DEVELOPMENT OF A NOVEL STRATEGY AND INSPECTION GUIDE FOR LOCALLY OWNED TRANSPORTATION ASSET MANAGEMENT

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(Under the Direction of Mi Geum Chorzepa)

ABSTRACT

This thesis aims to understand the current state of bridge, culvert, and pipe asset management systems in county governments across the state of Georgia and strengthen the relationship between the Georgia Department of Transportation (GDOT) and local governments in the state of Georgia. The research method involves understanding what other state agencies provide when working with local governments, conducting interviews with Georgia county governments, as well as meeting with and observing Georgia county governments who have successful asset management programs. This information culminates into a standard inspection guide, demonstrating how Georgia counties may conduct inspections of their culvert and pipe assets, as well as how to develop an inventory and condition management system in order to maintain public roads safe and open for motorists. The research also provides a strategic plan for improving the working relationship between GDOT and county governments.

Index Words: Asset, Bridges, Culverts, Inspection, Maintenance, Management

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by

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EXECUTIVE SUMMARY

The contents of this thesis aims to understand the current state of bridge, culvert, and pipe asset management systems in county governments across the state of Georgia and strengthen the relationship between the Georgia Department of Transportation (GDOT) and local governments in the state of Georgia. To accomplish this goal, the thesis shall present both a written strategy plan for the goal of improving GDOT-local government relationships and secondly provide an inspection guide for locally owned transportation assets such as culverts and pipes. The thesis is divided into seven sections. The first will provide necessary background to understand the context of the project and clearly state the objectives behind it. The second provides the results of literature review conducted for the research, including information regarding infrastructure law and practices in the United States, as well as funding sources for infrastructure projects in Georgia. The third chapter discusses the methodology used in developing both the strategy plan and the inspection guide, including the development of a survey for Georgia county governments and the research and observation of best practices both in Georgia and other states. The fourth section describes the results from the county survey developed. It provides both an overview of the survey on a question topic by question topic basis, as well as provides a summary of the answers for every county surveyed. The fifth section provides the goals and development process for the strategy guide using the survey results and the best practices from other state agencies. The sixth section provides the goals and the results of the strategies for developing the inspection guide. The thesis shall conclude in the final section, where the findings from the research will be summarized and future work will be described. The appendices of the report will present a copy of the survey, a draft copy of the strategy plan, and a draft copy of the inspection guide to be presented to GDOT.

CHAPTER 1. INTRODUCTION

BACKGROUND

It was early in the morning, just before morning traffic hour, on January 29th, 2022, when the Fern Hollow Creek bridge collapsed in Frick Park in Pittsburgh, PA. The bridge collapsed, plummeting 150 feet below, injuring ten people travelling over it at the time. Luckily no persons were killed in the event, with only 4 victims requiring hospital stays. The bridge had been inspected just a few months prior, in September 2021, and had been given a condition rating of "poor" (WTAE, 2022). The Fern Hollow Creek bridge collapse is just the latest reminder of the monumental task the United States faces when it comes to tackling our failing infrastructure, especially bridges. In 2021, the American Society of Civil Engineers released their latest report card on the status of infrastructure in the United States. They gave the overall infrastructure a "C-", while giving bridges a "C" (ASCE, 2022), which indicated that while America's bridge status is adequate, it's getting closer to failing.

In the report, it describes how currently 7.5% of bridges in the United States are considered "structurally deficient", meaning that their condition is considered "poor" or worse, just like the Fern Hollow Creek bridge above. At the same time, there has been a large push on the political side of the issue to finally tackle this from a federal level. In November 2021, the Biden Administration signed into law the "Infrastructure Investment and Jobs Act." This provided $550 billion dollars for the purpose of rehabilitating America's infrastructure, with $72 billion reserved specifically for bridges. These two items, in combination with other factors, have led to a renewed interest in infrastructure maintenance policy. More particularly, it has renewed an interest in the goal of optimizing the policies and future practices, especially at the state and local level.

In Georgia, the impact of this movement is already being felt. Georgia is one of the better states in the country regarding its bridge status. Only 3% of bridges in Georgia are considered “structurally deficient” compared to the national average of 7.5%. However, that level of success is not seen in all aspects of Georgia’s bridge maintenance. One of the major divisions that Georgia has seen in regards has been the difference in success between state agencies like the Georgia Department of Transportation (GDOT), and local governments and private owners’ ability to upkeep their bridges. In Georgia, agencies such as GDOT are responsible for bridges that are found on inter-county and interstate roads. The rest ultimately belong to their respective local governments and jurisdictions.

OBJECTIVES

The objectives of this report are two-fold, but both work towards keeping roadway users safe and for Georgia agencies to be more effective and organized in maintaining and managing their assets. The first objective is to research, identify and developed actions to improve the working relationships between state agencies such as the Georgia Department of Transportation (GDOT) and local governments. GDOT has systems in place to help local governments’ maintain and manage their locally owned bridges. They provides inspection on every bridge on a bi-annual basis in accordance with federal law and reports the findings to the local governments. However, GDOT can show that locally owned bridges lag behind state-owned bridges in regards to their condition ratings. In order to promote public safety and increase the overall health of Georgia’s transportation system, GDOT wishes to find ways to close that gap. Thus, this report will research and develop a strategy guide for GDOT to implement. The plan will look to attack the issue from multiple factors and aim to be feasible to implement in the next 3 years.

The other objective of this report is to provide resources that promote and guide local governments towards the development of preventative maintenance practices on the transportation assets they own and are in charge of. Under federal law, bridges under 20 feet in length are not required to be inspected every 2 years like those larger. These bridges and other bridge-like assets such as culverts are the responsibility of the local governance to maintain. GDOT has been able to help inspection bridges even smaller than 20 feet. However, GDOT does not have the resources nor the jurisdiction to oversee all these smaller assets and must rely on these local governments to maintain the rest. In order to help local governments, GDOT can provide resources to them in order to aid in their management and maintenance of these assets. The latest goal of GDOT is to encourage preventative maintenance practices for these assets. This involves improving both the inspection and inventory systems for the local governments. Thus, this report will aim to develop an inspection guide that will address how to improve both and be geared towards the experience of Georgia local governments.

CHAPTER 2. LITERATURE REVIEW

INTRODUCTION

In order to provide context and understanding for the project, as well as understand the latest information available for use, a literature review has been conducted. The review will cover many different areas of discussion. First, the review will cover the latest from the recently passed Bipartisan Infrastructure Law and how it could apply. Next, the review will cover infrastructure practices related to bridges. This includes understanding the philosophy behind bridge maintenance, what has been done to improve the maintenance including the development of models. It will also discuss the Georgia bridge inspection guide, inspection guides from other state agencies, as well as resources provided by other state agencies. Lastly, it will discuss funding options provided to Georgia local governments for funding. All these topics will provide the groundwork by which strategy plan and inspection guide shall be developed.

INFRASTRUCTURE PRACTICES

NBI System and NBI Element Data

Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges (FHWA, 1995)

No research, report, or project on bridges in the United States can be complete without a review of the National Bridge Inventory (NBI). Started in 1995, the NBI began with the goal of logging every bridge in the United States, as well as a list of over 100 properties associated with each bridge. It was become the gold standard for an extraction of bridge data in any given state in the country. Among the commonly used items in this dataset are the condition ratings associated with the different major sections of the bridge: the deck, the superstructure and the substructure. A more recent addition is the condition ratings of individual elements within a bridge, started in 2015, which provides a more extensive look at the individual pieces in a bridge. The condition ratings are rated from 0 to 9, 9 being a brand-new bridge, 0 being unfit for use and immediate closure. Most often, when a state Department of Transpiration provides a report on a bridge's condition, they are using this scale. Because of this, when developing the model, this rating system will be used, as it is a near universal language for those who work within the bridge maintenance and construction industry.

Improved Element-Level Bridge Inspection Criteria for Better Bridge Management and Preservation (Lin, Pan, Wang, & Li, 2019)

Understanding rating systems is important, but it is also important to understand the latest innovations in bridge inspection practices. The next report to review comes from the Mountain-Plains Consortium, whose goal was to improve the process of visually inspecting bridges and to improve the way information is conveyed about a bridge's status. With element inspection becoming the standard for bridge inspection, as shown by the expansion of the NBI data in 2015, the Consortium looked to develop practices that make that type of inspection more efficient and therefore more appealing to smaller-time organizations and bridge owners who do not have access to that kind of time and manpower. The report focused mostly on data extraction and reporting, but also provided unique solutions to human limitations while inspecting bridges. The team used a drone to inspect the bridge, record video that was then sent back to the inspector, all without the inspector having to move whatsoever, and record data with ease. They also incorporated systems like the support vector machine (SVM) that would be used to identify patterns and signs of deterioration, all on its own.

Advances in Bridge Inspection Practices

Development of Bridge Asset Management for Local Georgia Governments (Nguyen, 2020)

The last major piece to consider for this project has less to do with the mathematics and the models already developed, but more to do with the policies that have already been researched and implemented with a similar goal to the project at hand. Angela Nguyen had a similar goal to this project, in that she aimed to optimize Georgia's maintenance plans for local governments. However, rather than developing a model, Nguyen focused on finding where inefficiencies were occurring within local counties in Georgia, and why they were failing to meet their repair schedules. The largest problem came down to a lack of funding, or at the very least, a lack of plan for funding. From there, Nguyen developed a comprehensive guide to be used by local counties to understand options for funding, as well as ways to better utilize that funding to better their communities through improvement of their bridge asset maintenance plans.

Deterioration Rates of Typical Bridge Elements in New York (Agrawal, Kawaguchi, & Chen, 2010)

Another piece that needs to be reviewed for this project to be successful is to understand the models that have been created to attempt to predict bridge deterioration. Being able to predict when bridges will require repair will go a long way towards developing policy that will efficiently target bridges before their deterioration becomes out of hand, both physically and financially. Many departments of transportation have linear models they use to make predictions, but these models are often over-simplified, and fail to consider other factors that may accelerate a bridge's deterioration. Thus, the models typically overestimate a bridge's condition and allow it to deteriorate much further than it should before alerting the need for repairs. Models based on Markov chains were used next. While these models proved to be more effective, the purpose of this report from the ASCE (American Society of Civil Engineers) Library was to attempt to make the models for bridge elements better by building a model based on Weibull Analysis. Using historical data, they found a Weibull analysis provided a more accurate prediction of when elements deteriorated than the previous Markov chain model. Thus, when depreciation models are developed for analyzing the service life of bridges in Georgia, Weibull distribution may be used as the basis for the bridge deterioration.

Development of Depreciation Models Utilizing the NBI Condition Ratings Over 25 Years (Chorzepa & Oyegbile, 2019)

Previous models (Agrawal, Kawaguchi, & Chen, 2010) proved to work well, however, it did not incorporate the rating system used by the NBI data, which provides a more universal basis for models in states besides New York. This study conducted by the University of Georgia returns to the Markov chain method previously discussed, however, it looked to incorporate this with the rating system found within the NBI, as well as check the depreciation models with a Chi Square test. One of the more innovative parts of the study involved splitting the bridge in Georgia into 36 separate groups, and split culverts into 3. Each of these groups varied by region, as well as the material of a specified bridge structure. The chi-squared tests performed in the study indicated that the models were reliable, and could be reliably used as a piece of our larger, optimized policy model.

Optimal policy for Structure Maintenance: A Deep Reinforcement Learning Framework (Bao, Wei, & Li, 2020)

Two types of deterioration models have already been discussed: the Markov-Chain Method and the Weibull Analysis. Both were created using traditional mathematical methods. However, with the advancement of computers, and the ability to store vast amounts of data more accessible than ever, the concept of deep learning being used in predictive models has taken many industries by storm. If engineers wish to optimize their approach to bridge maintenance, then the bridge industry cannot be any different. This report looks at the ability to use deep learning reinforcement to produce a predictive model that is even more accurate than the previous models. The model was stated to have 3 distinct advantages. Firstly, a deep neural network will be able to make predictions based not only on historical data, but also what it has learned from other hypotheticals it has been proposed. Secondly, the optimization comes from the sample-based data, which comes from historical data from multiple bridges. Lastly, the general framework can be used for diverse types of structures, with the neural network architecture seeing minor change. The model was able to successfully optimize the maintenance plan for a given structure. Being able to replicate this model for Georgia bridges would go a long way towards achieving the goal of this project.

Available Resources in Georgia

In order to prepare to generate resources that will be used to benefit local governments ability to maintain, manage and replace their assets, it is important to delve into the systems and resources available to local governments already in place. This will allow the project to build on what has already been made, and to identify areas in which gaps in knowledge can be filled by the new resources.

Georgia Department of Transportation's Role in Local Bridge Inspections

The first item to understand when it comes to Georgia's locally owned bridges is the role that both GDOT and the local government have to play when it comes to the inspection, maintenance and rehabilitation/replacement of the assets. As discussed with the NBI system, every bridge longer than 20ft in the United States is required to have a full inspection on a bi-annual basis. The Georgia Department of Transportation has taken on this responsibility for all bridges in the state over 20 ft, so that this requirement can be met through the responsibility of 1 team, rather than trying to coordinate with 159 teams with 159 counties, each conducting their own inspections. This allows GDOT to be uniform with their inspection standards and to meet the criteria needed for the NBI system. For bridges owned by local governments, GDOT then packages the findings from the inspections into a single letter, which is sent out on a biannual basis. The letter includes a multitude of items. First, it will alert the local government to any bridge that has been posted for a lower load rating than it was initially constructed for. Then it will list every locally owned bridge in the county, the condition rating of the bridge in accordance with NBI standards, the maintenance items that need to be performed on the bridge, and the level of priority the maintenance warrants. The level of priority is based on an A B C system, with priority A being the most crucial. Most often, maintenance items will fall into priority B. These maintenance items are fully the responsibility of the counties to perform and budget for. GDOT does not get heavily involved in the process again until such time a bridge is required to be replaced. GDOT also provides some funding opportunities by serving as a bridge between local governments and state-wide funding opportunities, but the process is still the responsibility of the local governments.

Georgia Department of Transportation's InspectX Software (GDOT, 2022)

One of the more recent developments in the relationship between local governments and GDOT is the creation of a new software known as InspectX. InspectX was developed to provide a way for GDOT to send out full inspection reports to local governments regarding their bridge's health and condition. Rather than relying on paper and the mailing system, InspectX would be a could based system that local government officials could access via the internet. The local government would be able to search up any bridge within their jurisdiction and be able to access the full history of inspection reports. This would allow less information to be lost between local governments and the bridge inspectors, as both would now be able to read the same information. In addition, this would allow local governments to receive updated inspection reports as they were conducted, rather than having to wait 2 years to get a new update on their systems. Each inspection report begins with an outline of the information gathered about the bridge, written out exactly how it is entered into the NBI database. It then provides a detailed look at the inspection of the 3 main components of the bridge: deck, superstructure and sub structure. In each of these sections, the condition rating of the component is listed, the type of structure members used are described and comments are made about every possible issue with each section, from the smallest cracks to the largest spalls. Then, a brief is given about the load rating and posting for the bridge, if applicable. This is followed by a table showing the results of the NBI Element data collection for the bridge, highlighting different elements that require attention. The report will then list any maintenance items requested by the Georgia Department of transportation. One of the more important additions to these reports, compared to the summarized bi-annual reports, is the addition of photos. As the old saying goes, “a picture is worth a thousand words” and having pictures attached to the inspection reports, showing visually the areas of concern provides important context makes it easier for local government officials to discern what is being requested of them in the maintenance items.

Georgia Department of Transportation Bridge Structure Maintenance and Rehabilitation Repair Manual (GDOT, 2012)

While the biannual summarized inspection reports attempt to be as clear and accessible as possible in their maintenance suggestions and instructions, it is difficult to accomplish this goal all the time.

Thus, the GDOT Bridge Structure Maintenance and Rehabilitation Repair Manual has become a source of clarification for many local governments when attempting to decipher the reports from GDOT. The goal of this guide is to provide a one-stop shop for agencies looking to perform maintenance on their assets and to do so within GDOT's expectations and standards. The manual begins with an overview of the different bridge components, both for traditional bridges and for large culverts greater than 20 feet in length. It follows with a section on environmental considerations to be had when dealing with repair and maintenance on bridges, including the permits involved, how to deal with coordination between different agencies, and, finally, the documents necessary for the process. The bulk of the manual is then spent breaking down in detail what process is to be carried out when a local agency is asked to perform a maintenance item on a bridge. There are 44 different types of maintenance items listed in the manual, each containing detailed descriptions, tables, figures and more to help ease the process of performing the maintenance item. This is followed by a section dedicated to preventative maintenance that can be performed by bridge owners. These items are not listed by GDOT in the bi-annual inspection reports, as local governments are expected to be performing these on a regular basis without coaxing from the state agency. The manual provides instruction on cleaning deck and gutters, cleaning deck drains, cleaning expansion joints, sealing the deck, cleaning abutments and caps, redressing riprap, brush and tree removal, debris removal, and maintaining spillways. The appendices include several other potentially useful resources for local governments to take care of, including a list of generally referenced documents throughout the manual, a list of maintenance items that require special provisions, specifically in regards to concrete repair, and lastly, a list of GDOT approved quality products.

Georgia Department of Transportation's Local Government Webpage (GDOT, 2023)

Another recent development in the relationship between GDOT and local governments is the newly launched "Local Government" Page on the GDOT website. This webpage was launched as a way to create a one-stop shop for local governments to access resources and learn more about GDOT programs for agencies like themselves. The page is divided up into three main sections: Current and Future Investments, Local Programs, and Training. The page is still in its infancy, so the options presently available are limited and many are irrelevant to bridge and culvert maintenance. The page is also missing some existing resources, such as the previously mentioned Georgia Department of Transportation Bridge Structure Maintenance and Rehabilitation Repair Manual. This webpage is still developing and provides an excellent platform for resources developed by this research team, and other after it, to be hosted. **Figure 1** shows the current state of the webpage and what is included in each of the three subpages.

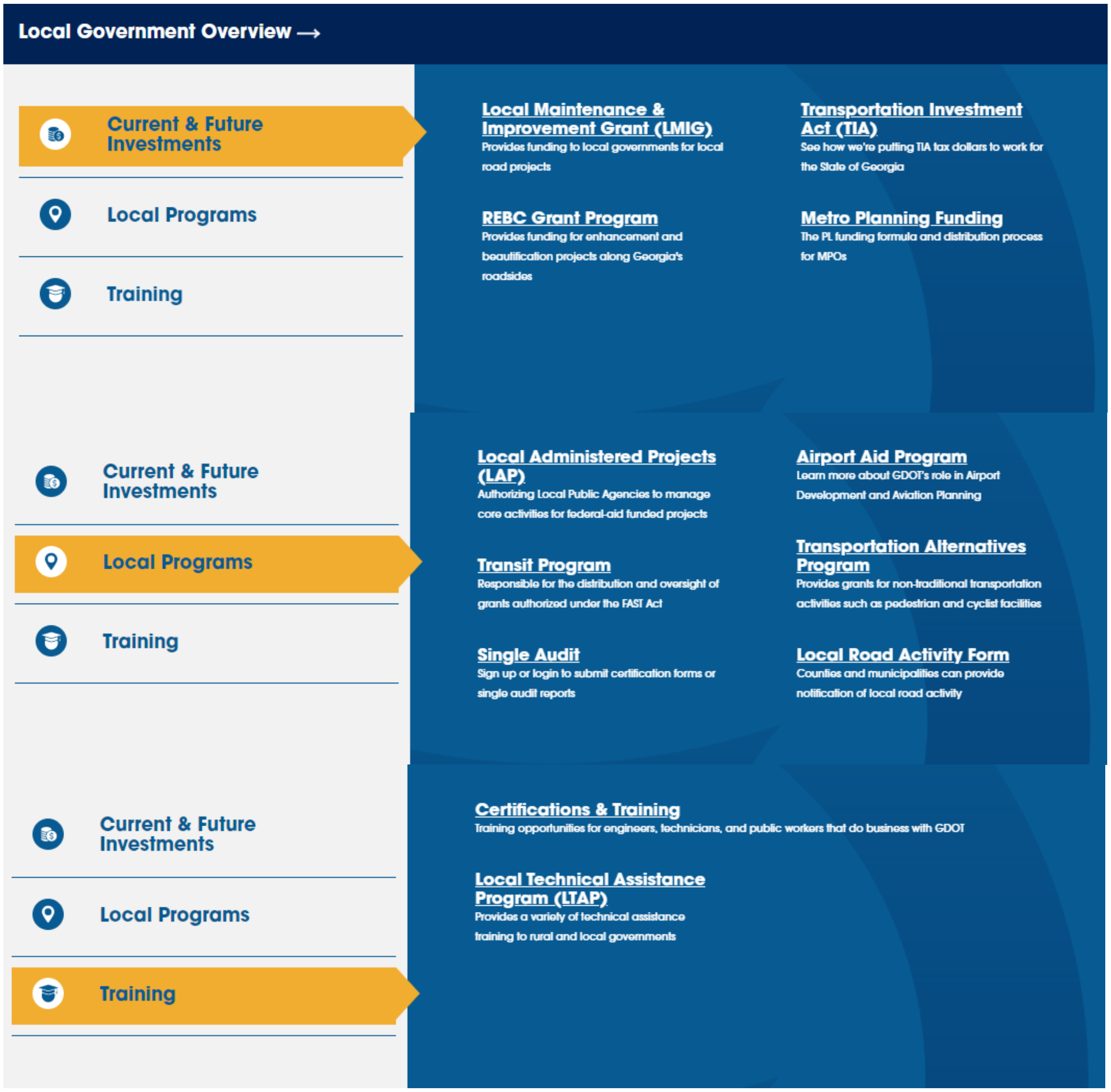


Figure 1. Local Governments Page on GDOT Website

Stormwater System Inspection and Maintenance Manual (Arcadis, AECOM, 2020)

The state of Georgia has incorporated the Municipal Separate Storm Sewer System, also known as MS4, program. This program is designed to designate urbanized areas which are held to a management and maintenance standard for local stormwater assets. The program was started in the state of Georgia in 2012 and saw an expansion of the areas it applied to in 2017. It is expected in the coming years for another series of expansions to take place. A map of the MS4 designated areas in the state of Georgia can be seen in **Figure 2**.

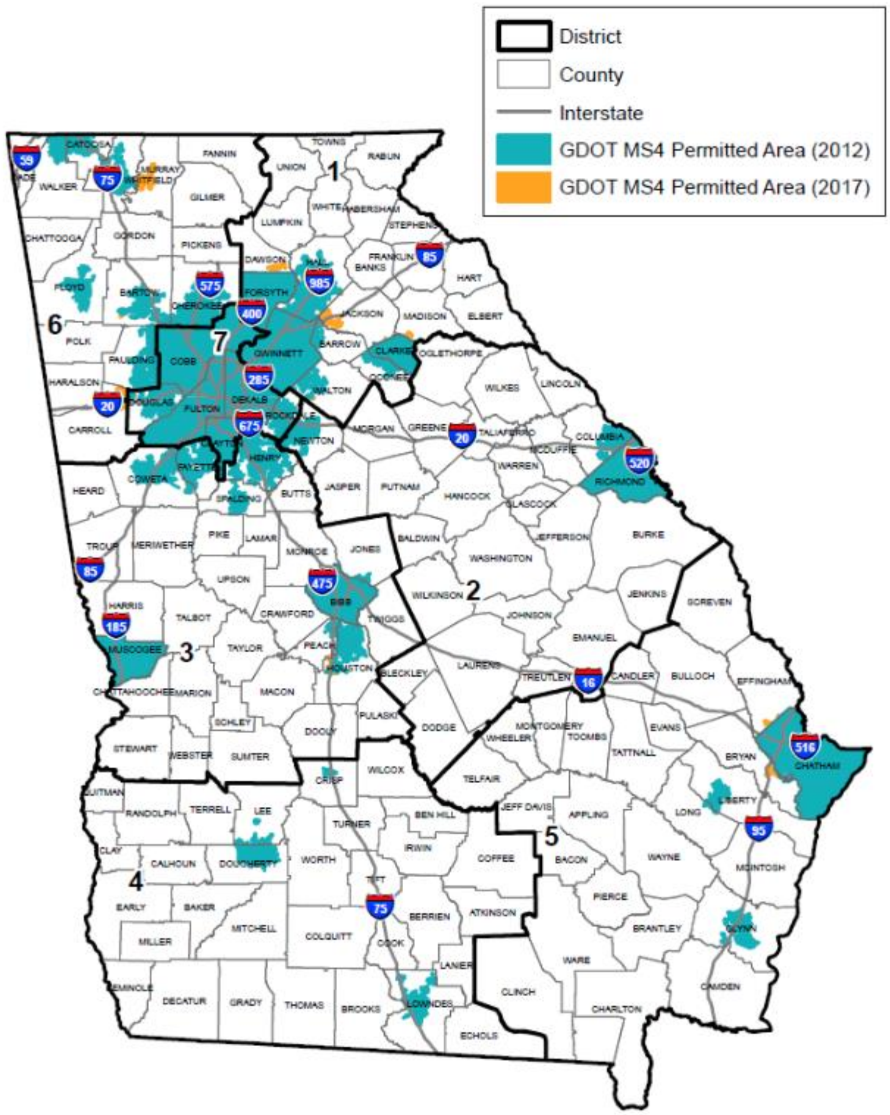


Figure 2. Revised MS4 Area Map for 2017 (GDOT, 2017)

The MS4 program standards cover the inspection and maintenance of all assets associated with stormwater management, including ditches, pipes, drainage structures, detention ponds and more. A guide that is readily available for local governments is the Stormwater System Inspection and Maintenance Manual, developed by GDOT in association with ARCADIS and AECOM. The manual speaks to all types of stormwater assets in accordance with MS4 guidelines. The ultimate goal of local governments to expand their economic development and to build up their community over time. If they succeed, there rural-like area will slowly urbanize over time, likely putting them in contention to be placed under MS4 guidelines. It is important to understand these guidelines because one of the goal of the inspection guide is to help local governments build the necessary foundations of a function inspection system for their pipe assets, so that if their assets are included in the next round of MS4 expansion, they are already conducting inspections that are in accordance with MS4 guidelines. The sections that are relevant to this research include Section 4.1.2, the Inspection and Maintenance of Pipe Structures, Section 7 on Record Keeping and Reporting, and the Inspection Checklist for Pipes located in Appendix A-1 of the manual.

In section 4.1.2 of the Manual, one will find a list of impairments for inspectors to be on the lookout for. This includes blockage or obstruction, cracks and/or joint separation, collapsing of the pipe, corrosion, root intrusion, bent or chipped ends, leakage, liner damage, lack of stabilization, and moderate/severe erosion. Every one of these items shall be covered in the guide this thesis seeks to develop, in order to adequately prepare counties for this type of inspection. The manual also notes that observations and notes should be take on if the surface or pipe cover is missing, scour is undermining the asset or evidence of animal burrows, whether blockages are due to sediment or vegetation, description of pipe deformation or collapse, and the level of corrosion within the pipe.

Section 7 of the manual deals with record keeping and reporting under MS4 guidelines. This is important to help determine the recommendations the research team's guide will make when it comes to keeping records of both inspections and maintenance. The manual describes what GDOT is responsible for, but local governments play their part in gather these records as well, as they'll gather their own up before sending it over to GDOT to be included in the statewide database for reporting. MS4 requires GDOT to maintain records of activities related to drainage structures and post-construction stormwater BMP inspection and maintenance. MS4 requires GDOT to develop procedures for receiving and investigating complaints related to drainage structures. Lastly, records are reported to Georgia EPD in each MS4 annual report in accordance with permit requirements. The annual report summarizes drainage structure and post-construction stormwater inspection, maintenance activities completed and complaints related to drainage structures.

The last section of note within the Stormwater System Inspection and Maintenance Manual is the inspection form provided within Appendix A-1. For each aspect of inspection, the form gives a select number of options that an inspector can choose between. All have the option of having multiple boxes checked, if applicable. The criteria include blockage, condition, erosion type, corrective action, and conveyance defect. The options for each criteria are listed below:

- Blockage – 0%, 1-25%, 26-50%, 51%-75%, 76%-100, Unknown
- Condition – New, Good, Fair, Poor, Inoperable, Unknown
- Erosion Type – No Indication, Syphon Holes, Settling, Exposed Pipe, Scouring/Undermining, Unknown, Creep, Other
- Corrective Action – No Action, Clean Pipe of Debris/Sediment, Remove and Replace Pipe, Repair Structural Defects, Re-Grade Ditch, Remove sediment/trash from ditch, Dig-out deposits around end sections, reinforce, install, unknown
- Conveyance Defect – No visible defect, joint separation, pipe collapsed, pipe corrosion, root intrusion, lack of stabilization, liner damage, surcharged flow, bent/chipped end, cracks/cracking, unknown, moderate erosion, severe erosion, leaking

One point of interest is that while the MS4 guidelines do ask inspectors to make a judgment call on the condition of their assets, this is a purely subjective call. The condition is not determined by the results of any other portion of the inspection. This is likely one area in which the guide developed by this report and MS4 guidelines will likely differ. However, differing in this case would not mean contradiction, as the guide would allow for a condition rating to be calculated and then checked off for MS4 assets, rather than making it guesswork.

Culvert Inspection Guides from Other State Agencies

To help provide a foundation for what can be included in a Culvert Inspection Guide for Georgia local governments, its important to research and summarize the guides that other state DOTs and organizations have build for their local governments. By examining these other successful state DOT guides for culverts, the research team can identify elements and sections they wish to see replicated in their own guide for Georgia. The following section contains summaries of six state DOT culvert inspection guides that stood out to the research team.

Michigan Non-NBI Culvert Structure Inspection Guide (MTAMC, 2021)

In September 2021, the *Michigan Non-NBI Culvert Inspection Guide* (Mi-NCSIG) was developed to provide local governments and private owners of culverts in the state of Michigan with a go to guide for culvert inspections. The guidance aims to help inspectors meet consistency standards needed to submit culvert data to the Michigan Transportation Asset Management Council (Mi-TAMC). The reason for the guide's development was that culverts that are not covered by the National Bridge Inspection Standards (NBIS) will have a standard inspection report and process. It then provided references to national bridge and culvert inspections guides which will also be used in the development of Georgia's future guide.

The first chapter of the Mi-NCSIG works to establish the collection of culvert data. It established that “Public Act 325 of 2018 requires large local road agencies to have an asset management plan that includes culvert assets.” This data is to be collected for a variety of reasons, but most importantly, it is used in the establishment of asset management planning and practice. Further into the chapter, it will explain how to identify non-NBI bridges or culverts, how to determine inspection intervals, what inspection equipment is necessary and finally, what safety resources are necessary for the inspections.

To identify whether a bridge or culvert is classified under non-NBI or NBI, there is one major factor to consider: the span length. The NBIS does not take into consideration bridges and culverts with a span length of less than 20 feet. How this guide defines a culvert is as follows: “a linear drainage conduit underneath a public roadway that is not considered a ‘bridge’ by the FHWA.” If a culvert is greater than the specified length of 20 feet, and therefore meets the definition of a bridge under the FHWA, must be inspected per the NBIS and the *Michigan Structure Inspection Manual (MiSIM).*

The next essential information to consider is the inspection intervals, and how to determine them. Inspection intervals that are too frequent can result in inefficient use of resources and minimal learning from changes in data. However, should the inspection intervals be too infrequent, the risk of a few possibilities could unfold. There could be major changes between inspections, leading to missed opportunities for preventative or reactive maintenance. Even worse, the risk of failure for the structure is also increased due to missing those earlier opportunities for repair and maintenance. The guide recommends developing a “risk-based interval matrix” based on the following characteristics of the culvert: Condition rating, size, material, age, and roadway average daily traffic (ADT). The other major recommendation that the Mi-NSCIG makes is that the inspection interval should change bridge by bridge, rather than creating a one size fits all policy. Their general rule of thumb is that the smaller the culvert, the greater the inspection interval can be. For example, for culverts less than 4 feet, they only recommend a maximum inspection interval of 72 months (about 6 years), while culverts that are between 10 and 20 feet, they recommend a maximum inspection interval of less than 24 months (about 2 years). In addition, they recommend that the inspection interval be shortened depending on the condition rating of the culverts. A culvert in a "good" condition rating can have its maximum inspection interval, but as its condition rating worsens, it is expected that the inspection interval will be shortened to allow for more frequent visits to the site to catch important developments and opportunities for repair and preventative maintenance.

The first chapter then finishes with sections dedicated to 'Inspection Equipment' and 'Safety Resources.' It recommends that any field agent should be familiar with the AASHTO (American Association of State Highway and Transportation Officials) *Culvert and Storm Drain System Inspection Guide.* In addition, it lists common personal protective equipment (PPE) including vests, hard-toe boots, gloves, hard hats, and safety glasses. If a field agent is working near water, as is often the case when inspecting culverts, life jackets are strongly encouraged. Agents also encounter heavily polluted water, so including waders or hip boots in their equipment can increase their level of safety there. Agencies should also consider dangers and risks specific to their local areas. This can include how to deal with local wildlife, accounting for higher elevations or the climate of the locality. Finally, it recommends that agents should review previous inspection reports to determine what equipment is needed, to avoid repeated unnecessary visits to the site that can be avoided by preparation. The chapter also provides a list of standard equipment for visual observation, diagnosis of unexposed defects and recording equipment. For visual observation, which includes binoculars, ladders, flashlights, and cleaning tools. For diagnosis of unexposed assets, the tables include rock pick hammers, probing rods and shovels, rafts, and a fathometer. For recording equipment, the tables recommend a camera, measuring tools, a level, and a smartphone. Finally, the chapter concludes with a list of common safety resources that can be used for further reading, including the aforementioned *AASHTO Culvert & Storm Drain System Inspection Guide*, the *Michigan Structure Inspection Manual (MiSIM)*, and the *Bridge Inspector's Reference Manual* (BIRM).

The second chapter of the inspection guide covers the importance of inventory data when maintaining culverts, as well as the best practices for doing so. This section does not cover the how individual pieces should be rated in terms of their condition, but rather covers which pieces of information it is important to record to identify the characteristics of the culvert, for easy identification later, as well as gaining a better understanding of how these characteristics show patterns in deterioration and how to optimize planning around their inspection. While initial recording of these values can be time-consuming and rigorous, having this data on hand will allow for quicker inspections in the future. The first piece of information that should be recorded is the 'Inventory Identification Number', which is established by the local agency and is meant to uniquely identify that culvert. Next item to record is the 'Inspection Date' of the latest inspection. The third item is the 'GPS Coordinates', which is the latitude and longitude coordinates of both ends of the culvert. Recording both ends is helpful regarding hydrological models and other similar modeling purposes. In addition to the coordinates, the elevation should also be recorded.

The next major piece of information to record is the material type. Additional subtypes are allowed to be included by discretion of the agency, but the guide suggests a baseline of the following material options: plastic, concrete, steel corrugated metal pipe (CMP), steel plate, aluminum corrugated metal pipe (CMP), aluminum plate, masonry, timber and other. The shape of the culvert will be the next item to record. The guide suggests the following options for this variable: round, horizontal ellipse, vertical ellipse, pipe arch, arch, low-profile arch, high-profile arch, pear, box, multi-cell box, three-sided, slab/superstructure and abutment, and other. If those names do not sound intuitive, the guide also included a visual guide (Figure 3) to reference to.

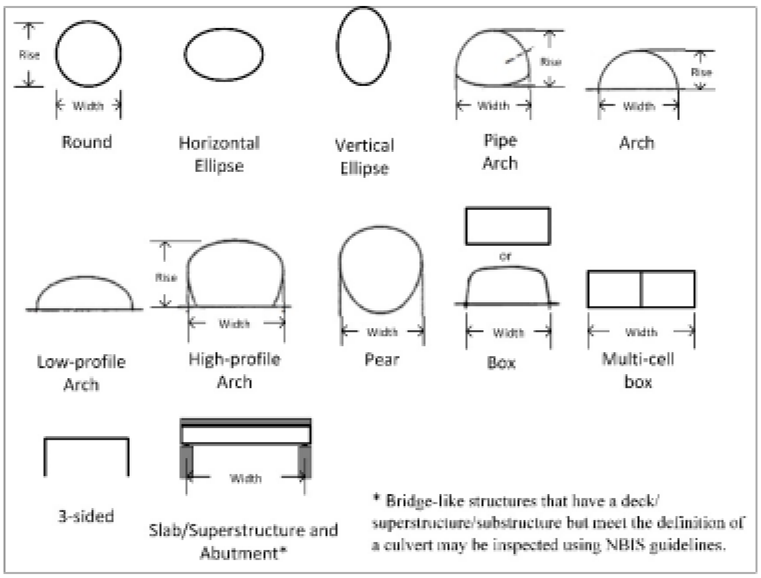


Figure 3. Culvert Shapes (MTAMC, 2021)

Skew angles are another item to record. This is a value between –90 degrees and 90 degrees that measures the difference between the line perpendicular to the direction of the road and the centerline of the culvert. For further explanation, a figure was provided to visualize this measurement, which can be seen in Figure 4.

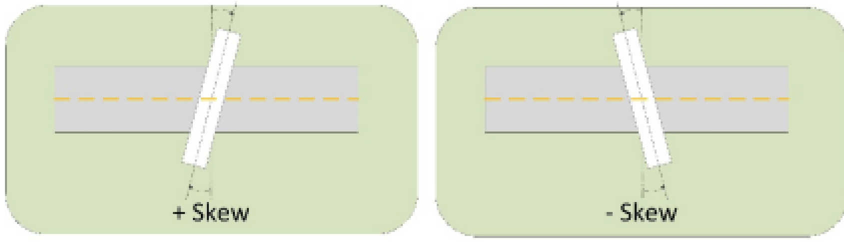


Figure 4. Culvert Skew Angles (MTAMC, 2021)

From here, the guide lists measurements to be made regarding the culvert itself, all measured in feet unless otherwise stated. First is the rise of the culvert, which is the measurement of the culvert barrel at its tallest point. Next is the width of the culvert, and the span if there are multiple barrels. The number of barrels is then recorded. The depth of cover for the culvert is required, which is the difference between the top of the barrel and the top of the road surface. Finally, the roadway surface type is recorded, as well as the condition ratings, which are covered in depth in Chapter 3 of Mi-NCSIG. There are several optional pieces of information to include, which includes the physical route number, the road name, the mile point (measured with 3 digits of precision), as well as the installation date. If an inventory program allows for it, photographs of the site are heavily encouraged.

The third and most extensive chapter of the inspection guide covers the practices and systems regarding collecting condition ratings data for Culverts. The condition ratings are broken down into two main categories, each their own divisional subcategories. Those two categories are the "vicinity and appurtenant structures" and the "culvert barrel." The actual condition rating system used is a common one, with four stages: Good, Fair, Poor and Severe. The guide provides a flow chart, that can be used by an inspector upon arriving at the site to establish what criterion they will be using for their condition rating judgements. It importantly notes that if a component's overall condition rating is determined by the poorest rating element. For example, if an element is in poor condition, the overall rating of the component is "poor", even if all other elements are in good condition in the component. The guide provides a chart, *Table 3-1* (Table 1), which provides general condition ratings, along with descriptions for each. It also notes that it is important to include photo documentation, along with visual aids to visualize where affected areas are located, for future inspection and repair work.

Table 1. General condition ratings, actions, and descriptions shown in Table 3-1 of Mi-NCSIG. (MTAMC, 2021)

Condition Rating	Good	Fair	Poor	Severe	Not Rated
Action Indicated	Action: none Note in inspection report only.	Action: none, but more frequent inspection may be warranted Inform maintenance personnel.	Action: corrective action based on inspector's evaluation. Recommendations made in inspection report.	Action: corrective action based on engineering evaluation to specify appropriate repair. Required action is urgent.	Action: none
Condition Description	Like new Deterioration: none to little Structurally sound Functionally adequate	Deterioration: some Structurally sound Functionally adequate	Deterioration: significant AND/OR Functionally inadequate Requires maintenance or repair	Very poor Deterioration: severe Structurally unsound Functionally inadequate Possible imminent failure or threat to public safety	Not part of the culvert design or structure Functional adequacy not required Not an inspection item at last culvert inspection. Excludes items missing due to vandalism, damage, or deterioration.

The guide then looks to provide more information regarding the two major categories established before. First, it provided information regarding the vicinity around the culvert. This includes guidance on how to evaluate the roadway, channel scour and blockage, and end treatments and appurtenant structures. Each piece of vicinity evaluation includes a description of the component, a guide as to what to look for, as well as a modified version of *Table 3-1* that is geared towards the component specifically. After the vicinity components, the guide moves onto the culvert barrel, which rather than breaking down the different components of the culvert barrel (there is only one, the barrel itself), breaks down the different types of barrels by material. It includes guidance for plastic, concrete, corrugated metal, masonry, and timber culverts. Similar to how the previous section was broken down, each section includes a description of the type of component, what to look for during inspection, and that modified version of *Table 3-1*.

NYSDOT Culvert Inspection Field Guide (NYSDOT)

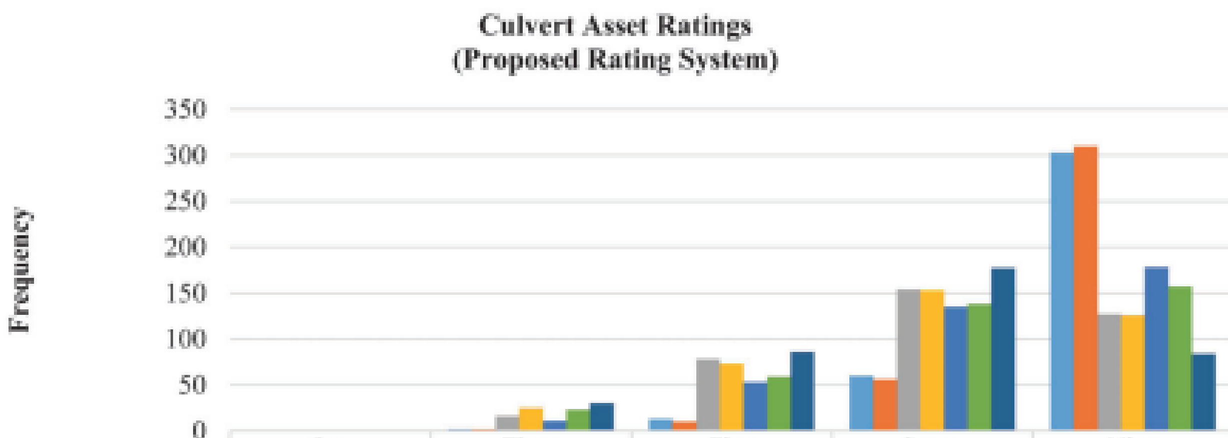
Previous guides such as the Michigan Non-NBI Culvert Structure Inspection Guide provide a great amount of information regarding how to organize inspection information for local governments taking care of their culverts. They also provide great descriptions regarding what to look for when inspecting these structures. However, one area in which it lacked was the inclusion of visual aids regarding what those conditions looked like. The NYSDOT Culvert Inspection Field Guide is a guide that is solely focused around visually aiding inspectors and is something that can be combined with the detailed instructions provided by the Michigan Guide to form a complete inspection guide. The guide includes the condition ratings system for the state of New York, including the difference between the ratings for the entire structure and the scale of individual items. Reminding inspectors of the rating systems before providing visual aids is important because it helps establish the context in which they will be rating these elements. From there, the bulk of this field inspection guide is filled with pictures of various elements at different stages of the ratings scale established at the forefront of the guide. The captions of the photos draw attention to the properties shown in the picture that justify the rating. Most often the guide shows ratings of 7 (the highest) down to a 3 or 4, where if something is at that rating or worse, additional maintenance/repair work is needed. The items listed in this inspection guide are those considered crucial to the State of New York, and thus do not fully match up with the elements listed in other guides. The elements/components listed and provided pictures for in this guide are as follows: pavement, shoulders, guide railing, settlement, embarkment, abutment and pier, span barrel, headwall, wingwall, opening, alignment, scour/erosion, and debris. The guide finishes with an appendix, providing common codes used in the state of New York to identify aspects of a culvert, such as the material, the coating, design type, end treatment type, guide rail, abutment type, bank protection, and the owner of the culvert.

