tactic for sharing information is selected in the previous section, the information about asset management should be explained during the meeting by the Champion. Following the discussion, questions, comments, and ideas should be talked through. The Champion should take notes or have someone take notes or record the meeting.

Champion should cover the following topics in this meeting:

- Define assets, the concept of asset management, and asset management systems
- APWA *Guide to Successful Asset Management System Development*
- Potential guiding policies within local government documents

Champion should facilitate discussion on the following topics in this meeting:

- Current asset management practices
- Asset management, work order, or other software usage – pros and cons of software in use
    - Departmental needs and desires for software
- Potential asset management policy
- Asset management related goals that exist within departments
- Questions and concerns

After all these topics have been discussed, the Champion should then explain the next steps where asset management policy and objectives will be determined.

STEP 4: Asset Management Policy Principles

The first section, **Asset Management Policy,** of the APWA guide walks through defining asset management policy principles that relate to the local government. It recommends using existing high-level guiding documents to determine asset management policy principles. These documents are very useful if they are organized and thorough in their discussion of plans and goals for the city. This section includes two approaches to policy development based on whether enough guiding documentation is available.

Case 1: If there are well defined plans and general policies in place, the recommendations from the APWA guide are appropriate and should be followed for this step. The Champion should determine asset management policy based on the plans and policies defined in high-level documents for the local government. The Champion should have already reviewed and compiled any helpful information from existing documents in STEP 2. The knowledge gained should be revisited along with information gained from discussion in the First Meeting. If there are overarching policy principles for the local government, the asset management system created should support one or more of them so that day-to-day activities of the government can be traced up to the highest level. For instance, if a principle or goal of the local government is to provide a healthy and safe environment for the citizens, this should be a goal that AMP activities like patching potholes or clearing debris from roads can be traced back to.

Case 2: Troubles arise if the documents are not well put together or if they do not exist for a local government. When this is the case, it is recommended that a few high-level principles are established. These principles should be very general and applicable to every aspect of government. It is recommended that a local government have approximately five of these overarching principles. A few additional examples are as follows:

- Principle Example: To promote economic development and growth within the local government jurisdiction.

- Principle Example: To promote sustainable practices within the management of the local government.

The Champion should determine a few options for policy principles and discuss them with the city or county manager. Typically, if there are not any in place, it is straightforward to come up with a few. If direction is needed, it is recommended that documents from other, similar local governments are referenced.

Asset management specific policy should be created based on the policy determined. Refer to **Case 1** and the APWA guide following the final decision.

Because of the extra steps in **Case 2**, more time should be allowed between meetings so that supplementary meetings and approvals can be completed.

STEP 5: Development of Asset Management Objectives

Once asset management policy principles are defined, asset management objectives should be determined using the second section in the APWA guide, **Asset Management Objectives**. A document should be created that includes the asset management policy principles with the asset management objectives associated with them organized neatly. This should be shared with the meeting attendees prior to the second meeting for review.

STEP 6: Second Meeting – Policy and Objectives Review

The second meeting should be used to review asset management policy principles and objectives determined by the Champion. This meeting should take place approximately **1-2 months** following the first meeting.

The Champion should take the time to present the principles and objectives and briefly explain how they were determined. Discussion should then be opened, giving the attendees time to express their thoughts and concerns. If changes need to be made, the Champion should be clear about the expected timeline for their completion.

Following this discussion, the Champion should then explain the next steps where a Strategic Asset Management Plan (SAMP) will be created for the public works department.

STEP 7: SAMP Development

Using the third section of the APWA guide, **Strategic Asset Management Plan**, the Champion is recommended to develop a SAMP for the public works department. This document is meant to be a working document that applies to all infrastructure assets. It should be reevaluated when changes are made to high-level guiding documents within the local government.

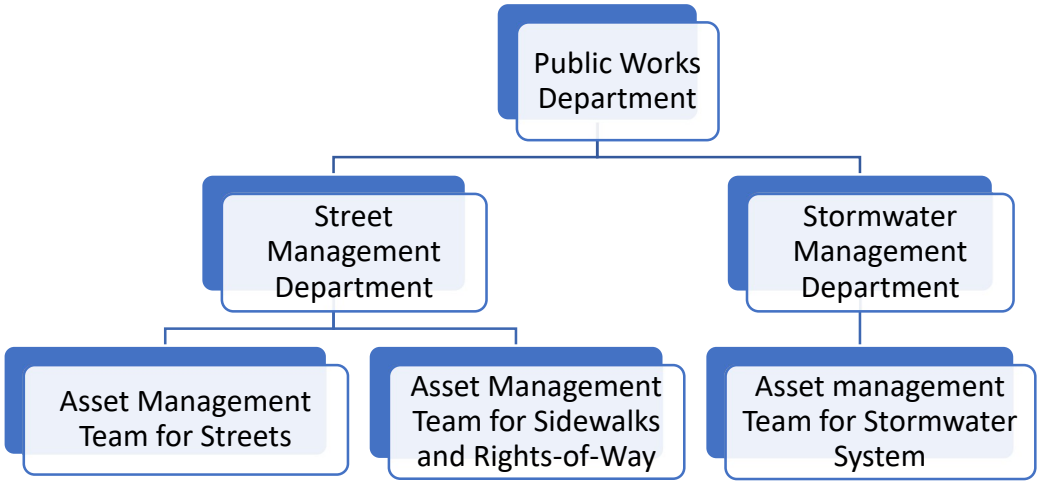
The SAMP should be created based on the direction of the APWA guide. This document can contain the asset management policy principles and objectives if it is a convenient place for them to be held. On top of this, the SAMP can include value assigned to each asset class, specified activities with time constraints, and any of the other suggestions from the APWA guide.

STEP 8: Third Meeting – SAMP First Draft Review

The third meeting should be approximately **1 month** following the second meeting.

During the meeting:

- Review and discuss SAMP developed by the Champion. Allow time for questions and concerns about the SAMP. Determine a timeline for the completion of the final draft of this document.
- Determine the quantity of separate AMPs that will be implemented in the local government. This will help with defining communication requirements between different departments. Form **Asset Management Teams**. This will vary depending on how many AMPs need to be created. There may be one team for the entire public works related infrastructure or one team for each department related to public works infrastructure with teams for each subsection of those departments.
    - Example:



- Asset Management Teams can take time discuss short term and long-term goals specific to each asset class in response to the SAMP. Each asset management team should estimate the time needed for creating their AMP. This will help to determine specific timelines for the completion of tasks so that the Champion can hold each team accountable

STEP 9: SAMP Completion

During the time between the second and third meetings, the Champion should make the changes and additions discussed in the second meeting. It is important to set attainable short-term goals and expectations while maintaining a long-term vision.

Specific timelines for future work within departments should be determined after the third meeting. This will assist with accountability and clear communication of expectations. Assigning tasks with clear deadlines will encourage less invested employees to engage. Champion may find it useful to create a table of the expected timelines for organizing and tracking progress of the first drafts of the AMPs, deadlines for final drafts, and full implementation timeline goals.

STEP 10: Fourth Meeting – SAMP Final Draft Review and Action Assignment

The fourth meeting should be scheduled for **3-5 weeks** following the third meeting. The final draft of the SAMP and the expected timeline table should be distributed to the attendees and other applicable people.

During the meeting:

- Review the final draft of the SAMP
- Review expected deadlines for each department and the responsibilities of each department head in this asset management system implementation process
- Ensure that all expectations are clear
- The Champion should schedule follow-up meetings with each asset management team for an update on their progress with the individual AMPs.

STEP 11: Final Asset Management System Evaluation

Upon completion, each individual AMP should be submitted to the Champion, the public works director, the city or county manager, and/or any other people for final approval and addition into local government documentation.

Once all AMPs have been approved, a final review of all documentation should be completed and a schedule of expected updates concerning each asset class should be created and shared with appropriate people.

STEP 12: Asset Management Software Determination

An asset management system does not require the use of a software system. However, an asset management software can be a beneficial tool for data collection, data retainment, information organization, and decision making within the asset management system if chosen and used based

on the SAMP and AMPs. Following are suggestions of how to manage asset management software whether it's already in use or not.

Case 1: This addresses the case where an asset management software is already in use.