HydInfra Inspection Manual: Culvert and Storm Drainage Systems (MnDOT, 2020)

Another Culvert inspection guide comes from the state of Minnesota, provided by the Minnesota Department of Transportation. What separates this guide from the others is that not only does it provide information regarding the inspections of culverts, it also provides guidance on how to inspect storm drainage systems, as well as how to differentiate the two. The organization and content of the guide is similar to that of previous guides discussed regarding inspection methods and how to identify characteristics and condition states. However, what sets this guide apart is the way it presents the information. Rather than providing information in paragraph form, the guide is filled with figures, tables and bulleted lists in each section, varying depending on what is needed, in order to provide that information in easy to digest ways. The guide does differentiate from other guides content-wise in some areas. Firstly, the rating system for culvert inspection in Minnesota is similar to that for the Element-based NBI data conditions states, where a condition state of '1' indicates "like new" or "good" condition and a condition state of '4' indicates a "severe" state, with states in-between. The inspection criteria is also somewhat different, as it is broken down into four main categories, with each looking at different aspect of the culvert/drainage system. The first is the *Condition Indicators,* which includes, pitt/rusting, spalling/flaking, cracks, holes, max joint separation, number of joints to fix, separated apron, misalignment, deformation, infiltration, piping, and deteriorated ties. All these are used to determine whether the structure is in need of repair. Next is *Roadway Indicator Flags,* which includes the inslope cavity, the road distress, voids in the road, and erosion. As the name would indicate, these are items outside the structure in the surrounding area that could indicate need for repair not obvious from inspecting the structure itself. There are other items to check that are labeled as *Not in Condition Rating*, which includes whether the structure needs to be cleaned, whether the structure is plugged, the percentage of sediment full, what the state of the water in the structure is (dry, slow, fast, standing, or full), and finally the percent water the structure is filled. The guide then goes into great detail about the different materials used in these structures. It provides information on how to identify the types of materials (especially the plastics) as well as what considerations are unique to those materials, which is broken down using the condition states described above. In terms of what elements could be replicated to Georgia's culvert inspection resource guide, the use of graphics to make information digestible to readers was expertly done here, and the breakdown of the changes in criterion for different materials would be something to consider in the final guide.

Processes of Small Culvert Inspection and Asset Management (Bowers, Magers, Pyrz, & Bullock, 2014)

While local counties and governments often rely heavily on GDOT for their larger assets, one type of asset that counties consistently know is their responsibility is the inspection and management of small culverts. In this case, there is great precedent to be found in the *Processes of Small Culvert Inspection and Asset Management* guide developed by the Indiana Department of Transportation's (INDOT) Joint Transportation Research Program. The guide includes five main sections: an introduction with literature review and motivation for research, a field data collection section that highlights equipment needed, a section highlighting two main inspection methods, a section regrading data collection and criteria, and finally a recommendations section that serves as a catch-all topic section. The items of interest that separates this guide form others comes in the third section regarding methods. This section breaks down two inspections methods that INDOT recommends for use of small assets, which includes the “Small Culvert Inspection Method” and the “Catch Basin Inspection Method”. As the names would imply, these provide information regarding what criteria categories inspectors should consider in their practice. In addition, it provides practical advice regarding practices during the inspection, many of which could easily be overlooked by an inspector who haven’t read the guide. The guide includes a copy of a single-sheet inspection form for both types of inspection. These sheets include keys and copies of the inspection ratings that are outlined later in the guide, for easier lookup information for inspectors during the inspection. They also provide examples of the practices, with pictures of an inspection in progress, as well as what a amp of these assets should look like. The next section goes into detail regarding those rating systems in each of the inspection methods for culverts and catch basins. After describing the rating systems, they once again show an example as to what a county’s management system should be able to produce graphically, an example of which can be found below in Figure 5.



	One	Three	Five	Seven	Nine
Embankment In	0	2	13	60	303
Embankment Out	0	2	10	56	310
End Section In	0	16	78	154	127
End Section Out	1	25	73	153	126
Flowline In	1	11	53	135	178
Flowline Out	1	23	59	138	157
Culvert Condition	1	30	86	177	84

Rating

Figure 5. Example of Culvert Asset Ratings Display (Bowers, Magers, Pyrz, & Bullock, 2014)

The last section regarding "recommendations" provides as a catch-all section providing advice and description of practices that didn't fit well in the previous sections. This included photography practices, as well as changes that might be considered for the rating scale, inspection processes or inspection frequency based on the needs of the local government. It also provides a section detailing the need for a dedicated staff towards these inspections, something many counties do not provide for in their staff departments.

SCDOT Pipe and Culvert Field Inventory and Inspection Guidelines (SCDOT, 2021)

In 2011, the South Carolina Department of Transportation released a guide in order to help standardize the expectations that the state government had towards local agencies when it came to the management and inspection of local pipe and culvert assets. The guide begins with a short introduction explaining why management and subsequent maintenance of these assets is important to transportation infrastructure. The introduction makes it clear which assets fall under its scope, which are those ranging in 3 ft. all the way to 20 ft. in their diameter or span. The next section is dedicated to the purpose of the document, where it states " This inventory and assessment program will provide a comprehensive review of the culverts located under the SCDOT's roadway system. It will provide not only a physical count of this feature, but also, an evaluation of the condition of each culvert." It explains how it will provide guidance in establishing an inventory system and then how to establish inspection schedules and condition rating systems. It also clarifies that it does not provide guidance on the actual repair activities.

Next, the guide includes a section on safety and potential hazards. It emphasizes the importance of pre-planning measures which includes safety meetings, assessing the site vicinity upon arrival and prior preparation for any known hazards. It lists a few programs that inspectors should be familiar with, including "Safety Awareness Orientation, Confined Space, Excavation, Personal Protective Equipment [PPE], Fall Protection, and an appropriate level of Work Zone Safety Awareness courses." It states that all inspection teams should contain two personnel and that each should have a ranged communication device to contact the other with. It lists the PPE it expects inspectors to have, including safety boots, hard hats, safety glasses, safety vest, PFD and work gloves. Some of the hazards this section discusses includes confined spaces, drowning, traffic, slips and falls, wildlife and toxins. For each of these subsections, the guide discusses what each hazard brings and how inspectors can avoid being put into danger with them.

The next section provides guidance on what items should be included in an inventory take of these assets. The items it lists include the district, the county, the name of the inspectors, the date of inspection, the route type, the route number, the route auxiliary type, the mile point, the latitude and longitude, the purpose of the asset, the orientation, the position of inlet and the position of the outlet. It states the goal of the inventory system by itself is to reduce the number of cases of missing or forgotten assets in the future. Next, it states the inventory should be able to identify the type and size of the asset. This includes the material of the asset, the number of barrels or pipes in one location, the area of the barrel and other geometric information, the culvert length, the culvert shape, the culvert liner, the pipe end type, the inlet/outlet end treatment types, and the aprons. Each of these items are given a general definition and associated pictures to help define how to identify them in the field.

The next section deals with condition assessments. This is where the guide gets into detail about how inspections ought to be conducted and it divides its standard inspection into 7 steps: 1. Planning the inspections, 2. Observe the overall condition, 3. Observe the roadway and shoulder around the asset, 4. Assess the waterway or channel, 5. Assess the condition of the inlet, 6. Assess the condition of the outlet, and 7. Assess condition of the barrel. For step 1, it states to check the checklist of tools, review prior inspection reports to familiarize oneself with the site and the asset, notify your superior of the inspection and to fill out what parts of the inspection report one can before reaching the site. For steps 2, 3 & 4, assessing the overall conditions, roadway and waterway, it states to look at the conditions of the vicinity, look for land use changes that may affect the assets function, and to look for sediment, sinkholes and eroded areas on the roadway. For steps 5 & 6, assessing the inlets and outlets, it askes for inspectors to look for scour, blockages from sediment or vegetation, erosion, cracks, separation, and corrosion. Finally, for step 7, assessing the barrel, it calls for inspecting for corrosion, cracks, alignment, sediment, join separation and blockages. The barrels should be inspected from both ends using a flashlight, binoculars and “extra care”. If addition assessment is needed, such as if special equipment is required, the inspector should contact their supervisor.

The guide then provides standard condition ratings for all aspects of the inspection. The general system the guide recommends is a 5-tier system with a “5” being the best condition and “1” being the worst condition. The condition ratings are broken down into two categories, “Inlet/Outlet” and “Barrel”, which are each broken down further into sub categories, which each have a written out rating scale. These rating scales show the 5 tier system, and small descriptors next to each tier describing what warrants that rating for said item. For “Inlet/Outlet”, its subcategories are alignment, erosion, cracked, separated, scour, vegetation, clocked and corrosion. For “Barrel”, its subcategories are corrosion, cracked, alignment, sediment, joint separation, piping, and blocked. For a visual representation of what this looks like, refer to Figure 6.

Inlet & Outlet

Alignment
Rating Description

5. Channel and culvert are aligned.
4. Channel and culvert are within plus or minus 15 Degrees alignment.
3. Channel and culvert are greater than 15 degrees and less than 45 Degrees misaligned.
2. Channel and culvert are greater than 45 Degrees misaligned.
1. Channel is parallel to road or undermining embankment or road.

Erosion
Rating Description

5. No erosion evident.
4. Some erosion to stream bank or fill.
3. Moderate erosion to stream bank or fill.
2. Heavy erosion to stream bank or fill.
1. Erosion threatening roadway.

Cracked
Rating Description

5. No cracks in structure.
4. Some minor cracking less than 1/8".
3. Some Cracks in excess of 1/8" efflorescence is evident, some rust streaks may be evident.
2. Large cracks are evident greater than 1/4", extensive cracking, exposed rebar.
1. Cracks greater than 1", exposed rebar and extensive spalling of concrete surface.

Separated
Rating Description

5. No separation between barrel and or structure.
4. Minor separation less than 1/8".
3. Medium separation less than 1/2".
Major separation in excess of 1 1/2".
Total separation in excess of 3".

Scour
Rating Description

5. No undermining or scour.
4. Minor scour or erosion at base of structure but not extending under structure.
3. Scour or erosion at base of structure extending underneath structure up to 12".
2. Scour or erosion at base of structure extending underneath structure up to 24".
1. Scour or erosion at base of structure extending underneath structure in excess of 24".

Figure 6. SCDOT Condition Assessment Scale Examples of Inlets and Outlets (SCDOT, 2021)

After the assessment guidelines, the guide provides a few additional sections that provide complimentary support. First, the guide provides an extensive glossary of both management and engineering terms used throughout the guide, in order to clarify any confusion and to standardize the definitions of the terms being used. Next, it provides a suggested equipment checklist. This list includes both inspection equipment and safety equipment. Finally, the guide provides a section that include a sample asset inventory form and a sample culvert inspection form. The forms are complete to the point an agency could print them off and begin their use immediately. The condition assessments and recommendations of the guide can easily be applied to these forms.

Resources for Local Governments Available in Other State Agencies

Local Government Procedures for Compliance with the National Bridge Inspection Standards from Arkansas Department of Transportation (ArDOT, 2019)

One thing that has been made clear to the research team early on in the process is that the line between what is the responsibility of the state agencies and what is the responsibility of local governments regarding transportation assets has been incredibly blurred. That is why constructing a resource, or at least including a section similar to it in a larger resource, like the "Local Government Procedures for Compliance with the National Bridge Inspection Standards" from the Arkansas Department of Transportation (ARDOT) could go a long way helping clarify that line. This guide goes into intense detail outlining where the responsibility lies between local and state government agencies. For local governments, it included the following: Notification of bridge information, participating in annual certification, bridge closings for non-state owned bridges, notification of school districts, designating a contact point for bridge inspections, notification of ownership change, load posting material assistance, procedures for scour susceptible bridges, and many more. Afterwards, it outlines the responsibilities of the Arkansas Department of Transportation, which include designating a contact engineer, inspecting and load rating bridges structures on county/city public roads, updating the inspection data, notification of a need to change bridge status or load posting, distribution of a "bridge inventory/posting certification" report to each county, and many more. The guide also provides examples of what databases should look like that are kept by the local counties and governments when it comes to managing the assets. Of course, the responsibilities laid out in this guide do not perfectly translate to the system that is currently set up lawfully between GDOT and the local counties and governments of Georgia. However, the concept of a guide such as this will prove essential in getting all counties on board and on the same page in regards to what is expected of them in managing these assets going forward.

Local Technical Assistance Program (LTAP) from Pennsylvania Department of Transportation (PennDOT, n.d.)

Not all resources and guides for local governments and states need to come in the form of a pdf of a booklet for inspectors and county workers to carry around with them. In the age of the internet, it is important to be able to take advantage of new technologies and ways to distribute information. One of the easiest ways you can do that is to build a website that provides a one-stop shop for counties to understand their resources. The Pennsylvania Department of Transportation (PennDOT) did just that. The program is called the "Local Technical Assistance Program" (LTAP) and is designed to be a center that provides "technical information and proven technologies dealing with roadway maintenance and safety methods to meet the growing demands on municipal governments." Under this website, there are several key components. Firstly, it provides a list and links to resources that local governments can utilize. These are broken down further into local resources, state resources, federal resources, international resources, software resources and LTAP planning partner resources. In addition, it provides links to webinars that counties can playback, as well as links to "drop-in sessions" where county and city governments can come together and discuss their issues. While this particular website is geared more towards road maintenance, there's plenty of reason to believe Georgia could provide a similar program regarding county owned and managed transportation assets.

Highway Bridge Program from California Department of Transportation (Caltrans, n.d.)

Another Department of Transportation that has utilized a website to condense its resources for local counties and governments is the California Department of Transportation. While this site isn't as substantive as the Penn DOT LTAP program website [6], it does provide information regarding Local training opportunities, as well as the links and PDFs in order to enact that training. It provides links to the Highway Bridge Program Site Index, a list of programs to "develop the Local Assistance HBP and Seismic Program components of the FTIP/FSTIP." It also provides links to Bridge Preventive Maintenance Program (BPMP) guidelines and plan templates to be used by local counties and governments. Finally, it provides a list of forms that should be used in order to fully adhere to the program's formatting and planning. The design of this site is less intuitive than what GDOT would want to implement, but some of the information provides could provide a basis as to what GDOT would offer on a site such as this.

FUNDING SOURCES FOR COUNTY OWNED ASSETS

The funding sources available for county owned bridge and culvert assets in the state of Georgia for infrastructure are listed below.

Community Development Block Grant Program (CDBG) (USHUD, 2022)

The Community Develop Block Grant Program, otherwise known as CDBGs, is a federal program authorized under the Housing and Community Development Act of 1974. The program provides grants on an annual basis to both state and local agencies. These grants are meant for developing urban areas, specifically for providing good housing and better living environments. The purpose of these funds can be flexible and local governments can use these fund specifically for the lump sum costs needed in the develop of asset management programs, especially if the assets fall within housing districts. This could fall under "public services" which is one of the listed eligible activities on the Department of Housing and Urban Development Website. These grants are for Principal cities of Metropolitan Statistical Areas (MSAs), cities with populations of 50,000 or greater, and states. Because of the nature of these grants, they can be helpful for larger local governments. However, smaller governments will not be eligible for them which makes them not universal for the purposes of recommendations in the guide or strategy plan.

Local Maintenance and Improvement Grant (LMIG) (GDOT, n.d.)

The Local Maintenance and Improvement Grant, more commonly known as LMIG, was a common cited funding program by counties when it comes to obtaining information for larger bridge projects in counties. The program was developed by the Association County Commissioners of Georgia (ACCG) and the Growth Management Act (GMA) and its purpose was to provide funds to exclusively local governments for local projects that normal county funding could not provide for. This includes a variety of different transportation projects, but mostly used for roads and bridge projects. The source of the funding for this program comes from Georgia's state motor fuel tax. Allocation for the funding is based on the percentage centerline road miles for each local road system, as well as the population of each local municipality compared to the statewide equivalent of those statistics. In total, 96 local governments in Georgia have received funding from the program and about $14 million has been invested using this program.

The process to apply is simple and one of the major reasons this program is so popular among the funding options for local governments. The application is short compared to application forms for other programs. The checklist for the application includes only 3 parts. First is a cover letter, which shall include an overview of the type of project being requested, the status of previous LMIG funding provided to the municipality, and the signature of the Mayor or the county commission chairperson. Next is the LMIG application form, which shall include the signature of the Mayor or the county commission chairperson, the county/city seal, as well as a notary signature and seal. Finally, a table must be filled out, giving a brief description of the work to be done at each location. A blank example of the table can be found below in Figure #.#.

Overall, the LMIG program sees a 98.6% approval of applications submitted to it. This, combined with the ease of applying, shoes once again why the program is so popular. All that is required of counties is a 30% match for the project, which is reduced to 10% if the county has passed a transportation investment act, which shall be discussed in detail later. Each GDOT distric in Georgia has a representative within the GDOT office that specializes in the LMIG program and other funding sources, the contact information of which can be found below in Figure 7. Overall, the program is popular among counties and other municipalities and more than one county representative has stated that an increase in budget for this program would go a long way to helping out counties' bridge problems.

District	Coordinator	Number
District One – Gainesville	Shane Giles	(770) 533-8491
District Two – Tennille	Matthew Sammons	(478) 553-3383
District Three – Thomaston	Brandy Spillers	(706) 646-7505
District Four – Tifton	Shannon Bradford	(229) 391-5438
District Five – Jesup	Jeremy Barwick	(912) 530-4396
District Six – Cartersville	Carla Ham	(678) 721-5293
District Seven – Chamblee	Chartrae (Trae) Kent	770-216-3880

Figure 7. Contact Information for GDOT Coordinators in Each District (GDOT, n.d.)

Low Impact Bridge Program (LIBP) (GDOT, 2019)

The Low Impact Bridge Program (LIBP) is a funding program designed to expedite the process of sending funds to local municipalities in order to take care of bridge projects that do not have a lot of complications associated with them. These are otherwise known as “least complicated” bridge projects. The benefits of the program are that once a bridge project is qualified for it, the funding comes quickly and allows the project to be done faster. The downsides of the program are that unlike LMIG, LIBP is very exclusive as to what projects are approved and not approved for its funding. As mentioned before, the program is looking for “least complicated bridges” which can mean a variety of things. Firstly, the bridges cannot have and major geography or elevation changes throughout its length, or any other properties that constitute as complex construction issues or time-consuming. In addition, environmental impact is a major caveat for the program. The program does not apply to projects that impact environmental resources or FEMA streams and cannot exceed established environment impact thresholds in compliance with the National Environmental Policy Act (NEPA).

The application process for Low Impact Bridge Program is much more complicated than LMIG. The process for project selection involves three phases. First is the initial screening of the project. This is where the program considers the information provided on the project. This information includes the hydraulics of the bridge, the roadway design, the utilities on the bridge, the environmental impact, the construction needs and the geotechnical needs of the project. Once a project makes it past the initial screening, it must go through the process of Candidate Bridge Selection, which involves a project selection meetings and a local government and stakeholder meeting. Once that is completed, the project moves to a third phase, which involves a Project Field Scoping meeting. Even when all three phases are complete, the project still hasn’t been approved for the funding yet. The program then has to consider the project in its “Final selection phase” in which it will then decide whether the project is approved for the funding or not, in competition with other projects. A variety of criteria is used to make this final judgement, most of which is environmentally related. A list of some of the criteria used in the final selection stage can be found below in Figure 8, taken directly from the LIBP Manual.

Due to the overall nature of projects selected for the Program, the following impacts will not occur:

- Noise impacts.
- Residential or commercial displacements, access changes or impairment of existing land functions.
- Impacts to Prime Farmland.

The following project conditions may be included to ensure that environmental impacts remain below the thresholds specified above. This list is not all inclusive as other conditions may be identified.

- For projects with identified protected species, the construction contract will include Special Provision 107.23 G and/or H. Restrictive work dates may apply if work below the water surface, including pile removal, pile driving and cofferdam construction, will take place within suitable habitat for federally protected aquatic species or if a federally protected species is known to occur within the action area.
- In accordance with Specification 107.23B, construction activities will be performed in such a way as to prevent siltation and to prevent construction waste or debris from falling into the water.
- Any ground disturbing activities will be prohibited in areas identified as Environmentally Sensitive Areas (ESA) that are delineated by Orange Barrier Fencing and the following note will be included on the plans:

  The contractor shall ensure that all construction related activities (easements, staging, vehicular use, borrow or waste activities, construction trailer placement and staging) be restricted to the existing right-o-way. The contractor shall install orange safety fencing between mainline stations XXX+XX and XXX+XX to ensure that the ESA is not adversely impacted during project construction.
- Context sensitive bridge (e.g., Kansas Corral or Texas Rail) rails may be included in the vicinity of historic properties.
- Projects will include Special Provision 150 (Traffic Control) which specifies the maximum number of days a detour may be in place.
- Projects will include Special Provision 108 (Prosecution and Progress) assessing liquidated damages for projects exceeding the road closure duration noted in Special Provision 150.

Figure 8. Excerpt from LIBP Manual (GDOT, 2019)

Georgia Transportation Investment Bank (GTIB) (Brantley, 2013)

The Georgia Transportation Investment Bank is a program set up by the state of Georgia to provide a way for local counties and governments to apply for funds on transportation projects which will then be paid back at a later date. The program was started in April after House Bill 1019 was passed and the policies were approved by Georgia’s State Road and Tollway Authority. The program was focused on providing funding for projects which are geared towards economic development of local communities and strengthening local transportation networks. The idea behind the program is that the bank would create a system that incentivizes projects that pay for themselves. Therefore, any money given out by the bank would eventually be paid back to the bank and that money could then be loaned out to other projects in other areas. The program also hoped to be a resource for agencies who needed just a little more funding to complete their projects. There were several benefits to using this program. Firstly, there is funding match required by the organizations applying for a loan. This means that the loans from the program could cover 100% of the costs. In addition, the funds are not strict in what they could be used for. While other program may need a project to be designated before the allocated money is given, the GTIB allows their money to be used not only for large projects, but also daily maintenance as well. Eligible projects include highways, roads, bridges and others and the costs can be applied to all project phases. It does not matter to them, so long as the loan is paid back when it is due. Another benefit is that the loans have very low interest payments and the timeline to pay them back is flexible. It is said that the loans can be paid back anywhere from 5-20 years and organizations have the ability to prepay ahead of schedule. LMIG dollars can also be used to pay back these loans. The major downside to this system is that organizations such as county governments are not fond of having to pay back their funding. They'd rather have grants that they don't have to make long term plans on how to recuperate that money. In addition, to apply for a loan at the GTIB, organizations must pay a fee of $250.

Local Administered Project (LAP) (GDOT, n.d.)

When initially researching funding sources for local county governments in Georgia, the Local Administered Project (LAP) program did not come up. It wasn't until a discussion with Mr. Carlos

Tubar of Baldwin County, Georgia, that the program was mentioned. Mr. Tobar mentioned that he was LAP certified and suggested other counties get LAP certified as well. The LAP program is a federal grant program designed to authorize qualified local public agencies to manage core activities for federal-aid funded projects. The program requires a minimum 20% match from the local agency, which must come in the form of direct funding, not loans. Overall, about 45 states are involved in the program, including Georgia, and about $6-8 Billion dollars are given out each year in the program. This type of program works great for larger, my resource heavy, counties, since they'll have the funds to meet the match requirements. However, smaller counties are at a disadvantage since they can't meet those match goals.

Special Purpose Local Option Sales Tax (SPLOST) (Gwinnett Co, 2017)

The Special Purpose Local Option Sales Tax is a program exclusive to Georgia that provides a way for local county governments to raise money for special projects without increasing the burden on their local economy too greatly. The program is especially popular in most counties across Georgia. It is easier to name the counties that don't use SPLOST than the ones who do. The counties who don't use it include Fulton, Glynn, Spalding and Ware counties. The program creates an additional 1% sales tax increase on local sales transactions, raising the state standard sales tax from 6% to 7%. That additional 1% goes directly to the counties to distribute it to projects as they see fit. The program cannot just be enacted by the county commissioners, however. The program must be decided by a referendum vote of the general public during an election cycle on election day of that year. The program must then be renewed every 5 years by the same process. The program can be used for a variety of projects across the county agenda.

There are quite a few benefits to the SPLOST program over other funding programs. Firstly, the 1% increase on sales tax is not burdensome to everyday consumers in the local economy, thus the blowback from that policy is less likely. Secondly, this program has been largely successful in counties across Georgia when it comes to enacting projects that have long been in the works, but haven't had the funds to finish or get them off the ground. With these benefits there comes a few downsides in regards to the goal of using this to fund transportation asset management and maintenances. The major issue is that because the program must be voted upon by the county electorate, the program is inherently political. The brings a number of issues into the table to consider that normally wouldn't if the program were a grant or loan. Because the program must be voted upon and renewed every five years, there is incentive to put the dollars of SPLOST towards more visual projects that the electorate can see and approve of. This includes projects such as upgrading schools, constructing new infrastructure for businesses and the like. While these are worthwhile projects, they are the kind of projects that county governments want associated with the SPLOST program to make it more politically viable when it comes up for reelection in 5 years. Maintaining and managing roads, bridges, and other assets is not very noticeable for counties to point to the electorate and say "this is what your SPLOST dollars are going towards!" When managing and maintaining the roads, bridges and other assets *is* noticeable, it is more likely due to the traffic that comes with the project or the unsightliness of the construction equipment and process. Thus, this makes management and maintenance systems for bridges and culverts low on the priority when it comes to getting funding from the program. Because of this, the need for a separate program to focus solely on transportation is clear.

Transportation Special Purpose Local Options Sales Tax (TSPLOST) (GSFIC, 2013)

Because of the combination of need for funding for transportation and the lack of political will to send much of the SPLOST budget towards it, a separate program was created in order to address this issue. The Transportation Special Purpose Local Options Sales Tax (TSPLOST) is exactly what the name sounds like. It is a program very similar to SPLOST in how it is structured, how the revenue is raised and how it is enacted. Like SPLOST, the TSPLOST program is voted upon every 5 years. Another similarity is that the TSPLOST adds an additional 1% to the sales tax of the affected region. This can be applied on top of the other additional 1% sales tax increase created by SPLOST. Thus, if a region has both programs enacted, the sales tax of the region will be 8%. One of the things that separates TSPLOST from SPLOST is it limits what kind of projects the funding can be spent on to a greater degree than SPLOST. These types of projects include roads, bridges, public transit, rails, airports, buses and all accompanying infrastructure and services needed for such programs. TSPLOST has some of the problems of SPLOST, including the political nature of it and the desire to see visual results from it, however those problems are lessened due to the nature of most transportation projects being roughly the same in terms of impact and visuality. One additional problem that TSPLOST has that SPLOST doesn't have is the limitations on what this additional sales tax can be applied to. There are several transactions that the TSPLOST 1% increase in sales tax cannot be applied to. This includes the sale of jet fuel, the sale of any type of fuel for off-road heavy-duty equipment, off-road farm or agricultural equipment, the sale of fuel for locomotives, the sale of motor fuel for public mass transit and, finally, the same, use, storage or consumption of energy that is necessary and integral to the manufacture of tangible personal property at a manufacturing plant in Georgia. Another key difference is that while SPLOST is uniform across counties in Georgia who use it, there are two different types of TSPLOST programs counties can apply, known as TSPLOST 1 and TSPLOST 2. TSPLOST 2, also known as Single-County TSPLOST is very similar to most SPLOST programs, where the county raises the funds for itself and spends those funds solely on itself. TSPLOST 1, also known as regional TSPLOST, allows for counties to group together to form a kind of regional alliance between neighboring counties to all past TSPLOST together and then pool their funds into one place to share among the counties for whoever needs it the most. TSPLOST 1 was allowed when the Georgia Legislature passed the Transportation Investment Act in 2010. Since then, 4 regions have passed a regional form of TSPLOST, including Central Savannah Region (Region 7), the River Valley Region (Region 8), the Heart of Georgia Region (Region 9) and finally the Southern Georgia Region (Region 11). The location of these regions and the counties they encompass can be found below in Figure 9.

Figure 9. Georgia Regional Map (GSFIC, 2013)

This kind of TSPLOST is popular among rural counties who, by themselves, cannot raise the funds for projects they need TSPLOST for, but also may not enough projects to use all their TSPLOST funds when there isn't a major project. It's also common to see a more urban county ally with smaller counties around it to help provide TSPLOST funding for the smaller counties in exchange for a greater revenue pool. Figure 10 lists what kind of elective programs each county in Georgia uses to fund their county budgets.

Effective October 1, 2022

Code 000 - The state sales and use tax rate is 4% and is included in the jurisdiction rates below.

Code	Jurisdiction	Rate	Type
001	Appling	8	L E S T
002	Atkinson	8	L E S T
003	Bacon	8	L E S T
004	Baker	7	L E S
005	Baldwin	7	L E S
006	Banks	8	L E S T2
007	Barrow	7	L E S
008	Bartow	7	L E S
009	Ben Hill	8	L E S T
010	Berrien	8	L E S T
011	Bibb	8	L E S O
012	Bleckley	8	L E S T
013	Brantley	8	L E S T
014	Brooks	8	L E S T
015	Bryan	8	L E S T2
016	Bulloch	8	L E S T2
017	Burke	7	L S T
018	Butts	7	L E S
019	Calhoun	7	L E S
020	Camden	7	L E S
021	Candler	8	L E S T
022	Carroll	7	L E S
023	Catoosa	7	L E S
024	Charlton	8	L E S T
025	Chatham	7	L E S
026	Chattahoochee	8	L E S T
027	Chattooga	7	L E S
028	Cherokee	6	E S
029	Clarke	8	L E S T2
030	Clay	8	L E S T
031	Clayton (Not Clg Prk)	8	M L E S
032	Clinch	8	L E S T
033	Cobb	6	E S
034	Coffee	8	L E S T
035	Colquitt	8	L E S T2
036	Columbia	8	L E S T
037	Cook	8	L E S T
038	Coweta	7	L E S
039	Crawford	8	L E S T2
040	Crisp	8	L E S T
041	Dade	7	L E S
042	Dawson	7	L E S
043	Decatur	8	L E S T2
044	Dekalb (Not Atlanta)	8	M E H S
044A	DeKalb (Atlanta)	8.9	M E H O mTa
045	Dodge	8	L E S T
046	Dooly	8	L E S T
047	Dougherty	8	L E S T2
048	Douglas	7	L E S
049	Early	8	L E S T2
050	Echols	8	L E S T
051	Effingham	8	L E S T2
052	Elbert	8	L E S T2
053	Emanuel	8	L E S T
054	Evans	8	L E S T
055	Fannin	7	L E S
056	Fayette	7	L E S
057	Floyd	7	L E S
058	Forsyth	7	L E S
059	Franklin	7	L E S
060	Fulton*	7.75	M L E Tf
060A	Fulton (Atlanta)	8.9	M L E O mTa
061	Gilmer	7	L E S
062	Glascock	8	L E S T
063	Glynn	6	L E
064	Gordon	7	L E S
065	Grady	8	L E S T2
066	Greene	8	L E S T2
067	Gwinnett	6	E S
068	Habersham	7	L E S
069	Hall	7	L E S
070	Hancock	8	L E S T
071	Haralson	8	L E S T2
072	Harris	8	L E S T
073	Hart	7	L E S
074	Heard	7	L E S
075	Henry	8	L E S T2
076	Houston	7	L E S
077	Irwin	8	L E S T
078	Jackson	7	L E S
079	Jasper	7	L E S
080	Jeff Davis	8	L E S T
081	Jefferson	8	L E S T
082	Jenkins	8	L E S T
083	Johnson	8	L E S T
084	Jones	7	L E S
085	Lamar	8	L E S T2
086	Lanier	8	L E S T
087	Laurens	8	L E S T
088	Lee	8	L E S T2
089	Liberty	8	L E S T2
090	Lincoln	8	L E S T
091	Long	8	L E S T2
092	Lowndes	8	L E S T
093	Lumpkin	8	L E S T2
094	Macon	8	L E S T
095	Madison	8	L E S T2
096	Marion	8	L E S T
097	McDuffie	8	L E S T
098	McIntosh	8	L E S T2
099	Meriwether	8	L E S T2
100	Miller	8	L E S T2
101	Mitchell	8	L E S T2
102	Monroe	8	L E S T2
103	Montgomery	8	L E S T
104	Morgan	8	L E S T2
105	Murray	8	L E S T2
106	Muscogee	9	L E S O T
107	Newton	7	L E S
108	Oconee	7	L E S
109	Oglethorpe	8	L E S T2
110	Paulding	7	L E S
111	Peach	8	L E S T2
112	Pickens	7	L E S
113	Pierce	8	L E S T
114	Pike	7	L E S
115	Polk	7	L E S
116	Pulaski	7	L E S
117	Putnam	8	L E S T2
118	Quitman	8	L E S T
119	Rabun	8	L E S T2
120	Randolph	8	L E S T
121	Richmond	8	L E S T
122	Rockdale	7	E H S
123	Schley	8	L E S T
124	Screven	8	L E S T2
125	Seminole	8	L E S T2
126	Spalding	7	L E T2
127	Stephens	7	L E S
128	Stewart	8	L E S T
129	Sumter	8	L E S T
130	Talbot	8	L E S T
131	Taliaferro	8	L E S T
132	Tattnall	8	L E S T
133	Taylor	8	L E S T
134	Telfair	8	L E S T
135	Terrell	8	L E S T2
136	Thomas	7	L E S
137	Tift	8	L E S T
138	Toombs	8	L E S T
139	Towns	7	L S O
140	Treutlen	8	L E S T
141	Troup	7	L E S
142	Turner	8	L E S T
143	Twiggs	7	L E S
144	Union	7	L E S
145	Upson	8	L E S T2
146	Walker	7	L E S
147	Walton	7	L E S
148	Ware	8	L E T T2
149	Warren	8	L E S T
150	Washington	8	L E S T
151	Wayne	8	L E S T
152	Webster	8	L E S T
153	Wheeler	8	L E S T
154	White	7	L E S
155	Whitfield	7	L E S
156	Wilcox	8	L E S T
157	Wilkes	8	L E S T
158	Wilkinson	7	L E S
159	Worth	8	L E S T2
800	Fulton (Hapeville)	8.75	M L E O Tf
801	Fulton (College Prk)	8.75	M L E O Tf
802	Fulton (East Point)	8.75	M L E O Tf
804	Clayton (College Prk)	9	M L E S O

*Fulton County outside of Atlanta, Hapeville, College Park, and East Point

M = MARTA
L = LOST
E = Educational
H = HOST or EHOST

S = SPLOST
O = Other (MOST, 2nd LOST, or constitutional)
T = TSPLOST 1
m = Local MARTA (Atlanta MARTA)

T2 = TSPLOST 2
Tf = Fulton TSPLOST
Ta = Atlanta TSPLOST

Additional rate charts and up-to-date changes are available at dor.georgia.gov/sales-tax-rates-current-historical-and-upcoming.

Figure 10. List of Georgia Counties and Funding Sources (GaDOR, 2023)

Infrastructure Investment and Jobs Act (2021) [Public Law 117-58] (H.R. 3684, 2022)

While this is not an evergreen program by which local governments can acquire funds for the management and maintenance of local assets, it is important to understand the latest develops in transportation funding, especially from the federal level. The Infrastructure Investment and Jobs Act was passed by the Biden Administration in 2021 as a way to address transportation issues within the country. The following section will provide both an overview of the bill, as well as how the fund works and can be used by local governments.

Bipartisan Infrastructure Law: Overview of Highway Provisions (FHWA, 2022)

The following provides an overview of the Infrastructure Investment and Jobs Act (also known as IIJA or Bipartisan Infrastructure Law, BIL) using a 73 page presentation provided by the Federal Highway Association. The presentation provides information regarding the highway provisions available in the IIJA, including programs regarding bridges. Before beginning, it defines several key terms, including budget authority, contract authority, appropriated budget authority, advance appropriations, apportionment, allocation, obligation, and highway trust fund. It provides several benefits the bill proposes, including at "once-in-a-generation investment in infrastructure", growth of economy, around $550 billion in federal investment and finally, the creation, on average, of 2 millions jobs per year.

The bill provides funds for highway programs for 5 years, including $350.8 billion over the fiscal years between 2022 and 2026. It creates more than a dozen new programs, including formula programs (such as resilience, carbon reduction, bridges and electric vehicle charging infrastructure), and discretionary programs (such as bridges, EV charging infrastructure, rural projects, resilience, wildlife crossings, and reconnecting communities). The $303.5 billion in funding from Contract Authority is divided between apportion money and allocated money nationwide by a ratio of about 90% to 10%, respectively. For the 47.3 billion dollars from the general fund, about 72% is distributed by formula, while 28% is discretionary spending. There are nine major categories of highway infrastructure planning under the general fund, which includes $27.5 billion for Bridge Formula Program and $9.2 billion for the Bridge Investment Program, which is considered under the discretionary spending. The funding for these programs is available to multiple recipients. However, only the state (including DC or Puerto Rico) or tribes can receive funds from the Bridge Program (formula), while the Bridge Investment Program (discretionary) is available to the state, the MPO, local governments, tribes, PA and the Federal Land Management Agency.

The presentation next covers changes that have been made to existing programs. There are some changes that can affect this project moving forward so it is important to note them here. For the National Highway Performance Program, there is increased desire to incorporate extreme weather events into consideration for future planning. For the Asset management plans, they now require consideration of extreme weather and resilience in lifecycle cost and risk management analyses. For the Surface Transportation Block Grant (STBG), new types of eligible projects were added including protective features to enhance resilience. It increases off-system bridge set-aside and adds eligibility to include replacing a low water crossing with a bridge.

After covering several other program, the presentation provides more detailed explanations of the Bridge Formula Program and the Bridge Investment Program. The Bridge Formula Program is the formula based program that distributes the funding based on characteristics of the states. The formula is based 75% on the relative costs of replacing the state's bridges in poor conditions, 25% based on the relative costs of rehabilitating the state's bridges in fair condition. However, no state shall receive less than $45 million for each fiscal year. Georgia is one of many states who is receiving this minimum amount. Table 2 below shows the apportionment for the Bridge Formula Program on a state by state basis. In addition, it shows what portion is meant for NBI bridges and how is reserved for smaller non-NBI bridges.

Table 2. Revised Apportionment of Highway Infrastructure Program Funds for the Bridge Formula Program Pursuant to the Bipartisan Infrastructure Law

State	Bridge Formula Program		
	Bridge (Main)	Off-System Bridges	Total
Alabama	38,250,000	6,750,000	45,000,000
Alaska	38,250,000	6,750,000	45,000,000
Arizona	38,250,000	6,750,000	45,000,000
Arkansas	51,137,381	9,024,244	60,161,625
California	488,567,652	86,217,821	574,785,473
Colorado	38,250,000	6,750,000	45,000,000
Connecticut	102,990,424	18,174,781	121,165,205
Delaware	38,250,000	6,750,000	45,000,000
Dist. of Col.	38,250,000	6,750,000	45,000,000
Florida	44,772,107	7,900,960	52,673,067
Georgia	38,250,000	6,750,000	45,000,000
Hawaii	61,922,724	10,927,540	72,850,264
Idaho	38,250,000	6,750,000	45,000,000
Illinois	252,678,280	44,590,285	297,268,565
Indiana	63,361,353	11,181,415	74,542,768
Iowa	79,398,653	14,011,527	93,410,180
Kansas	38,250,000	6,750,000	45,000,000
Kentucky	80,367,406	14,182,484	94,549,890
Louisiana	186,214,294	32,861,346	219,075,640
Maine	38,250,000	6,750,000	45,000,000
Maryland	74,911,138	13,219,613	88,130,751
Massachusetts	206,998,770	36,529,195	243,527,965
Michigan	103,388,157	18,244,969	121,633,126
Minnesota	55,391,557	9,774,981	65,166,538
Mississippi	38,250,000	6,750,000	45,000,000
Missouri	88,982,221	15,702,745	104,684,966
Montana	38,250,000	6,750,000	45,000,000
Nebraska	38,250,000	6,750,000	45,000,000
Nevada	38,250,000	6,750,000	45,000,000
New Hampshire	38,250,000	6,750,000	45,000,000
New Jersey	209,199,776	36,917,608	246,117,384
New Mexico	38,250,000	6,750,000	45,000,000
New York	347,626,950	61,345,932	408,972,882
North Carolina	83,888,881	14,803,920	98,692,801

North Dakota	38,250,000	6,750,000	45,000,000
Ohio	88,646,875	15,643,566	104,290,441
Oklahoma	48,959,111	8,639,843	57,598,954
Oregon	49,033,120	8,652,904	57,686,024
Pennsylvania	300,371,235	53,006,688	353,377,923
Puerto Rico	38,250,000	6,750,000	45,000,000
Rhode Island	43,341,710	7,648,537	50,990,247
South Carolina	50,357,611	8,886,637	59,244,248
South Dakota	38,250,000	6,750,000	45,000,000
Tennessee	68,556,517	12,098,209	80,654,726
Texas	98,056,920	17,304,162	115,361,082
Utah	38,250,000	6,750,000	45,000,000
Vermont	38,250,000	6,750,000	45,000,000
Virginia	98,252,567	17,338,688	115,591,255
Washington	111,077,373	19,601,889	130,679,262
West Virginia	93,174,236	16,442,512	109,616,748
Wisconsin	38,250,000	6,750,000	45,000,000
Wyoming	38,250,000	6,750,000	45,000,000
Total	4,511,374,999	796,125,001	5,307,500,000

Some other key provisions from this program include benefits for "off-system" bridges. "Off-system bridges refer to non-federal-aid highway bridges. About 15% of funds are reserved for such bridges, and the Federal share will be 100% if the bridge is owned by a local agency or federal-recognized tribe. The Bridge Investment Program is the smaller and discretionary-based bridge program. These funds are available to a much wider range of entities, as mentioned above. Eligible projects include replacing, rehabilitating or preserving one or more bridges on the National Bridge Inventory. Eligible projects can also include replacing or rehabilitating culverts to improve flood control or improve habitat connectivity for local species. Some other key provisions for this program are that at least 50% of the funding is reserved for rare projects, and that multi-year funding agreements are available. The section concludes with miscellaneous provisions provided for bridge-related items, none of which dramatically affects the way this project should be handled moving forward.

Another program that can provide help for local governments and counties regarding bridge planning and maintenance is the Local and Regional Project Assistance Program. While this program is not specifically designated towards bridges, the language used to describe it does not remove the possibility of using it for bridge projects. The program is a discretionary program similar to the Bridge Investment Program and is open to the same entities as it is available to. It provides $7.5 billion for each fiscal year between 2022 and 2026 as advance appropriations from the General Fund. It covers a wide variety of eligible projects, however at the top of the list, it clarifies “Highway/bridge projects eligible under title 23”.

CLOSING REMARKS

It is concluded that the federal NBI system has been instrumental in the improvement of bridge maintenance practices around the United States. Setting up a nationwide preventative bridge maintenance strategy has improved the health of the nationwide transportation infrastructure, no state more so than Georgia where only 2.9% of bridges are considered failing. It is also concluded that other state agencies have attempted and succeed to promote preventative maintenance in their local agencies as has been seen in the Michigan, New York, Minnesota, Indiana, and South Carolina guides, proving that preventative maintenance can be encouraged at the local level and is not just reserved for a statewide level agency and its resources. It is also concluded that Georgia has many options by which local governments could raise funding for projects and that understanding which of these sources are used the most and which ones are not widely known about could help to aid local agencies in maintaining their transportation assets.

While the literature review for this project is complete, there are some gap in knowledge that will need to be filled through other methods. The literature review provides plenty of information regarding how other states manage their assets and what they recommend for their local governments. However, in order to provide resources geared towards Georgia local governments, an understanding of the current state of inspection and inventory management practices for Georgia counties must be had. Limited information is available on this subject as very few Georgia counties offer public information regarding their practices. In addition to their practices, in order to better the working relationship between GDOT and Georgia local governments, the project also needs to hear directly from local officials regarding their experience working with GDOT, in order to gain perspective on one end of the relationship. In order to better summarize the takeaways the research team found important from each section of the literature review, a table was prepared, which can be seen in Table 3.