Any required data collection for the management of asset should be defined within individual AMPs. Software should be used to collect and retain data as needed. If the asset management software in place cannot collect a significant portion of data required by the individual AMPs, a new software should be considered. Paying for a software system that is not efficient or useful for the tasks required is not cost effective. The *Asset Management Decision Tree* may be helpful in determining whether a new software is needed and what to look for in a new software.

If it is determined that the current software should stay, the use of this software must be evaluated and updated to support and comply with the individual AMPs.

Case 2: This addresses the case where there is no asset management software in use, and a software system is desired.

It is recommended that the necessary data for use in asset management, defined by each AMP, is compiled along with all intended uses of the software. Intended uses may include actions like work order management, inventory management, asset management, compatible usage with other software systems, etc. The *Asset Management Decision Tree* should be helpful for determining what should be considered when shopping for asset management software packages.

NEW SOFTWARE:

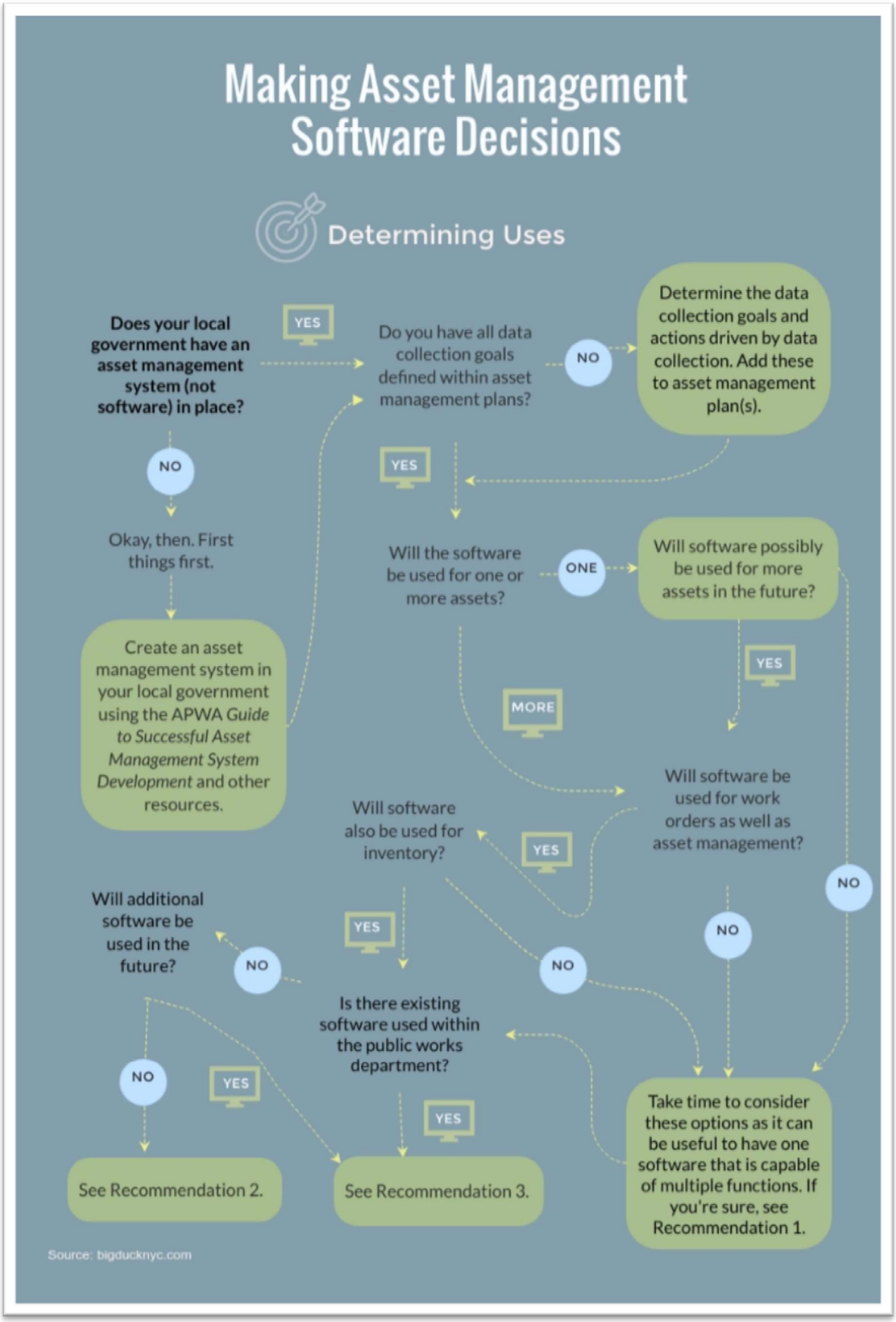
- Obtain quotes from multiple software companies. Be sure to confirm that all necessary data can be collected and maintained using the software. Confirm that software package options will perform all desired activities as well. If optimization is included in package at an affordable price, this can be a useful and cost-effective option for the maintenance of infrastructure.
- Decide on software package and begin implementation. Share and explain asset management system with the software representative. Ask for their recommendation of where to start, e.g. inventory is important to establish so infrastructure can be tracked.