Table 3. Summary of Takeaways from Literature Review

Infrastructure Practices: NBI System	• Started in 1995, the National Bridge Inventory (NBI) was created to log every bridge in the United States over 20 feet long. • For each bridge, a list of over 100 properties are provided. • Inspections of every bridge are required once every 2 years. • One of the most common cited items for those who frequently use the NBI are the condition ratings associated with each bridge. • The condition ratings are based on a 0-9 scale and each bridge has three corresponding with the deck, superstructure and substructure. • These are the basis behind preventative maintenance systems on the bridges. • In addition to the standard NBI data, starting in 2016, Georgia began recording NBI Element data. • Rather than breaking down the condition ratings into three broad components, each single element on the bridge is given a condition state between 1 and 4. • By breaking condition states down to elements, many believe this will make preventative maintenance practices more efficient in the future, as certain elements can be targeted for scheduled repair/replacement, rather than waiting for the bridge's overall health to falter.
Advances in Bridge Inspection Practices	• The use of drones during bridge inspections has become more common place, allowing inspectors to get closer to hard-to-reach areas and collect more data. • Instruments designed to analyze the interiors of materials during inspection have also grown in popularity. • Deterioration models for bridges have been built using Markov-Chain Method, Weibull Analysis and Deep Learning techniques. • This allows for better predictions of when bridges are heading towards failure and thus agencies can be more efficient in maintaining them.
Available Resources in Georgia	• GDOT provides inspections for any large bridge structure that would qualify for the NBI, regardless of the ownership of the bridge. • GDOT sends out biannual reports to the counties.

	• However, GDOT does not provide the maintenance and repair. That is the responsibility of the owner. • GDOT has begun launch of a program known as InspectX, which is still in its beta-phase. • GDOT does provide a Bridge Structure Maintenance and Rehabilitation Repair Manual • GDOT provides agents in each of its 7 districts to answer questions regarding bridge practices, whether it be repair, funding, etc. Oftentimes these are the bridge inspectors and engineering staff. • The contact information for these agents can be difficult to find. • GDOT provides some information on their websites, but many report they are difficult to navigate and that many links or widgets aren't functional. • Local Government webpage was created in January of 2023, which includes pages for resources dedicated to “Current & Future Investment”, “Local Programs” and “Training”. • Georgia participates in the national Municipal Separate Storm Sewer System (MS4), which is a program designed to designate urbanized areas to hold to a standard for stormwater assets. Georgia has a resource developed by AECOM that helps lay out these requirements in the Stormwater System Inspection and Maintenance Guide
Other State Culvert Inspection Guides	Many State DOT inspection guides were reviewed, but the two that would provide the most influence moving forward for the guided developed by this thesis were the Michigan and South Carolina guides. Michigan: • The Michigan Non-NBI Culvert Structure Inspection Guide is a resource provided by the Michigan Transportation Asset Mangement Council • Provides information on how to set up a preventative maintenance system, including inventory, inspection schedules and condition ratings. • Covers all terms and information needed for an inspection to be conducted. • Includes condition rating tables for a variety of material types. South Carolina: • The SCDOT Pipe and Culvert Field Inventory and Inspection Guidelines is another example of a state DOT developing a similar inspection guide for Non-NBI assets. • Very similar to the Michigan guide, although this guide contains more detail on the step-by-step inspection process. • Includes sample inventory and inspection forms • Brief and designed to be easily carried into the field with inspectors.
Resources for Local Governments Available in Other State Agencies	A review of resources provided by other state DOTs was conducted, but the two that provided the most influence for the Strategy Plan developed within this thesis were the resources from Arkansas and Pennsylvania. Arkansas: • The Local Government Procedures for Compliance with the National Bridge Inspection Standards is a resource guide provided by the Arkansas DOT that clearly lays out the role and expectations ArDOT has for its local governments and their part in maintaining the bridge inventory of the state. • It fully outlines the process by which ArDOT gathers inspections, notifies the local government, grants annual certifications, closes bridges and many more. • Demonstrates the importance of making procedures and expectations clear and available.

	Pennsylvania: • Local Technical Assistance Program (LTAP) is program offered by PennDOT that serves as a resource haven for local governments. • Schedules of webinars and workshops are provided. • Resources are broken down between state, federal, local and even international resources. • Contains "drop in" sessions where local governments can come together and discuss issues. • Site is primarily geared towards road maintenance, this type of structure could easily apply to bridges and other assets.
Funding Resources for Local Governments in Georgia	Community Development Block Grants (CDBG) • Grants meant for the development of urban areas. Meant to be flexible and bridges/culvert projects could fall under the "public services" activity. Local Maintenance and Improvement Grant (LMIG) • Match Program designed to provide funds to counties such they can complete large transportation projects. High approval rate (98.6%) for applications. Requires 30% match, or 10% match if the county has TSPLOST. Low Impact Bridge Program • Program Designed to speed up sending funds to local governments for bridge that do not have complications. Program is very exclusive. Georgia Transportation Investment Bank (GTIB) • Program set up by the state of Georgia to provide funds for transportation projects, which shall be paid back at a low interest rate. Designed to incentivize projects that pay for themselves. Local Administered Project (LAP) • LAP Certification provides local governments an opportunity to have someone on staff trained for federal grants. This allows local governments to seek these funds themselves, rather than rely on the state to distribute them. SPLOST • Program exclusive to Georgia that allows an additional 1% sales tax to be used in the conduction of projects around the county. Must be voted on every 5 years and is project based. TSPLOST • The offshoot of SPLOST, except these funds are solely for Transportation projects. Allows an additional 1% increase in sales tax. Two types of TSPLOST: Regional and Single County.

CHAPTER 3. RESEARCH METHODOLOGY

METHODS USED FOR COUNTRY SURVEYS AND OUTREACH

This project is broken down into three different phases. The first of which is an county outreach program in order to establish what the current state of transportation asset management plans are within the counties of the state of Georgia. In addition to learning about the current state, the outreach program will allow the research team to hear directly from the groups it is looking to help and learn about what the county governments are doing in order to better their ability to adequately perform transportation asset management. In order to do this, as standardized survey was developed and distributed to counties across the state of Georgia. The second phase involves the development of a strategic plan moving forward for both the research projects and GDOT's relationship with the counties of Georgia. In order to do this, the research team looked into recommendations made by both the FHWA, GDOT, and other state and federal organizations regarding the establishment of standardized programs for off-system bridges and other transportation assets. Lastly, the research team would use both other state inspections guides as well as visually observe counties within the state of Georgia in order to complete one of 2 main deliverables, which is the development of a standardized inspection guide for the state of Georgia for culverts and other smaller transportation assets. The other includes the development of a resources guide.

Develop A Questionnaire Used in Survey of Counties

Early on in the process, it was understood that in order to accomplish the goals of the project, the research team would need to involve as many counties in the state of Georgia as possible. Hearing directly from the counties regarding the current state of transportation asset management in

Georgia as well as what their thoughts are in regards to how things can be improved would be a valuable asset going forward. However, an open discussion and emailing county staffs doesn't provide consistent info information the research team would need to truly compare and contrast different strategies for transportation asset management. Therefore, the team decided that the development of a standard survey to send to as many counties as possible was the best way to achieve this goal. The process used to develop this survey is visualized in Figure 11, and each step will be expounded upon in the following section. An overview of the process includes defining the scope and objectives that the team aims to achieve in the survey, finding relevant metrics, such as their dependence on GDOT, their confidence to carry out strategy plans and other concrete items, to measure these objectives by, creating questions that will help gather information regarding those metrics, and then finally a continuous revision process until the research team demes the survey complete for distribution.

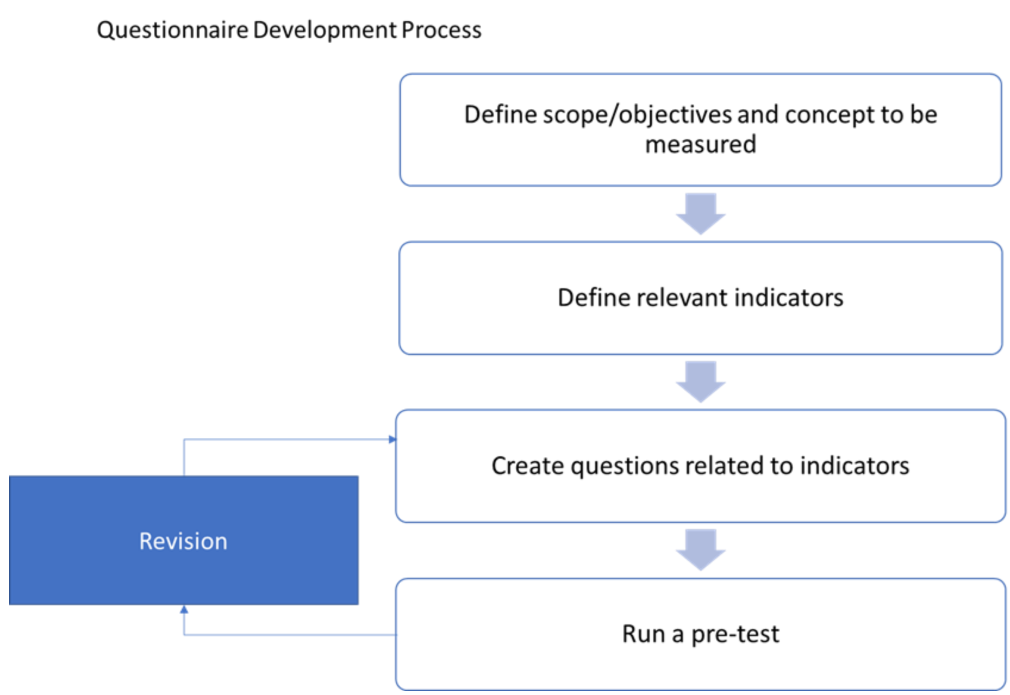


Figure 11. Image. Questionnaire Development Process Flowchart

Define Scope/Objectives

The purpose of developing the survey was multi-facetted. First of all, it provided a way to easily provide the same scope and questions to each county who participated in our "Ask" phase of our research. Secondly, surveys are sometimes easier for county officials to work with and fill out during their workdays and they can be more flexible with how long it takes them to fill it out to competition. In terms of the content of the survey, the objective was to gather information regarding the process and management systems for local transportation assets. This included systems for inventorying the assets, as well as their maintenance. Another objective was to understand whether counties feel that they have what they need in order to be successful in order to manage and maintain their assets. If they do not, where do they think they are lacking and from there, the team can work with GDOT in order to identify ways to help bridge those gaps.

Define Relevant Indicators

Early on, the team aimed to learn several things out of this survey that will be key to understanding the current state of local transportation assets. Firstly, the survey will help establish a key contact between the research team and each county moving forward into different phases of the research project. This included asking for information such as name, email, phone number, all the standard contact information. One of the first things the team wanted to learn was which counties have a written plan regarding their transportation assets. Then, depending on the answer to that question, it would either ask what the plan is (in a brief description) and how long it has been in place. If they answered they do not have a written plan, it will then ask them how their assets are managed. Another indicator the team aimed to define was whether counties keep a list of their locally owned assets. The team also wanted to know information regarding the budget a county puts forward towards managing the transportations assets. Lastly, the team would like to know what kind of resources that local counties either already utilize to accomplish their transportation asset management and maintenance, or what resources or tools the counties wished they had access to in order to accomplish the same.

Create Questions Related to Indicators

In order to find the relevant indicators described in the previous section, it was important to develop a set of questions with that goal in mind. The survey was designed to undergo multiple versions, whose revisions will be discussed in a later section. However, the initial version of the survey was the first attempt to establish the kind of questions needed to obtain the information crucial for the overall success of the project. First, a section dedicated to gathering contact information for the county government was created. This included questions asking for the name of the survey participant, what county they represented, and their contact information. Next, the survey establishes whether the county has a transportation asset management plan already in place. From there, based on the answer to that question, there are follow-up questions. If they did have an asset management program, an interviewee was asked if he/she was able to briefly describe it. If the county did not have one, it was asked how its assets managed in the county. Next, the survey inquires as to whether a county keeps a list of their smaller bridges and culverts in the county. If they answered yes, the survey would ask what kind of information was kept on this list. The survey included examples of information such as the asset ID, the location, and condition rating. This questions was a free-response or open-ended question. If the county answered “no” regarding whether they kept a list or not, the survey would want to know who then keeps track of the assets in the county.

Afterwards, the survey asks the counties is willing to share their list of transportation assets with the GDOT/UGA research team. This question was designed because GDOT had shared its experience with one of sizeable counties regarding data-protection policy. Next, the survey looks into the common maintenance activities observed when it comes to maintaining smaller assets. This is designed to provide important information needed for what types of maintenance activities should be focused on when developing inspection and resources guides. Rather than making this a free response question, common maintenance activities listed in GDOT's GAMS application are provided, and the counties are asked to rank in order from most (1) common to least (14) common. The activities listed included the following: approach undersealing, brush and tree cutting, erosion control, repair of existing guardrail, bridge joint sealing, header joint reconstruction and repair, deck repair, bridge curb and rail repair, culvert repair, pile replacement, repair of main structure members, bridge painting, and other. An additional question below would be provided to explain any activities that would fall under "other".

Next, in order to gain more information about the funding used by counties, the survey asks a similar ranking style question as the maintenance activities. However this time, it lists common funding options. The funding options listed in the question include the ones established from earlier research: SPLOST, TSPLOST, LMIG, LIBP, LOCBR, GTIB, State-based funding, federal based funding, and other. An additional question below is provided to explain any activities that would fall under "other". Two last free response questions would be provided. The first of which asked about the biggest barriers that the county official could identify when it comes to bridge maintenance in the county. Lastly, there is a question asking about what kind of resources the county officials believe could be helpful for them to accomplish their transportation asset management plan that they do not already have. These two questions would be helpful in helping identify possible policy suggestions moving forward. Finally, the interviewees are asked to provide any suggestions and/or advice for improving current asset management practices.

Run a Pre-test

One of the initial ways in which this survey was pre-tested was through conversation with county officials when trying to make initial contact. When contact was made with county officials and offices, the team explained the purpose of GDOT RP 21-02. Oftentimes, this initial explanation revealed gaps between the language and knowledge of the research team and the county officials. For example, one things that became clear early one was that greater clarity and explanation needed to be given regarding the phase “transportation asset”. When the research team referred to this term, they referred to physical assets such as bridges, culverts, drains under roads, etc. However, when county officials heard the term, they believed the team wished to know about public transportation options, vehicles and the like. Another source of gaps came with our initial definitions of NBI vs non-NBI assets. We initially labeled NBI assets as anything larger than 20 feet in span length per definition in the National Bridge Inspection Standards (NBIS) and that the inspection was the responsibility of GDOT. However, GDOT inspects many more assets, even those under 20 feet for local counties, as long as they are not pipe structures. Therefore, rather than focusing on the division between span length, the team made it clearer that the purpose of these investigations was to ask about the assets that GDOT inspects versus does not inspect.

Additionally, edits around word choice and phrasing of questions are considered because the use of a logic system within the survey ask follow-up questions based on the answer of previous questions. After some edits and revisions, the survey had gotten too long. In order to help with this, the team developed a PDF of the survey for the county officials to look at before conducting the survey and thus could increase their speed taking the survey once they begin it.

Revisions

The first major change made to the survey was to split it into two parts. It became clear early on in the initial trial runs with the survey that differentiating between larger NBI bridges and culverts and smaller non-NBI assets such as culverts and cross-road pipes was critical. Not only would this allow the team to provide more information to GDOT regarding how counties viewed their responsibilities, but it would also clear up much of the confusion regarding the types of assets each section was looking for. This also allowed the research team to ask the same question regarding each type of asset, but kept them in separate places on the survey and thus made it easier to analyze later. The first section was labeled "Sizable bridges and Culverts" and these were defined as assets "that are owned by your county or local government, but are inspected by GDOT" and that "maintenance, repair and rehabilitation (MRR) is still the responsibility of the county"…"even if GDOT is maybe involved in these processes." The second section was labeled as "Small Bridges and Culverts" and referred to assets that are "owned by your county or local government and are *not* inspected and reported upon by GDOT." To provide further clarification, two pictures were provided of the type of assets the section of the survey would be referring to. In addition to the splitting of the survey into two sections, a foreword was written to start the survey in order to clarify the context around which the survey is being conducted. It explained the RP 21-02 project and its goals and how the results from this survey would be used going forward. The foreword also clarified some terms such as the types of assets the team was asking about, as well as what kind of policies the team wished to learn about, namely inspection strategies and schedules. Lastly, it clarified to the counties that the survey was not an evaluation of their transportation asset management plans, but solely was about gauging the current state of transportation asset management plans for counties in the State of Georgia. This was to increase the credibility of the survey results.

The second major revision was the addition of more questions in order to provide more information on a variety of potential topics for this project. The initial set of questions on the first draft of the survey captured the bare-bones necessary information needed from this survey. However, the research team felt it could go further in the information it could acquire. The following section will cover both the revisions to previous questions, as well as the thought process behind new ones added. Firstly, when it comes to whether a county has a transportation asset management plan for either its large or smaller assets, the research team felt it was important to know how long the county had been using its plan. Thus, if a county answered "yes" to the question of whether they had a asset management plan, they would be prompted to estimate how many years their county have used that plan. One thing that stood out to the research team in the preliminary talks with county governments is the level of reliance that some counties have on GDOT for their larger bridges and culverts. It was understood that GDOT provided inspections and inspection reports for the counties on their larger bridges. However, discussions with some counties lead the team to believe it went beyond that. For example, the acquiring of funds and contracting work. The team decided that adding a question to measure this reliance based on the response of counties would provide good information. Thus, a "reliance score" was developed. This was a percentage score from 0% to 100% on how much the county feels it relies on GDOT for the management of their larger assets. This score was asked of large bridges and large culverts separately, as initial talks lead the team to believe counties were much less reliant on culverts than bridges. Separating the two would help to test that hypothesis.

During the iteration process, there was a question surrounding whether a county kept an inventory of their bridge and culvert assets. Now that there was a separate section for NBI bridges, it did not make sense to ask that question, as the NBI database is the inventory system. However, the research team did decide that it was still important to know if the counties kept a list of the maintenance activities they performed for their larger county owned bridges. In addition to being a yes/no type of question, the research team decided than including a third option of "in the process of compiling" was necessary as that could be the reality for different counties. Thus the question was revised, and the follow up question asking what kind of information was on said list was also revised. Rather than being a free-response question, it instead became a checklist of different information the research team deemed important and possible to be included. This information checklist included asset ID, location information, geometric information, owner information, dates of maintenance/repair/replacement, date of construction, material information, maintenance activity type and other. If the county says that they do not have a list or are in the process of compiling one, an addition question would be asked in order to estimate how long in months it would take for the county to compile the list.

The next area of revision was regarding how the survey asked about budget information. In addition to funding sources, it was important to know a few additional items. A question was added to the start of the funding sections that inquired whether there was a separate budget for managing the type of transportation asset the section was about. If the answer was yes, the county would then be prompted to estimate how large that budget is on an annual basis. Knowing this information would be helpful in seeing the type of monetary situations some counties found themselves in compared to others.

The questions regarding resources and the confidence counties have in being able to carry out transportation asset management plans also needed some expanding. Firstly, a trio of statements were added to start the section and the counties were asked to give a value on a scale of 0 to 10 on how much they agreed with the statement. The statements were all the same with minor changes in order to gauge differences. The statement were as follows: “My county has the ____ we need in order to adequately perform management for ______ bridges and culverts”. The first blank would rotate between the words “funds”, “resources” and “knowledge”, while the second blank would change between “sizable” and “smaller” depending on the section the question was found. These statements and how much the counties agreed with them would become a “confidence score” that can help the research team gauge which area, between funding, resources and knowledge, to focus on in order to close gaps between the current state of asset management and where expectations are for the future. Additionally, GDOT has begun its rollout of the InspectX software, geared towards providing an easier way for counties to access bridge inspection reports for their bridges. However, it is unclear as to how widespread the rollout has been, so adding a question as to whether or not a county has access to the InspectX software was important to gauge how many counties are getting access to helpful resources such as InspectX.

Lastly, because of the split between sizable bridges and culverts, and the smaller culverts and assets, the research team saw an opportunity to ask some unique questions regarding the smaller assets. First, the need for an additional question to ask about inventory data for these smaller assets was needed, as there is no NBI database to keep track of these smaller assets outside of the counties. This would be asked in addition to the question regarding whether the county kept track of maintenance activities for smaller assets. Because inspection practices are not as standardized for smaller assets, asking questions on how they assets are maintained was also imperative. A question regarding whether or not the assets were inspected on a regular schedule was added and how long that regular schedule was. If the answer was yes, a question was provided to asked who was responsible for the inspections. In addition, the research team wanted to know if counties had developed their own condition rating systems for their smaller assets, as there is no standard when it comes to condition ratings for smaller non-NBI assets. Lastly, some questions were added in order to describe the type of smaller assets found in Georgia counties. The free response question would provide the counties an opportunity to list the types of assets they have, and some of the properties of those assets, such as materials and geometric information. Two questions were added about pedestrian bridges, asking whether the county has some and do they inspect them.

Distribution/Contact Methods of Survey

Once the final revisions of the survey were completed, the next step was to determine the best ways to distribute the survey to the counties. When it comes to distribution of the survey, acquiring an email list and sending it out to the list and seeing who responds is normally a good first step to gain initial results. However, when it comes to gathering contact information for county officials and public works directors, there is no said list. Any list provided by GDOT or even county websites were admittedly outdated and thus could easily provide unreachable contact information. Thus, the research team needed to tackle two problems at once. First, they needed to find updated contact information for the county's relevant staff, and from there, contact those staff members to fill out the survey. Initially, a contact list was compiled by visiting counties' website. Once an updated contact was found for a county, the research team put together a new contact spreadsheet to be used moving forward in the project and to be shared with GDOT if its employees wish to contact the same county staff members. Once contact information began to be updated, the research team initially tried to email the survey to the county staff members once an email contact was established. However, leaving the county staff to fill out the survey would either lead to no response from the county, or it would lead to misinterpretations of questions or clarification questions from the county staff. Additionally, county employees was often engaged in site work and thus on the road. With this in mind, the research team decided to go with a different approach. Rather than simply emailing the survey to the county staff, the team would look to discuss the survey over the phone (or an online meeting) with the staff member, or schedule a time later to do so. Having the conversation directly with the county staff, with the survey questions providing a guide for the conversation, quickly became the most successful way to have the survey filled out. Not only did it make the process less tedious for the county staff, but if there was any questions or unclarity, they had a member of the research team there to answer or clarify. The research team continued with this strategy moving forward with the survey and the results from their findings can be found in Chapter 4. Overall, the research time saw more success by answering the survey questions over the phone rather than reading questions and typing answers, particularly those who need to address field issues daily and thus not working in an office.

METHODS USED FOR DEVELOPING A STRATEGIC PLAN

The initial brainstorming of the strategy plan began with a series of four core questions, which can be seen in Figure 12. The goal of these 4 questions was to give the research team a starting point by which the goals of the strategy plan could be achieved.

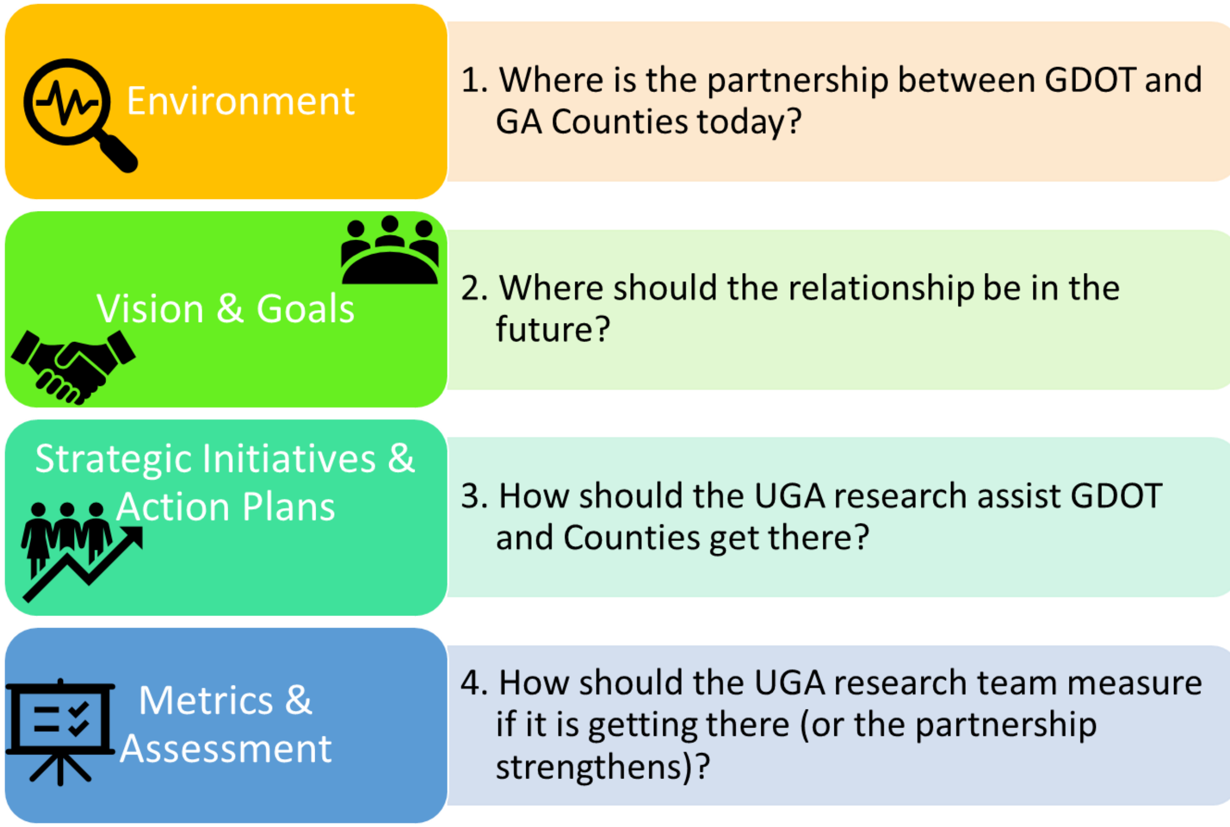


Figure 12 – Four Core Questions for Strategy Guide.

The first core question to be answered was " where is the partnership between GDOT and GA County/City governments today?" Based on discussions with GDOT and local county officials, there are plenty of ups and downs regarding the current status of the relationship. In some cases, GDOT works very closely with county officials and the relationship is strong, leading to minimal issues between the two. Other times, there is frustration on both ends of the relationship, particularly when it comes to communication and the transfer of information. The variation in both the expectations and the development of relationships from local government to local government and the lack of understanding of processes from some also contributes to the angst. The second core question to be answered was "where should the relationship be in the future?" GDOT is in charge of building the transportation infrastructure of Georgia to its strongest potential for the safety of its residents. There are many infrastructure items that fall outside their jurisdiction and thus a strong relationship with any local government will help them to still have a hand in monitoring these assets without having to overreach their jurisdiction. The relationship should have clear points of contact between GDOT and the local government, with personnel at both who understand both the processes of GDOT and the processes of the local government. These personnel would be the keys to navigating both systems and making contact and working relationships more efficient. Overall, the goal of the relationship would be to improve how quickly projects can be managed and completed. The third and fourth core questions to be answered was "how should the UGA research assist GDOT and Counties to get there?" and "How should the research team measure if the partnership is strengthening?" The following section will address the third question in depth, analyzing the different areas by which the UGA research team has identified to achieve the goal set forth. In addition, a strategy plan can only work if there is a way by which the implementors of the plan can measure its affect. Throughout the discussion, potential ways to measure each area discussed will be addressed.

METHODS USED FOR DEVELOPING AN INSPECTION GUIDE

Other State DOTs' Best Practices

Based on the literature review in Chapter 2, it was determined that the two guides that this thesis would look to emulate were the Michigan Non-NBI Culvert Structure Inspection Guide and the SCDOT Pipe and Culvert Field Inventory and Inspection Guidelines. Both not only provided information as to how to inspect an asset, but also provided information on how to develop a long term strategy to keep up with local assets like culverts and cross-road pipes.

Observing Inspection Processes in Selected Counties

The questionnaire developed by the research team was designed to reach out to a larger quantity of counties in order to gather information about the current state of asset management systems for bridges, culverts, and other smaller transportation assets. This information was crucial towards understanding what local governments did or did not have that they needed. The next step was to identify counties from the survey that report to have successful asset management systems by using their own resources or ability to obtain outside resources. The reason for this was to find systems that counties or city governments with similar sized budgets, population, or nominal asset numbers could emulate. The research team believed that one way to enhance the resources provided to these counties was to include success stories and case studies of other counties in Georgia, with similar limitations and problems, and how they were able to implement their systems. It can provide templates for other counties to emulate and provide answers on how to navigate common problems and combat perceived limitations for certain kinds of counties. For example, a smaller county could easily wave away the idea of a transportation asset management system with regular inspections because that's something only those larger counties with big tax revenue systems and large budgets can handle. However, if they were to read about how a smaller county such as themselves was able to successfully implement a management plan, suddenly the process may appear more feasible. In addition, it would also provide a point of contact for this county, should they have questions on how to implement the system, which would also achieve one of the research team's goals in encouraging inter-county conversation.

However, in order for successful knowledge sharing and emulation of best practices to occur, the information needed regarding how these asset management systems work goes well beyond what could be obtained with the survey. Understanding these counties and their systems would require personal observation and meeting directly with the counties to see them in action, first hand. The research team has identified three counties to contact beyond the survey and establish times to observe the execution of these management plans. As mentioned before, the goal for this portion of the project was to report on counties who could represent different situations across the state of Georgia that other counties could be working with. Thus, it was imperative that the three counties chosen for case study each represented different stages of urbanization. The team identified Fayette/Fulton County as their representative for larger, urban counties, as it make up the heart of Atlanta, GA. Oconee County was chosen as the mid-sized, mix between urban and rural, county, as it lies just outside of Athens, GA. It also helps to provide representations for middle Georgia, latitudinally. Finally, Sumer County represents a smaller, rural county, and additionally offers representation as a county closer to Georgia's southern border. Between those three counties, the research team believes it has enough representation such that any county in Georgia can find ways to emulate one or more of the three in regards to inspection practices. The research team also planned to visit Fayette County and Clarke County, due to the newness of their programs and to see how the population growth in their counties affects their strategy.

Each county has specific items the research team will look for in regards to their unique situation as a county, which will be expanded upon in the following sections. However, an overall strategy was developed that would apply to all three counties regarding what common information the research team would be gathering. Firstly, the team would establish a time to meet with the Director of Public Works for the County, road supervisor, or any equivalent position who were in charge of maintaining the assets. The team would ask the counties to prepare visits to 5 separate culverts or cross-road pipes that county believed provided a good representation of the assets they have. Not only would these assets need to be diverse in their material make-up, size, and location.

What is meant by that is that the process to inspect an asset on a 2-lane dirt road will be much different than it would be to inspect a culvert on a 4-lane paved road down a major roadway. It will be interesting to see what type of assets the different types of counties provide as their representative sample.

During the visit, the team would observe as the county staff conducted their inspections, looking for what equipment was commonly used, what steps were taken to ensure safety, and other items. Between inspections, the team would engage in conversation designed to inquire into the day to day operations of the inspections, as well as problems and situations that often arise. During the trip, it is also imperative that the team meet with the county staff to learn more and observe their inventory management system for these assets as well as how they keep track of maintenance activities. Learning more about the development of the system and what resources were used to create it would provide great information for other counties to utilize. Finally, the team would need to see how these inventories and maintenance lists are updated once the inspections are completed.

Gwinnett County

On the other end of the rural-urban spectrum is Gwinnett County, which represents the heart of Atlanta, GA. Being a part of an urban county brings forth several of its own advantages and disadvantages, and some neutral unique situations. Some advantages include the increased tax revenue of the county leading to larger budgets. Another advantage could be their proximity to political or organizational headquarters. In addition, the staffs for urban county departments tend to be some of the most robust, not just in numbers, but in positions held. Urban counties tend to be the counties that can afford not just to have an engineer on staff, but an entire department dedicated to engineering. However, there are some disadvantages as well. Working within urban areas typically means a larger number of nominal assets to keep track of, which can be more difficult on the staff as the number of assets per staff member can grow quickly out of control in a growing county. In addition, urban environments lead to higher runoffs, which means larger culverts and pipes to be used and maintained. These larger assets lead to higher costs and high manpower needs to maintain them. Additionally, urbanized county governments tend to have more regulations in terms of what kind of assets can be used, as well as how to maintain them. These regulations, while beneficial at times, can lead to being constrained in solutions when dealing with unique problems. Finally, another unique feature of urban counties that is neither an advantage nor a disadvantage on its own is that the county governments have to work closely with larger city governments who often have jurisdiction over the county governments themselves.

Fayette County

Fayette County struck an interest with the research team because of its population increase it has seen in recent decades. It is a county that has seen large urbanization efforts in recent years, and thus its strategy for dealing with local assets has likely had to shift over the last couple of decades. It is of interest to find out what kind of regulations the county has found itself under, as well as if there are any new self-imposed standards they now abide by. Understanding this dynamic could help other local governments better understand how to handle these assets whenever their local jurisdiction sees the economic growth they are building for. In addition, it will be interesting to see what new challenges have appeared as the county has grown and the staff has had to manage it.

Oconee County

Because Oconee County represents an in-between county regarding its urbanization, less was emphasize on its unique problems and benefits, and more was placed on how the tradeoffs going from rural to urban impacted them. What is meant by that is there are advantages and disadvantages to being a heavy rural or heavy urban county when it comes to establishing an asset management plan, as was observed in Evans County and Fulton County. Thus, it follows that as a county slides along the spectrum from rural to urban, the combination of advantages and disadvantages will shift, creating a unique set of challenges that the county will have to navigate. Oconee County is one of the few counties the research conversed with that contained sections under MS4 urbanized guidelines, as well as section outside of that jurisdiction. The research team will look to identify how the Oconee staff handles the difference between the two standards, if there are any.

Clarke County

Clarke County was not initially scheduled be one of the counties the research team behind this report sought to visit. However, after speaking with the staff at an APWA event and following with a phone call to fill out the survey, the research team was intrigued by Clarke County's relatively new Live-Stream Pipe Replacement program. The program matched all three of the aspects the team was looking for in a proper inspection system for pipes and culverts. In addition, because the program was so relatively new, the team wished to learn about the early lessons learned from the Clarke County staff when implementing this program. The county is a larger county with a large budget to work with annually, so some of the problems the county faces should be comparable to Gwinnett and Fayette County.

Sumter County

The last observation case study the research team participated in will differentiate itself from the previous visits in a few ways. Firstly, the four counties visited above all have relatively large populations with some urbanization, if not totally urbanized by MS4 standards. Sumter County will be the county visited with the smallest population out of the group, meaning it will also likely have the least resources compared to other counties involved in this report. Sumter County does not have an kind of inspection program for its pipe and culvert assets, instead totally relying on reports from constituents and performing reactive maintenance. A full description of Sumter County's system can be found in Chapter 4. Jim Littlefield, Public Works Director of Sumter county, wishes to move many of the county's systems "into the 21st century" using his own words. This includes upgrading the way they inspect their locally owned assets. The research team will develop an early draft of the inspection guide, bring it to Sumter County, and receive feedback from Mr. Littlefield and his staff regarding how feasible the recommendations are for a small county like themselves, while also testing out certain features like the inspection forms in the field.

CHAPTER 4. RESULTS AND FINDINGS FROM COUNTY SURVEY

INTRODUCTION

Once the research project had received responses from about 1/3rd of Georgia's 159 counties, analysis was begun in order to begin finding patterns within the responses of the surveys. This chapter will provide summaries for and analyze the results of the surveys in two ways. First, the survey developed covered a variety of subjects. Summarizing the findings at a statewide level and discussing patterns noticed provides important information regarding decisions to be made on what needs to be included for a future inspection guide and the strategy plan for GDOT moving forward. After this, a short summary will be provided on a county by county basis. Summarizing the results in this way allows for a better understanding of how a county government handles its assets and allows for better decision making on which counties to highlight as the potential standard bearers for other counties to emulate.

SURVEY RESULTS SUMMARIZED AND ANALYZED SUBJECT BY SUBJECT

In order to generalize the results of the survey at a statewide level, the questions included in the survey and their results have been broken down into 8 categories that have been discussed below. Just like the survey, these categories have been broken down further between sizable bridges and culverts and then smaller culvert/pipe assets. The sizable bridges and culverts results are imperative when it comes to determining areas that can be addressed by GDOT in the strategy plan to be developed by this research project. The results from the questions regarding smaller Non-NBI assets like culverts and pipes will be used heavily in the development of an inspection guide regarding those assets.

Sizable Bridges and Culverts

Existing Transportation Asset Management Plans and Reliance on GDOT

The first section of the survey wished to gauge what kind of asset management plans county governments have developed for themselves, as well as gauge how reliant they are on GDOT for the management and maintenance of these assets. Of the counties surveyed, only 7.84% of them report having a written asset management program in their county for larger bridges and culverts. Of the few counties who did report having one, they stated that they rely on the Preventative Maintenance Bridge Guide. Otherwise, 92.16% of counties report they do not have a written asset management plan for their structures. With the number of county-own bridges and bridge-like structures in the state, one has to wonder how these assets are managed at all. The answer to this lies in how reliant county governments have become on GDOT to handle bridge projects, at almost every step of the way. The survey gauged a reliance score, from 1 to 100, on how reliant the county felt on GDOT and the services they provided, whose averages can be seen below in Figure 13.

Figure 13 – Average Reliance Score on GDOT by Sizable Bridges and Sizable Culverts

The services that GDOT provides on these bridges takes much of the management responsibility away from the county governments. GDOT is required to inspect every NBI-eligible bridge in the state on a bi-annual basis, according to federal law. Thus, they are the ones in charge of maintaining the inventory of the bridges and making sure the inspection schedules stay on schedule. Where the counties are involved is after the inspections are complete. GDOT releases an inspection report to every county on a bi-annual basis and lists which bridges are in need of repair and maintenance and what needs to be addressed. These reports are what county governments use to determine how to proceed with their maintenance plans and how to determine projects and budgeting for them. However, some counties report that these inspection reports often include jargon and can be difficult for county personnel to understand what needs to be done. Smaller maintenance items are often taken care of inhouse by the county governments and larger repair items, if they cannot be taken on in house, will then be contracted out. However, many counties report relying heavily on GDOT should a bridge need to be closed and replaced. This includes the engineering, construction and the acquiring the funding. Counties have also reported having difficulty of acquiring funds for major repairs, as those are left up to the counties as to how to acquire them. The difficulty comes in their inability to find alternative funding sources if their general funds are not enough to keep up with the demands of the project, which they often aren't.

Common Maintenance Activities and Systems of Logging Activities

When asked about if their county maintains a list of maintenance, repair and replacement activities for their sizable bridges and culverts, only 52.08% of responding counties states they do keep track of this, either through paper-log or electronic database. An additional 10.42% said they currently are in the process of compiling this data. Of those counties, they believe it will take roughly 1 year to compile the data. The information kept on these lists can vary, although the most commonly reported items on the list include the Asset ID, the location information, the day of maintenance or repair, the maintenance activity performed, as well as which personnel were involved. For many counties, this list is maintained through their own in-house or purchased work order system.

When it comes to common maintenance activities performed by the county staff, by far the most common is brush/tree cutting. This is followed by activities such as erosion control, bridge joint sealing, under approach sealing, guardrail repair and deck repair. Maintenance of the bridge's structural members is listed as one of the least common activities the county has to deal with, however, that is the maintenance activity that will give them the most fits, due to it being the most expensive, outside of outright replacing the bridge.

Budgets and Funding Sources

When asked about whether their county set aside a specific budget for the purpose of maintaining sizable bridge and culvert assets in their jurisdiction, only 48.94% of counties said they did. For those that did have a separate budget, the nominal amount was heavily based on the size of the county and the general funding it gets from its tax revenue. Other counties who did not have a set aside budget say their funding just comes a needs-based county general funding pool. Where this funding comes from varies from county to county, however, when the results are conglomerated together, a clear order of commonality appears. The most common funding source for counties for their bridge projects comes from SPLOST programs. Just above half of the respondents to the survey listed SPLOST as their top funding option. The next most common funding sources were TSPLOST, of which one third of the counties stated they used and LMIG, of which 47.05% of counties stated they used for funding of these projects.

Resource Usage and Needs

The final portion of the sizable bridges and culverts section asked several open ended questions regarding how counties felt overall about their ability to manage and maintain their larger bridge assets, as well as inquire as to what resources they needed in order to do better. The first question of this section asks three identical questions, sans one word, and asks the counties to agree or disagree with the statement on a scale of 1-10, the score of which they given has been renamed a “confidence score”, referring to how confident they are in these categories. The question follows a pattern of “My county has the _____ we need in order to adequately perform management for sizable bridges and culverts”, with the blank being filled by either “funds”, “resources” or “knowledge”. He average of these confidence scores can be seen in Figure 14. The confidence scores were overall low, although knowledge of the assets and their management was slightly higher.

Figure 14 – Average Confidence Score By Counties on Sizable Bridges and Culverts

The survey also asked if counties had been given access to the newly formed InspectX program, for the use of keeping up with inspection reports. Of the respondents, 81.25% of them had either never heard of it or they had no access to it. The rest of the respondents had received access and were overall positive in their reviews of it. Given the information that InspectX is able to offer when it comes to the inspection reports of bridges made by GDOT, the research team inquired why

GDOT hadn't made a bigger push to make it more widely available. The answer to this question was two-fold. First, GDOT expressed concerns about over loading the servers for the young program and thus were rolling it out slowly. In addition, some counties mentioned having heard of the program, but didn't use it because it required resetting their accounts password once a month. The reason this practice was necessary was due to security reasons, given the information is state government property, however it was enough to make the experience with the software cumbersome for county officials. When it comes to the biggest challenges a county faces when managing and maintaining these assets, the repeated theme was funding, funding and more funding, especially for larger bridge projects. The second most common complaint was the lack of staffing the counties had on hand in order to take care of in-house maintenance. Another place of concern was the ability to access equipment that counties typically do not have on hand. Many of the counties mentioned that additional training resources from GDOT on the process would help take the guesswork out of much of the process. Counties have expressed a desire to learn more about the process because their reliance on GDOT for many steps of the process has made them helpless whenever they cannot reach GDOT for help. Some counties have mentioned that resources that will help them better understand the inspection reports sent out biannually will be a great deal of help.

Smaller Culverts/Pipes/Similar Assets

Existing Transportation Asset Management Plans and Inventories

Several of the topics covered in the section of sizable bridge and culverts were repeated, except this time they are referring to small Non-NBI assets that GDOT does not inspect themselves and whose maintenance and management are totally reliant on the county. When it comes to whether a county does or does not have a written asset management plan for these smaller assets, only 4.17% of them responded "yes". The other 95.83% stated they do not have written plans. The counties that did respond positively to having a written plan described their systems as preventative maintenance systems, which involves regular inspections and applying resources based on the results of those inspections. An interesting note is that the counties that have their plans have typically had them for 10+ years. While many counties responded that they do not have written asset management plans for these smaller assets, when they were pressed for further details, many described either systems of regular inspection, or they described reactive maintenance systems based on work-order calls. Some counties have a system where every time it rains, the staff rotates around the assets looking for problems. This is part of their "anticipate and react" strategy where they know heavy rain is when any non-functioning assets are going to be apparent. The next question on the survey asked counties if they keep an inventory of their assets. If the goal for a county is to have a preventative maintenance system, having an inventory of these assets is a must. Of the responding counties, only 41.67% of them said they maintained an inventory of their assets. An additional 12.5% said they are in the process of building their inventory. The 45.83% that stated they don't have an inventory shared how they kept track of their assets, which included work order lists and "just knowing where they are". These are systems that are primed for assets to be forgotten and to deteriorate beyond function, causing bigger problems down the line. For the counties that did have inventories, the items included in the inventory were commonly the ones asked about in the survey. Asset ID, Location Information, Geometric Information, Dates of Construction/Repair, and Material Information were all included in most of the inventory systems. Figure 15 shows how common these items were included in inventories relative to one another. Some less common features were condition ratings, which shall be discussed further, and owner information. Owner information being less common makes sense as counties often only inspect their own assets, so it doesn't make sense to give them a separate designation for ownership since they all have the same one. For the counties who are in the process of compiling data for their inventories, they said it will take anywhere from 1-2 years to complete the inventory.

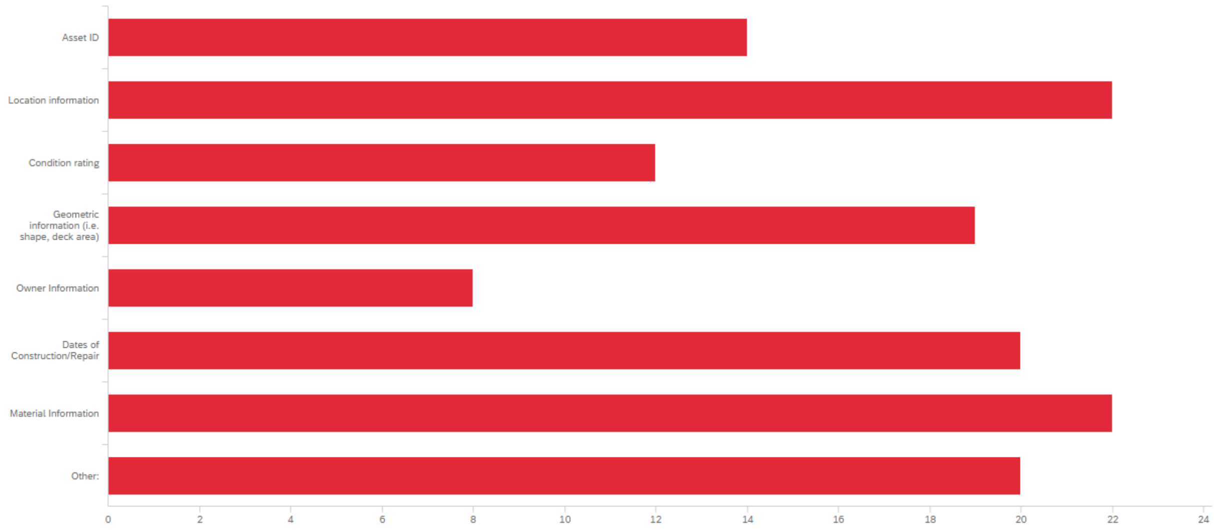


Figure 15 – Common Items Listed in County Inventories of Culverts and Pipes

Another important aspect of having a preventative maintenance program for assets is the ability to establishing regular inspection intervals of the assets. Of the responding counties, 48.94% of them stated they have some regular inspection schedule of their assets. When inquired about how long these inspection intervals are, the numbers ranged wildly. Some counties inspect their assets once every 5 years while some claimed to inspect their assets every day. The wide variety in answers begs the question of how varied in quality are these inspections being conducted. Most of the time, the inspections are done by in-house employees, however, some have stated they've contracted out the inspection work.

Another important feature to establish when creating a preventative maintenance program is the development of a condition rating system. Of the major features of a preventative maintenance program, this one was the least commonly adopted among Georgia county respondents. This time, only 25.53% of respondents states that they applied a condition rating system to their assets. The counties that do use these condition rating systems, use them to help determine priority for which assets should be fixed first. The counties that don't use them but do inspect regularly are using the inspections to determine a "pass/fail" system, where when a asset fails, then it's placed on a work order system.

Types of Smaller Local Transportation Assets Common in Georgia

Based on the answers to the survey, the research team was able to gauge what kind of assets are used in the state of Georgia for culverts and pipes. The team was mostly interested in materials used and structure types, in order to gauge which ones would be most applicable for an inspection guide. The sizes of the pipes typically seem to range from the smallest ones being 12-1in., but can be as large as 108 in. in diameter. The length of these pipes also vary, but they seem to be sold at different lengths in 10 ft. increments. The largest reported is 60 ft. and the smallest reported was 20 ft. Box Culvert sizes tend to be larger, however, none surpass the 20 ft. span marker than would make them NBI assets. Regarding materials of the pipes, the most common materials used for these assets are corrugated metal and reinforced concrete. What material was used for an asset is often based on function, however some counties are against using one material over the other. Many counties cite not being able to used concrete due to its difficulty to install and the cost. Meanwhile, other counties cite not being able to use metal pipes due to local ordinances. Other materials like plastic and brick have been cited by some counties, but their numbers are insignificant compared to the number of concrete and metal assets. The research team initially inquired about pedestrian bridges and wooden bridges, however not enough counties responded owning them to warrant including them in the guide. Wooden bridges especially, as most of them are scheduled for replacement with a bridge of another material, rather than being repaired.

Common Maintenance Activities and Systems of Logging Activities

When it comes to whether counties maintain a list or log of the maintenance activities they perform on their smaller culvert/pipe assets, 57.45% of respondents said “yes”, while 36.17% said “no” and 6.38% said “in the process of compiling”. For those who were in the process of compiling, they mostly said that it would take anywhere from 2 years to 3 years. Many of the counties who keep their lists are heavily dependent on work order systems and some incorporate their maintenance activities into their inventory system. When it comes to common maintenance activities, the most common are brush/tree cutting and blockages within the pipe. Between those two activities, 75% of responding counties had one of them listed as their most common activity. Some other common maintenance activities include joint separation, erosion control, metal corrosion, scour and stability programs, and channel alignment.

Budgets and Funding Sources

The next section asked questions regarding budgeting and funding sources for managing and maintaining these small culvert/pipe assets. Of the counties surveyed, 72.34% of them said they do have a separate budget for this purpose. When asked to put an estimated annual amount to that budget, the numbers varied wildly just like the bridge budgets. Some counties had budgets as large as $20 million for this purpose, while others had budgets as small as $15,000. The purpose of this budget could vary as well, as some incorporate spending for equipment and maintenance only, while others included payment for staff and labor. When it comes to commonly used funding sources, the two most commonly cited by counties were SPLOST and needs-based general county funding. TSPLOST was also cited as a common funding source, although many counties who had TSPLOST say that its funding is more for the maintenance of roads, rather than sub-road assets.

Resource Usage and Needs

The final portion of the small culverts/pipes section asked several open ended questions regarding how counties felt overall about their ability to manage and maintain their larger bridge assets, as well as inquire as to what resources they needed in order to do better. The first question of this section asks three identical questions, sans one word, and asks the counties to agree or disagree with the statement on a scale of 1-10, the score of which they given has been renamed a "confidence score", referring to how confident they are in these categories. The question follows a pattern of "My county has the _____ we need in order to adequately perform management for sizable bridges and culverts", with the blank being filled by either "funds", "resources" or "knowledge". Figure 16 shows the average score for each of these statements. It is notable that the counties are overall more confident in their ability to manage their own assets than they were for the bridges.

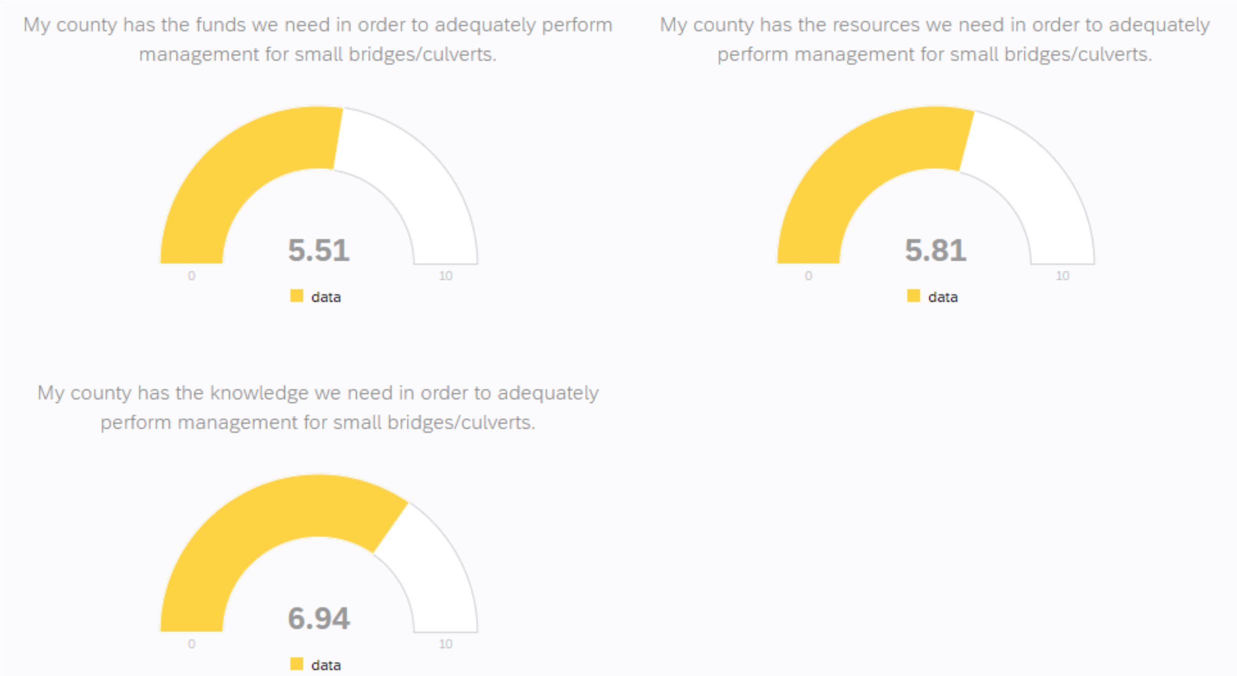


Figure 16 – Average Confidence Score By Counties on Small Culverts/Pipes

When asked about the biggest challenges that county staff face when maintaining and managing these assets, there were a variety of areas of concern. Naturally, funding and manpower were the two most commonly cited areas. In regards to manpower, many counties specifically want their staff to be better trained on the technical aspects of the job. The other issue cited is being able to keep up with the growing number of assets. Many counties have seen population growth and thus the number of assets they maintain multiply. However, their staff, funding and resources aren't typically keeping up with these number of assets. Some counties also cite obtaining materials for repair or replacement as difficult.

The survey also asked counties what resources they think they would need in order to better maintain and manage their assets. Aside from funding and staff concerns, some staff have mentioned that major flooding events can leave a county staff unsure of how to tackle a large scale problem, so resources that provide advice on that are welcomed. Many counties have said that a resource to help them find where to get large equipment such as excavators would be helpful. Some have said that obtaining asset management software is on their to-do list, but finding the right company or making their own have proven difficult. Many counties have states that the price of repairs and replacement projects have risen with recent inflation and the county funds aren't enough to keep up.

Miscellaneous Notes

The survey included a small section at the end for an miscellaneous notes the survey takers wished to speak that did not apply elsewhere. This section will provide a written list of some of the more applicable notes. One county brought up the Local Administered Project (LAP) certification program as a way for counties to become more knowledgeable in obtaining federal-based funding, which according to the survey, very few counties use. A few counties wanted to reiterate their frustrations with the lack of communication from GDOT on projects and that improving that communication would be one of the best things they could do.

Many counties have said they want to go beyond a reactive approach and move towards preventative maintenance but are unsure how to secure the funds or how to establish such a program. Additionally, counties seek help in prioritizing bridge maintenance items for working with budgetary constraints, particularly when most of the items are rated with the priority 'B' – schedule maintenance. Finally, transparency in state and/or federal funding opportunities and eligibilities is requested several times. While some counties trust GDOT to make wise decisions as to which bridges are in most need of replacement, others wish to understand the current selection mechanism and why bridges in other counties are prioritized. When bridges are posted or closed, counties tend to want to learn more about funding opportunities. A couple of respondents expressed that they have a great working relationship with their GDOT district office and/or bridge inspectors. Furthermore, respondents that have contacted GDOT' bridge maintenance unit have shared their positive experience in obtaining more details on bridge conditions and recommendations for maintenance although most were not successful in obtaining additional information on funding. Several of the respondents wanted to express their welcoming of the idea of counties sharing knowledge with one another.

SURVEY RESULTS SUMMARIZED AND ANALYZED BY COUNTY

The following section provides summaries of the responses from the Georgia counties who participated in this study's survey. The survey gathered information from 50 counties across the state of Georgia over a period of 6 months and the counties are representative of all regions of Georgia. A map of the participating counties can be seen in Figure 17 below. The counties are listed in alphabetic order and a list of the participants who represented each county in the survey can be found in Appendix E.

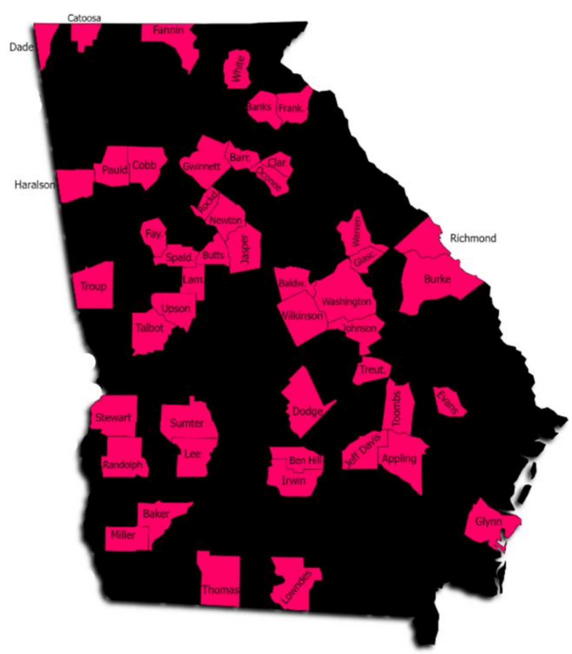


Figure 17 – Map of Participating Counties in Survey

Atkinson County

Atkinson County is a low population county located in south-central Georgia. Its largest city is Pearson, GA. For larger bridge assets, there is no written asset management plan. The county declined to comment on their reliance on GDOT's services. The county is very heavily reliant on a relationship with "State-wide Engineering" which is a consulting service. The county declined to comment on the common maintenance activities, as it is mostly handled by State-wide Engineering. The county typically sets aside $150,000-$200,000 annually to help pay for services for these assets. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their asset management and maintenance, the county declined to comment on resources or knowledge, while funding was given a more positive confidence score of 7 out of 10. Atkinson County does not have access to InspectX.

For smaller assets like culverts and cross-road pipes, there is no written asset management plan in Atkinson County. The overall strategy relies on 5-6 crew members to replace pipes and it is on a needs-basis. The type of assets in Atkinson County include mostly metal pipes. They do not maintain an inventory, do not regularly inspect the assets and do not have condition ratings for their assets. The county also does not keep track of its maintenance items and contracts out major pipe work as well. The only common maintenance item listed is corrosion. The county does set aside a budget for these activities, ranging in $75,000 to $100,000 depending on the year. The funds come mostly through SPLOST, TSPLOST, LMIG and general county budgets. The county contact declined to comment on the confidence they have in their resources and knowledge, but gave a confidence score of 8 to funding for the management of these type of assets.

Baker County

Baker County is low population county located in southwest Georgia. Its largest city is Newton, GA. It was indicated that for larger bridges and other transportation assets, Baker County did not have a written plan for maintaining them. He indicated that the county was largely dependent on GDOT for such projects (100% for sizable bridges and 75% for sizable culverts). In regards to maintaining a list of activities performed on these assets, Mr. Johnson said the county was in the process of obtaining this data and that it would take roughly one year to generate. This list of maintenance activities included every item that the survey asked about. He said he would be willing to share this database with the UGA research team and GDOT. Among the common maintenance activities cited for these assets were brush and tree cutting, erosion control, culvert repair and pile replacement. For funding, Baker County relies mostly on Local Bridge Replacement Program (LOCBR) and State-provided funds, with some additional dollars from SPLOST. For these larger assets, Mr. Johnson indicated that Baker county does not have the funds, resources or the knowledge needed to maintain these assets. Baker County does not have access to InspectX and sees funding and knowledge as its biggest barriers to enacting maintenance on these structures.

In regards to smaller bridges and culverts not maintained or inspected by GDOT, Mr. Johnson once again indicated there was no written plan towards maintaining these assets. He stated the County Road department managed these assets. The type of assets maintained directly by the county include 18-30 in culverts and 19 small concrete bridges. The road department supervisor is in charge of inspections, which are done on a regular, annual, basis. Mr. Johnson did not provide information regarding who the Road Supervisor is for Baker County, nor any contact information. It was indicated that Baker County contains a database of the condition ratings of all their small assets, however, they do not contain a database of their maintenance activities for their smaller assets. They believe it would take about 6 months to bring this database up to date. They indicated that crack repair was the most common maintenance practice for these smaller assets, followed by Brush/tree cutting and erosion control. For these smaller assets, a budget of roughly $15,000 dollars is set aside. This budget makes up the entirety of the funds for these assets, and Mr. Johnson did not indicate where these funds come from. Once again, Mr. Johnson said the biggest barriers for maintaining these smaller assets were funding and knowledge.

Baldwin County

Baldwin County is a medium population county located in central Georgia. Its largest city is Milledgeville, GA. The county contact first wanted it to be known that they are Local Administered Project (LAP) certified and that he has experience working with smaller asset management during his time in California. For sizable bridges and culverts, Baldwin county does not have a written plan for it. Their unofficial maintenance plan is to receive the bridge report from GDOT every two years, and then work to perform every item to fix on that list. He indicated that the county is 100% dependent on GDOT for these funds and resources for the larger bridges and culverts. He specifically said the county is in the process of replacing older bridges, but haven't found ways to get themselves the funds to do so. He brought up that the LAP certification for the county earns them 70% of the funds they need, however, they don't know how to earn the last 30% to match. For the larger assets, they do maintain a list of the maintenance activities performed on them and that list includes all the information provided in the survey. Among the maintenance activities, Brush/tree cutting was once again the most common item. It was indicated that Baldwin county set aside a budget of $300,000 for these larger projects, although that number likely indicates a budget for the entire department, rather than simply just bridge/culvert projects. For funding, Baldwin County relies mostly on SPLOST, Local Maintenance and Improvement Grant (LMIG) and Property taxes. While they believes the county easily has the knowledge to do what they need to do in order to maintain these assets, he believes they severely lack when it comes to funding and resources. Baldwin County does have access to InspectX.

For smaller bridges and culverts, Baldwin county again does not have a written plan and they most rely upon reactive maintenance. Among the smaller assets, Baldwin county mostly has corrugated steel pipes, which vary greatly in size. They also use a lot of plastic. Baldwin County does not maintain a list of their smaller assets, nor do they regularly inspect them. They do keep a list of maintenance activities, which includes most of the items listed in the survey. The omissions include "asset ID", since they double the location information as an ID, and a "date of construction" since many of the assets are so old, no one knows when they were built. This maintenance list is up to date, and they indicated they'd be willing to share with the UGA research team. The most common items are brush/tree cutting, scour and stability problems, and blockages within the culvert or pipe. They do not set aside a specified budget for these assets, rather they just use the general county fund. They did try to pass TSPLOST, however the vote failed. In terms of the county feels about the funding, resources and knowledge, they feel the same as the larger assets, except they feel better overall about the funding and resources, but that still lags significantly behind the knowledge. In terms of the biggest challenges, the county contact indicated climate challenge (upsizing pipes and building bridges at higher elevations), impacted pipe replacements, and more drainage from growing communities. He finished by summarizing how larger bridge replacements is a major problem for smaller counties because of how much budget it takes away and thus leaves too little for smaller maintenance activities, as well as the fact they don't have the personnel to pull it off.

Banks County

Banks County is a low population county located in northeast Georgia. Its largest city is Baldwin, GA. Like many counties, Banks county does not have a written plan for maintaining sizable bridges and culverts. Mr. Turk indicated heavy reliance on GDOT for locally owned bridges, however only asked to put 25% reliance for that question, which was interesting. Mr. Turk was blatant about the fact that he nor his county staff have a lot of trust towards GDOT engineers. Banks county does maintain a list of maintenance activities, including all of the items asked about in the survey, however date of construction only include if structure was recently constructed. Mr. Turk said the county would not be willing to share that database. Of the common maintenance activities for the larger bridges, brush/tree cutting, erosion control, repair of guardrail, and header joint repair were cited as the most common. It was told that Banks County has a budget of $500,000 towards these bridges and culverts, however it’s likely that represents a department’s entire budget. For funding options, Local Maintenance and Improvement Grant was cited above all the rest, however it was also indicated that LOCBR, Low Impact Bridge Program (LIBP) and SPLOST were utilized. Similar to other counties, Banks county feels good in its knowledge of how to maintain sizable bridges/culverts, it just lacks in the resources and funding. Banks County does not have access to InspectX.

When it comes to smaller assets, Banks County does not have a written plan to maintain those either. Their assets include culverts with diameters from 16in up to 6ft, and their material used was galvanized for old ones and smooth poly for new ones. They do keep an inventory of their small assets, which includes the asset ID, location information, geometric information and material information. They do not regular inspect their smaller assets and do not assign them condition ratings. They do keep a database of all maintenance activities, which includes all items listed on the survey, excluding the date of construction. Of the maintenance activities, the most commonly cited were surface damage/spalling, brush/tree cutting, erosion control, and scour/stability problems. They do set aside a budget for these maintenance activities, which they said was $200,000. However, this is an estimate and is likely indicative of a larger budget. The largest source of funding by far was the TSPLOST initiative. Overall, Banks county does not feel good about their funding, resources or knowledge to maintain these assets. They wanted to reiterate they don't feel like they're being listened to by GDOT, especially in regards to more unique projects.

Barrow County

Barrow County is a medium to large population county located between the Atlanta Metropolitan area and Athens, GA in north central Georgia. When it comes to sizable bridges and culverts, Barrow county does not have a written asset management plan. However, this is something that the road department and the stormwater department are looking to remedy. Our point of contact stated he has been with the county for 2 years and was brought on to help facilitate this transition. When it comes to how the larger assets have been handled by the county, any major repair or replacement projects have been included into the county's 5-year "Capital Plan". Regarding how much the county depends on GDOT for their larger bridges, the contact gave it an overall 75% reliance score. However, the contact broke it down further, saying that the county 100% relies on GDOT for the inspection of the assets, and views it as a 60/40 split between county and GDOT when it comes to the post-inspection process. He gave an example of a recent bridge where GDOT handled all the inspection, but the county was able to contract out the engineering for the bridge project post-inspection without much help from GDOT. The county does maintain a list of the maintenance activities performed on these larger assets, which includes asset ID, location information, owner information, dates of maintenance, material information and maintenance activity performed. The date of construction is included if the asset is new enough. Some common maintenance activities for larger assets in the county include brush/tree cutting, erosion control, guardrail repair, and approach undersealing. The county does not have a set-aside budget for these assets, as they are included in the 5-year capital plan. The funds come mostly from SPLSOT, however the county staff are not strangers to utilizing federal funds when available and the GTIB. The county is also expected to establish a referendum to pass a TSPLOST program in the next 5-year period. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their asset management and maintenance, Barrow County feels neutral in its funding and resources, giving both a confidence score of 5 out of 10. However, they gave their knowledge a score of 3 out of 10. When asked to further explain this, the contact stated that the county's reliance on GDOT for bridge inspection over the years has made it to where the county staff have not needed to stay up to date with practices regarding inspection and repair of these assets. It is something he hopes to change in the county and would appreciate help from GDOT in this course of action. The county does not have access to GDOT 's InspectX software and when the software was described, he seemed to want to learn more about it and would contact his GDOT representatives to find out more. When it comes to the biggest challenges, funding was cited as such.

For smaller assets such as culverts, pipes and other similar assets, there is no written asset management plan. However, there is clearly a system in place in order to do so. Rather than the public works department, the inspection of the pipes and the culverts are done by the stormwater management department. This staff inspections 20% of the assets each year, making each asset inspected once every 5 years. Of the assets, about 80% are corrugated pipe culverts, ranging from

12 in. to 48 in. The county does have one timber bridge but does not have and pedestrian bridges. The county staff does keep an inventory system of their assets and includes all the information asked about in the survey except for condition ratings. However, the contact says they are currently working with the company who developed their work order system software to add a feature where a condition rating can be provided. The county already has a 5-tier condition rating system for their roads and they are looking to adopt a similar system for their assets. The staff also collects a list of their maintenance activities performed on these assets, using the work-order software described before. This list includes all the information asked about in the survey question. Common maintenance activities on these smaller assets include brush/tree cutting, erosion control, blockage within the pipe, crack repair on concrete assets and surface damage/spalling. Regarding budgets, the money for maintaining these assets comes from the same capital plan described before. When it comes to how Evans County feels about their funds, resources and knowledge for their smaller assets, the overall feel is neutral to good. Funds was given a confidence score of 6, while resources and knowledge were given scores of 5 and 7 respectively. It's notable that the confidence in knowledge is much higher for the assets that the county is asked to maintain themselves. One last comment from the contact reiterated that staff knowledge and funding are the biggest issues his county face.

Ben Hill County

Ben Hill County is a low population county located in south central Georgia. Its largest city is Fitzgerald, GA. For larger bridge and culvert assets, there is no written asset management plan in Ben Hill County. The county is somewhat dependent on GDOT for bridge maintenance and management, indicated by their 50% reliance score. They do maintain a list of the maintenance activities, which is done through reports and documents given to the county commissioner.

Common maintenance activities include brush and tree cutting, and erosion control, specifically riprap placement. The county does not set aside a budget for these assets. Rather the funds are procured through the SPLOST and TSPLOST programs. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their asset management and maintenance, the county has varied confidence on different categories. Resources was the lowest confidence score at 2 out of 10. Funding was more neutral with a score of 4, and knowledge was given the highest score at 7 out of 10. The county does have access to the InspectX software, but internet issues is keeping them from fully exploring and using it. The contact wishes there was an easy way to print out inspection reports rather than reading online. Labor and funding are their biggest issues.

For smaller assets such as cross-road pipes and culverts, there is no written asset management plan in Ben Hill County. The county is confident in its ability to remember where the assets are located and they are inspected and maintained on a needs basis. The types of assets in Ben Hill county are mostly plastic, about 80%, with some metal pipes, around 20%. Plastic is commonly used because it is easier to repair the ends. They typically used steel metal pipes on dirt roads, which are supposed to last around 80 years. The county relies on a work order system to double as an inventory system. The county does not regularly inspect the assets and does not have a condition rating system. The county, much like with the bridges, keeps track of its maintenance activities through reports to the counter commissioner and their work order system. The contact stated it would take about 3 years to inventory all of the assets. Common maintenance activities for these small assets include brush and tree cutting, blockages within the pipe, and corrosion. For the blockages, the county use sewer pressure pumps. The county does not have a separate budget for these activities, instead using SPLOST funds for project based funding. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their smaller asset management and maintenance, the responses were neutral to positive. Both funding and resources were given a confidence score of 5 out of ten, while knowledge had the highest with 7. The county is working on passing a TSPLOST fund which will help with pipe maintenance. Labor continues to be the biggest issue.

Burk County

Burk County represents a medium sized county on the eastern border of Georgia and contains the city of Waynesboro. For larger bridges and culverts inspected by GDOT, Burk County does not have a written asset management plan. These assets are managed through the budget process and contracted out. The county is heavily dependent on GDOT for large bridges, giving a 75% reliance score. They are less reliant for larger culverts, giving a 10% reliance score, however this is because they don't have many culverts that qualify under GDOT inspections. The county does maintain a list of the maintenance and repair activities performed on these larger assets. However, the information is limited to only the location information, date of maintenance and the maintenance activity itself. Among the common maintenance activities on larger bridges, the most common are brush/tree cutting, culvert repair, erosion control, repair of existing guardrail, bridge joint sealing and repairing the main structural members. Burk County does have a separate budget for maintaining these assets, which is roughly $60,000. This funding mostly comes from SPLOST, TSPLOST, LMIG, LIBP, LOCBR, and GTIB. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, Burk County feels good about their resources, giving them a confidence score of 6 out of 10. However, they fell less secure in their knowledge and funding for doing so, giving both a confidence score of 3 out of 10. Burk County does not have access to the

InspectX program. They consider their biggest challenge for these larger assets to be funding and if they could obtain some resources to help them out, it would be to add an engineering staff to spec out the bridge replacement and to have more knowledge regarding alternative funding sources.

When it comes to locally owned and maintained small culverts and pipes, Burk County does not have a written asset management plan. The assets are maintained in house by the county staff. The makeup of the county assets includes about 90% of them being corrugated pipes with a few larger ones being made of concrete. There are no pedestrian bridges owned by the county. The county used to have timber bridges but have been replaced over the year. The county does maintain an inventory of their assets, however the information is limited as it only includes location information and dates of construction and repair. The staff does not regularly inspect these assets and don’t maintain a database a condition rating system for them. The county does keep track of the information regarding maintenance activities on these assets, and that list includes information such as the date of maintenance, material information, and maintenance activities. Of the common maintenance activities for these smaller bridges, culverts and pipes, the most common are blockages within the pipe, corrosion control on metal assets, scour and stability problems and joint separation. The county does keep a budget for these activities as well, and it looks like its included in the $60,000 budget mentioned earlier. The sources of this funding look to be county general funding, SPLOST, TSPLOST and LMIG. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, the county feels overall good about their current place. Fund and resources were both given a confidence score of 6 out of 10 and knowledge has been given a 8 out of 10. The biggest challenge for these smaller assets that Burk County can cite is the large number of aging culverts that need to be replaced as they reach end of their useful life. Burk County also stated that being able to hire additional staff for the express purpose of inspecting these assets on the road system would be a big help.

Butts County

Butts County is a low-to-medium sized population county located just to the southeast of the Atlanta metropolitan area. Its largest city is Jackson, GA. For larger bridge and culvert assets, there is no written asset management plan in Butts County. The county hires contractors for majors work. The county indicated they are not heavily reliant on GDOT, giving a reliance score of only 20%. The county does maintain a list of its maintenance work on bridges through document keeping with contractors. Common bridge maintenance activities include spalling, brush and tree cutting, and repair of existing guardrail. The county does not set aside a separate budsget and the funds are procured on a needs basis through SPLOST and LMIG. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, resources was given the lowest confidence score at 3 out of 10. Funds was given a neutral score of 5, while their knowledge was given the highest score of 7 out of 10. Butts County does have access to the InspectX program. The county contact expressed happiness about how easy it is to access individual inspection reports, but also expressed frustration at how often the password expires and needs to be renewed. The contact also expressed interest in resources and tools that help to determine which projects to prioritize given a limited budget.

For smaller assets like culverts and cross-road pipes, there is no written asset management plan in Butts County. The type of assets in the county are mostly metal corrugated assets, as concrete is more difficult to work with. The county does not have an inventory for these assets. The county has recently purchased a work order software and may use a mapping feature in the future. The software is called IWorks. The county will use this asset to also keep track of its maintenance activity history. The county does regularly inspect its assets, as it has 2 employees whose job it is to go out and informally inspect the assets each day. Repairs and replacements are done on a needs-based basis. There is no condition ratings associated with these inspections. It is believed it would take about 3 years to map out all the assets. Possibly only 1 year if a single person was dedicated to it. Common maintenance activities include brush and tree cutting as well as blockages within the pipes. Butts County does set aside an annual budget of $20,000 annually for these activities. Its included as a line item for roads and bridges. This funding mostly comes through SPLOST and county-based general funding. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, funding was given the lowest score of 5. Resources and knowledge were given much higher confidence scores of 8 and 9 respectively. The biggest challenges according to the contact us staffing and funding. The contact also stated a desire to see more transparency in state funding mechanisms, communication and enhanced priority for budgetary decisions.

Catoosa County

Catoosa County is a medium sized county located in in northwest Georgia along the border with Tennessee. Its largest city is Fort Oglethorpe. For larger assets such as bridges and large culverts, there is no written asset management plan. The county relies on GDOT post notifications and totally relies on GDOT for bridge replacement projects, as is seen in their self-reported 100% reliance score for larger bridges and culverts. The county does keep track of maintenance activities for their bridges through their in-house project management system. Common maintenance activities on these larger assets in Catoosa County include brush and tree cutting, erosion control and section losses. The county does not set aside an annual budget for these activities, but rather approaches funding on a per-project basis, which can come from SPLOST, LMIG, LIBP and state funds through GDOT. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, Catoosa County feels overall neutral, giving all three categories a confidence score of 5 out of 10. The county does not have access to InspectX. The county does not have any engineers in house, so all work is contracted out. The county contact did express some frustration that communication with GDOT is poor and that the inspection reports are not user friendly.

When it comes to smaller assets such as cross-road pipes and culverts, Catoosa County does not have written asset management plan. Their overall strategy is to look at their pipes biannually and present those conditions as a part of their annual report. The types of assets included in Catoosa county include mostly metal and concrete pipes, with some plastic HDPE pipes, some wooden pipes and a few box culverts made of brick. The county contact mentioned that concrete assets are harder to acquire in recent years. The county maintains an inventory through their in-house built database, which includes location information, condition rating, geometric information, dates of construction/repair and material information. The county has not mapped out the pipes yet, and they are currently located by mileposts in the database. The county contact stated it would take about 3 years to map out all of the assets. The staff looks to inspect every asset once every 2 years. The county does have condition ratings to go along with their inspections. It is a three tier system of good/fair/poor. The county keeps track of the maintenance activities for these assets through their work order system. Common maintenance activities include brush and tree cutting, corrosion, blockages within the pipes, scour and stability, settlement/rotation control, and joint repair. The county gets its funding for these activities on a needs-basis from the county SPLOST fund. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for smaller assets, Catoosa county feels slightly more confident in their ability compared to larger assets, giving all three categories a confidence score of 6 out of 10.

Clarke County

Clarke County Georgia is a medium-to-large county located in northeast Georgia. Its largest city is Athens, GA and is home to the University of Georgia. There is no written asset management plan for larger bridges and culverts in Clarke County. The county relies on the bridge inspection reports given by GDOT every two years. Soft maintenance such as tree trimming, mowing, adding riprap, and grassing are all handled within 12 months. Structure repairs such as joint filling, concrete patching, painting, deck patch and rehabilitation are usually done every 4 years and done so by contractors. The county indicated heavy reliance on GDOT, with a 90% reliance score. The contact did state a desire to see more equitable treatment from GDOT on joint-ownership projects, as well as replacement responsibilities. The county does keep track of its maintenance activities and the reports while doing so include all the information listed in the survey. Common repair activities include brush and tree cutting, erosion control, repair of existing guardrail, bridge joint sealing, deck repair, and header joint repair. Clarke County does have a separate budget for these activities, totaling around $400,000. The funding for this budget comes form SPLOST, TSPLOST, LIBP, LOCBR and GTIB. . When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, Clarke County had a low confidence overall. For funding and knowledge, they gave confidence scores of 1, while resources was given a slightly higher score of 3. Clarke County does not have access to InspectX, but wishes to have access and training for it.

For smaller assets, Clarke County does have a written asset management program. Their assets are divided up into two categories. First are the MS4 assets which encompass the urbanized areas of Clarke County and are inspected regularly, once every 5 years) under the MS4 guidelines. Assets that fall outside that range can be put on the Live-Stream Pipe Replacement program. Assets are regularly inspected and ones with a low enough condition score are placed on the list to be presented to the county officials when funding opportunities arise. There are currently 40 assets on this list. The program is relatively new, at only 4 years old. Clarke County has around 300 small pipe and bridge crossings, which are half concrete and half corrugated metal pipes. The size of the pipes range from 15in to 96in. Clark County is in the process of compiling its full inventory. The Live-Stream Replacement Program serves to inventory the failing assets, but Clarke County has contracted out the building of the full inventory, which will take roughly 1 year. On this list will be included all the items listed on the survey except for date of construction. The county does regularly inspect their assets for both programs, with the goal of inspecting them at least once every 2 years. The county does have a condition rating system for these assets, which is an average of multiple criteria, each with a rating of 1 (good) to 5 (bad). The county does have pedestrian bridges, but does not regularly inspect them. Clarke County does keep track of its maintenance activities for these types of assets. The county does set aside a budget for the purpose of managing and maintaining these assets, which is estimated to be $1 million annually. The funding comes from SPLOST, TSPLOST, LMIG, General county funding, and LOCBR. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, Clarke County was once again low on its confidence for funding and resources, giving both a confidence score of 1. Meanwhile, their knowledge for maintaining and managing these assets was given a more neutral score of 5. The biggest challenges Clarke County faces with these smaller assets if funding and staff retention. Add in the pandemic and rising prices and the program is being hit from multiple problems at once. The contact expressed disappointment that the National Culvert Replacement Program did not target small replacement funding. The contact also expressed the desire for a working asset management software.

Cobb County

Cobb County represents the first fully urbanized county discussed. This provides us an insight into what a county with likely more tax payers dollars and resources could be capable of, as well as what unique problems could be faced by a different type of populous. For the larger bridges and culverts, Cobb County *does* have a written asset management plan/procedure. A quoted summary of their plan from the county contact is as follows, “We rely on the GDOT Bridge inspection (excluding bridges less than 20' and pedestrian bridges) process every two years for routine maintenance. For bridges that GDOT doesn't inspect, we try to inspect from a 2 to 5 year interval. Any maintenance issues identified from either inspection, we have our Maintenance Department address those that they can and contract out the rest.” They’ve had this plan since around 1994. Cobb County feels as though they don’t rely on GDOT much for their larger assets, signaling an only 20% reliance. They do keep a list of maintenance activities, which includes all information asked for in the survey. They are willing to share this database with the research group. The most common maintenance activities listed include brush/tree cutting, sidewalk repair at ends of bridges, repair of guardrail, bridge joint sealing, and erosion control. Cobb County does not set aside an annual budget for the management of their sizable bridges and culverts. For funding options, the county contact was clear that Cobb County heavily relies on SPLOST dollars for its funding, and when that isn’t enough, they use the Local Maintenance and Improvement Grant. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their asset management and maintenance, Cobb County feels most confident in their knowledge, and is most concerned not about their funding, but their resources. However, we asked further on what resources they'd like to see more of, funding was the answer. They do have access to InspectX.

When it comes to smaller bridges and culverts, Cobb County does not have a written management plan. As with others, their management plan for smaller assets is based around reactive maintenance, rather than preventative. They rely on citizen request or when sinkholes appear. In terms of the assets in Cobb County, they have over 800 culverts, less than 8 bridges less than 20 feet, and have about 60 public owned pedestrian bridges. They are in the process of compiling a database of these assets and should take about 12-16 months to update fully. The information kept on this database includes everything asked about in the survey with the exception of owner information, since all of the assets contained on the database are publicly owned. They do not regularly inspect their assets and don't keep track of condition ratings for them. According to the county contact, they are currently developing an inspection interval plan. Just like their database to list their assets, Cobb County is in the process of compiling a list of maintenance activities for their smaller assets and will also take 12-16 months to complete. The most common maintenance activites for smaller assets include corrosion control for metal assets, deformation and damage repair for metal assets, scour/stability problems, blockage within the pipe, and joint repair. They have indicated they'd be willing to share their databases. Funding for this management and maintenance comes from the same soruces, SPLOST and county general funding. When asked about their feelings towards the funds, resources and knowledge to adequately perform maintenance for these small assets, Cobb County feels they easily have the knowledge. However, they feel they lack the resources and funds to perform it, at a worse confidence level than the larger assets. Cobb County feels the biggest challenges to maintaining the small assets is the degree of CMP pipe failures of pipe 30+ years old. In addition, one resource area Cobb County wishes it had more in was storm water utility.

Dade County

Dade County is a low population county located in the very northwestern corner of Georgia. Its largest city is Trenton, Ga. There is no asset management plan for larger bridges and culverts. The county has indicated heavy reliance on GDOT, giving a 90% reliance score. The county compiles its maintenance activities through its work order systems. Common maintenance activities deal with brush and tree cutting, settlement, and approach sealing. There is no annual budget for these activities, instead done on a per-project basis through the general county funding. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, both funding and resources were given a neutral confidence score of 5, while their confidence in their knowledge was a very high 9 out of 10. The county does not have access to the InspectX software.

For smaller assets such as culverts and cross-road pipes, there is no written asset management plan or program. The county relies on inspection while ditches are checked routinely. The type of assets in the county are mostly corrugated galvanized pipes. Older pipes are concrete, making up about 30% of the inventory, while newer pipes are corrugated metal, making up about 70% of the inventory. Metal pipes are more common due to issues of settling with concrete pipes. The county is getting ready start their inventory system and are still deciding what information will be included. This process will take 3+ years. The county does not have a condition rating system for its assets. The county keeps track of its maintenance activities through its work order system. The county does set aside a budget for these assets, although the contact could not provide an estimate for this annual amount. The funding comes from the $10 million roads budget. When asked about their feelings towards the funds, resources and knowledge to adequately perform maintenance for these small assets, the overall confidence is neutral to positive. Its resource confidence score was the lowest at 5, while funding and knowledge were both given a score of 7.

Dodge County

Dodge County is a low-to-medium population county located in central Georgia. Its largest city is Eastman, GA. For larger bridges and culverts, Dodge County does not have written asset management plan. The county contact indicated a heavy reliance on GDOT for these assets, indicating 80% reliance score. The county keeps a paper trace system of all the maintenance activities for these assets. Common maintenance activities include brush and tree cutting. There is no separate budget for the management and maintenance of these assets, mostly funded by SPLOST, LMIG, TSPLOST and state-based funding opportunities. When asked about how confident the county feels in turns of funding, resources and knowledge to adequately perform their asset management and maintenance, the county is overall neutral to positive. For funding, they gave a neutral confidence score of 5, while resources and knowledge were both given positives scores of 7. The county does not have access to the InspectX.

For smaller assets such as culverts and cross-road pipes, there is no written asset management plan in Dodge County. The county does not regularly inspect the assets and does not have a condition rating system. The county does no keep a list of their maintenance activities outside of their work order system. When it comes to having a separate budget for managing and maintaining these smaller assets, the county does set aside one, however the contact did not provide an estimate to the amount. The budget comes solely from county funds. When it comes to how

Dodge County feels about their funds, resources and knowledge for their smaller assets, the county is overall neutral, giving all three categories a confidence score of 5.

Evans County

Evans County is a geographically and population-wise small county just to the west of Savannah, Georgia. The largest city to its name is Claxton, Georgia. However, in this small county, the answer to what kind of programs could be built for managing and maintaining small assets can be found. The discussion the county contact was an enlightening one and his story during his employment with Evans County provides a perfect case study for other counties to replicate moving forward. Like all counties discussed, Evans County does not have a written management plan for their larger bridge assets. They are heavily reliant on GDOT for inspection and reporting of issues for their larger assets, however there is no strain in the relationship with GDOT. The way Mr. Hicks spoke of the process made it sound as if the staff for Evans County was familiar and comfortable with the process, something that hasn't been said much of from other counties. They do keep a list of all their maintenance activities on larger assets, including all of the data points asked about in the survey. The county contact mentioned that the county heavily involved their IT team to build up this data base for future use. As for common maintenance practices, Evans County deals with many of the same activities as other counties, including brush/tree cutting, erosion control, repair of guardrail, and undersealing of approach and slabs. The county does set aside a budget for maintenance activities of larger assets, but does not set anything aside for replacement projects. This amount is roughly $40,000 annually. The two common sources for funding these programs is SPLOST and LMIG. The county contact mentioned that TSPLOST does exist in the county, however in order for a program to take advantage of it, the projects must be allocated funds before the passage of the bill. Thus, in Evans County, TSPLOST is mostly used for roads, not bridges and other similar assets. The county contact mentioned that he had heard of the Low Impact Bridge Program and had done some research on it. However, he said the program seemed too complicated for him and his staff to understand, thus they'd rather rely on what works already. When it comes to how Evans County feels about their funds, resources and knowledge to upkeep their larger assets, the results are not surprising. The county gave their funding and resources the lowest score (2 for each) and their knowledge the highest score (8). These results are not surprising given other county's results. Evans County does not have access to InspectX and once the program was explained to the county contact, he agreed that the program would go a long way towards making the process of updating counties on bridge conditions much easier than the current process of receiving a letter. While the county understands the process and their plan to maintain their assets, he believes they could always use more funding and manpower.