STEP 13: Set a Time to Review and Update Asset Management System

The Champion should determine how frequently the asset management system should be evaluated and updated. The recommended frequency is annually. This process will include analyzing changes in other guiding documents and plans for the local government and assessing how they affect the asset management system. Update as necessary and submit for approval by appropriate authority figures.

APPENDIX G: Asset Management Decision Tree

The following pages exhibit the decision tree titled *Making Asset Management Decisions* created for use alongside the APWA *Guide to Successful Asset Management System Development* and the *Step-by-Step Asset Management* in this research project.


Making Asset Management Software Decisions
Determining Uses
Does your local government have an asset management system (not software) in place?
YES
Do you have all data collection goals defined within asset management plans?
NO
Determine the data collection goals and actions driven by data collection. Add these to asset management plan(s).
NO
YES
Okay, then. First things first.
Will the software be used for one or more assets?
ONE
Will software possibly be used for more assets in the future?
YES
Create an asset management system in your local government using the APWA *Guide to Successful Asset Management System Development* and other resources.
MORE
Will software be used for work orders as well as asset management?
Will software also be used for inventory?
YES
NO
Will additional software be used in the future?
YES
NO
NO
NO
Is there existing software used within the public works department?
NO
YES
YES
See Recommendation 2.
See Recommendation 3.
Take time to consider these options as it can be useful to have one software that is capable of multiple functions. If you're sure, see Recommendation 1.
Source: bigducknyc.com

Recommendations

1. This recommendation applies to your government if one software for one asset class with no future use for other modules or assets is desired. It is recommended that data collection needs are defined prior to receiving quotes from software companies. Search for the best software option for data collection and use as defined in the asset management plan for the asset in question. If actions like mapping are desired, confirm that this is an option in the software package. Software priced by the quantity of the asset is recommended as this will generally be less expensive.

2. This recommendation applies to you if your government wants an asset management software that provides a work order module, an inventory application, applies to multiple assets, and DOES NOT require compatibility with other software. More general asset management software systems that contain many module options are suggested. If your community has limited funding and a small population, discuss a pricing option based on population.

3. This recommendation applies to you if your government wants an asset management software that provides a work order module, an inventory application, applies to multiple assets, and DOES require compatibility with other software. For example, if a specific software is used to gather data about the road conditions, it should be straightforward to transfer the data into the asset management software. The other software in use or potential future software should be thoroughly discussed with software representatives. The process for transferring data should be understood for comparison with other options. As in Recommendation 2, more general asset management software systems that contain many module options are suggested. If your community has limited funding and a small population, discuss a pricing option based on population.

Options for Consideration

OPTIONS FOR RECOMMENDATION 1

- StreetSaver - Pavement Management
- AgileAssets - Transportation Management
- Samsara - Fleet Management
- Storm Water Management Model (SWMM) - Storm Water Management
- ArcGIS - Mapping and Tying Information to Maps

OPTIONS FOR RECOMMENDATION 2 & 3

- Cartegraph - General Asset Management
  - Has small community option with fixed packages
- Cityworks - General Asset Management
  - Work orders, Inventory, Asset Management
- HiperWeb - General Asset Management
  - Inventory, Multiple Assets, Work Orders, GIS and Google Mapping