For smaller assets, such as culverts and cross-road pipes, what the county contact describes as their asset management and maintenance system sounds like what GDOT and the research team have been looking for in counties in Georgia. Evans County does have a written management plan for their smaller assets and are currently in the process of developing a digital map of all county assets, with great help from their IT department. This plan has been put into place recently, having only been started in the last year. On this map, the assets will be able to be looked up, and their information will be attached to them. This will include all the items asked about on the survey. The process of completing this map will likely take at least one year longer. When it comes to the type of assets in Evans County, it was said they have mostly concrete/corrugated pipes ranging in 18in to 30in diameters and do not have any pedestrian bridges in the county. It was stated that as much as the county would like to, they do not regularly inspect their assets. However, they do rely heavily on the landscapers around the assets to report issues that they find. The landscapers have been told what to look for, and their reports help determine the priority of assets when it comes to maintenance. Something that separates Evans County from many other counties is that they have a condition rating system for their smaller assets. It is not a complicated one, but it accomplishes what it needs to in order to help determine priority. The three categories of the rating system are "good", "needs repair" and "needs replacement". While each category is broad and doesn't help determine priority at a minutiae level, it does its job to help get that process rolling along and is much more effort than other counties put in to set up a system. Evans County does maintain a list of their maintenance activities for their smaller assets and includes all the information asked about in the survey. To make sure the list is up to date, it would take about 12 months. The common maintenance activities for smaller assets are no surprise, as they include items such as tree/brush cutting, unblocking the pipes, erosion control and the like. The county contact wanted the team to note that Evans County had found success with lining culverts/pipes rather than replacing them. While it is still an expensive process to obtain the material, the manpower and time required is greatly reduced. They would be willing to share this list with the UGA research team. The county also does set aside a budget for these smaller assets, which comes out to roughly $20,000. The funding options are the same as with the larger assets. When it comes to how Evans County feels about their funds, resources and knowledge for their smaller assets, the answer is a resoundingly positive one. Funds was given a 6 out of 10 for its confidence score, while resources and knowledge both were given a 7 out of 10. As is typical, these confidence scores aren't higher than they are mostly due to funding and manpower as challenges. The county contact has been working at Evans County for 3 years and was brought in with the purpose of upgrading the public works department and tackling how to make maintenance of assets more efficient. He's seen great support from his county in his journey to secure funding specifically for the purpose of managing and maintaining both larger and small assets, as well as setting up the databases and systems needed for those purposes. The fact that this staff was able to accomplish this recently in a county as small and resource deprived as Evans County is a testament to how possible this is to achieve for other similar counties in Georgia.

Fannin County

Fannin County represents a low-to-medium population county and is a northern county along the border of Georgia, Tennessee and North Carolina. Its largest city is For larger assets, Fannin County does not have written plan. What they do is they make a list of assets that need to be repaired and then categorize them by priority. The county indicated a large dependence on GDOT for larger assets (75% for bridges, 50% for culverts). They had some additional comments about the state of larger asset maintenance. They don't have a lot of culverts in the county. In 5 years, they've only had 4 major repairs and no bridges replaced. They do have one bridge closed for repair and have applied for the low impact bridge program and are awaiting the next step. The county does keep tack of the maintenance activities, however it's limited in the information provided. It is a paper log spreadsheet, including only Asset ID, Date of Maintenance, Date of construction, material information, and maintenance activity. They would be willing to share this list with the research team. Among the common maintenance activities performed on larger assets, Fannin County listed bridge joint sealing, erosion control, approach sealing, and brush/tree cutting. For these larger assets, Fannin county does set aside a budget, which is estimated to be $50,000. For funding options, Fannin County cites SPLOST, LMIG and LIPB. They specified they have 2 bridges on LMIG. When it comes to how the county feels about funding, resources and knowledge to perform their asset management for larger bridges/culverts, they feel roughly even on all three, giving each a 4 on a 1-10 confidence score. The county does have access to InspectX. As to what the county feels is needed to better complete the asset management, Mr. Ratcliff says training on bridges and more funding would help.

For smaller transportation assets such as culverts and small cross-road drains, Fannin county does not have a written asset management plan. Like many counties, their assets are maintained on a needs-based plan. Recently, they've replaced around 400 plastic pipes. Of their smaller assets, it's mostly pipes, divided roughly half and half between concrete and galvanized pipes. These pipes are slowly being replaced by plastic, since they are easier to maintain, cleaner and cheaper. The county does maintain an inventory of their assets, which includes Asset ID, Dates of Construction/Repair and Material information. It's all in a spreadsheet and no GIS data to go along with it. Fannin County does not regularly inspect their smaller assets. It was indicated on the survey that Fannin county does maintain a database of condition ratings for their small assets, so a follow up on that will be needed. Fannin County says they have pedestrian bridges but do not inspect them. They do have a list of maintenance activities, which includes all the information asked about on the survey, except for Asset ID and Owner Information. In order to update the list, the county will need 24 months. Of the common maintenance activities for smaller assets, Fannin County cited erosion control, corrosion control, and blockages within the pipe. The budget used for the smaller assets is the same $50,000 set aside for all transportation assets. Fannin County feels very confident regarding their ability to obtain funds, resources and knowledge in order to adequately perform management and maintenance of these smaller assets. The biggest challenges they face is getting more staff, and from there to train those staff to inspect the assets. Finally, Mr. Ratcliff wished to say that his wife works for the UGA extension and that he may be a source of contact regarding plastic pipes.

Fayette County

Fayette County represents a county just to the south of Urban Atlanta and includes the city of Peachtree City. For large bridges and culverts, Fayette County does not have a written plan. In terms of how the larger assets are managed, the county contact mentioned getting a sales call from a software company, Grationsmith, however it does not seem that went very far. He noted that GDOT letters have changed over time to become shorter and include mostly listing repairs and inspection items. Like many other counties, Fayette county relies a large amount on GDOT for sizable bridges (81%) while not relying on them as much for sizable culverts (15%). Fayette has said they've had a great experience with GDOT and they've been able to get funding from GDOT and Appalachian Regional Commission (ARC) in order to take care of bridge projects. They do not maintain a list of maintenance activities for these bridges. Overall, the approach to maintenance is a reactive approach outside of vegetation control. For common maintenance items regarding larger bridges and culverts, the county contact referred us to his road department staff, who said that brush/tree cutting, erosion control, repair of existing guardrail and bridge joint sealing were the most common. Fayette County does set aside a budget for larger bridges and assets, which is roughly $50,000. The funding comes from three major sources: SPLOST, LMIG and General county funding. Regarding how Fayette County feels about their funding, resources and knowledge for maintaining bridges, they feel better about those items than most counties who have responded, rating each item 5, 7, and 5, respectively. The county does not have access to InspectX. The biggest challenge cited for Fayette County is staffing issues/vacancies. They have an engineer on staff and have the equipment they need. However, any structural engineering problems must be contracted out since they do not have a structural engineer on staff.

For smaller bridges/culverts/pipes, Fayette does not have a written plan for managing and maintaining these assets. The main reason for this is that they have very few bridges not inspected by GDOT. They do allow NPDS to inventory and inspect them every 5 years. Among their assets, the existing drainage structures are corrugated metal. However, a new ordinance says any new replacements must be concrete. For these smaller assets, they do keep an inventory, which includes all items asked about in the survey except for owner information. As mentioned above, they do regularly inspected their assets once every 5 years. They do have a system for condition ratings of smaller assets. When it comes to maintaining a list of maintenance activities for these smaller assets, Fayette county does keep track of that. Just like the larger assets, they keep track of all the items the survey asked for except owner information. The list is up to date and does not require time to compile. When it comes to common maintenance activities for smaller assets, erosion control, blockage within the asset, pipe/channel alignment and scour/stability problems were cited as the most common. The road department provided a detailed list of the number of different types of assets in their county, which can be found below in Table 4 and Table 5 In addition, they noted that the length of all pipe systems was 478,340 ft and the average length of a pipe was 85.85 ft.

Table 4. Number of Pipe Segments by Material Type (Public and Private) in Fayette County

Material Type	**Number of Pipe Segments**
Bituminous Coated Corrugated Metal Pipe	2,752
Corrugated Metal Pipe	1,411
High-Density Polyethylene Pipe	152
PVC	3
Reinforced Concrete Pipe	1,026
Other	123
Unverified	116
Total	5,583

Table 5. Pipe Count by Diameter in Fayette County

Pipe Diameter (in)	Number of Pipe Segments
96	8
84	10
72	37
60	50
54	28
48	145
42	152
36	475
30	572
24	1,267
18	2,393
15	235
12	20
Other	59
Total	5,451

For the small assets, Fayette County sets aside $200,000 per year to handle emergencies and SPLOST can be used to handle pre-identified problems. This funding comes from SPLOST and County-based funding. Overall, Fayette County feels very good about their resources and knowledge to handle this, rating both a 9 out of 10. For funding, they feel less prepared for, giving that statement a 5 out of 10. In terms of final thoughts, the county contact wanted the team to know he saw GDOT as a "wonderful asset", both in terms of their technical skill and their knowledge sharing. He also wanted to comment on the LMIG program. He says the program is a great asset due to the fact that there's very few string attached and can be used for emergency situations. He believes that increasing the LMIG budget would go a long way to helping counties.

Franklin County

Franklin County represents a county along the Georgia-South Carolina border, to the north east of Athens, GAFor larger assets, they do not have a written management plan, and primarily rely on GDOT for inspection, which can be seen in their 90% reliance score they have for both larger bridges and culverts. They do not maintain a list of maintenance activities for their larger bridges/culverts. Of the activities, the most common ones cited were culvert repair, deck repair , brush/tree cutting, and erosion control. Franklin County does not have a set aside budget for these larger bridges/culverts. For funding, they use SPLOST, LMIG and LIBP. Similar to other counties, Franklin County does not feel good about their funding and resources for the larger bridges, as indicated by their 3 out of 10 score for each. They do feel good about their knowledge, giving it a 7 out of 10 score. Franklin County does not have access to InspectX. The most commonly cited problems, as with other counties, is funding and staffing shortages.

For smaller assets, Franklin county does not have a written plan for them either. Inspections are performed by Public Works staff whenever they're doing road maintenance activities. Among the small assets, Franklin includes corrugated pipes, concrete box culverts, wood deck bridges and concrete deck bridges. They do not keep a database to inventory their smaller assets, and their Public Works Director is in charge of managing them. They do regularly inspect their assets every 5 years. Franklin county does not keep track of condition ratings for their assets and do not have and pedestrian bridges in their jurisdiction. They do not keep track of their maintenance activities for these smaller assets either. If they did begin to compile one, it would include all the information asked about on the survey except for the date of construction and it would take about 1 year to compile the information. Of the common maintenance activities for the smaller assets, the most common were brush/tree cutting, erosion control, deformation/damage repair of metal assets, corrosion control of metal assets and blockage within the culvert or pipe. If they were to compile a list, they would be willing to share it with the research team. Franklin County does not set aside a budget for their small assets. Their funding comes from pieces of SPLOST, LMIG and county-based funding. Regarding how the county felt about the resources, funding and knowledge to maintain their small assets, they felt the same as their larger assets. However, they feel better about their resources on small assets. Once again, funding was named as the chief problem faced by the county.

Glascock County

Glascock County represents a county in eastern Georgia to the southwest of August, GA. For larger bridges and culverts, Glascock County does not have a written management plan. The way these assets are managed is that the county hires contractor for large projects and for smaller projects where you have the equipment and you can take care of them in house. In terms of how dependent Glascock county feels on GDOT, they said they were 70% for larger bridges and 60% for larger culverts. The county team does keep a list of maintenance activities performed on larger assets on a paperlog, however the list only includes the Asset ID, the date of maintenance, and the maintenance activity performed. Of the common maintenance activities cited, the most common were once again erosion control, and brush/tree cutting. They claim to not have had anything major the last three years outside of one culvert washing out due to aging. The county does set aside a budget for the road department (roughly $100,000), but nothing set aside specifically for bridges. For their funding options, Glascock county uses the usual options in SPLOST and LMIG, however they also have a TSPLOST program. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, the county gave all three a 2 out of 10, showing a gap at all three. Glascock County does not have access to InspectX. One thing the county contact argued for was increased training regarding reading the letter from GDOT regarding inspections. Specifically, how to understand some of the jargon.

For smaller bridges/culverts/pipes, there is no written management plan for Glascock County. The management system is that they regularly go out and check them roughly every 6 months or when it heavily rains. Among the assets about 75% are concrete, 10% are metal, and 15% are plastic. Newer pipes are plastic and are mostly driveway pipes. If it’s a large pipe, they go metal. The diameters of the pipe are between 48in and 30ft, so a wide variety. Glascock County does not maintain an inventory of these assets. They do not maintain a database of condition ratings for their smaller assets and do not have any pedestrian bridges. The county team does keep track of all maintenance activities for their smaller assets. This database is paper log and only includes date of maintenance and the activity performed. It would take about 2 years to convert this to a comprehensive list. Of the common maintenance items, the common ones cited were brush/tree cutting, erosion control, and join repair. Once they have this list together, they’d be willing to share it with the research team. The funding budget is the same budget as described above. Regarding how they feel about their funding, resources and knowledge to perform their small transportation asset management, they feel equal to all of them, however they feel better about them than they do for larger bridges and culverts, indicating a 5 out of a 10.

Glynn County

Glynn County is a medium-to-large county located in southeast Georgia and is south of the Savannah metropolitan area. Its largest city is Brunswick, GA. For larger bridge assets, Glynn County does not have a written asset management plan. The county contact stated they preferred to not have a written plan because its standards could be used against you. They rely on the inspection reports for GDOT and indicated a 100% reliance score on GDOT, especially for repairs or grants. The county does maintain a list of the maintenance activities through a work order system. When it comes to the common maintenance activities, the county contact stated that the options listed in the survey are mostly equal, however, they do no typically do scour, pile or painting. The county does not set aside an annual budget for these activities, instead relying on capital funding opportunities. Other places where funding comes from include SPLOST, LMIG, and LIBP. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, the overall feeling is neutral. They gave all three categories a confidence score of 5. The county does not have access to InspectX. Some final thoughts on larger assets from the county contact include a desire to see who his county’s bridges are doing condition-wise compared to other counties. He would also like to see resources to help him determine how likely his bridge projects will be approved for funding by different funding opportunities.

For smaller assets, there is also not a written asset management plan in Glynn County. The county is divided into 4 district and each district is in charge of its assets. The county has between 5,000 and 7,500 assets, ranging in diameter from 12in to 60in and ranging in length from 30ft to 100ft. The assets are roughly a 80/20 split between concrete and metal assets. The county avoids metal assets, as corrosion is more common because of the salt marshes. The county does use a GIS database to inventory their assets, which includes all the information asked about in the survey excluding ownership and condition ratings. The county does inspect their assets regularly. They inspect larger assets at least twice a year and they inspect smaller pipes when visiting sites. The county does not have a condition rating system. The county does not document or list the repairs done on assets, but does document replacements. To fully inventory the assets would take about 2-3 years. Common maintenance activities includes brush and tree cutting, blockages, erosion control, settlement/rotation control, and scour. The county does have a set aside budget for these assets, roughly $200,000 for repairs, maintenance and equipment, with an additional $4,000 for erosion control materials. The funds come from general county funds with SPLOST dollars set aside for special projects. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for smaller assets, the confidence varies with each category. Resources were given the lowest confidence score of 3. Funds were given a more neutral score of 5, while knowledge had the highest score of 8. The county contact would like to see resources that aid in the acquirement of equipment such as excavators and dump trucks.

Haralson County

Haralson County is a low-to-medium sized county located in northwest Georgia along the western border next to Alabama. Its largest city is Bremen, GA. When it comes to larger bridges and culverts, Haralson County does not have a written asset management plan. Overall, the county tries to minimize obstruction, prioritizing projects that could result in roads being closed. Some preventative maintenance has been performed by the county in the past, however the funding has not been able to keep up. Haralson County indicated a total reliance on GDOT for the management and maintenance of their local bridges, giving a 100% reliance score for both larger bridges and culverts. Haralson county does not keep a list of the maintenance activities they perform on the bridges, instead relying on GDOT to keep track of that information. Common maintenance activities for their bridges include pile replacement, brush and tree cutting, approach sealing, and erosion control. Haralson County does set aside a separate budget for the maintenance and management of their local large bridges and culverts, however the county contact elected not to share a number for the budget, as it varies greatly each year. In terms of where the funding for this budget comes from, LMIG was cited as the greatest source, since its funding is flexible, along with supplementary funding from TSPLOST and SPLOST. When asked about how the county feels in terms of its funding, resources and knowledge to adequately perform their asset management and maintenance for larger assets, Haralson County was overall not confident. For funds and resources, each was given a confidence score of 1. Knowledge was slightly better, with a confidence score of 4. Haralson County does have access to the InspectX program, but the county contact stated it was easier to view things in a paper copy. The contact also reiterated that more funding opportunities is the best resource they could currently receive.

For smaller assets, there is no written plan for maintaining small bridges/culverts/pipes. The county staff is confident in the fact they know where their assets are located. They type of assets in the county are roughly split 50/50 between concrete and metal assets, with the size varying. The county does not keep a list or inventory of their smaller assets. They keep track of the assets through informal inspections, conducted by the road supervisors. The county also does not apply condition ratings to their assets. To keep track of their maintenance activities, the county is mostly reliant on a paper work order system. Common maintenance activities conducted by the staff include brush and tree cutting, erosion control, scour and stability problems, and blockages within the pipes. Haralson County does keep a separate budget for maintaining these assets, which is roughly 10% of the Public Works total budget. This funding mostly comes from LMIG and the general county budget. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, the confidence scores were still overall low. Funds and resources were given a 3 as their confidence score, and knowledge was given a 4. When it comes to their biggest challenges, fixed salary and personnel were cited as so.

Irwin County

Irwin County is a county in central South Georgia and represents a smaller population county with no major cities in its jurisdiction. When it comes to larger bridges and culverts, Irwin County does not have a written asset management plan. Overall, the county gets a letter from GDOT every two years. Usually 1-2 bridges need to be addressed. Last 3 years have had nothing major outside of spraying guiderails. If it’s a bigger repair, the county finds a contractor to repair the bridge. Irwin County indicated a heavy dependence on GDOT for large bridges (80%) and large culverts (50%). The county does not keep a database for the maintenance activities performed on the larger assets, just paper documentation. Of the common maintenance activities the county performs on larger assets, brush/tree cutting, bridge curb/rail repair and rail spray painting were listed as the most common. Irwin County does not set aside a separate budget for these assets. The funding source did not meet any of the options listed on the survey and was simply described as “needs-based.” When asked about how the county feels about the funding, resources, and knowledge to adequately perform their maintenance plan, Irwin County bucks the trend we've seen with other counties. While typically it's been seen the confidence around funding and resources on the lower end, Irwin County gave both a 6 out of 10. Bucking another trend, the lowest rated item was the knowledge to perform the plan. Typically, this is the highest rated item over funding and resources. Irwin County does not have access to InspectX. The biggest challenge cited by the county is similar to others, which is manpower and equipment.

For smaller assets, there is no written plan for maintaining small bridges/culverts/pipes. Mr. Wallace says he knows how to take care of the assets, but he needs to consistently contract out the work due to manpower. In the county, there are roughly 500 pipes, about 90% of them are concrete. Most are up to 2 ft in diameter and up to 40 ft long. They don't have a database inventorying these assets. Mr. Wallace just has a paper copy documents and update it every couple of months. They don't regularly inspect the small assets or keep condition ratings for them. Irwin County does not have any pedestrian bridges. Irwin County does not have a database of maintenance activities performed on these assets, either. The common maintenances for smaller assets in Irwin County include joint repair, brush/tree cutting, and blockages within the culvert or pipe. The county does set aside a budget and it can be anywhere from $10,000 to $25,000 and comes from the same sources as the larger assets. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, all three were given a high rating of 8 out of 10. Final thoughts from Mr. Wallace included reiterating manpower is a major problem and that more knowledge on repairing bridges would be appropriate.

Jasper County

Jasper County is a small county to the south east of Atlanta and does not contain any major cities in its jurisdiction. Jasper County does not have a written management plan for larger bridges and culverts. When they get a letter from GDOT, they attempt to address smaller items and larger items they contract out. Due to being a small county, Jasper doesn't have enough larger assets to be truly dependent on GDOT for those projects. Their system of contracting out larger items works well for them. This showed when they only gave a 15% dependency rating on GDOT for larger bridges and 0% for larger culverts. They do maintain a list of maintenance items for their larger assets. These are in the form of work orders which only contain the dates of maintenance and the maintenances activity performed. Jasper County has indicated they do not wish to share their work orders with us. The common maintenance items for larger assets are listed as brush/tree cutting, maintaining road surfaces on dirt roads and resurfacing. The county does not set aside a separate budget for the management of these larger assets. The funding for this comes from general county funding, no specific program. When it comes to how the county feels about their funds, resources or knowledge to adequately perform this management and maintenance, Jasper County shows a low confidence rating for all three as all three were rated 2/10. The county does not have access to InspectX. When it comes to the challenges Jasper County faces, manpower is a primary one. The county staff has only 23 people and only 2-3 people on bridges. It's difficult to keep up with their desire to visually inspect their assets quarterly. It was also cited that the county needs equipment like excavators and graters.

For smaller assets such as culverts and cross-road pipes, Jasper County does not have a written management plan for those either. Mostly their system is based around work-order systems, and when that is slow, that's when they can go out and visually inspect themselves for problems. The makeup of the type of their assets is as follows. They have roughly 3,000 assets, mostly metal and plastic. They don't use concrete because is takes more labor and its more expensive. They don't have any timber bridges not inspected by GDOT, nor do they have pedestrian bridges. They say they keep an inventory of their assets, but they just cite their work orders, so it’s unclear how that works as an inventory system. They do keep a list of maintenance items, but will not say what information is kept on them, only that it is a work order on a small software system. The county does not regularly inspect their smaller assets and does not have a condition rating system. Common maintenance activities include the usual suspects of tree/brush cutting and blockage within the pipe or culvert. They said they would be willing to share their database of maintenance activities with the UGA research team for smaller assets. Regarding budget, the county does set aside money for the smaller assets, roughly $20,000, which comes from the general county fund and not any specific program. When it comes to how the county feels about its fund, resources, and knowledge to perform maintenance on smaller assets, Jasper County is very confident in its resources and knowledge, giving each a rating of 8 and 9 respectively. Funding is still a place of low confidence, as they gave that a rating of 3. When it comes to challenges, manpower and funds once again were cited. Specifically, the county contact would like to see more state funds. Per final comments, the county contact indicated that he looks forward to seeing more training and knowledge sharing among the different counties. Specifically, he is looking forward to finding out what contractors counties use.

Jeff Davis County

Jeff Davis County is a smaller county in the middle of south-east Georgia, of which its largest city is Hazlehurst, Georgia. For larger bridges and culverts, the county does not have a written management plan for it. Like many counties, the assets are managed and maintained on a need based system. When it comes to dependency on GDOT, the county indicated a 100% dependency on GDOT, with a 40% dependency on larger culverts. The county does not maintain a list of maintenance activities for the larger assets. The county contact says he maintains his own list, but there is not comprehensive list. He said he'd be willing to share his list with the research team. When it comes to the common maintenances activities for larger assets, the most cited were brush/tree cutting, culvert repair, and deck repair. He wanted to note that deck repair happens rarely in the last 3-4 years. They have two bridges to replace by GDOT, but haven't back on it. The county does set aside a budget each year of about $50,000-100,000 to maintain the areas around. As to where the funding is coming from, Mr. Bush says that SPLOST sounds the most familiar to him. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the county bucks the trends of other counties. The highest confidence rating they gave was for funding, which was a 7. Most counties have their lowest rating as the funding. Meanwhile, they gave the resources and knowledge a much lower rating of 2 each. The county does not have access to InspectX. When it comes to the biggest challenges for larger assets, cutting trees and branches under bridges was cited. However the more interesting information came when they indicated that the county has no idea when GDOT is going to come out and work on their bridges. Communication seems to be an issue. Mr. Bush says he looks forward to future knowledge sharing and training.

For smaller assets, there is no written management plan. However, it is expected that the county goes out and inspect them all at least once a year. The types of smaller assets in the county are as follows: mostly metal pipesm 15in-72inches in diameter and 30-60ft in length. Recently the county replaced concrete pipes on major highways with metal pipes. There are no timber assets. There are around 1,000 pipes, which are mostly metal, with a few concrete pipes from the past. They do not have any pedestrian bridges in the area. The county does not maintain an inventory of the assets. Instead they "just know where they are." There are a total of 8 people traveling in 2-4 teams. They inspect each asset at least once a year. The county does not have a condition rating system for the smaller assets and culverts. They do maintain a list of maintenance activities for the smaller assets. The list includes location information, geometric information, date of maintenances, material information, maintenance activity. These are kept on work orders. It would take about 12 months to compile all the assets. The most common maintenance activities include activities found common with other counties: brush/tree cutting, erosion control, scour/stability, and blockage within the pipe. The county has said they'd be willing to share their maintenance item list with the research team. For funding, the county does set aside a budget of $50,000 a year to handle the smaller assets. The funding comes from the general county fund. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the county overall feels good. They gave funding, resources and knowledge scores of 6, 6, and 7 respectively. The county contact says he looks forward to hearing what other counties do and that he would love information on where to get equipment for projects. As with other counties, one of larger problems continues to just be funding and manpower. He would also like to see improved communication from GDOT, who he says they have not heard from in 6 months.

Johnson County

Johnson County is a small county of just 9,980 people in the middle Georgia region. As expected by this point, there is no written management plan for larger bridges and culverts. As is common, small jobs are done in house, while larger ones are contracted out. Johnson County feels very dependent on GDOT for these larger assets, as they gave larger bridges an 80% dependency score, and larger culverts a 70% dependency score. They do not keep track of maintenance items for the larger assets. Instead, they rely on 2 guys twice a weeks to visually inspect and look for debris. The common maintenance items include brush/tree cutting, deck repair, and culvert repair. The county does have a set aside budget of $700,000. However, given the size of the county, that number is skeptical or indicates a larger budget of which the maintenance is included. The funding mostly comes from SPLOST and TSPLOST programs. The county is consistent with that funding number, though, in their confidence score of their funding. The give their funding a confidence score of 5, higher than resources or knowledge. Their confidence in their knowledge to maintain the larger assets is their lowest score, at 2. This indicates they have great need for training and knowledge sharing between counties. The county does not have access to InspectX. Some additional comments from the county contact include his desire to be able to ask more questions to GDOT about Inspection results and the desire to be able to access more equipment.

For smaller assets like culverts and cross-road pipes, Johnson County does not have a written management plan. Instead, they rely heavily on the grass cutters to report problems to the county. The cutters usually touch up and check on each asset roughly every two months, especially during the summer. The makeup of the assets in Johnson County include the following: they have mostly pipes of varying sizes from 18in to 36in. On dirt roads, they've begun the process of replacing concrete pipes with coated metal ones, as they are easier to work with and don't have the joint separation issues that come with concrete or cement pipes. The county does not have an pedestrian bridges. The county does have some timber bridges that are not inspected by GDOT. The county does keep a paper list of all the assets, which includes location information, dates of construction/repair, and material information. The county does not regularly inspect the assets outside of their grass cutters as discussed above. They do keep a paper list of their maintenance activities performed on smaller assets. This list includes the geometric information of the asset, the date of maintenance, the material information and the maintenance activity. It will take about 2 years to make a complete list in one place. The common maintenance activities for smaller assets in Johnson County are similar to other counties. However, the county contact wanted to note for other counties that they should place soil/gravel and rye seeds to keep soil together. They spread hay, which helps to keep the moisture and makes the seeds grow faster. Regarding budgeting, Johnson County does set aside money for maintaining these smaller assets. The amount is estimated to be roughly $50,000. As to where the funding is coming from, SPLOST and County general funding were cited, although the county contact couldn't recall whether or not Johnson County used TSPLOST. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the confidence scores are what we expect. Low confidence scores for funding and resources (both were given a 2) and a higher score for their knowledge, of which Johnson County indicated a 7. Final comments from the county contact included the excitement to see more training, and learning about what other counties do. He'd love to see more man power and equipment for his crew, as he is 3 men short and missing equipment such as solder cutters, dump trucks and more grass cutters. Lastly, he wants more training on major bridge projects. Specifically, he wants more information on the process GDOT goes through when dealing with county bridges. He also wants to hear directly from GDOT the best practices counties can do to make the process easier.

Lamar County

Lamar County is a low-to-medium sized population county located outside and to the south of the Atlanta metropolitan area. Its largest city is Barnesville. When it comes to larger assets, Lamar County does not have a written asset management plan. The county relies on the inspection letters sent out by GDOT and gives a 50% reliance score for how often they rely on GDOT to help get the items done. The county does maintain a list of the maintenance items they conduct, which includes all the information asked about in the survey outside of owner information. The software they use is called Facility Dude and they've been using it since 2014. Its very similar to a work-order system. Common maintenance activities for larger assets in Lamar County include brush and tree cutting, erosion control, crack sealing, pile replacement, and undersealing of approach slabs. The county does not set aside an annual budget for these activities, but they are funded primarily through SPLOST and TSPLOST, with some use of LMIG. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, Lamar is another interesting case where their funding confidence score is the highest at 5 out of ten. Meanwhile, their resource confidence score is 1 and knowledge confidence score is 2. The county is in the process of obtaining access to the InspectX program. When it comes to their biggest challenges, the contact with Lamar county stated that filling vacancies in labor is difficult, as there are few interested in the wage they are offering for the work.

For smaller assets such as culverts and cross-road pipes, Lamar County also doesn’t have a written asset management plan. The county is confident in their ability to locate the assets by memory, despite not having a list or mapped inventory. The makeup of the type of assets within the county are about a 90/10 split between metal and plastic pipes. Anything less than 4 feet in diameter is plastic and most pipes are about 20 feet in length. The county uses their work order system to double as their inventory, but it mostly serves to keep track of maintenance history. They do not regularly inspect their assets and do not use condition ratings. Common maintenance items for these smaller assets include brush and tree cutting, erosion control, corrosion, and blockages within the pipe. The county receives a $20,000 budget to provide these services, which mostly comes from SPLOST and the county general fund. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, there was variety in their scores. Knowledge was given a confidence score of 7, while funds and resources were given lower scores of 4 and 3, respectively. The county contact once again reiterated the issues with hiring skilled laborers to conduct these services. In addition, the contact spoke on the cost to replace a pipe increasing by 3 times in recent years. This increase in cost to replace pipes has made him more interested in preventative maintenance systems and practices.

Lee County

Lee County is a mid-to-small sized county in southwest Georgia just to the north of Albany with a population of about 28,000 residents. For larger bridges and culverts, Lee county does not have a written asset management plan. They have only two bypass bridges on state routes, which are maintained on reactive process whenever a need arises. They indicate a large reliance on GDOT for these larger bridges, giving a 100% reliance score. Culverts they have far less reliance on GDOT for, giving only a 20% reliance score. Any larger items of maintenance are contracted out. Overall the county does not have a lot to maintain, since 217 miles of their roads are dirt. The rest of the roads are about 50/50 paved/unpaved. The county does maintain a list of maintenance activities for these larger assets, however the information kept on this list is limited. The system is a work-order system that only includes information like date of maintenance, material information and the maintenance activity. The location information included is limited, as they only list what road is going over the asset. The maintenance activities seen are the common ones seen with other counties: brush/tree cutting and erosion control. The county does not set aside a budget for these larger assets and the funding comes mostly from SPLOST, TSPLOST and LMIG. When it comes to how Lee County views its ability to have the funds, resources and knowledge to adequately maintain these larger bridges, the county gave the funds a score of 4 out of 10, which was the highest score. For resources and knowledge, he gave a 1 out of 10. This is interesting because usually these scores are flipped, relatively. This could indicate that Lee County has the funds they need because they have so few larger assets, but they aren’t sure what the process of repair and maintenance actually looks like because of their heavy reliance on GDOT and contractors they work with. Lee County does not have access to InspectX. Their biggest challenges is looking for more staff (only 2 people on the county staff work on bridges) and finding more equipment.

For smaller assets, Lee county also does not have a written management plan for them either. There is no set schedule of inspection. They just go out when it has rained a lot recently and address issues on a needs basis. As to what type of assets the county has, they have mostly plastic pipes (roughly 3,000-4,000), typically 24 ft long and ranging in diameter from 18in to 36in. The reason for using so many pipes is how cheap and easy they are to deal with. The county does not have any timber bridges or pedestrian bridges. The county contact noted that the supply chain issues and the price of sand/gravel going up has made their job more difficult. Lee County does not keep a list of all their smaller assets. However, the county contact said that he's interested in starting a list. The staff does not keep track of condition ratings for their assets either. Similar to the larger assets, Lee County maintains a list of maintenance activities, although this is once again in the form of work orders. For common maintenance activities, the county did not mention any of the common ones we've seen with other counties, but focuses on controlled burning of pipes. Unlike the larger assets, the county does set aside an annual budget for these smaller assets. This is roughly $25,000. The funding for this mostly comes from the county general fund, with SPLOST dollars being mostly reserved for resurfacing projects rather than culverts and the like. Overall, Lee County feels very confident regarding their ability to fund, find resources and have knowledge to maintain their smaller assets, giving each a 10, 8 and 9 out of 10 on the survey. The biggest challenges the county faces is continuing to find funding sources and manpower. Specifically, the county contact says he's been with Lee County for roughly 18 months and has challenges regarding hiring and training new staff all the time, because he can’t retain anyone for long. This is either because they moved on or because they couldn’t be kept because of the limited budget.

Lowndes County

Lowndes County is located on the southern border of Georgia and is home to Valdosta, one of the largest cities in southern Georgia. For larger assets such as bridges and large culverts, there is no written asset management plan. The county address items recommended in a letter by GDOT and do monthly in-house maintenance in order to minimize repairs. Lowndes County surprisingly indicated little reliance on GDOT, giving only a 10% reliance score for larger bridges and 0% for larger culverts. During their monthly inspection, a team of about 12 people cut the grass around the assets and use the time to inspect their assets. The county does maintain a list of maintenance activities for the larger assets and includes all the information asked about in the survey except for owner information. It even includes other information the survey did not ask about, including listing what resources were used and the cost of the maintenance activity. The county would be willing to share this list with the UGA research team. As for common maintenance activities for larger assets, the usual suspect of brush/tree cutting is there, while items such as culvert repair, erosion control, bridge painting and bridge joint sealing were cited as less common practices, but done enough to be notable. They also wanted to mention that clearing graffiti was a relatively common item to address. The county does set aside an annual budget for maintaining these larger assets, which is roughly $100,000 directed towards bridge repairs. The total repair budget is said to be $10 million but includes everything such as roads, patches, etc. For larger bridge projects, the funding comes from TSPLOST, but all general maintenance comes from county taxes. Overall, Lowndes County feels great about their ability to obtain the funds, resources and knowledge they need to adequately keep up with their larger assets. They gave all three categories a confidence score of 8 out of 10. The county does have access to InspectX, which helps get up to date information on their bridges quickly. As far as challenges, more man power and equipment were once again cited.

For smaller assets such as smaller culverts and cross-road pipes, there is no written asset management plan. Twice a year, maintenance crews make a visual inspection while performing smaller maintenance activities. As to the type of assets Lowndes County has, they only have concrete pipes. The reason for this is that steel pipes do not hold up and they have an ordinance requiring concrete pipes. They have roughly 3,000 pipes, which range from 18-24in in diameter and 23ft to 40ft long. They do not have any pedestrian bridges or timber bridges. The county does keep an inventory of all their assets, which includes all the items mentioned before except for a condition rating system. The database for their larger assets and smaller assets are one and the same, created on a software called Lucity. As mentioned before, the county does make regular inspections every 6 months. Lowndes County does maintain a list of their maintenance activities for smaller assets, which includes all the information the survey asks about except for geometric information and owner information. They also use the Lucity software to manage this as well. To have a completely up to date system, it would take roughly 1 year. Common maintenance activities for smaller assets include the usual suspects for brush/tree cutting and erosion control, as well as scour/stability problems and blockage within the pipe. Joint repair was also listed as a notable, but less common maintenance item. The county has indicated they'd be willing to share their lists with the UGA research team. For funding and budgets, about 60% of the total $10 million general county fund is set aside for smaller maintenance, which is one of the largest budgets reported so far. Once again, Lowndes County feels great about their ability to obtain the funds, resources and knowledge they need to adequately keep up with their smaller assets. They gave all three categories a confidence score of 8 out of 10. In addition to once again citing labor and equipment as problems, The county contact indicated that the growing population of Lowndes County and Valdosta made for more challenges. She also mentioned that the main issue in the last year has been availability of materials.

Miller County

Miller County is a low-population county located near the southwestern corner of Georgia. Its largest city is Colquitt, GA. When it comes to larger bridge and culvert assets, Miller County does not have a written asset management plan. The county is heavily dependent on the GDOT letter telling them the maintenance activities to be performed and works closely with a representative at the GDOT office in Dawsonville to take care of the items. Miller's reliance scores were among the lowest of the counties surveyed, only indicating a 50% reliance score for both bridges and larger culverts. The county contact stated that the county has a software program that gives the list of activities to be done, as well as the activities done on assets within the past 5 years. He also stated that improving their system has been difficult, as most of the county's transportation budget has gone towards paving dirt roads. Among the common repair activities for bridges in Miller County are erosion control, brush and tree cutting, and undersealing of approach slabs. Miller County does not have an annual budget for maintaining their bridges, but they are proficient at securing funds for projects as needed, especially from SPLOST, TSPLOST and state-based funding programs. Overall, Miller County feels great about their ability to obtain the funds, resources and knowledge they need to adequately keep up with their larger assets. They gave all three categories a confidence score of 8 out of 10. The county does not have access to InspectX. Miller County cites its success and confidence when it comes to maintaining bridges in its jurisdiction to their ability to know who to contact for information that isn't presently known among county staff members. They also stated that GDOT has been more willing to help because Miller County has looked to do a lot of the work themselves, rather than dealing with contractors.

For smaller assets, such as culverts and cross-road pipes, Miller County does not have a written asset management plan for such assets. The county is confident in their ability to locate where their assets are by memory, especially the assets who are repeatably problems. The county has an 80/20 split between metal and concrete assets. The county has been moving towards only metal pipes, as concrete pipes are difficult to handle and shift more in the sandy soil of the region. Miller County does not keep a list of their assets, but relies on their in-house software, just like for the bridge assets. The staff does regularly inspect the assets once a year, but it is not a formal process by their own words. These regular inspections are for the assets with repeat problems. They do not have condition ratings to go along with these assets. The county does keep track of their maintenance activities for these assets through their software and includes all the information asked about in the survey. The staff is heavily reliant on the motor grader crews to spot issues with assets that aren't available in their software. Common issues that require maintenance for these assets include blockages within the pipes, corrosion, and joint separation. The county does have a set aside budget specifically for purchasing new pipes in replacement projects, which is roughly $2000-$4000 annually. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, Miller county feels very confident in their knowledge, giving it a 9 as a confidence score. However, they're less confident in their resources and funding, giving both a 4 out of 10. When it comes to common challenges, rising costs of operating has made things difficult in Miller County. The cost of motor graders has increased 3 times, and pipes are almost 5 times in cost. This, as well as increased waiting lists for pipes and materials, has forced the county to plan ahead more in their projects. Lastly, the county contact wished to point out that part of their success is owed to the relationships Miller County has built with neighboring counties and encourages other counties to do the same.

Newton County

Newton County is a medium-to-large county located in the southeast portion of the Atlanta metropolitan area. Its largest city is Covington, GA. When it comes to larger assets, there is no written asset management plan in Newton County. The overall strategy is based on the GDOT inspection reports every two years. The county will then decide what can be done in house and what can be contracted out or work directly with GDOT for help. This is reflected in the 70% self-reported reliance score. The county does not keep a list of their maintenance activities, rather simply maintaining contracts and documents for their projects. Common maintenance activities for larger bridges include brush and tree cutting, approach undersealing, repair of guardrail, and bridge curb repair. The county is able to set aside an annual budget of $500,000, of which bridge activities are a small portion. This funding comes mostly from SPLOST, The Atlanta Regional Commission (ARC), LIBP, and LMIG. . When it comes to how Newton County views its ability to have the funds, resources and knowledge to adequately maintain these larger assets, they are overall positive. Funding was given the lowest confidence score at 6, but knowledge and resources were given higher scores at 8 and 9 respectively. The county does not have access to InspectX. The county contact seemed most interested in opportunities for additional training, especially in small maintenance type items, so that more can be done in house by the county staff.

For smaller assets such as culverts and cross-road pipes, Newton County does not have a written asset management plan for them. Newton county is a mostly urbanized county, therefore its inspection standards are that of MS4 guidelines, meaning they have 3-4 in house drainage crew members go around and inspect assets, looking to reach each asset at least once every 5 years. The county has roughly 2,000 assets that are kept in an inventory on a GIS database. It is about a 50/50 split between concrete and metal assets. Concrete is the county's first choice, but it is difficult to install. If a pipe is greater than 36in, they move towards metal and HDPE pipes. The diameters for all assets range from 18in to 84in and the length ranges in 40-60ft. The county does use a condition rating system for its assets. The county does keep track of its maintenance activities through the same GIS software as its inventory. Common maintenance items for smaller assets in Newton County include brush and tree cutting, blockages within the pipes, and joint separation. The county does set aside an annual budget of roughly $100,000 which is funding through SPLOST and the general county fund. When it comes to how Newton County views its ability to have the funds, resources and knowledge to adequately maintain these smaller assets, they are overall neutral to positive. Both funds and resources were given neutral scores of 5, while knowledge was given a 7 out of 10. When it comes to the biggest challenges regarding the management and maintenance of these assets, the sheer number of assets was cited. In addition, corrugated metal pipes have become an issue for the county, as they only last around 20 years and currently around 30% of the county's corrugated metal pipes need to be replaced.

Oconee County

Oconee County is one of the three counties that make up the Athens, Georgia area and is located in the northeast portion of Georgia. When it comes to their larger assets, there is no written management plan. They use the inspection reports given to them by GDOT to make a decision as to how to proceed next. Despite this, the county does not indicate a large reliance on GDOT, giving a 20% reliance score for both larger bridges and culverts. When the county receives the letter, they call the bridge inspectors to clarify any questions from the reports. GDOT 100% takes care of any bridge replacement projects. The county is responsible for smaller projects. If an item requires immediate attention, it is directed to the city of which is responsible. For larger projects, such as culvert repairs, headwalls and bridge repairs, those are typically contracted out. The county does maintain a list of maintenance activities for larger assets, however these come in the form of work orders. They include information such as the location, date of maintenance, material information, and maintenance activities. This is all done on an in-house developed software. The county would be willing to share this information with the UGA research team. As far as common maintenance items for larger assets are concerned, brush/tree cutting, erosion control and culvert repair, once again show up as top options. A few less common items compared to other counties that are listed as common for Oconee include repair of existing guardrail and deck repair. The county does set aside a budget for larger bridges, to the tune of roughly $50,000. The funds are mostly from the general county fund, however LMIG is used for larger bridge projects and SPLOST can be used for culvert replacement, but it must be designated ahead of time. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the scores are overall mid to low, with funds being the lowest score. Funds was given a confidence score of 3, while resources and knowledge were both given a 4 out of 10. Oconee County does not have access to InspectX software. As far as biggest challenges go, funding was once again cited as the major problem. They mentioned that equipment for the most part is adequate, although access to specialty equipment would be appreciated.

For smaller assets, Oconee County does not have a written management plan. Instead, the county is divided into 4 regions and one region each year is inspected. The type of assets in Oconee County include the following: 60% of assets are concrete and 40% are meta pipes. They can range anywhere from 24-36in and 30 to 40 ft in length. The layout of the land determines which is used, since metal pipes don’t have as many joints. The county has two timber bridges, one of which is inspected by GDOT, and no pedestrian bridges. The county does keep a GIS inventory of all their small assets and includes all the information asked about in the survey. The assets are regularly inspected once every 4 years. As mentioned before, the county divides itself into 4 regions and one region gets inspected each year. Thus, it'll be 4 years before the same asset is inspected again. The inspection does include a rating system of 1-10. Michael Weathers and his crew are the ones responsible for the inspections. Oconee County also keeps a list of maintenance items for the smaller assets in the form of work orders. These work orders include all the information asked about in the survey except for owner information. They also, additionally, include the man hours that were required for a maintenance activity. In order to compile a complete list of their assets, Oconee County says it would take only about a month, since they just have to pull it out of the GIS system. Common maintenance activities for the small culverts include debris removal, brush/tree cutting, blockage within the pipe/culvert, deformation of metal pipes, scour/stability problems and erosion control. The county does set aside a budget for maintaining these smaller assets, which is roughly $18,000. This is used to purchase new pipes and placement is done by the in-house road department. This funding comes directly from the general county funds. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they feel very confident. All three categories were given a confidence score of 8 out of 10. A few last comments made by the duo included how much they advocate for preventative rather than reactive maintenance.

Paulding County

Paulding county is a mid-sized county in western Georgia that makes up the western edges of the Atlanta-Metro area and contains the city of Dallas, Georgia. For larger assets such as bridges and large culverts, there is no written management plan. The county indicated a heavy dependence on GDOT, giving large bridges a 70% reliance score and large culverts a 60% reliance score. They do maintain a list of maintenance activities for their larger assets. However, this list is limited in information, as it only includes location information, owner information, dates of maintenance and the maintenance activity. The county has indicated they'd be willing to share the list with the research team. Common maintenance activities cited include brush/tree cutting, erosion control, repair of existing guardrail, and bridge curb/rail repair. Paulding county does not set aside a separate budget for the larger assets and the funds come mostly from general county funds and SPLOST. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the county overall feels neutral, with funds and resources being given a score of 5 and knowledge being given a confidence score at 4. The county does have access to InspectX. When it comes to resources the county wishes it had, they cited an asset management system.

For smaller assets like culverts and cross-road pipes, there is no written asset management plan. The staff has started compiling a database of those assets, however they still mostly use a work order system. The types of assets in Paulding County include a variety of types of pipes and have started using aluminum arch culverts. They do not have any pedestrian bridges. On the list the county is working to compile, the information kept on it includes location information, condition rating, geometric information and material information. The fact that they listed condition rating is interesting because later in the survey they indicated they do not have a condition rating system. If the county dedicated personnel to compiling the list, it would take about 2 years to inspect all the roadways. Paulding does not regular inspect the assets. Paulding does keep a list of maintenance activities, however the information is extremely limited. It only includes the location information of the asset and the maintenance performed, nothing else. The common maintenance activities are the usual suspects: blockage within the pipe, corrosion control, erosion control and brush/tree cutting. The county does not set aside a budget for this maintenance and it comes from the general county fund. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they feel very good. For funds, they gave a 8 out of 10 confidence score while both resources and knowledge were given scores of 7 out of 10. Overall, Paulding County says they wish they had more time and more manpower.

Randolph County

Randolph County is a county in southwest Georgia near the border with Alabama and just to the east of the Walter F. George water reservoir. For larger assets there is no written management plan and decisions are made how to proceed with the letter from GDOT. The county does not use contractors and leaves large bridge projects completely up to GDOT, which is indicated by their 100% reliance score for large bridges. There are only 2-3 people on the staff and thus it’s difficult to cover things in-house. The county contact has been with the county for 36 and hasn’t had to deal with major bridge projects, as GDOT takes care of everything. Randolph County does not keep a list of their maintenance activities for larger assets, but the county contact logs a list himself and relies heavily on work-orders. He said “I don't get around every bridge but most of them.” The common maintenance activities for larger assets include what has come to be expected: brush/tree cutting, erosion control and sealing cracks on the surface. The county does not set aside a budget for these activities and the county contact is unsure where the money comes from. Says he has heard of SPLOST and TSPLOST, but that the commissioner takes care of all that. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the county overall feels neutral, with all three categories being given a 5 out of 10 confidence score. Randolph County does not have access to InspectX.

When it comes to smaller assets like culverts/cross-road pipes, Randolph County does not have a written management plan for this either. The county staff reportedly go around “everyday” to clean up the assets, including brush/tree cutting. The kind of small assets in the county include mostly 18in-24in pipes around 30 feet long, as well as 72in pipes also around 30 feet long. Older pipes are concrete and newer ones are metal. He is unsure how many the county has. The county does not have an inventory of these assets. The county does not have a list of maintenance activities, but they do have a paper log, which includes information like location, dates of maintenance, and maintenance activities. Its unclear as to how long it would take to inventory all of their assets, as there are so many of them. The common maintenance activities for these smaller assets are what are expected at this point: brush/tree cutting, erosion control, blockage within the pipe, etc. The county does not have a separate budget for these smaller assets and the funding continues to come from the general county fund. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the county overall feels neutral, with all three categories being given a 5 out of 10 confidence score. A few final thoughts from the county contact include the fact that Randolph county has a lot of dirt roads, he could always use more man power and that keeping small pipes clean and unclogged is a common problem.

Richmond County

Richmond County is a county in east Georgia along the border between Georgia and South Carolina. The city of Augusta is the major population center for this region.. The county does not have a written asset management plan for their larger assets. As far as the county is concerned, not having an asset management plan is just standard practice because of how heavily involved GDOT is on the process and how limited resources are in-house. This is reinforced by the 100% reliance score they have on larger bridges. The county use contract services for repairs and if they need to design repairs, they reach out to consultants and contractors. They are currently in the process of building up a list of maintenance activities, which should take 6-12 months depending on how detailed they wish to get on their assets. The information they're adding right now includes asset ID, location, geometric information, dates of maintenances/repair and maintenance activity. This is all done on an asset management program (GIS platform) purchased by the county. The common maintenance activities reported by the county for larger assets include brush/tree cutting, erosion control, sealing, culvert repair, etc. The county does not set aside a budget for these larger bridges and the funding comes from SPLOST and LMIG mostly. They mentioned that going for federal funds are too much of a hassle to obtain. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the pattern of funding and resources being the least confident with a higher confidence in knowledge reappears. Funding and resources were given a confidence score of 1 and knowledge a confidence score of 7. A stark difference between the two. The county does not have access to InspectX. When it comes to challenges and resources the county needs, more funding is needed and training on bridge inspection procedures and repair processes are also needed.

For smaller assets in the county, there is not a written management plan for that either. The plan for the assets is entirely reactive and needs-based. Among the assets in the county, one can find 80%+ of them are concrete, ranging from 60in to 72in. Older pipes are metal and the county does not have timber or pedestrian bridges. The county is in the process of compiling an inventory of the smaller assets in the county. The list will include information such as asset ID, location information, geometric information, dates of construction, material information and elevation. It will take roughly 1 year to complete this list. The county does not regularly inspect the assets. As mentioned before, they rely entirely on reactive maintenance. The county does not keep a list or database of the maintenance activities done on these assets, but relies on maintenance work orders. The common maintenance activities are the same common ones found in other counties. The county does not have a separate budget for maintaining these assets. The funding for it comes from mostly SPLOST and a little from LMIG. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the county feels neutral to good. They gave funds a 5 out of 10 confidence score while both resources and knowledge were given 6 out of 10 confidence scores. A few final comments from the county contact include him reiterating the desire for more funding and the desire to see a dashboard that shows other county's activities and the desire to build a map of their assets.

Rockdale County

Rockdale County is a medium-to-large population county located in the southeast portion of the Atlanta metropolitan area. Its largest city is Conyers, GA. For larger bridges and culverts, there is no written asset management plan. Bridge repairs and maintenance are handled on a case by case basis. The county showed heavy reliance on GDOT with a self-reported 80% reliance score. Common maintenance activities include brush and tree cutting, erosion control, repair of existing guardrails, culvert repairs, bridge joint sealing and deck repairs. The county does not have a set aside budget for these activities. It relies on acquiring funding for each project through SPLOST, LMIG or GTIB. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, Rockdale County feels confident in its knowledge, scoring a 7 confidence score, but lacks in its funds and resources, which scored 3 and 2, respectively. The county does not have access to InspectX. The biggest challenges the county still faces are funding and staff.

For smaller assets, there is also no written asset management plan. Most of the assets are steel or concrete. The county does have some pedestrian bridges it inspects. The county does keep an inventory of their assets, which includes all the information asked about in the survey. The county does regularly inspect their assets once every 3 years and does keep a condition rating system for these assets. Unfortunately, the rest of the survey results were incomplete regarding the county's funding sources and confidence in their system.

Spalding County

Spalding County is one of the suburban counties to the south of Atlanta and is included in the Atlanta-Sandy Springs-Roswell, GA Metropolitan Statistical Area. The largest city located within it is Griffin, GA. The county does have a transportation asset management plan and that it is heavily dependent on the Preventative Maintenance Bridge Guide from GDOT. The research team requested a copy of that guide to better understand the resources that GDOT is providing. They have been relying on this guide for roughly 8 years. When it comes to their reliance on GDOT for larger bridges, the county gave a 100% reliance score. For larger culverts, they gave a 30% reliance score, indicating that they can mostly rely on their own resources to handle them. One thing that the county wished for us to note was that much of their success is owed to a great relationship with their local GDOT inspector, Mark Gooden. Spalding County does keep a list of maintenance activities for their larger bridges and assets, which includes the information asked about on the survey, except for geometric information and owner information. When it comes to material information, this specifically refers to the material used to repair the asset. The county would be willing to share this list with the research team. When it comes to common maintenance activities for larger bridges and culverts, the expected activities once again show themselves: brush/tree cutting, erosion control, bridge curb/rail repair and deck repair. The county does not set aside a budget for these larger assets and mostly relies on the Low Impact Bridge Program (LIBP) and the Local Bridge Replacement Program (LOCBR). Based on conversations, the county staff seems to have a good handling of these programs compared to other counties and explains their success even without a funding program such as SPLOST or TSPLOST, as other counties have relied on. Once again, a lot of the credit for this goes towards their local GDOT inspector, Mark Gooden. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the scores provided match the confidence present in the conversation. For funds and knowledge, the county contacts gave a 7 out of 10 confidence score. For resources, they gave a 6 out of 10. The reason for the slightly lower score on resources is that the county feels the lack mostly in manpower, equipment and other such resources. Specifically, they'd like to see a program helping counties find contractors to rent equipment from. Some examples of equipment that they gave included mini excavators and vehicles designed to help access areas underneath a bridge. Spalding County does not have access to the InspectX software.

When it comes to smaller transportation assets, such as culverts and cross-road pipes, the county does not have a written asset management plan. Their asset management for these type of assets is done as needed and the smaller bridges are inspected annually by the bridge crew. The types of assets that make up the inventory of Spalding County's smaller transportation assets include cross-drains that range from 15 inches to 16 inches, most of which are made of galvanized material with some being made of concrete. The county also has 7-8 wooden bridges which are inspected by the bridge crew and has no pedestrian bridges. The county does maintain an inventory of the smaller assets, which includes information such as the Asset ID, location information, dates of construction/repair, material information, and latest maintenance activity. The county does maintain the assets regularly, with inspections being done every 4 months at the latest. The county does not have a condition rating system for their assets. The county contacts stated that they believed a formalization of the inspection plan could benefit the county and team moving forward. The county does maintain a list of the maintenance activities performed on the assets, which includes all the same information at the larger asset maintenance database. Common maintenance activities for the smaller assets include blockage within the pipe/culvert, brush/tree cutting, scour/stability problems, and concrete crack repair. The county would be willing to share their maintenance activity list with the UGA research team. Spalding County does not set aside a separate budget for the management/maintenance of these smaller assets. They, instead, rely on the county general funding, and each project is given its own separate budget. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the county once again showed high confidence in their ability to manage their assets. They gave funding and resources a 7 out of 10 confidence score, while giving knowledge a 9 out of 10. They once again cited that the great relationship they have with their local GDOT inspector leads to a lot of their success as whenever they run into problems, they have someone they can contact to help them solve issues.

Stewart County

Stewart County is a small population county on the western border of Georgia and whose largest city is Richland, GA. The county is within the Columbus, GA area. For larger bridges and other similar assets, the county does not have a written asset management plan. The plan is mostly reactive to incidents. The county works with GDOT whenever they receives the letter from them. They will outsource/contract out the work for major repairs, as the county does not have any funds to make their own major repairs. Stewart County stands out among other counties, as they give a low reliance score on GDOT for Bridges (5%) and Culverts (0%). This is because the county contact only cites GDOT's assistance when it comes to the inspections of the assets, but nothing else. This shows the county, despite their claim to not have a written management plan, clearly has some sort of system that allows them to easily contact contractors to repair their assets. This also has to do with the very limited number of local bridges. The county does keep track of maintenance activities, which includes location information, date of maintenance, material information, and the maintenance activity. The county would be willing to share this with the research team. The common maintenance activities reported included brush/tree cutting, erosion control and cosmetic work. The county contact wanted to make sure it was noted that the team only includes 7 employees. For these larger assets, the county does keep a separate budget. The total comes out to roughly $700,000. However, this includes roughly $400,000 for benefits and insurance. This leaves roughly $300,000 left over to pay for everything else. When it comes to sources for this funding, Stewart County cites SPLOST and TSPLOST. The Transportation Investment Act is a big part of this funding and helped established the SPLOST and TSPLOST programs. Columbus takes most of the funds from the TIA programs to buy equipment for road repairs. Stewart County's local roads are mostly dirt, so they don't benefit from that spending as much as other counties. The county contact has stated he's tried to use LMIG and LIBP programs in the past for funding, but feels the need for more guidance from GDOT regarding how to take advantage of these programs. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the scores are overall low. All three categories were given a confidence score of 2 out of 10. The county contact does not have access to InspectX software, but the county manager may have access. He also notes that finding ways to get equipment for shoring up bridges would be of great benefit.

For smaller transportation assets such as culverts and cross-road pipes, Stewart County does not have a written management plan. The strategy is another needs-based one, that is based on regular inspection. When it comes to the make-up of these assets, about 60% of them are older metal pipes, about 20% are concrete pipes, and 20% are plastic pipes. These range in diameter from 16 inches to 60 inches and can see lengths typically around 48-60 ft. These are often two 24-30 ft pipes put together. The county does not have timber bridges or pedestrian bridges. The county does not keep an inventory as the county contact says he “pretty much knows where they are and mark where the pipes” are. The county regularly inspects the assets twice a week, especially if there has recently been rain. The county does not maintain a condition rating system for their smaller assets. Some of the common problems that occur during these inspections include wildlife, finding source of soil/rip-rap materials and the recent increase in the cost of the materials. Stewart County does not keep a list of their maintenance activities, but instead uses work orders. The information on these orders include the same information for maintenance activities of larger assets, listed above. The county uses a software called iworks to keep these work orders organized. When it comes to common maintenance activities on smaller assets, the items seen to be common in other counties are once again present. This includes brush/tree cutting, erosion control, concrete crack repair, metal corrosion repair and the blockage within the culvert or the pipe, specifically sand and trash. When it comes to the funding, the budget given earlier also includes the budget for these smaller assets and that for these assets, the funding mostly comes from the TSPLOST program. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, Stewart County has high confidence in their funding and their knowledge, giving both a confidence score of 7 out of 10. However, they give a 2 out of 10 for their resources. This is mostly to do with their manpower and where to find sand and GAB for erosion control. The county contact wanted to leave on last comment regarding how the county's relationship with GDOT is. He mentioned that GDOT roads sometimes hinder his ability to do his job. Often times their pipes have a problem and are blocked, but GDOT has no resources to address the problem, and thus keeps staff from being able to address the problem as well.

Sumter County

Sumter County is another county in the southwestern region of Georgia whose largest city is Americus. When it comes to comes to larger transportation assets such as locally owned bridges and larger culverts, there is no written transportation asset management plan in Sumter County. The county relies heavily on GDOT, both for inspections and repairs. The contact gave a reliance score of 100% for both bridges and large culverts when it comes to GDOT and their assistance. The county is in charge of routine maintenance but rely on GDOT for major repairs. The county is currently in the process of gather information regarding the maintenance activities performed on bridges. The information kept on the list is what it is expected. The county government does not go inside the city ordinance. The city maintains the GIS software. It will take roughly 1 year to complete the list. When it comes to common maintenance activities for these larger bridges and culverts, the ones cited were brush/tree cutting, erosion control, with some less common but notable activities including repair of guardrail, deck repair and support for foundation on anything underwater. Sumter County does not have a separate budget for these larger assets. Instead the funds for the assets come from a combination of pooled funds from TSPLOST, SPLOST, LMIG and LOCBR. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, surprisingly, funding had the highest confidence score at 7 out of

10. This is much different than what has been come to be expected from the counties. They gave resources and knowledge lower scores, 4 and 3 respectively. To provide further detail on this, the county contact says that the county lacks the funding and resources to handle engineering problems and they lack someone knowledgeable in those areas in the county.

For smaller transportation assets, there is no written asset management plan for them. The strategy given to the research team was one of “anticipate and react”. The kind of smaller assets one can find in Sumter County includes roughly 50% corrugated pipes, about 25-33% metal pipes, and about 12-25 concrete culverts. These can range from 42in to 72 in in diameter. The county does not have any timber or pedestrian bridges. The county is in the process of putting together an inventory of their smaller assets, which will take about 2 years to complete. Included on the sheet will be location information, geometric information, dates of construction/repair, material information, as well as some unique items, such as activity history, project description, contractor and county. The county wants to have an annual inventory of the drainage pipes and is willing to share it with GDOT. Currently, most information is in a paper-log, but the staff has been converting it to a spreadsheet. The county does regularly inspect their culverts, once a year. They feel the need to, due to large farming and logging industry prevalent in their community. The county does not keep a database of condition ratings for their assets. The county contact has said that he did an asset management training course and may buy an asset management program. Sumter County, along with the inventory described above, will be working to collect a list of maintenance activities performed on each asset and combine them into the same program. When it comes to budgeting, the county does set aside its own budget for the smaller assets. This budget is roughly $150,000, which includes funds for professional services such as contractors. This budget does not include funds from SPLOST. Most of the budget comes from TSPLOST and general county funds. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the scores are high across the board. Both funding and resources were given an 8 out of 10 and knowledge was given as high as a 9 out of 10 confidence score. The biggest challenges the staff face is being able to proactively identify problems and develop the asset management systems, as well as the shortage of man power and materials, especially with the rising costs. The county contact also wished to provide several suggestions for GDOT he believed would not only help Sumter County, but other counties as well. Firstly, he suggested a clearing house for counties to be able to have a singular place to facilitate transactions. In addition, he acknowledges that GDOT offers technical support for counties, however he is often confused as to who to contact. He suggested that counties begin looking into the Community Development Block Grant federal program as an option for regional development. Finally, he wished to express his interest in working with GDOT to map the assets and for traffic count data.

Talbot County

Talbot County is a low population county in west Georgia located at the latitudinal center of the state. The largest city located within it is Talbotton. For larger assets, Talbot county does not have a written asset management plan. They are heavily reliant on the GDOT "handout" that is given to them that updates them on the repair and maintenance needed to be done. This was also indicated by their 90% reliance score for sizable bridges given in the survey. However, the county contact indicated a 0% reliance on larger culverts, which they maintain themselves. The county contact has been with the county for 3 and a half years and so far he has not had to deal with a bridge being replaced. The county does keep a digital list of the maintenance and repair activities done to their bridges. The information kept on this list includes location information, start/end dates of maintenance, initial construction date, material information, the maintenance activity, and the number of people involved. For large culverts, they also include whether rip-rap was used, the number of loads, and any materials that were used for the maintenance. For common maintenance activities on larger bridges and culverts, culvert repair was labeled as the most common, followed by brush/tree cutting and erosion control. It was also mentioned that the most common culvert repair activity was the washing out of dirt roads. When it comes to budgets for these maintenance activities, Talbot County has set aside about $100,000 annually for maintenance, equipment, gas, and other miscellaneous costs. Mr. Nolan recalled the SPLOST and LIBP programs as potential sources of funding, but says that the funding is all handled by the county managers. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the county feels neutral about their funding and resources, giving both a confidence score of 5. For their level of knowledge for maintaining larger assets adequately, they gave a confidence score of 7. Talbot county does not have access to the InspectX software. When asked about the challenges to managing these assets, the contact stated he doesn't face many due to the good relationship his county has with their inspector, Mark Gooden. In terms of resources he believes his county could use, the contact mentioned additional training and knowledge on the bridges themselves.

For smaller transportation assets such as culverts and cross-road pipes, Talbot County does not have a written asset management plan. Instead, it falls on our contact to inspect the roads and assets periodically. The kind of smaller assets that can be found in Talbot County include pipes ranging from 12 inches to 96 inches in diameter and their length can be anywhere from 30 feet to 60 feet. Most, if not all, of the pipes are galvanized, corrugated pipes. The county has 4-5 100 foot timber bridges, which they re-deck in-house without contractors. The decks are typically 14 feet wide and 72 feet in length. There are no pedestrian bridges in Talbot County. The county does maintain an inventory of their smaller assets, which includes information such as location information, geometric information, start and end dates of construction/repair, material information, names of people involved, and the equipment used. The county does regularly inspect these assets. Our contact and his staff go around daily to check on the assets, specifically looking for waterflow and pipe damage. This is done especially after rain has been seen. The county staff do not maintain a condition rating system for these assets. In addition to an inventory, the county also keeps a list of the maintenance activities for these smaller assets. This list includes all the information asked about in the survey except for asset ID. In this instance, the location information serves as the asset ID. In order to provide a complete up to date list, our contact says it would take the county roughly 3 months. For common maintenance items for the small assets, our contacted states the three most common problems were blockages within the pipes/culverts, settlement/rotation control, and scour/stability problems. For budgets and funding, the $100,000 budget described earlier includes funds for this type of management as well. There is no separate fund. Similar to larger assets, our contact cited SPLOST and general county funding, but leaves those details to the county managers. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the confidence scores are quite high. Their confidence in their ability to acquire and use resources, as well as their knowledge were both given a confidence score of 7. Their ability to acquire and use funds was given a confidence score of 8. The biggest challenges the contact and his staff faced were weather related and overall he felt he and his staff were in a good place resource-wise, which is backed up by his previous confidence scores, although that isn’t to say he wouldn’t welcome more.

Thomas County

Thomas County is a medium-sized county located along the southern border of Georgia. Its largest city is Thomasville. When it comes to larger bridges and culverts, Thomas County does not have a written asset management plan for them. Minor items are taken care of in-house by their 5-man construction team. Major items are contracted out, especially if the work involves concrete or a column on the bridge. Their wooden bridges are replaced in house. When it comes to their reliance on GDOT for these assets, Thomas County gave a reliance score of 50%. The county is in the process of compiling a list of maintenance activities, as well as an inventory for their larger assets. They have two staff members working with GIS to do so and it should take roughly 1 year to complete. When it comes to common maintenance activities, these include brush and tree cutting, spalling, deck crack sealing and some wooden pile replacement. The county does keep aside an annual budget for bridge maintenance, totaling anywhere between $80,000-$100,000. This funding mostly comes from SPLOST and the county general fund. The county currently has 4 bridges under the LIBP. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, Thomas County is overall neutral to confident. For each category, they gave a confidence score of 7, 5 and 6 respectively. The county does not have access to the InspectX software. When it comes to the biggest challenges the county faces, the county contact stated that finding qualified individuals, especially crane operators, is especially difficult.

When it comes to smaller assets such as culverts and cross-road pipes, Thomas county also does not have a written asset management plan. Their crews go out every day and look for issues to solve and take care of them as needed. The type of assets that are in Thomas County are all concrete assets, ranging in 18in to 42in diameters and range in length from 40ft to 60ft, with 8ft segments. The county also has multiple timber bridges. The county does keep an inventory of all of their assets, using a GIS software. This GIS system includes all the information asked about in the survey accept for Asset IDs. The county des regularly inspect their assets, however it is not a formal program and its unclear how often every asset is visited. The county did state they have condition ratings for their assets, but further information was not provided. The county does not keep a list of each maintenance activity performed, rather relying on a work order system. Common maintenance activities for the smaller assets include brush and tree cutting, scour and stability problems and join separation. Thomas County does keep aside a budget for maintaining and managing these assets. It is a part of a $200,000 budget for all road maintenance that isn't resurfacing roads. This is a line item in the county general funding each year. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, all three were given a high rating of 7 out of 10.

Toombs County

Toombs County is a low-to-medium sized county located in south east Georgia and whose largest city is Vidalia, GA. When it comes to larger assets, the county does not have a written asset management plan. The county takes care of erosion and vegetation problems with the bridges, with GDOT taking care of most other issues. This is reflected in the county's reliance scores, for which they gave a 100% reliance score. Much of what was described to us may represent an incomplete picture of the county's overall process, as the county contact has only been with the county for 3.5 years, during which they've only seen minor repairs or a full replacement, which was done solely by GDOT. Common maintenance activities include brush and tree cutting and erosion control. The county sets aside a portion of its $2 million total public works budget towards bridge maintenance. The total budget comes from mostly SPLOST and TSPLOST dollars. When it comes to how the county feels about funding, resources, and knowledge for managing these larger assets, all three were given a high rating of 3 out of 10, showing a low level of confidence. The county does not have access to InspectX. When it comes to things he contact would like to see changed, they stated they want to see more detail in the inspect summary letters.

For smaller assets such as culverts and cross-road pipes, Toombs County does not have a written asset management plan for them either. The process for maintaining and managing the assets is a reactive one and the county staff are confident in their ability to recall the locations of the assets, as there is no written list or inventory. The type of assets maintained within the county vary. Newer assets are concrete and HDPE pipes. Paved roads contain concrete pipes and dirt roads contain the HDPE pipes. Older assets can be metal, but the county is looking to replace them. The county does not regularly inspect their assets and do not have a condition rating system. Common maintenance items include brush and tree cutting, blockage within the pipe or joint separation. The county does give an annual budget of $20,000 for the managing and maintaining of these assets. These funds come mostly through SPLOST and the general county fund. When it comes to how the county feels about funding, resources, and knowledge for managing these smaller assets, all three were given a high rating of 3 out of 10, showing a low level of confidence.

Treutlen County

Treutlen County is a low population county located in middle Georgia and whose largest city is Soperton. The county does not have a written transportation assessment management plan for larger bridges and culverts. The county staff is dependent on the GDOT inspection report provided to them to determine what needs need to be addressed. Our county contact has been with the county for 13 years and has seen limited need for major maintenance. There has been only one bridge replacement he can recall and some columns on bridges needed to be repaired. This dependence on GDOT's inspection report can also be seen in their 60% reliance score for sizable bridges. This reliance is mostly for the inspection work and the county is adequate in finding contractors to handle the maintenance and repair. The county is in the process of making a list of maintenance activities performed on these larger bridges. This list is a paper-log work order system that includes location information, dates of maintenance, and the maintenance activity. It'll take roughly a year to bring this list up to date. The most common maintenance activities cited by the county for larger bridges include brush/tree cutting, erosion control and repair of existing guardrail. Most activities beyond that are contracted out. When it comes to a budget for the upkeep of these bridges, our contact says he believes there is a fixed amount but the county managers deal with the funding. Because of this, he was only able to provide the research team with limited information regarding where the funding came from. He stated he had heard of TSPLOST but that was it. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, Treutlen County gave higher confidence scores for their resources and knowledge, 7 and 6 respectively. However, a lower confidence score of 1 was given for the funding. Treutlen County does not have access to the InspectX program. A few last comments were made by the contact regarding the challenges they face for larger bridges include their ability to find contractors, and the contact frequency of GDOT. The contact said that GDOT contacted them in the last year. However, they did not hear from GDOT for the entire year before that point. The contact also mentioned that the ability to get equipment such as an excavator would be helpful.

When it comes to smaller local transportation assets such as culverts and cross-road pipes, Treutlen County does not have a written asset management plan for those, either. Like the larger assets, the county maintains there asset on a needs-based plan. The types of assets in county include mostly metal assets, which make up about 50% of the inventory. These are typically newer pipes. The other 50% of pipes are concrete, which work so long as they are installed properly. The newer pipes being made of metal is because the metal pipes are cheaper and easier to install. The county does not have any timber bridges or pedestrian bridges. Treutlen County does not keep an inventory of their assets. They inspect the assets on a 3 year regular basis during a 3-4 month period during the summer. They also rely on their landscaping maintenance crew to spot issues on culverts not set to be inspected by the staff. These are not formal inspections, according to the contact. The county does not keep track of condition ratings for their assets. The county does not keep track of the maintenance activities through a list, but rather a set of work orders. These work orders include information such as the location information, the date of maintenance, and the maintenance activity. The county staff says it would take roughly 2 years to develop a formal list of maintenance activities. The common maintenance activities cited for smaller assets include brush/tree cutting, erosion control, scour/stability problems, join repair, blockage within the pipe, and metal corrosion. For funding and budgeting, our contact says that there is a fixed amount each year, however he is not aware of what it is. He once again cited TSPLOST and general county funding as the source for the funding. He also mentioned a time where a large culvert was replaced by applying for a state grant, however he did not mention what program or grant was used. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they are very confident. All three categories were given a confidence score of 9 out of ten. The contact mentioned that the biggest challenge they face is the ability to secure materials and that more information on how to secure those materials would be helpful, especially for smaller jobs, as for larger jobs, the material securing is done by the contractors.

Troup County

Troup County is a medium sized population county located in west central Georgia along the border with Alabama. Its largest city is LaGrange. For larger bridge assets, Troup county does not have a written asset management plan. Troup County does seem to have a lot of agency when it comes to maintaining these assets, as is seen in the 30% reliance score the county contact reported in the survey. The county has 3 engineers in house, allowing them to design repairs in house without contracting out work. Construction work is then outsourced. The county does maintain a list of their maintenance activities through a work order system called Asset Essential, which includes location information, date of initial construction and the maintenance activity. The staff has acquired a GIS system but no assets are entered as of yet. Common maintenance activities include bridge joint sealing, brush and tree cutting, repair of existing guardrail and erosion control. The county does set aside a budget for these activities, which is roughly $20,000. This funding mostly comes from SPLOST and county general funds. When it comes to how the county feels about funding, resources, and knowledge for managing these larger assets, the confidence varies. The county is most confident in their knowledge, which was given a confidence score of 9. Meanwhile, funds and resources were lower, being given confidence scores of 5 and 3, respectively. The county does have access to the InspectX software.

For smaller assets such as culverts and cross-road pipes, Troup County also does not have an written asset management plan. The county is dependent on a work order system and pipes are replaced on a case-by-case basis. The pipes are mapped in a storm management system built on CAD, but they are working to convert to a GIS system. The types of assets within Troup County are a 50/45/5 split between metal, concrete and HDPE pipes. Newer pipes are concrete and HDPE due to corrosion issues in metal pipes. If pipes are less than 4ft in diameter, HDPE pipes are used. Otherwise, concrete pipes are used. The county does not keep an inventory outside of the previous CAD map mentioned. The staff does inspect the assets regularly, however it is not a formal program. When rain comes, the county staff will take the opportunity to go out and inspect the assets, informally, for blockages. The county, subsequently, does not keep condition ratings for these assets. The county keeps track of maintenance items through the same work order system as with larger assets. Common maintenance activities include blockages within the pipe, corrosion, and brush and tree cutting. The county does set aside a budget of $55,000 for the maintenance and management of these assets, which comes from SPLOST and general county funding. The SPLOST is only used for pipe replacement projects. . When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they are anywhere between neutral and positive. Funds was given a confidence score of 5, the lowest of the three. Resources was given a higher score of 7, while knowledge was given a score of 8, the highest of the 3. Additional comments from the county contact stated that they would like to see more personalized interaction from GDOT when working with projects.

Upson County

Upson County is county in western Georgia located at the latitudinal center of Georgia with a medium sized population. The county does not have a written asset management plan for larger bridges and culverts and they rely heavily on GDOT for inspection, as indicated by the 100% reliance score they give for larger bridges. The county does not maintain a list of the maintenance activities done on these larger bridges. The common maintenance activities cited by the staff of Upson County include brush/tree cutting, erosion control, guardrail repair, deck repair, and header join repair. The county does not set aside a separate budget for these larger assets, but rather relies on a combination of SPLOST, TSPLOST, LOCBR, LMIG and LIBP, for whatever will fund a project. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the confidence scores were overall low. For funding and resources, a confidence score of 4 was given, while a confidence score of 3 was given for knowledge. Upson

County does not have access to the InspectX program. When it comes to shortcomings and challenges, the contact for Upson County says the biggest problem is the "capability of staff" and that further training for his staff members would be helpful.

When it comes to smaller assets, there is also no written asset management plan for them either. Upson County relies on casual inspection of their assets and they do not maintain an inventory of their assets. The county contact did not provide information about the types of assets the county contains, although they did specifically mention they did not have any pedestrian bridges.. The county also does not have regular inspections of these assets, and do not have a condition rating system for these assets. The county is in the process of compiling a list of maintenance activities performed, which will include an asset ID, location information, dates of maintenance, material information, and the maintenance activity. The county says it'll take about 2 months to compile this information. The common maintenance activities for smaller assets included blockages within the pipe. corrosion control, brush/tree cutting, surface damage/spalling, and deformation and damage repair. The county does set aside a separate budget for these assets, which is roughly $200,000. This funding comes from SPLOST, TSPLOST, LMIG, and general county funds. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the staff feels overall confidence. Both funding and resources were given confidence scores of 7, while their knowledge was given a 6 out of 10. When it comes to challenges and needs, the county contact cited time and personnel as his biggest challenge and that software resources would help. The contacts says that having a centralized statewide database and expanded general consulting from GDOT would be an excellent step.

Warren County

Warren County is a low population county located in central east Georgia whose largest city is Warrenton. When it comes to larger bridges and culverts, the county does not have a written asset management plan. Like many other counties, Warren County reviews the GDOT inspection report and decides how to proceed from there. This often involved contracting out work for larger repairs. The county did not indicate a heavy reliance on GDOT as both the reliance scores for large bridges and large culverts were given a 30%. This may be due to the county contact regarding the work GDOT does as inspectors as only 30% of the total work for the bridges, while the rest, like contracting, is done by the county. The county does not keep a standard list of all repairs done on their larger assets, rather using a work order system. Among the common maintenance activities for larger bridges and culverts, the county contact cited brush/tree cutting, erosion control, culvert repair and deck repair. The deck repair is mostly wood decking and is done in house. The county does not set aside a separate budget for the larger assets' maintenance, and relies on the other broad items. This funding comes from a variety of sources, but mostly LIBP, TSPLOST, SPLOST and LMIG. The county is also not afraid to take advantage of federal and state funding when opportunities arise. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the confidence in all three categories were given a confidence score of 3 out of 10. In terms of what the county could use more of, the contact repeated that more funding and manpower is always needed.

For smaller assets like local culverts, there is no written asset management plan either. THe county relies on periodic inspections, usually every 3-6 months and they have a staff of 2-3 people who look at their pipes. The county has roughly 100 pipes in its jurisdiction, of which 80 are metal, 19 are concrete and 1 is plastic. If the pipes are done in-house, they use metal. If they're done by contractors, it is whatever the contractor recommends. Typically, the diameters range from 16 in. to 72 in. and the lengths are roughly 30 ft. The county does have some timber bridges and they are inspected. The county does not keep an inventory of their smaller assets and does not have a condition rating system for them. The county heavily relies on the inspection of assets whenever landscaping maintenance is being done near the assets. The county, like with their larger assets, does not keep a list of maintenance activities, but rather relies on work orders. The county contact said it would roughly 1 year to put together a comprehensive list of their maintenance activities. Common maintenance activities for the smaller assets include blockages within the pipe, brush/tree cutting, erosion control and deformation/damage repair of metal pipes. Like with their larger assets, there is no separate budget for maintaining the smaller assets. They rely on the same funding sources except for LIBP. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, the county feels overall neutral. Both funding and resources were given a confidence score of 6, while knowledge was given a slightly lower confidence score of 5. A few last notes from the county contact includes a reiteration that manpower and funding are their greatest challengers and that any resources that help to share information on funding options as well as best practices would be welcomed.

Washington County

Washington County is a county in central east Georgia that contains a medium-to-low-sized population and is home to Sandersville, GA. For larger bridges and assets, there is no written plan for Washington County. The county mostly contracts out the work for major repairs, the size of the contracts varying depending on the job. The county contact indicated a total reliance on GDOT, giving both larger bridges and larger culverts a 100% reliance score. The county does not keep a list of their maintenance activities, rather keeping it on paper file for future reference. Common maintenance activities for the larger assets include brush/tree cutting, culvert repair, erosion control, repair of guardrail, bridge curb/rail repair, and ditch cleaning. The county does not set aside a separate budget for these larger assets and relies on funds from SPLOST and LMIG. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the confidence is much higher than other counties have indicated. Funding was given a confidence score of 8, resources were given a confidence score of 7 and knowledge was given a confidence score of 9. This all indicates that the county is very comfortable with the system of contractors they have and their ability to secure funding with the above options. The county does not have access to the InspectX program. The biggest challenges the county contact cites is erosion control and the ability to access and look at the assets in hard to reach places. The contact also said that any additional help with GDOT, inspection and resources would be appreciated.

For smaller assets, there is no written asset management plan. The county just visits culverts and other assets whenever problems arise. The kind of assets included in Washington County include mostly corrugated pipes ranging from diameters of 18 in. to 72 in. and ranging in lengths of 30 ft. up to 40 ft. There was no indication The county does keep an inventory of their smaller assets. This inventory includes information such as location information, geometric information, as well as general materials. This inventory is a paper list. The county does regularly inspect their assets multiple times each month. The two staff members drive a route as they are inspecting all assets and check the pipes as they roam. The county does keep a paper list of the maintenance activities they perform on their smaller assets. This list includes information such as location information (road names), geometric information, owner information, dates of maintenance and construction, material information, and maintenance activity. It would take about 3 months to enter a year’s worth of information into a database. Common maintenance activities for smaller assets in Washington County include erosion control, brush/tree cutting, surface damage/spalling, blockage within the pipes/culvert, scour/stability and pipe alignment. The county also has to deal with ventilation pipes that have been left behind from past jobs. The county does not have a separate budget for these smaller assets. The funding comes mostly from the county general fund and SPLOST. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they are once again confident in those categories, giving each a confidence score of 9, 7 and 8, respectively. In terms of resources that the county needs, the contact says that having more staff members who better understand the nature of the assets would be helpful. Last remarks from the contact included commenting that counties having effective equipment for digging out pipes and lifting equipment is crucial. Finally, the contact says the UGA research team is more than welcome to visit and observe the county's practices.

Wayne County

Wayne County is a low population county located to in the south eastern portion of Georgia and is to the west of the Savannah metro area. Its largest city is Jesup, Ga. For larger assets, there is not written asset management plan for sizable bridges and culverts. The county's plan for maintaining and managing these larger assets by relying on the letters sent by GDOT. The county has worked well with GDOT, both in securing funds and managing projects. The contact for Wayne County gave a reliance score of 90% on GDOT for these projects. The county does not keep a list to the maintenance activities and is done on a needs basis and is not documented. The county contact gives credit to their 30 years of experience with GDOT, as well as having two engineers on staff, for how smoothly their operations run. The county stated they do no keep a list of their maintenance activities. The common maintenance activities for sizable bridges cited by the county contact include brush and tree cutting, repair of existing guardrail, pile replacement and culvert repair. Wayne county does not set aside an annual budget for its bridge activities. These activities in Wayne County are most commonly funded by LIBP, TSPLOST, SPLOST and LMIG. It should be noted that most of these programs are for a wide variety of issues, of which bridge maintenance is only a small portion. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, Wayne County feels better about their resources and knowledge than they do about their funding. For funding, they gave a confidence score of 4, while resources and knowledge earned a confidence score of 7. The county does not have access to the InspectX software and considers funding to be its greatest challenge. It was also stated that necessary software and personnel were also a great need.

For smaller assets such as local culverts and cross-road pipes, there is not written asset management plan. Assets are mostly maintained in house unless larger than 6 feet, in which the county hires contractors. The type of assets that are common in Wayne County include mostly concrete assets, averaging around 3 feet in diameter. Wayne County will use corrugated metal assets in emergency situations, however they avoid them due to them having a shorter lifespan. Wayne County does not keep an inventory of their assets. They are aware of where their repeat problems are and they rely upon their mower grader operators to report any issues while they conduct their work. Wayne County does not regularly inspect their assets and do not have condition ratings for their assets. They also do not keep a list of the maintenance activities they have completed. The county does have a public request for work software that logs activities made by the public. These are kept track of in a log by the Admin Secretary. The county contact stated it would take about 2 years to build an inventory of all of their assets with their current staff and tools. They stated that if they were to develop a software for it and dedicate personnel to it, less than a year. Common maintenance activities for smaller assets in Wayne County include brush and tree cutting, blockages within the pipes and join separation. It was also stated that wildlife such as beavers, as well as storms, are common problems. Wayne County does not set aside a specified budget for the management of their smaller assets and are mostly funded through SPLOST and TSPLOST. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, Wayne County feels overall confident, giving a confidence score of 9 in all three categories. When it comes to the biggest challenges they face with these assets, Wayne County said that keeping them all open and functioning is their biggest issue, especially on dirt roads where pipes dislocate easily.

White County

White County is a low-to-medium sized population county located in northeast Georgia. Its largest city is Cleveland, GA. For larger assets, there is no written asset management plan and the county is heavily dependent on GDOT for these assets. This is shown in their 90% reliance score. The county is in the process of gathering data and management strategies to build their own management plan in the future. They're currently compiling the history of maintenance activities on their local bridges, which includes all information asked about in the survey except for owner information. This process is expected to take about 3 months. Common maintenance activities for larger assets in White county include erosion control, repair of guardrail, deck repair and culvert repair. The county does not set aside an annual budget, but gets funds on a needs basis from SPLSOT, LMIG, LIBP, and LOCBR. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the county is very negative on its funding and resources, which is gives a 1 out of 10 confidence score. Their knowledge was given a much higher score at 7. The county does not have access to InspectX. Its biggest challenges are limited funding and manpower. The county contact stated they have good asset management softerware and what limited funds they have are spent on urgent needs.

For smaller assets such as culverts and cross-road pipes, White County does not have a written asset management plan. Currently the county contact stated they do not have a valid inventory system and are in need for resources for data collection. They are currently in search of a contractor to build their inventory for them. The county attempts to visually inspect their assets once every two years. The county does maintain a list of the maintenance activities performed on these assets, but the information is limited to the activity and the material used in the activity. Common maintenance items for smaller assets in White county include brush and tree cutting, erosion control, blockages within the pipes, and settlement/rotation control. The county does not have a set aside budget for these items, instead gathering funds on a needs-basis from SPLOST and LMIG. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, it is very similar to that of their larger assets. The county is very negative on its funding and resources, which is gives a 1 out of 10 confidence score. Their knowledge was given a much higher score at 8. The county contact finished the survey be reiterating that counties cannot inventory their assets without funding.

Wilkinson County

Wilkinson County is a low population county located near the geographical center of the state of Georgia. Its largest city is Gordon, Ga. For larger assets, there is not written asset management plan for sizable bridges and culverts. The county is mostly responsible for landscaping around the assets and performing repairs according to GDOT inspections. This is reflected in the reliance score they give for sizable bridges, which is 100%. The county does not keep a list to the maintenance activities and this is kept track by the county manager. The common maintenance activities for sizable bridges cited by the county contact include brush/tree cutting, signage changes, cleaning drains, and pile replacement. The county does not have a set aside budget for these activities. The only program directly cited by the contact as a funding source for the activities was the LMIG program, with the rest coming from the county's general funding. When it comes to how the county feels about their funding, resources and knowledge to maintain their larger assets, the confidence varies greatly across each category. For funding, they gave a confidence score of 1, indicating a great need there. For resources, the county gave a confidence score of 7, which means they think they have the equipment and connections to get materials for maintenance activities. Lastly, the county gave a confidence score of 4 for knowledge. The county does not have access to the InspectX software and cited funding and manpower as its greatest needs.

For smaller assets such as local culverts and cross-road pipes, there is no written asset management plan in Wilkinson County. The county does not keep an inventory of their assets, however they do inspect their assets annually. These inspections are done by county road department employees and consist of landscaping, erosion control, clearing blockages within pipes, and, if needed, replacement. The county does not include a condition rating system. The county does keep track of the maintenance activities they perform on their assets. However, this list is limited as it only includes location information and the dates of maintenance. Wilkinson County does not keep a separate budget for their small asset management and maintenance. The only source of funding that was cited was the LMIG program. When it comes to how the county feels about their funding, resources and knowledge to maintain their smaller assets, they feel very comfortable with their resources and knowledge, which they gave a 10 out of 10. However, funding was given a 1 out of 10 confidence score. The contact reiterated their biggest challenge is funding and manpower.

SYNTHESIS OF FINDINGS FROM SURVEY

The findings on the survey go far in showing how important it is for GDOT to provide as many resources as possible to county governments to understand the process. Without them, counties are often left in the dark, as their agency regarding the project can be taken out of their hands and they are left waiting for information that's difficult to acquire. Reliance on GDOT for these larger bridges and culvert assets is not by itself a detriment to the overall process of maintaining assets. However, when you combine this reliance with a reported lack of communication and lack of general knowledge of the process, it is understandable how some county governments have grown frustrated with and have mistrust for GDOT and their assets. However, there are plenty of counties that have reported great communication with GDOT and those are often the counties who see the most success with maintaining their assets. If GDOT can look to apply those successful communication channels to all counties, it would go a long way towards fixing the gap between counties and GDOT.

CHAPTER 5. DEVELOPMENT OF A STRATEGIC PLAN TO STRENGTHEN PARTNERSHIP WITH LOCAL GOVERNMENTS

GDOT explained early in the project that they had a desire to improve their relationship with local governments in the state of Georgia. In order to help achieve this goal, this research team has brought together a comprehensive strategic plan to be implemented over the course of several years. As G.L. Musgrave once said, “For anything to change, someone has to start acting differently.” GDOT identified that the status of their relationships with local governments was insufficient to what they needed to achieve their goals, so the plan with center around actions GDOT can take and services they can provide. However, the strategy plan will work better if local governments are engaged as well, and thus the strategy plan will include some action items that they can engage with.

To this point, the team has conducted its survey with at least 1/3rd of the counties in the State of Georgia and can now begin to develop a full strategic plan towards achieving the goal of improving the asset management in counties across the state of Georgia, as well as improve the relationship and cooperation between different agencies. A final draft strategic plan documents are provided in Appendix B and C.

The following section directly addresses what resources and policy changes the research team believe need to be developed and implemented. It first describes the three resources to develop for use by the counties, which includes a standardized inspection guide for Georgia counties to be used on culverts, cross-road pipes and other smaller, locally maintained assets. The contents and goals of this guide will be discussed in this section, and even greater detail on a recommended inspection guide will be provided in the following chapter. Another team member is preparing a resource guide to be used by the counties, in order to provide information regarding funding options, equipment and other needed materials and thus is not the scope of this thesis. Lastly, the team will develop a bridge/culvert asset management algorithm or decision aids on a website, through which counties will be able to make informed decisions regarding their counties' assets such as their budget, their nominal asset numbers, and other information that will then be used to create a preventative maintenance plan depending on the county's needs.

In addition to the three resources (inspection, resources, and decision aids) above, the strategy plan also includes information and recommendations regarding how to improve both County-GDOT relationships and inter-county relationships. The involvement from GDOT and local "large" bridges is already strong. However, the team has identified ways to improve the previous existing relationship and ways to expand the relationship further when it comes to the involvement of providing resources and guidance for counties. This will include suggestions such as developing training modules, creating information webinars and enhancing transparency and access to information to counties.

In addition, the research team has also found that it is important to facilitate and encourage cooperation between counties. Not only does this take some of the pressure off of state agencies such as GDOT, counties working together and improving their relationships with one another provides opportunities for them to learn from their peers and promote best practices to be shared at a quicker pace among them. All of these elements come together to provide a strategic plan for this research project.

Providing Resources for Counties

The research team aims to develop three resources for counties in the state of Georgia. These resources are an inspection guide for local assets, a resource guide to help counties obtain funding and equipment, and a transportation asset management plan algorithm. After interviewing the counties and seeing how well similar guides and tools have worked in other states, the research team determined that these resources would provide great benefits to the counties of Georgia. The following section provides the contents each of these resources contain and how they are expected to provide such benefits.

Funding Consultation Resources

The first resource idea brainstormed will include information regarding common funding opportunities, including the three below and any other applicable programs in the future.

A. Low Impact Bridge Program

B. Local Maintenance and Improvement Grant

C. Local Administered Project Program

For each of these programs, the guide should explain the process by which counties need to apply for them. This includes providing URLs and sections dedicating to navigating the program's website in order to find the application in the first place. From there, the guide should break down the program's application, highlighting each major section or requirement of the application and explaining what is expected to be reported for the section. If possible, a sample of a successful application should be provided as well. This section can also provide tips and tricks to make a project more applicable to the funding program and have a greater chance of being granted funds. From there, the process by which the funding is distributed for each of these programs should be fully explained. This is done in two ways. Firstly, the criteria by which the programs make their selections as to which projects will be granted funds should be explained in a way that person without extensive jargon of the field can understand. Currently, too many resources on these programs that attempt to explain the criteria are filled with terms that cause more confusion than actual clarification of the selection process. In addition to the criteria being clearly stated, the guide should also explain how long counties should expect to wait to hear back on there applications, as well as know how to contact the program in order to find out the status of an application.

Equipment and Equipment Consultation Resources

In addition to providing information regarding funding resources, another resource should also keep an up-to date list of firms and other organizations that can allow counties to purchase or rent equipment, as well as find materials for the use of repair and maintenance. This section should be divided up into pages that each focus on a type of equipment or materials that counties could use in their practices. For example, a county should be able to do the following with this section of the guide. First, once they identify that they need an excavator for an upcoming project, they should quickly find the section in the guide for excavators. Run through a list of firms, sorted by alphabetical order and by county, that can provide excavators for purchase or for rent, and each firm should be clearly marked as to which one provides which service. Once a company is identified and fills the needs of the county, contact information as well as website information should be right there the county staff to utilize. This can be done with all sorts of equipment, from smaller bulldozers to large cranes. It can also be used for counties to identify where to find materials used in repair. For example, there should be a section that contains where to find different types of adhesive used in repairs and the process and format should be similar to the excavator example above. Lastly, the resource guide can also provide contact information for engineering firms that specialize in different types of assets. This list of firms should be updated on a yearly basis in order to keep the information current and keeping the guide from falling out of relevancy. It is creates a more level playing field for newer engineering firms if the list is updated regularly.

GDOT Consultation Resources

A third resource should be provided that explains the resources provided by GDOT that counties can take advantage of. This section can include well-established practices such as GDOT's inspection of bridges. However, it should also take great care to organize the programs and resources that GDOT offers in a way that counties should be able to look up this section by need. This means that a county who is in need of best inspection practices consultation should be able to look into this section, find a section for inspection practices and find some contact information or a preview of a program that can help them solve this issue. For example, it could provide contact information that will allow the county to receive the latest copy of the Georgia Culvert Inspection Guide. The section can also describe many of the programs that'll be later discussed in the following sections of this report. The resource guide will be a catch all service that if counties every have questions regarding their practices or how to find information or items they need, it will be the first place they will be trained to look. Think of it as a FAQ section on a company's website.

Transportation Asset Management Algorithm

The last major resource to be developed for GDOT is the Transportation Asset Management Algorithm. This will also be known as the "Life Plan for a Bridge Asset" Algorithm. GDOT takes on much of the responsibility of maintaining a schedule and practices for the inspection of larger bridges and culverts. However, this tool will be able to take some of the power and place it back into the county's hands when it comes to the managing and maintenance of these assets. The algorithm's goal will be to create a schedule of preventative maintenance on a larger asset that a county is then expected to follow. The schedule will include dates by which different elements on the asset should be replaced in order to better the health of the overall bridge, and each date should include a detailed description of what kind of smaller repair needs to take place and where to find the materials for this kind of repair. This schedule will be based on several key factors of the asset, including the average daily traffic the asset is expected to see, the weather and elevation, the number of different elements on the structure and many others. The algorithm should also provide the amount of expected funds a county will need to raise in order to adequately follow this schedule. Following this schedule will make it so that regular inspections from GDOT should be nothing more than a checklist, providing less stress on GDOT and the counties that a bridge asset could score a low enough rating to need major repair. The switch to a preventative style of maintenance, rather than a reactive one, has been a goal of GDOT and other asset managers for some time and the development of a model to predict failure and guide counties and other organizations in how to set those schedules up will be the tool that they'll need to finally make the switch.

Improving County-GDOT Relationships

While the resources to be developed will go a long way towards achieving the goal of improving transportation infrastructure maintenance in Georgia, another aspect of the problem is the ability to improve the working relationship between Georgia County governments and GDOT. The research team has several recommendations that can be initiated on the side of GDOT in order to achieve this goal. The first of which creating standardized training modules for new county managers, directors, superintendents, and other similar positions. Secondly, GDOT should facilitate regular webinars between county staffs with the goal of providing new information to the counties regarding updated practices and programs, as well as an opportunity for counties to socialize with one another and ask questions. Thirdly, a effort needs to be made to improve accuracy and transparency of information for the counties.

Developing Onboard Training Modules for New County Employees

The first way that GDOT and county governments in Georgia can improved their relationship is for GDOT to facilitate the development of training modules for incoming staff members. The last couple of years, county governments have seen more turnover at their positions than they're used to and with that turnover, long-time experience and knowledge usually leaves with the veteran staff members. The modules would cover a variety of topics that every staff member who in charge of the county's physical transportation assets.

Firstly, there should be a set of modules dedicated to the process of bridge inspections by GDOT and what role counties play during that process. The video should clearly state where the responsibility of GDOT ends while the responsibility of the county/local government begins. It should explain the format of the GDOT inspection report and how to interpret the terms and jargon used within it. It should also clearly state how to contact their GDOT district's engineer if there are any questions regarding the contents of an inspection report. A set of modules to explain some of the more common maintenance activities and how to quickly address them and what resources are available from GDOT to do so.

A second set of modules should be developed explaining the recommendations that GDOT has for counties when it comes to the creation of transportation asset management plans regarding small, locally owned assets, such as culverts and cross-road pipes. This module should explain the benefits of preventative maintenance practices, as well as how creating an inventory system and diligently updating it will prevent greater problems from arising in the future, both in terms of the physical asset's health, but also in terms of the knowledge the staff will have to routinely fix the smaller issues that do arise.

A third set of training modules should be developed focused on explaining the programs that GDOT can offer counties in order to help facilitate their asset management plans. This includes the resources and knowledge counties can receive from their GDOT district offices, but also how to obtain funding and equipment through GDOT programs. It can also explain who at GDOT can be contacted if a county or other local government is having difficulty finding a contractor for a project. Each state funding program, such as the Low Impact Bridge Program, may have its own module that clearly states what the criteria is for a bridge or other asset to qualify. Making these modules separate and reviewable will make it an excellent source for county officials to quickly be able to look up whether a larger asset project qualifies, rather than having to rely on outside information and guesswork. Each of these funding program modules should clearly state who in GDOT is to be contacted should there be any questions. It is also important that a module be developed that explains the process GDOT conducts to qualify a project for funding within the program, and should include expected wait times for counties to hear back from GDOT regarding the status of a funding application for some of the programs. Developing training modules that go hand in hand with the inspection and resource guides, as well as teach how to easily contact and work with GDOT for funding and resources, would shorten the learning curve for the new staff members and allow both GDOT and the county to pick up where they left off with the previous staff member.

Developing Regular Webinars and Training Programs

Another way that GDOT and county governments in Georgia can improve their relationship is to work together to find ways to facilitate and develop webinars. These regular meetings and discussions provide an opportunity for county officials and GDOT to come together to provide the newest information and best practices regarding transportation asset management. Some can even provide full training workshops for county officials to receive certification for some practices. It is recommended that GDOT work to establish these meetings on a quarterly basis as the largest interval between meetings. The more regular the meeting intervals, the better. Constant communication such as this and the ability to see one another face to face would be crucial to improving the relationships between county officials and GDOT staff. This undertaking would have several obstacles that would need to be overcome. However, there are ways to address them.

The first obstacle that comes to mind is the amount of coordination and administrative burden that would be needed to gather officials from so many different counties. One way to address this is to regionalize the webinars and split counties into smaller subsets to be gathered together. GDOT is already split into 7 districts, so it makes sense that each district is in charge of conducting its own webinar for the counties within their district. This addresses the coordination problem and provides other benefits in multiple ways. Firstly, it would strengthen the relationship counties within the district have with one another by being a part of a smaller group and giving more accessibility to both the GDOT district staff and to each other, since they are competing with fewer other counties for time to address their specific needs. Secondly, having the districts host their own webinars would allow the facilitators of the webinars to have more time to address regional issues. The counties of District 7, which makes up the heart of Atlanta, are going to have different issues than that of District 5, who makes up the Savannah Region and the rest of Southeast Georgia. Thirdly, coordinating a time and a place for representatives from each county government in a region to meet up is much easier than finding a time and place for representatives from every county. Rather than finding time for 159 county staff members, a GDOT district staff would only need to find a meeting time that works with, on average, 23 county staff members. Lastly, regionalizing these webinars and meetings would help with any traveling distances, should an in-person presence be required for the meeting.

The last two points above then beg the question of whether these meetings should be required attendance for county officials. This is the next major obstacle to consider, as outright requiring attendance at each individual meeting would make scheduling nigh impossible, especially if these meetings were to be quarterly or even more common than this. Thus, it is recommended that not every meeting have required attendance. The goal of these meetings to provide updated information and answer questions regarding new practices, but as regular as these meetings will be, not every meeting will have must-hear information for the counties and instead spend their time more wisely facilitating conversation of current practices and programs. These are the kind of meetings where counties should be heavily encouraged to attend, but not required, should their attention be needed elsewhere. GDOT can provide additional incentives to attend the non-required webinars, such as information regarding exclusive funding opportunities only available at the webinars. Of course, by making some meetings non-required, it should make it all the more important when some webinars and meetings *are* required. These webinars should be stated well in advance of their set dates and should be made very clear to the counties that they are required attendance versus the other meetings and webinars. By allowing GDOT to make some webinars and meetings required viewing, it provides GDOT the opportunity to distribute information on a quick and efficient medium, should an issue or program call for it. It is also recommended that GDOT and its district staff only schedule a required in-person meeting when it is able to compensate county staff members with travel expenses.

The last major roadblock that GDOT would face when attempting to schedule and facilitate webinars is the lack of technological prowess of certain areas of the state. This problem is two-fold. First, several areas of the state, especially south Georgia, do not have access to high speed internet. While the state government has made this a priority to fix in recent years, any program that relies heavily on the internet will be more difficult for these counties to take advantage of. The second part of the problem deals with some county staffs not being used to technology that enables the use of webinars. Many members of county staffs come from a generation that is not used to the extend that technology is used to communicate and coordinate groups from a distance away, Many of these staff members prefer talking over the phone and the occasional email, rather than downloading and learning a video-calling service. GDOT being patient and working with those county staffs to help explain why video-calling webinars are more efficient and effective than mass emails or calls is a must. Many times, it is these kinds of staff who are in need of the newest information the most, so finding ways to accommodate them means making sure those who would benefit the most from the program get what they need.

Enhancing Transparency and Access to Information

Another way that GDOT and county governments can improve their working relationship is to enhance transparency and access to information. The role that GDOT plays in county owned projects and assets has become routine and fully understood by the staff at GDOT. However, the research team has found through their interviews that many counties feel out of their league when working with GDOT on projects and feel as if, on a knowledge level, they have been left behind in a way. The research team has found a few courses of action GDOT can take to help mitigate this perception.

Recommended Actions and Priorities

One major area that GDOT could improve their access to information for counties is to provide more clarity on the process by which funding in some programs is distributed, as well as increased transparency regarding the status of applications for additional funding for counties and their projects. The resource guide described in the previous section would be a good starting place to solve this issue, as it would have an entire section dedicated to this information. However, GDOT providing more of this information on more easy to each places such as its website will make finding the information more accessible. Closing this knowledge gap between counties who have a better understanding of how to take advantage of funding programs and those who do not should be a key priority for GDOT moving forward to make sure some counties do not fall behind, but also to regain the trust from some counties. This should be prioritized in order to level the playing field among counties.

Equitable and Inclusive Access to Inspection Reports

The inspection reports provided by GDOT are something that almost every county in Georgia relies on in order to understand the conditions of their larger transportation assets. Thus, it was striking when the researchers found a gap in the understanding of inspection reports with multiple counties. Counties reported that the jargon used in the inspection reports was often different terms than the county staff generally use to describe assets and maintenance activities. In addition, the format of the inspection reports can be difficult to decern for new staff members who have not been used to interpreting the reports. If a county staff member reading the report did have questions about the contents of the inspection report, many counties have reported that they are not sure who to contact at GDOT in order to have these questions answered. Some counties contact bridge inspectors for questions. The logical answer is for them to contact their GDOT District Office and staff, however, there seems to be an inequity between the service some GDOT district offices give when it comes to knowledge sharing versus other districts. The resources guide and training described in the previous sections are expected to close this knowledge gap of how to interpret the report and what resources are available to answer questions regarding it.

Another way to solve the inequality of understanding between different counties regarding the inspection reports is to expand the number of counties who have access to the InspectX software. InspectX provides a singular service for counties to quickly access individual GDOT inspection reports on any bridge within their jurisdiction and see what comments have been made on that bridge, rather than relying on the summarized comments of a single GDOT letter. Currently, an insufficient number of counties have access to this software and the ones who do report to have a better understanding of the problems associated with their bridges. Access to the software would also allow county staffs to view inspection photos and review comments made by the inspectors. This would mean no more waiting on a bi-annual report of the county's bridge conditions, and it would allow them to act more immediately on a bridge who required maintenance.

Improving Ways to Update County Contact Information

The last way to improve the working relationship between Georgia counties and GDOT is to provide a service that will allow for counties to easily update the contact information for relevant county workers and staff. One of the biggest roadblocks the research team faced was that time and effort needed to be expended to find out who holds the relevant positions in the county in terms of bridge/culvert asset management and their contact information. Counties in Georgia have seen a lot of turnover in the past couple of years, especially during the pandemic. During the time of the pandemic, many counties saw long-standing staff member retire or leave their ranks for other opportunities. This lead to many counties searching for new staff to replace them and they did not think to update organizations like GDOT of the staff change. Further, it was reported by many counties officials in the survey that the younger workers they are hiring are increasingly likely to leave for other opportunities sooner than previous generations. This constant turnover has lead to GDOT having difficulty contacting who they need. Creating a system where counties can go specifically for the purpose of updating contact information would streamline the process, and is a much more efficient system than relying on the counties to provide the new information through email. Even if the counties do provide the contact information through email, it is likely that the updated information can be lost in the seas of emails sent to them. It is unclear as to whether GDOT can require counties to provide this information. However, if such process can be established, it is recommended, so that there is incentive for the counties to do so.

Improving and Facilitating Inter-County Relationships

One last major area in which GDOT can implement their goal of benefitting counties moving forward in regards to physical transportation assets is to encourage the partnership not just between GDOT and county governments, but also within the county governments. While GDOT provides guidance and resources for all counties in Georgia, another county transportation department can better understand the issues a county transportation department is going through than GDOT. This is especially true of counties who are located geologically close to one another. Encouraging counties to speak to one another on how they have been successful in accomplishing their projects and establishing maintenance practices might provide more benefit than any top-down decision made by GDOT at the state level. Being able to share resources, ideas, success stories, equipment with one another will build then bond of inter-county relationships.

Development Stages of Strategic Plan

Outline

Once the results from the survey had been analyzed, and major concepts to address in the strategy plan have been synthesized from those results and discussions, the next step was to develop an initial draft of the Strategic Plan. First, it was important to create an overall mission for the strategy plan and state it into words. Ultimately, it was decided that the stated vision of the plan would be to "prepared, grow and sustain resources, and/or activities that safeguard locally-owned bridges and culverts and promote partnerships between GDOT and Georgia local governments." This draft took the concepts developed in the previous sections and divided the plan into three major goals: Improve Communication, Enhance Transparency and Access, and Promote Learning and Engagement. From there, these three goals were then divided into two sub-goals, illustrating multiple avenues by which the overarching goal could be satisfied. A graphic was then developed to provide an overview of the vision, the goals, the strategies associated with those goals, the tasks that would be needed to implement those goals, and lastly, assessment measurements by which GDOT could measure how successful different strategies and tasks were. This graphic can be seen below in Figure 18.

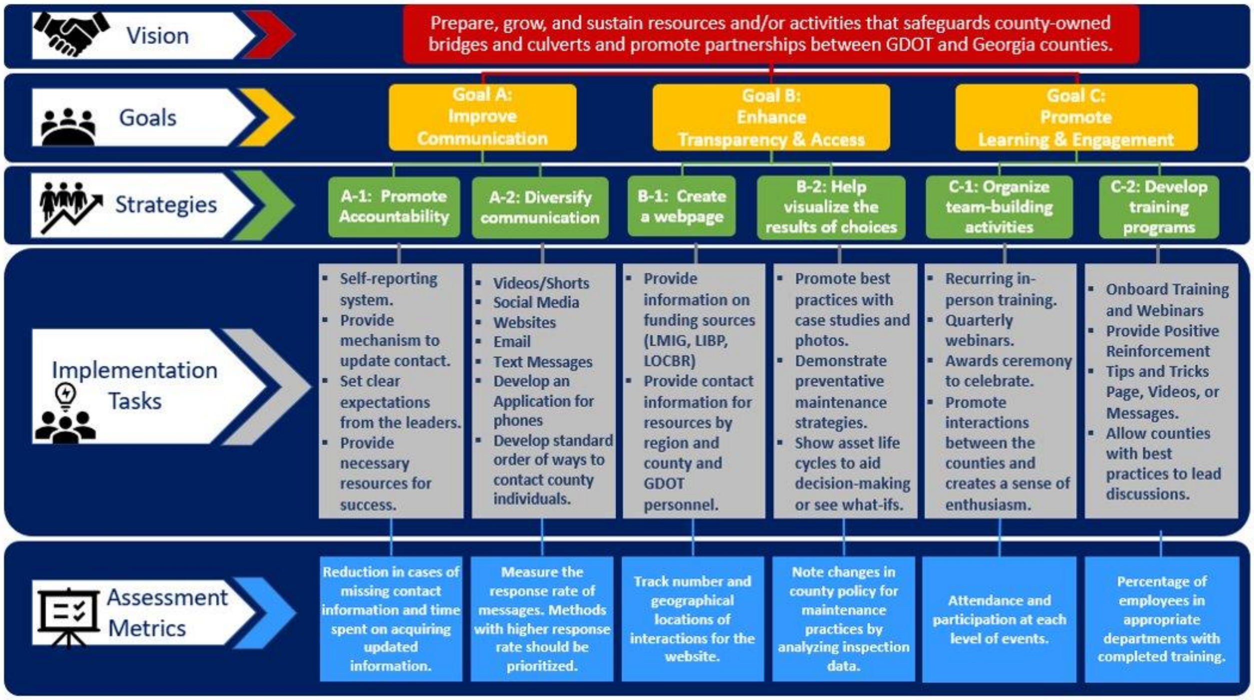


Figure 18. Initial Strategic Plan Concept Graphic

Initial Written Draft

Once this initial graphic was developed, the ideas contained within it needed to be fleshed out and provide more detail as to how to fully implement the strategies described above. This includes fleshing out the proposed strategies and resources discussed earlier in Chapter 5. This draft was presented to other members of the UGA Research team, as well as representatives at GDOT for comments and feedback. The feedback was overall positive, with some minor changes made to help differentiate some of the suggested practices from practices already done at GDOT.

Final Written Draft

After receiving feedback from GDOT representatives and future brainstorming, the final version of the strategic plan was to be developed. This final draft of the Strategic Plan can be found in Appendix B, with a brochure version of the plan in Appendix C. The first major change was that initially, the Strategic Plan called for the creation of a local government webpage. In January of 2023, GDOT launched their first rendition of a local government webpage. Thus, rather than focus on the development and create of a webpage, the Strategic Plan shifted to enhance the webpage, making suggestions as to what types of tools and resources could be made available in each of the existing webpages, when it comes to bridge maintenance. The second change involved the strategy of “Help Visualize The Result of Choices.” This strategy was renamed to “Build Visual Tools” and rather than focus on conceptual ideas of ways to visualized decision making, the section provided suggestions on three types of tools that could be developed that have been directly asked for, based on discussion with local governments. These are case studies, budgetary decision making tools, and life cycle analysis tools. While none of these tools are developed as a part of this thesis, future funding from GDOT can be used to develop these tools and resources and make them accessible to local governments. Once the Strategic Plan was finalized after further approval from GDOT, a brochure version of the Strategic Plan was developed in order to condense the ideas of the plan into an easily distributed form that still promote the goals and strategies of the plan.

CHAPTER 6. DEVELOPMENT OF GEORGIA NON-NBI CULVERT AND PIPE STRUCTURE INSPECTION GUIDE

Overall Strategy Behind Inspection Guide

As the research team discussed inspection practices for small local transportation assets during the interviews and field observation, the need for a standardized inspection guide became clear. Many counties have developed their own inspection standards and schedules that have made them successful in being able to keep up with their local assets. Among these counties, three were chosen to highlight successes and case studies within the inspection guide, so that other similar counties can learn best practices, and GDOT can help them reach their asset management goals. However, as interviews were conducted, there were plenty of counties that had not developed their own systems and were heavily reliant on reactive maintenance for their assets. An inspection guide that covers not only how to inspection the assets themselves, but also teach them how to develop an asset management, maintenance and inventory system would help these counties take their that step out of their inefficient reactive systems.

The contents of the inspection guide will cover multiple areas. It'll first contain a section that'll explain the purpose of the guide, which will be to help counties not only have a standardized practice for the inspection of these assets, but also how to set themselves up with a system moving forward that'll make their asset management more efficient. It'll next include a section dedicated to providing definitions for regular terms used during inspections and asset management, in order to clear up any questions regarding the meaning of these terms and to standardize conversation about them between counties. The next section will include a comprehensive list of the equipment needed by county staff in order to perform the inspections. After that, a section will be provided to each counties how to develop and maintain an asset inventory and how to manage it. It'll include information like example software used by other counties, as well as what information this inventory system should include in order to be complete. This is followed by a section teaching counties how to determine what inspection intervals should be required for their preventative maintenance plan, and how to change it depending on the condition system of their assets. Further, it'll include a section that will explain the logic and overall nature of the recommended condition rating system. The condition rating system will be similar to the systems seen both in other state GDOT guides, as well as successful inspection systems within the state of Georgia. This being a 5-tier system, where 1 is the best condition and 5 is the worst. The direction of order of the tiers and what they represent, (i.e. should 1 represent “best” or “worst”), was a topic of debate. Ultimately the team decided to stick with the 1=best, 5 = worst model, due to its use among successful counties in Georgia. However, the guide makes it clear this is only a recommendation and that counties should build systems around what is intuitive to them. The guide will then include a copy of a sample inspection form, as well as an inventory form, which can be used as paper copies of each, or they can provide the basis of what is inputted into an online inventory system.

The guide will then conclude with 5 county case studies. Four of these case studies are for observing existing successful programs by which local county governments have developed already and other local governments can seek to replicate. The last case study will involve a smaller county government that is seeking to establish their own program. This study will involve the research team providing an initial copy of the inspection guide and discussion of how the contents and strategies within the guide can be implemented into the county’s system and how successful it would be. These will be expanded upon in the next sections. A final draft of the Inspection Guide can be found in Appendix D.

Counties Visited to Observe Inspection Processes

One can base the development of an inspection guide on previous culvert and pipe inspection guides and produce a satisfactory product. However, the research team decided that interacting with and visually observing successful culvert asset management and maintenance systems from county governments in Georgia would provide critical information on two fronts. Firstly, it would allow the research team to see common practices and element between county plans that can be used as a baseline for the inspection guideline. In addition, the visits and subsequent reports on the asset management and maintenance system would serve as a basis for case study files that would be included in the inspection guide developed by the research team. These case files would serve as references by other counties who would want to establish systems of their own.

The following sections will recap and cover what was learned during these observation trips by the research team. Each section will provide some introductory information regarding how the meeting was arranged, followed by a summary of the meeting participants and what knowledge they brought to the visit. A general summary of what was discussed during the meeting and visit will then be provided. If it was discussed, a brief history of the program and how it has developed and evolved over time will be provided, as it adds important context as to how to develop a program from scratch. It will then cover a summary of the type of assets a county has to manage and whether there are any local codes that limit what kind of assets they can use. If the county uses a GIS or asset management software, a section explaining its use will be provided. Next, how the county goes about raising funds for its projects and program, as well as how it engages with the public will be discussed. Then a detailed explanation of their inspection process will be discussed, as well as whatever equipment they are using for these inspections. Finally, the sections will conclude with an overview and opinionated assessment from the research team of the culvert asset management and maintenance program and what can be applied from them to counties at large in the state of Georgia.

Oconee County

Introduction

Members of the research team of GDOT Research Project 21-02 visited the Oconee County Utility Department office, located on 1291 Greensboro Hwy and the Oconee County Road Department office, which is shown in Figure 19. This visit aimed at achieving the goal of highlighting best practices among county governments regarding the asset management including maintenance of small, locally maintained, bridges, culverts, pipes and other similar assets. In a previous phone call with Dr. Mi Geum Chorzepa, the county public works director described their system for managing and maintaining these assets and the description matched many of the practices that the research project wished to highlight for other counties to consider adopting. This includes the practice of scheduling regular inspections of locally-owned assets and a strategy to ensure each of these assets are maintained regularly and to promote preventative maintenance practices. The visit of Oconee County provided an opportunity for the research team to observe the practices of a county maintaining their assets with a medium-sized population relative to the rest of the state of Georgia. In addition, Oconee County was the first county the research team had visited where less than half of the geological area was considered under a MS4 permit zone, but a significant portion of it still was, as can be seen in Figure 20. This provided an opportunity to see how a county balances the expectations of inspection under and MS4 program and their own expectations for inspection of assets outside those designated zones.

Figure 19 - Front Face of the Oconee County Road Department Building

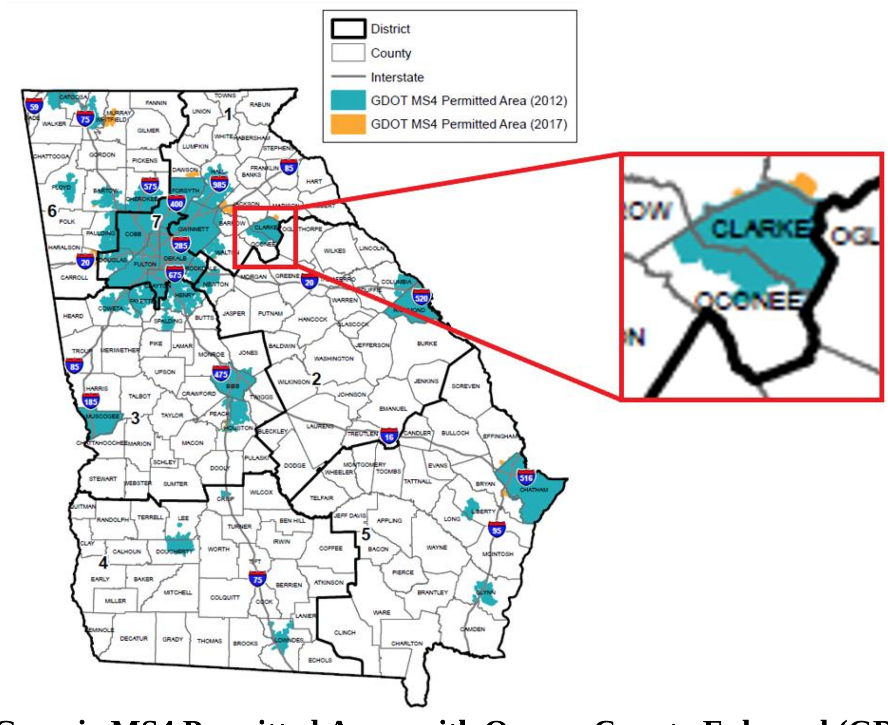


Figure 20 – Georgia MS4 Permitted Areas with Oconee County Enlarged (GDOT, 2017)

Meeting Participants

The public works staff of Oconee County's Utility Department and Road Department worked with the research team of the University of Georgia (UGA) to schedule an in-house visit in order to observe the practices for maintaining and managing the locally owned assets. The UGA Research team included Jared Palmgren and Dr. Mi Geum Chorzepa. The staff of Oconee County present at the meeting included Jody Woodall, P.E., the Director of Public Works, Michael Weathers, the Road Superintendent, and Allen Hawkins, the Crew Supervisor for the Road Department and his staff members. Mr. Woodall serves as a supervisor over all public works projects in Oconee County, which includes the Road Department, as was able to provide information on the overall strategy behind their maintenance and management systems for their assets, as well as what the process looks like once an asset is identified as in need of repair or replacement. Mr. Weathers serves as the supervisor over the Road Department and ensures the coordination needed to attend to all projects regarding the assets. This included explaining and showing the work order system by which Oconee uses to keep track of maintenance history, as well as double as an inventory system. Lastly, Mr. Hawkins was able to provide the onsite experience for the UGA research team. He showed a variety of assets and varied conditions under which he and his crew must inspect and repair assets.

Summary of the Meeting

The UGA Research team arrived at 8:30am at the Office of the Utility Department of Oconee County for an initial meeting with Jody Woodall, P.E. and Michael Weathers. During this initial discussion, the group discussed the overall strategy Oconee County uses to maintain their assets. The Oconee staff members discussed the philosophy to pursue preventative maintenance in their strategy as much as feasible in order to avoid larger problems with their assets in the future. The team discussed how the county-city government relationships worked when it came to dealing with urban-area assets, particularly ones under MS4 permit zones. The team then discussed how the strategy varies between assets managed solely by county standards and the asset which are under MS4 permits. The meeting participants then discussed a few recent projects that reflected some of the common maintenance activities they have completed over the years.

After the initial meeting, the UGA Research joined Allen Hawkins and his crew on a routine inspection and maintenance visit. During the visit, the team was able to observe the crew as they inspected assets, made decisions on what needed to be addressed on said assets, and then see the tools they used to accomplish their tasks. After observing the crew conduct its work, the UGA Research Team followed Allen Hawkins to a series of additional sites which contained assets of varying size and challenges. These sites were all ones discussed in the previous meeting with Jody Woodall and Michael Weathers. The research team was then able to observe and inspect the assets themselves while also discussing the strategy by which the crew and inspectors would approach these assets. The visit was concluded by returning to the Road Department office, where the research team was able to observe the work order system that the Road Department uses to log their inspections and maintenance activities for the assets.

Overview of the Strategy for the Inspection System

Oconee County has successfully implemented a system by which they regularly inspect their locally owned transportation assets such as culverts and cross-road pipes using a work-order system. Their own standard for maintaining and managing these assets is to divide their county into 4 sections and to provide inspections and maintenance on every asset within one section each year. The Oconee County staff did not have a visual aid to show in order to showcase these sections. However, Figure 21 shows an estimation of the four different sections, as described by the public works director. The type of assets the county works with are mostly corrugated metal pipes with a few larger concrete assets and none are smaller than 15 inches. One thing that separates Oconee county from the previous counties the team has observed is that they invest more effort in maintaining driveway pipes for roadway safety. For all these assets, the inspection and maintenance crews are one and the same, making repairs as they inspect the assets, when appropriate. The notes from the inspection, as well as any maintenance items done during the inspection are then documented through a work-order system developed for the county's use by the Athens Technical College. For these assets, there is no conditional rating system applied to the asset. It is simply a pass-fail system. Pass if the asset needed no or minimal maintenance. Fail if the repair crew needed to visit the site in the future with specialize equipment to conduct repairs or replacement. The county Road Department includes 16 employees, most of which have been trained to conduct these visual inspections and repairs.

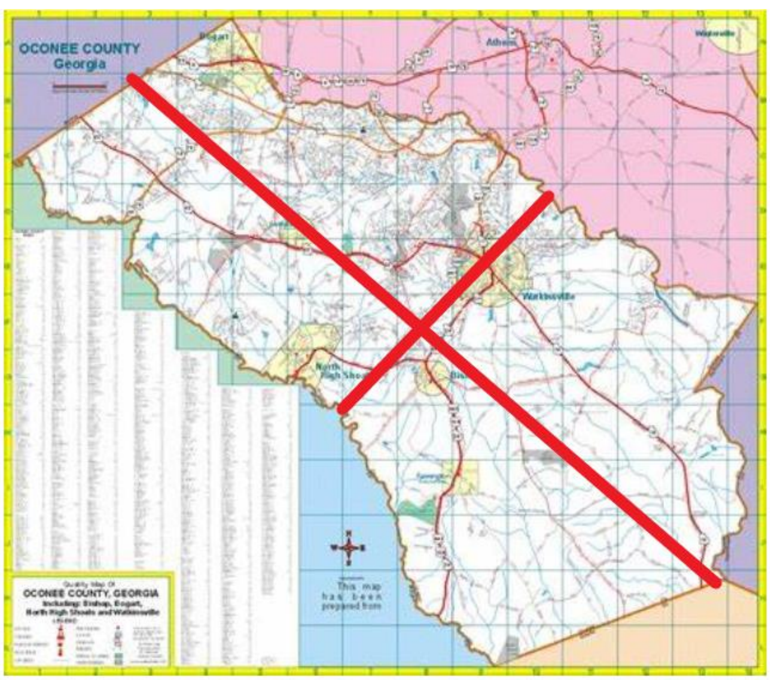


Figure 21 – Rough Estimate of the Four Regions Local Assets are Divided into for Oconee County

One of the things that made Oconee County such an interesting case study was that certain geographical portions of the county fell under MS4 permit while others were left entirely up to county standards. How Oconee County went about handling the different jurisdictions was identified as a point of informational interest going into the site visit. Although the assets are of similar type to the ones outside of the MS4 permit zones, Oconee County has a different strategy regarding the maintenance of those assets. Firstly, any of the assets included within Watkinsville and Bogart city limits were the responsibility of the city governments and their staff. Oconee County does monitor that the city governments are doing their part, but those assets are ultimately outside of their jurisdiction. These city assets make up for only about 26 miles of road compared to the 400+ miles of road within the county. Outside of the city limits are MS4 permit areas which are still regarded as “urbanized” by GDOT, and thus the assets fall under MS4 guidelines. Figure 22 provides a map of the different jurisdictions. Purple areas are city limits. Green areas are Oconee County, non-MS4-applicable, and the tan areas are Oconee County areas under MS4 guidelines. Under MS4, this means that these assets must be inspected at least once every 5 years. Oconee County currently contracts out the inspection process for these assets. The reason for this is because one of former Oconee County employees that was in charge of asset management might not have been aware of the requirements for these assets until early 2022, and thus needed to hire outside help in order to inspect 5 years’ worth of inspections within a 1-year period. They are currently in contract with William Rhodes of Bureau Veritas and state they plan to continue to work with him and his company in the future to conduct these inspections, since they cannot add more workload to their own staff for these assets. Any repair work and maintenance that needs to be conducted for these MS4-applicable assets is given to the county maintenance crew to complete. Most of the maintenance repairs were minor.

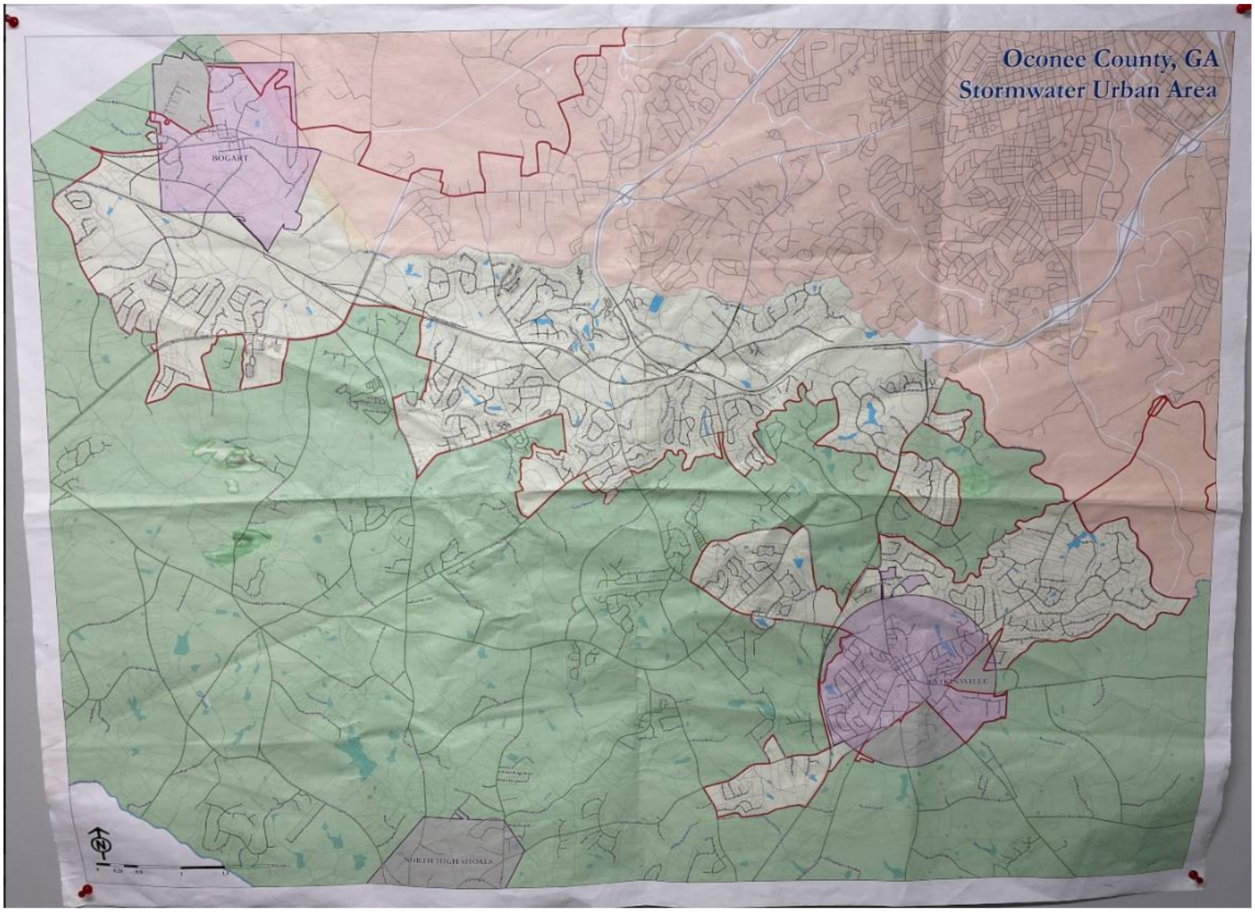


Figure 22 – Map of Northern Oconee County Showing City Jurisdiction and MS4 Jurisdiction

Asset Management Software Usage

Oconee County does not have a GIS system they rely on for inventory of their assets. However, this does not stop them from having a functional preventative maintenance plan, as they have in their possession a comprehensive work order system that can double as an inventory because of its completeness. The system the county uses is a Microsoft Access system developed by Athens Tech, such that only members of the Oconee County system can have access to it. The work order system includes all the information needed to be reported for an asset, including the staff who conducted the inspection/maintenance, the actions taken, location of asset (usually road name) the date of action, equipment uses and so on and so forth. A visual of the work order system can be seen in Figure 23**.** The system has been in use since 2009 and by this point includes records of every asset that the county regularly maintains. Thus, the previous inspection cycles records from 4 years ago could be used as a checklist for assets to be inspected.

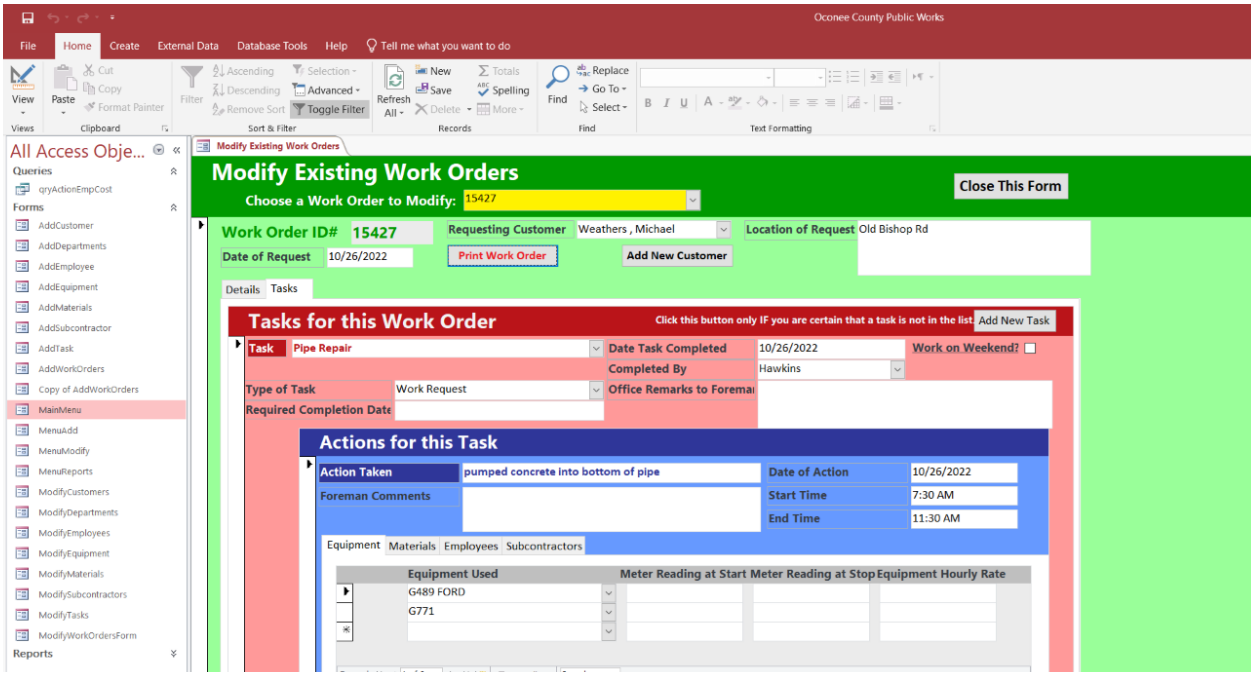


Figure 23 – Example Page of Work Order System Used by Oconee County Public Works

Inspection Processes and Equipment Used in During Inspections

Oconee County's inspection and maintenance systems work hand in hand with one another. Some other counties interviewed and observed have inspection duties and maintenance duties sperated into different crews. Oconee County has the same crew conduct both and look to accomplish both in the same visit. The county has one main crew that is to address the assets' inspection and maintenance. The crew is to observe and inspect assets, identify issues and then make judgements on what issues can be addressed there and now, and which required a future visit and additional equipment.

When the crew arrives at the site of an asset, they first look around the asset for signs of blockages or obstructions to its functionality. This includes looking for flooded areas that are not supposed to be flooded while also looking for obvious obstructions such as sediment buildup or vegetation. The crew then inspects the entrances or exit of the pipe/culvert, depending on which end they are on, for any signs of deterioration. Since these portions are exposed to the elements, they are the mostly likely areas of deterioration and/or suceptable to scour/erosion. The crew then shines a flashlight into the asset to look for signs of deterioration or blockages within the pipe.

The equipment used by the inspection and maintenance crew contained much of what is expected of such a crew, including shovels, writing pads, writing utensils, measuring tape, and safety equipment. The crew also included with them some larger and advanced pieces of equipment, mostly for the use of maintenance. The first equipment showed to the research team was a tool known as “Jaws of Life”. This is an electronic and hydraulic prier that is used often by fire departments to open doors and cars during emergencies. The Oconee County fire department is required to replace its equipment once every number of years. Oftentimes, this would mean discarding stiff functioning equipment, thus the road department was willing to take used tools in order to utilize during maintenance. These “Jaws of Life” tools are used by the crew to reopen deformed entrances and exits for the pipe, as seen in Figure 24**.** These pipes are typically corrugated metal pipes that are deformed from landscaping maintenance.

Figure 24 – Hydraulic "Jaws of Life" Tool Used to Reopen Corrugated Pipes

Another major piece of equipment that was carried with the crew was a miniature excavator. When possible, the crew would make minor earthwork fixes with shovels in order to clear pathways for stormwater drainage. However, some assets require the movement of more earth. This is where the excavtor is used. The earth removed from the site is placed onto a truck and weighed out at a separate site in order to record the amount of earth removed. A picture of the excavtor used by the crew can be seen in Figure 25**.**

Figure 25 – Excavator Used for Earthwork Necessary in Asset Maintenance

The third advanced piece of equipment used by the inspection/maintenance crew is what is known as a jetter. The jetter is an advanced hose designed to clean and clear the interiors of pipes using presurized water, while also propelling itself through the pipe using two rear holes that water is also ejecting from. A picture of the jetter can be seen in Figure 26**.** This is the county's main way to clean out the interiors of the pipes, and it is shared between the Utility Department and the Road Department. Finally, a specialized inspection camera is also available in the Utility's Department and is used when necessary.

Figure 26 – Jetter Tool Used for Clearing Interiors of Assets

Summary of Three Assets Visited

During the visit, the research team was able to observe 4 different assets. The first of which allowed the team to see some routine maintenance and inspection being conducted, before observing the last three, which showed slightly different methods the county utilizes to inspect and maintain their assets.

Asset #1: Two Cross-Road Corrugated Metal Stormwater Pipes

The first asset the team visited were two corrugated metal pipes that ran under two roads at an intersection. One pipe was 18inch in diameter and the other was 30 inch in diameter. These two pipes are part of the same stormwater system, thus clearing the way from one to another was part of the inspection and maintenance process. Observing this asset allowed the research team to see the inspection and maintenance of smaller assets. It was here the team could observe the "Jaws of Life" be used to pry open the exit of the smaller of the pipes and following this, the team observed the excavator be used to dig a shallow trench to allow better flow of water from one asset to another. The before and after of the latter process can be seen in Figure 27 and Figure 28.

Figure 27 – Asset #1 Prior to Earthwork Maintenance

Figure 28 – Asset #1 After Earthwork Maintenance

Figure 29 – Maintenance on Driveway Culverts

From this intersection of the main road, driveway pipes along a road leading to a residential area are also maintained as shown in Figure 29.

Asset #2: Large Corrugated Metal Pipe Asset with Concrete Bottom Lining

Figure 30 – Asset #2: Large Corrugated Metal Pipe Asset with Concrete Bottom Lining

The second asset observed by the inspection team was a large corrugated metal pipe, located under a major road. The pipe was 72inches in diameter and flowed from a creek to a nearby pond. One other thing that the research team is looking to highlight is ways that counties can promote tips and tricks they have learned over the years to help save the county money while also accomplishing their functional and structural repair for these assets. This asset provided one of those opportunities. As can be seen in Figure 30**,** the bottom of the asset is lined with concrete. The asset was dealing with a major deterioration problem on the bottom side and previous efforts to mitigate this with tar were not producing the necessary prevention of deterioration. Thus, rather than conducting a full pipe replacement, which would cost $60,000 estimated, the county decided to line the bottom of the pipe with concrete instead, which only cost the county $1,500 estimated and provides all the necessary fixes both functionally and structurally.

Asset #3: Large Reinforced Concrete Box Culvert

Figure 31 – Asset #3: Large Reinforced Concrete Box Culvert

The next asset the research team was able to observe was a large concrete box culvert that spanned over a major stream on a dirt road, which can be seen in Figure 31. This was an NBI asset but provided opportunity to discuss two aspects of the county's strategy that had not been discussed up until that point. Firstly, how inspection of a large concrete structural asset such as this was conducted in addition to GDOT's biannual inspection and secondly, how sediment control was a major issue for the county to deal with. The team was told that the structural inspection of this particular asset was left to GDOT to conduct and report to the county; however, the functional aspect is more frequently inspected based on the county crew's past experience.

Asset #4: Corrugated Metal Pipe Asset with Sleeve Addition

Figure 32 – Exterior of Asset #4

The last asset the research team was able to observed was a 48in. corrugated metal pipe located on a rural/minor road, emptying into a local pond. A photo of the asset can be seen in Figure 32**.** The asset contained rip rap above and to its sides. What was interesting about this asset was that if provided an opportunity to see the results of one of the county's most common maintenance activities, which was inserting sleeves into preexisting pipes. This asset had seen deterioration not only on the bottom of the barrel, like asset #2 had, but also on the sides and the top. Thus, a sleeve was needed. One of the goals of providing the sleeve was to effectively replace the walls of the pipe without having to dig up and actually the replace the whole pipe. Typically, sleeves are used to prevent erosion around a pipe structure and keep it from washing out. In this case, the goal was to keep the sleeve to as similar as size as possible to the original pipe while also making sure it can slide in easily. Thus, some sealant was used at each end to hold it in place. A better view of the interior, as well as the small gap between the original pipe and the sleeve where the sealant is laid, can be seen in Figure 33.

Figure 33 – Interior of Asset #4 with Sealant Holding Sleeve in Place

Public Engagement and Funding Advocacy

For funding of the inspections and maintenance of these assets, Oconee County is heavily dependent on SPLOST and TSPLOST programs. The county is conscious of the public perception of their department's work when it comes to those programs, since the 5-year vote that institutes those programs is dependent on the public's vote.

Research Team's Opinion of Oconee County's Culvert Management

The visit to Oconee County's Road Department and subsequent site visits to assets around the county provided plenty of great information for the research team to use when considering how to present best practices on the maintenance and management of local transportation assets. The work order system that Oconee County has developed for itself has clearly been successful and allows them to adopt preventative maintenance practices for these assets within their means. Oconee County's work order system for their Public Works division provides all possible necessary information on the history of an asset, as well as other factors such as the cost going into the maintenance and repairs of the assets. The county does a terrific job maintaining a comprehensive list of all inspection results and subsequent maintenance activities on the assets and does so in a work order system that is intuitive to all that use it. The county also exemplifies one aspect of preventive maintenance and that's its ability to keep a regular inspection schedule for its assets. It is the opinion of the research team that while Oconee County's system is successful, there are still steps that can be taken to improve it. The other two main aspects of a true preventative maintenance system are not as prevalent in Oconee's management and maintenance system for these local assets, and those are condition ratings and an inventory system that can be used for budgetary planning.

Athens-Clarke County

Introduction

Members of the research team of GDOT Research Project 21-02 visited the Athens-Clarke County (ACC) Public Works and Transportation Department office, located on 605 Spring Valley Road. This visit aimed at achieving the goal of highlighting best practices among county governments regarding the asset management including maintenance of small, locally maintained, bridges, culverts, pipes and other similar assets. In a previous phone call with Jared Palmgren, the county public works director described their system for managing and maintaining these assets and the description matched many of the practices that the research project wished to highlight for other counties to consider adopting. ACC either has or is in the process of acquiring the three major needs for a preventative maintenance system for their local transportation assets, which is regular inspections, a condition rating system, and a comprehensive inventory system. The crown jewel of the Public Works Department regarding the maintenance and rehabilitation of culvert and pipe assets within the county is their Live-Stream Pipe Replacement Program (LSPR), which is a strategy plan built to highlight in-need culvert and pipe assets and to begin steps to rehabilitate those assets, which they hope to expand to all their assets in the future. The visit of Athens-Clarke County provided another opportunity for the research team to observe the practices of a county maintaining their assets with a medium-sized population relative to the rest of the state of Georgia.

Meeting Participants

The public works staff of Athens-Clarke County's Transportation and Public Works Department worked with the research team of the University of Georgia (UGA) to schedule an in-house visit in order to observe the practices for maintaining and managing the locally owned assets. The UGA Research team included Jared Palmgren and Dr. Mi Geum Chorzepa. The staff of Athens-Clarke County present at the meeting included Jason Jones, the Engineering Design Coordinator, Josh Archer, Surveyor, and Hunter Kunzelmann, their Engineering Intern. Prior to the meeting, Rani Katreeb, P.E., the Assistant Director of Transportation and Public Works, provided insight into the county's relationship with GDOT and their handling of bridge assets. Mr. Jones is the head of the county's LSPR program and is in charge of maintaining the county's locally owned transportation assets such as culverts and cross-road pipes. Mr. Archer is one of the county's surveyors and provided some insight into the inspection process for the assets. Lastly, Mr. Kunzelmann was able to provide his knowledge of the program and experience working on the different assets within the program.

Summary of the Meeting

The meeting began at the ACC Office of the Department of Transportation and Public Works, where the GDOT research team was treated to a presentation by Jason Jones, with help from Josh Archer and Hunter Kunzelmann, regarding an overview of their Live Stream Pipe Replacement (LSPR) program, the work they have done to implement it, and what still needed to be implemented in the future. The presentation first covered the inspection process, including the presentation of their inspection forms and how they are used to determine overall condition scores. This was followed by a presentation of their LSPR spreadsheet, which documents all assets within the program. Discussion was then had regarding funding practices and strategies used by ACC to fund this program. The team then discussed the process by which ACC was gathering data and mapping an inventory of all of their assets, including the software and company they were using. The presentation ended with a projection as to where the program's ultimate goals (e.g., funding and public safety) lie .

After the presentation, the UGA research team and the representatives from ACC's Transportation and Public Works Department took site visits to four different assets. Three of these assets were considered failing and are now considered emergency projects as a major storm in early January lead to sinkholes and washed out roads appearing at the assets' sites. The 4th asset was a newly redesigned pipe in good condition, providing an opportunity to see what a routine inspection on a newer asset would look like. During each of the visits, the UGA research team was told some of the history behind the projects, how the LSPR program gave the count heads up that these assets could fail.

Overview of the Strategy for the Inspection System

Athens Clarke County either has or is in the process of acquiring the three major needs for a preventative maintenance system for their local transportation assets. They are in the process of having an external company, Arcadis, build their inventory. They have regular inspections for assets. Lastly, they have built and fleshed out a condition rating system for use by their inspectors to give overall condition rating to their assets. The condition rating system is slightly different from the ACC's. However, the inventory creation effort with Arcadis is currently still being developed, and it is important to first understand where the program is now and where it is headed towards with its ultimate goals. The following section will provide some brief history on the program, as well as cover how the program has helped build a strategy for tackling at-risk assets within the county.

The Live Stream Pipe Replacement (LSPR) Program was established in 2018 in the ACC Public Works and Transportation Department. The county identified a need to rehabilitate failing culvert and pipe assets, both for stormwater maintenance, as well as road maintenance. Assets were added to the list through either public complaints called in by county constituents or by locations discovered by staff. By 2021, the list has grown to 52 assets, and currently the list includes 45 assets. The assets are located all across the county, not just in urban areas, as can be seen in Figure 34**.** The program currently covers only at-risk assets, but the stated goal of the program is to one day include every local transportation asset located within ACC. Overall, the staff for the LSPR includes 5 members who work with it full-time. They often work in coordination with the streets and drainage division, which includes 30 additional staff members. An important note is that assets are mostly taken care of in-house; however, assets greater than 10 feet below the road surface or ones larger than 5 feet in diameter are reserved for contract work.

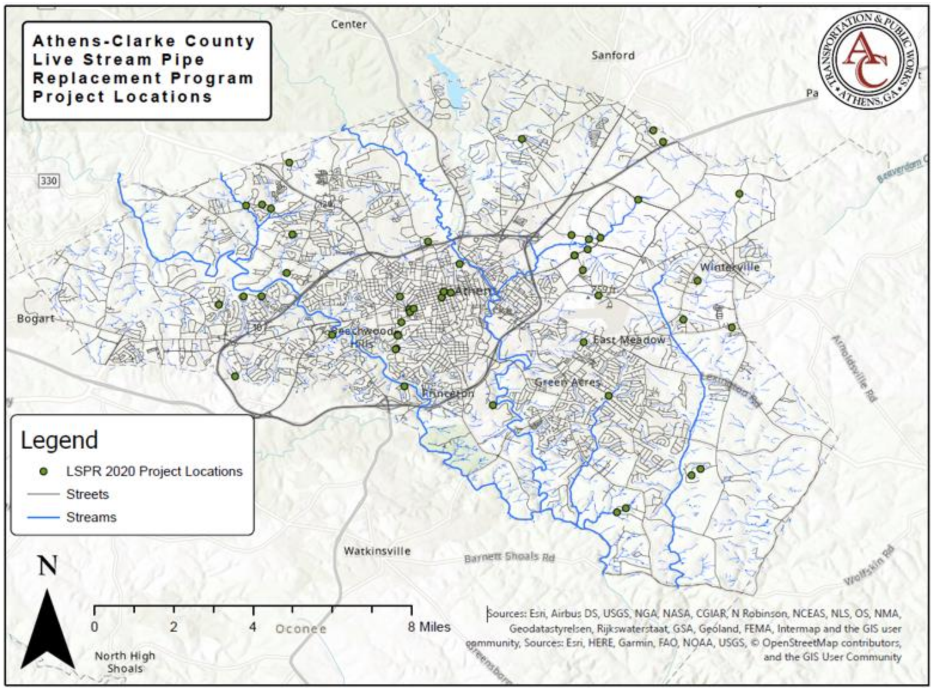


Figure 34 – Map of LSPR Assets in Athens-Clarke County as of 2020 (Jones, 2022)

Once the assets for the program have been identified, they are then put into a list and ranked by their current overall condition rating. The 2021 version of the LSPR list can be seen in Figure 35**.** The condition ratings listed are based on a 1-5 scale with 5 being the worst condition. Any asset between 4 and 5 is given an "F" designation for "Fail". These are assets that should be put in preliminary design for replacement. Any asset between 3 and 4 is given "C" for "Critical". These assets typically are set to be prepared for rehabilitation practices, rather than full replacement. Anything between 1 and 3 is given "P" for "Poor". These assets are of lower priority, but are taken care of as soon as the county is able. Having the assets in the worst condition at the top of the list makes it easier to identify which assets the county should place resources and funding into fixing first.

No.	LSPR 2020	Rating	Condition	Street Name/Address	Conceptual Cost Estimate	Project Status
1	14	5.00	F	Seagraves Dr (191)	$400,000	preliminary
2	1	4.80	F	Voyles Rd (1270)	$506,250	preliminary
3	2	4.60	F	Lavender Rd	$650,000	preliminary
4	3	4.40	F	Olympic Dr	$650,000	preliminary
5	4	4.40	F	Cleveland Ave	$606,250	conceptual
6	5	4.40	F	Charlie Bolton Rd (1143)	$530,000	preliminary
7	6	4.40	F	Olympic Dr	$381,250	preliminary
8	7	4.40	F	Roberts Rd	$550,000	preliminary
9	28	4.40	F	Charm site College Ave	$856,250	conceptual
10	8	4.30	F	W Huntington Rd (270)	$85,000	conceptual
11	9	4.20	F	Millstone Circle (345)	$150,000	concept - UGA
12	10	4.20	F	Woodhaven Dr.	$165,000	concept - UGA
13	12	4.00	C	Charlie Bolton Rd (1450)	$112,500	concept - UGA
14	13	4.00	C	Old Epps Bridge Rd (385)	$165,000	conceptual
15	30	4.00	C	Idylwood Dr (255)	$400,000	conceptual
16	31	4.00	C	Idylwood Dr (330)	$550,000	conceptual
17	15	3.80	C	Lavender Rd	$112,500	concept - UGA
18	!58*	3.80	C	Chase St	$800,000	conceptual
19	17	3.60	C	Cleveland Ave (132)	$693,750	conceptual
20	18	3.60	C	Baxter St (1088-1080)	$756,250	conceptual
21	20	3.60	C	Olympic Dr (1350)	$918,750	preliminary
22	23	3.60	C	Minor St. (275)	$650,000	conceptual
23	24	3.60	C	Rhodes Dr (282)	$180,000	concept - UGA
24	25	3.60	C	Riverbottom Circle (101)	$180,000	conceptual
25	26	3.60	C	Walton Creek Rd (205)	$75,000	conceptual
26	27	3.40	C	Winterville Rd (1958)	$112,500	conceptual
27	29	3.40	C	Cedar Shoals Dr (1325)	$668,750	conceptual
28	54	3.40	C	Reese Street	$95,000	conceptual
29	!57*	3.40	C	Oakbend Ct	$200,000	conceptual
30	32	3.20	C	Athena Dr	$918,750	preliminary
31	34	2.80	P	Hancock Ind. Way	$112,500	conceptual
32	35	2.80	P	Hickory Dr (6085)	$50,000	In Progress
33	36	2.80	P	King Ave (424)	$320,000	conceptual
34	39	2.80	P	Riverbend Pkwy	$50,000	conceptual
35	!59*	2.60	P	Cleveland Rd (1550)	$650,000	conceptual
36	37	2.60	P	Fortson Dr	$550,000	conceptual
37	38	2.60	P	Hunters Crossing Rd (159)	$45,000	In Progress
38	53	2.60	P	Paris St	$2,300,000	conceptual
39	40	2.40	P	Lavender Rd	$731,250	conceptual
40	41	2.40	P	Hills Chapel St. (190)	$450,000	conceptual
41	42	2.20	P	Walton Creek Rd	$75,000	conceptual
42	43	2.20	P	Woodhaven Dr (281)	$45,000	conceptual
43	44	2.00	P	Crossbow Cir (197)	$550,000	conceptual
44	45	2.00	P	Westlake Dr.	$1,100,000	conceptual
45	46	2.00	P	Waddell St. (905)	$600,000	conceptual
46	55	2.00	P	Riverbottom Rd (675)	$500,000	conceptual
47	47	1.80	P	Jennings Mill Parkway	$400,000	conceptual
48	48	1.80	P	Milledge Circle	$900,000	conceptual
49	52	1.80	P	N Pope St (252)	$80,000	conceptual
50	50	1.60	P	Lake Dr (126)	$60,000	conceptual
51	51	1.50	P	N Church St (133)	$48,000	conceptual
52	49	1.20	P	Lake Dr	$45,000	conceptual

Red = In Preliminary Engineering Design w/ Contractor Green = Construction In Progress/Scheduled to be completed in 2022
Blue = Under Consideration as a Rehab Solution Brown = !* project added to LSPR2020 after M&C approval – not eligible for funding

Total Estimated Cost w 20% contingency: $ 27,336,600

Figure 35 – LSPR List for 2021 (Jones, 2022)

In addition to the current year's ranking, the asset's rankings from the previous year's list is also available. **Figure 23** above shows the 2021 asset list which references the 2020 rankings. This ranking mechanism can also be used to help determine which assets should be targeted first. An asset such as the "Charm Site College Avenue" Asset, which has gone from the #18 ranked asset to the #9 ranked asset in **Figure 23**, is showing signs of much faster deterioration than the assets around it. This might mean that it would received resources and funding before the "Roberts Rd" asset even though "Roberts Rd" has a higher ranking this year, because "Roberts Rd" has only gone from the #8 ranked asset to the #7.

Each asset is also given a conceptual cost estimate. This cost is developed through a rough estimate of 4 different cost categories that are then summed together into the table in **Figure 23.** These four cost categories are "Rough Design Cost", referring to engineering design, "Rough Construction Cost", referring to construction activities of the asset, "Right of Way Acquisition", referring to any cost of purchasing right of way for county workers and vehicles around assets, and lastly, " Utility Relocation", referring to the cost associated with moving utility lines should this be needed for the project. This strategy has allowed the ACC Public Works and Transportation Department to estimate a total budget they can present to the county at larger in order to take care of all assets. As of 2021, this total was roughly $27.3 million. This total represents the total amount of money the department will need to get back to solely preventative maintenance practices and minor rehabilitation projects on their assets. The department does not expect to get all this funding in a single year. However, the goal is for this total to decrease year by year as projects on the list are completed and for any newer projects that are added to be less severe and less expensive than previous projects. A visualization of this strategy can be seen in Figure 36**,** where the black line represents the budget each year the program receives, the green line represents what the county needs to do preventative maintenance activities and the blue bars are the actual budget from previous years. The figure shows that for the short term, the budgets for the program will need to be larger in order to make up for the lack of funding in previous years; however, these will decrease to a financially sustainable level as projects are rehabilitated and completed.

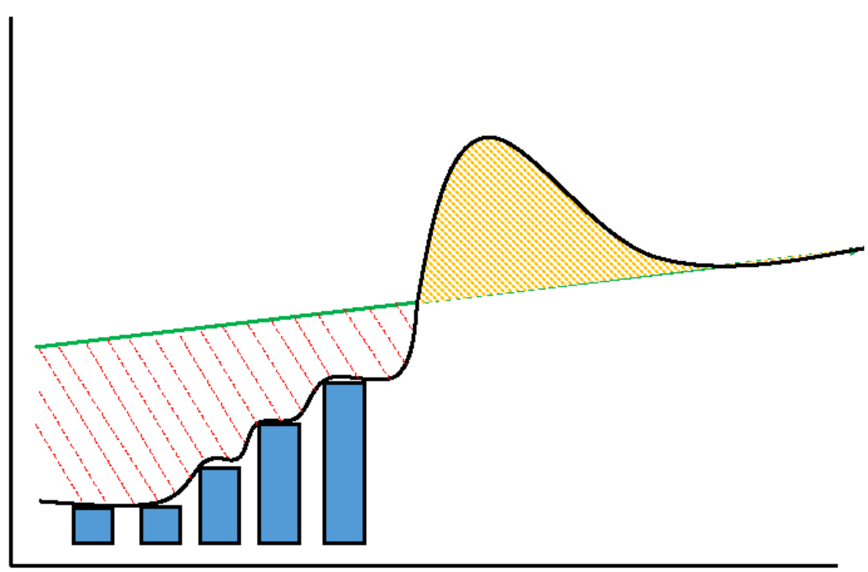


Figure 36 – Visualization of Future Funding Strategy for ACC Assets (Jones, 2022)

In terms of the future, the goal is to eventually have a sustainable budget for the LSPR program such that it can cover preventative maintenance practices and there would not be such a need for rehabilitation or replacement funding. Eventually, all ACC locally owned transportation assets are expected to fall under the LSPR program in order to promote these preventative practices. Already, ACC is seeing this program help them save money long term and prepare for future issues. In early January 2023, a large storm washed out several culverts in the ACC jurisdiction. All three of these culverts were on the LSPR program, which means that preliminary steps for their replacement had already begun. This puts ACC ahead of the process compared to a local government that did not know the condition of those assets ahead of time.

Inventory Management and Asset Management Software Usage

As mentioned before, the LSPR program will eventually apply to all assets located within ACC. In order to do this, ACC will need to have a comprehensive inventory system for their stormwater and transportation assets. In order to do this, ACC has contracted with a firm known as Arcadis, which is made up of a 2-man team to map out the GPS coordinates and features of every asset in Athens-Clarke County. The county has spent roughly $1 million on the contract so far over the last 3-4 years. However, this is not a single lump sum the county has to pay at one time. The way the contract is written, Arcadis will map as far as the funding provided by ACC will take them. Once the funding runs out, they will stop until they receive additional payment from ACC. This can be an effective strategy for smaller counties with not as robust and/or sustainable budgets to plan out a similar contract over multiple years. The map provided by Arcadis for ACC as of 2021 can be seen in Figure 37**.**

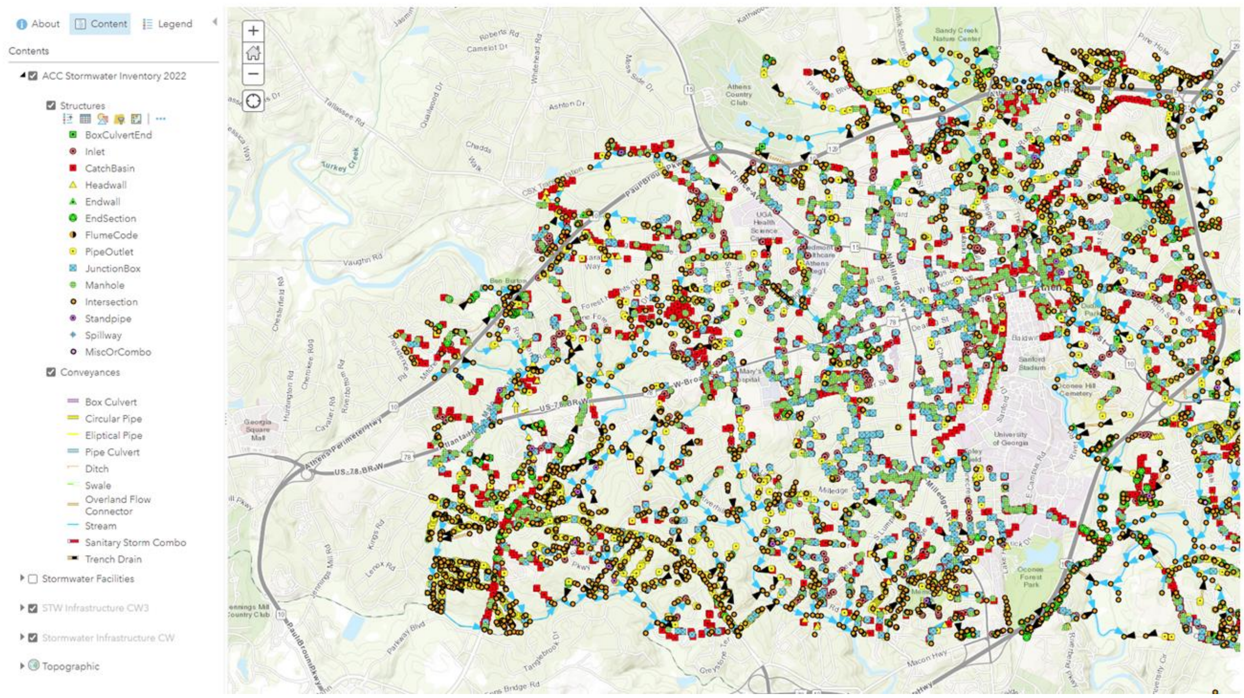
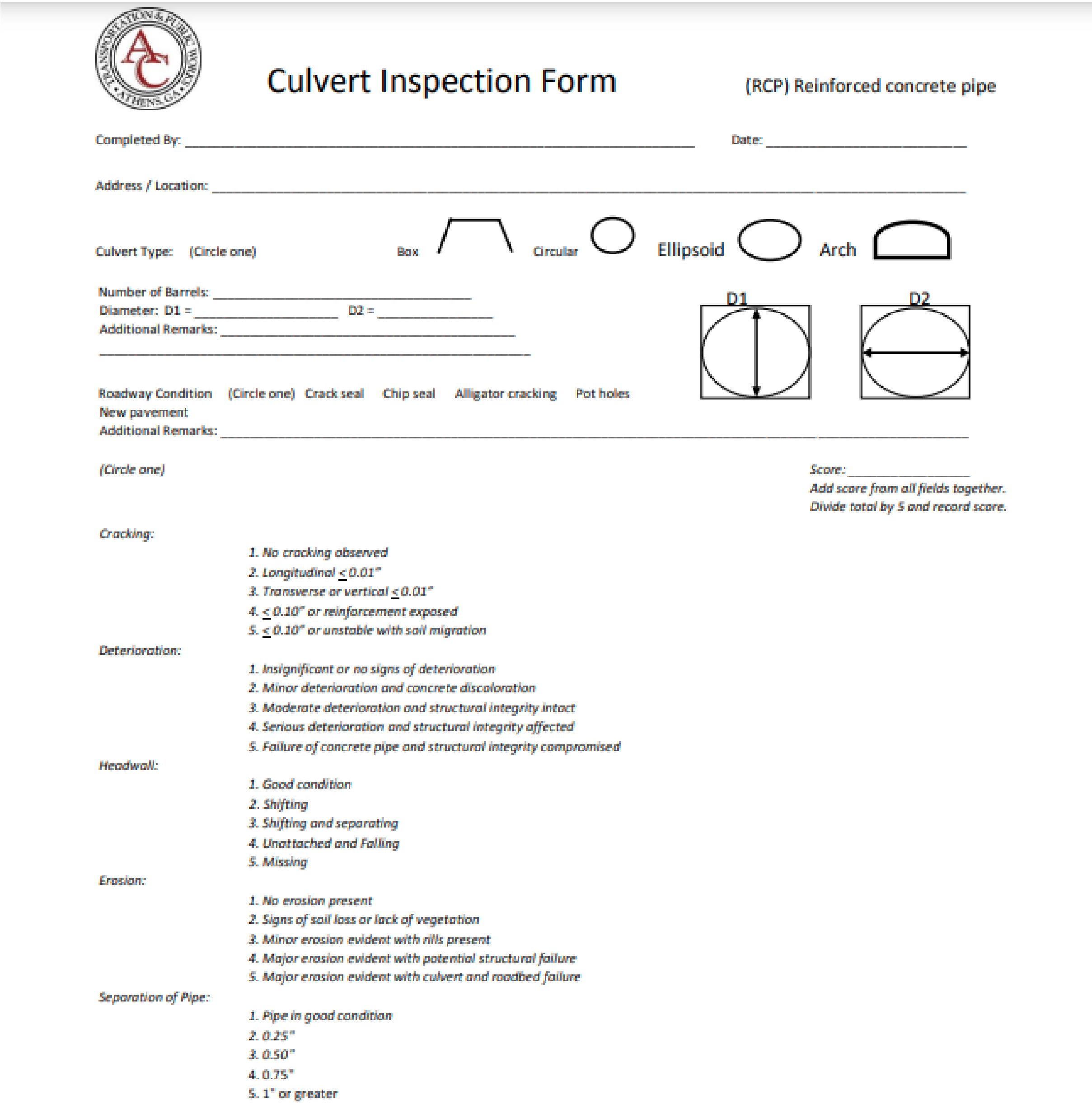


Figure 37 – Map of ACC Stormwater Inventory Developed by Arcadis (Jones, 2022)

The information included in this inventory system can be accessed by an in-house GIS system. With each asset, a number of properties will be able to be accessed, including the location, condition ratings, geometric information and much more. Jason Jones stated that each asset will contain everything from the inspection reports they currently use and more.

Inspection Processes and Equipment Used in During Inspections

For now, regular inspections and condition ratings are reserved for assets of concern, but ACC has everything they need to apply those to all of their assets in the future. The Department of Public Works and Transportation have developed their own set of inspeciton forms, one for each type of major asset they have under their jurisdiction: reinforced concrete pipes (RCPs) and Corrugated Metal Pipes (CMPs). They are currently in the process of developing a separate inspeciton form for their plastic pipes, as those have started to become more popular for driveway pipes. The blank form of these forms can be seen in Figure 38**.** While these inspection forms can be printed, ACC has developed a survey through ARCGIS that inspectors can complete in the field on a tablet that asks all of the same questions and prints out a finished version.



Culvert Inspection Form

(RCP) Reinforced concrete pipe

Completed By: ______________________ Date: ______________

Address / Location: ______________________________________

Culvert Type: (Circle one) Box Circular Ellipsoid Arch

Number of Barrels: ______________

Diameter: D1 = __________ D2 = __________

Additional Remarks: ______________________

D1 D2

Roadway Condition (Circle one) Crack seal Chip seal Alligator cracking Pot holes New pavement

Additional Remarks: ______________________

(Circle one)

Score: ______________
Add score from all fields together.
Divide total by 5 and record score.

Cracking:

1. *No cracking observed*
2. *Longitudinal ≤ 0.01"*
3. *Transverse or vertical ≤ 0.01"*
4. *≤ 0.10" or reinforcement exposed*
5. *≤ 0.10" or unstable with soil migration*

Deterioration:

1. *Insignificant or no signs of deterioration*
2. *Minor deterioration and concrete discoloration*
3. *Moderate deterioration and structural integrity intact*
4. *Serious deterioration and structural integrity affected*
5. *Failure of concrete pipe and structural integrity compromised*

Headwall:

1. *Good condition*
2. *Shifting*
3. *Shifting and separating*
4. *Unattached and Falling*
5. *Missing*

Erosion:

1. *No erosion present*
2. *Signs of soil loss or lack of vegetation*
3. *Minor erosion evident with rills present*
4. *Major erosion evident with potential structural failure*
5. *Major erosion evident with culvert and roadbed failure*

Separation of Pipe:

1. *Pipe in good condition*
2. *0.25"*
3. *0.50"*
4. 0.75"
5. 1" or greater

(a) Reinforced Concrete Pipe (RCP)

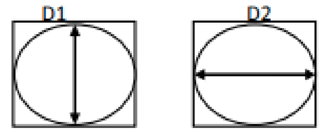
Culvert Inspection Form (CMP) Corrugated metal pipe

Completed By: ______________________________ Date: ______________

Address / Location: ______________________________

Culvert Type: (Circle one) Box Circular Ellipsoid Arch

Number of Barrels: ______________
Diameter: D1 = __________ D2 = __________
Additional Remarks: ______________



Roadway Condition (Circle one) Crack seal Chip seal Alligator cracking Pot holes New pavement
Additional Remarks: ______________

(Circle one)

Score: ______________
Add score from all fields together.
Divide total by 5 and record score.

Deflection:

1. *No deflection*
2. *5%*
3. *10%*
4. *15%*
5. *20%*

Invert condition:

1. *Good condition*
2. *Discolored only*
3. *Signs of oxidization*
4. *Oxidizing with holes*
5. *Completely rusted*

Headwall:

1. *Good condition*
2. *Shifting*
3. *Shifting and separating*
4. *Unattached and Falling*
5. *Missing*

Erosion:

1. *No erosion present*
2. *Signs of soil loss or lack of vegetation*
3. *Minor erosion evident with rills present*
4. *Major erosion evident with potential structural failure*
5. *Major erosion evident with culvert and roadbed failure*

Separation of Pipe:

1. *Pipe in good condition*
2. *0.25"*
3. *0.50"*
4. *0.75"*
5. 1" or greater

(b) Corrugated Metal Pipe (CMP)

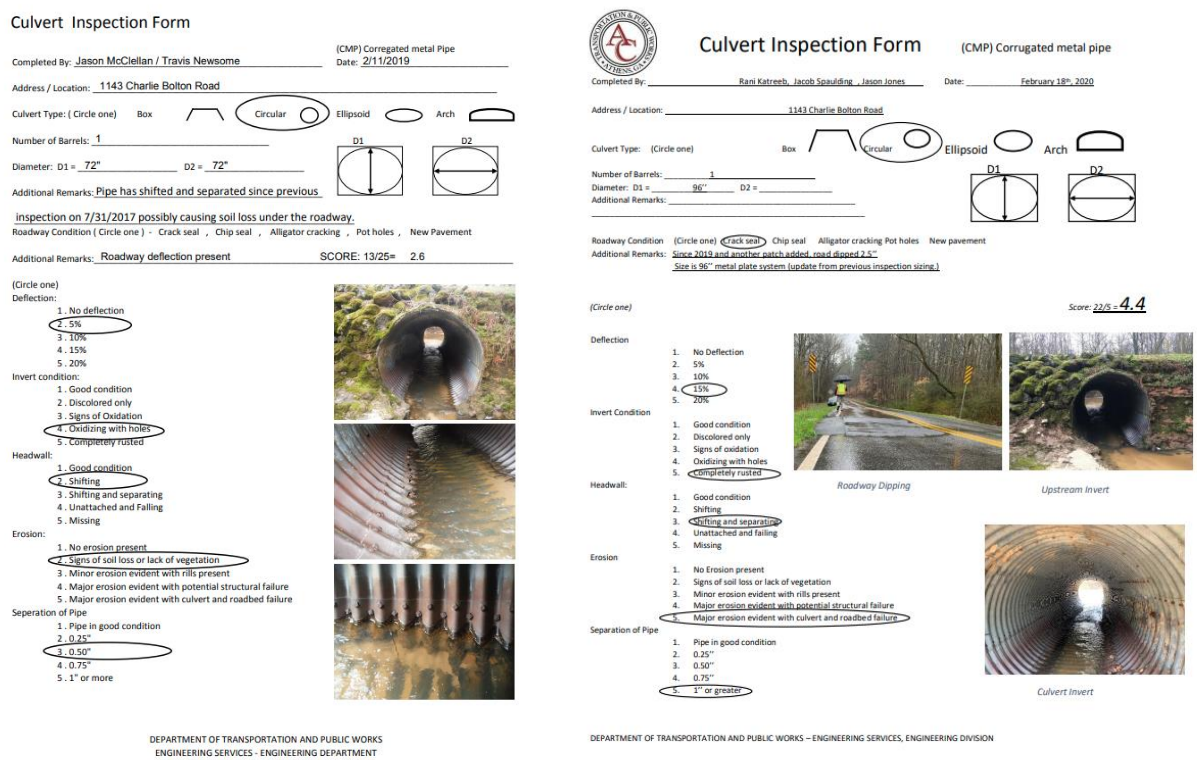
Figure 38 – Culvert Inspection Forms for Reinforced Concrete Pipe (RCP) and Corrugated Metal Pipe (CMP)

The forms are similar on several fronts. Each one asks for who is conducting the inspection, what day the inspection is occurring on and the location of the asset. The form then asks for geometric information on the asset. First it asks for the shape, of which there are 4 options: box, circular, ellipsoid and arch. It then asks for the number of barrels, and the 2 diameters of the asset. Diameter 1 refers to the top to bottom diameter while Diameter 2 refers to the left to right diameter. The forms then ask about the roadway conditions around the asset, for which there are 5 options: crack seal, chip seal, alligator cracking, pot holes, and new pavement.

After this information has been gathered, the condition assessment can begin. Both types of assets are rated on a scale of 1 to 5, with 1 being the best condition and 5 being the worst. Each type of asset has 5 criteria by which it is evaluated, although the criteria differs between the two. Each criterion has its own 1-5 scale and descriptions to go along with it. Once the evaluation is complete for all of the criteria, an average score is calculated and that is the overall condition for the asset. For both assets, headwall, erosion and separation of pipe are evaluated. For headwalls, the inspector is mostly concerned with whether it is shifting or separating from the pipe. Any asset that doesn’t have a headwall is automatically given a 5 for the criteria. For erosion, the inspector is concerned with how much the erosion is affecting the structural integrity of the asset and the area around it. Jason Jones mentioned that he would like to see the category overhauled to include environmental impact as well. Specifically, how the culvert is affecting water quality and stream geometry. Lastly, both types of pipe are evaluated on the separation of pipes. Anything greater than 1 inch is automatically a 5, with lesser scores for lesser separation.

For RCPs, cracking and deterioration are evaluated as 2 of the criteria. For cracking, the inspector is looking for presence of longitudinal cracking and transverse cracking. Then they measure the cracks and assess based on that. If any reinforcement is exposed, the pipe is automatically given a 4 for the criteria. If a soil migration makes the asset unstable then the asset is given a 5. For deterioration, inspectors are looking for deterioration of the concrete and any discoloration. They are also evaluating how much the deterioration is affecting the structural integrity of the asset. For CMPs, the two unique criteria for them are deflection and invert condition. For deflection, the inspector is looking for how much of the Diameter 1 measurement from before has decreased from its original value at the lowest point in the pipe. Anything over 20% reduction is given a 5 for the category. For invert condition, inspectors are looking at the condition of the metal within the pipe, especially along the bottom. Inspectors should look for signs of discoloration, oxidizing, presence of holes or if there are entire sections rusted out.

These inspection forms are already providing much needed information for culverts around ACC. They are helping to capture rapidly deteriorating structures such as the example below in Figure 39**.** The county was able to see the structure go from a condition rating of 2.8 to 4.4 in just a year's time and immediately put this structure at the height of their funding and resource plans.



Culvert Inspection Form

(CMP) Corregated metal Pipe

Completed By: Jason McClellan / Travis Newsome   Date: 2/11/2019

Address / Location: 1143 Charlie Bolton Road

Culvert Type: (Circle one)   Box   Circular   Ellipsoid   Arch

Number of Barrels: 1   D1   D2

Diameter: D1 = 72"   D2 = 72"

Additional Remarks: Pipe has shifted and separated since previous inspection on 7/31/2017 possibly causing soil loss under the roadway.

Roadway Condition (Circle one) - Crack seal , Chip seal , Alligator cracking , Pot holes , New Pavement

Additional Remarks: Roadway deflection present   SCORE: 13/25= 2.6

(Circle one)

Deflection:
1 . No deflection
2 . 5%
3 . 10%
4 . 15%
5 . 20%

Invert condition:
1 . Good condition
2 . Discolored only
3 . Signs of Oxidation
4 . Oxidizing with holes
5 . Completely rusted

Headwall:
1 . Good condition
2 . Shifting
3 . Shifting and separating
4 . Unattached and Falling
5 . Missing

Erosion:
1 . No erosion present
2 . Signs of soil loss or lack of vegetation
3 . Minor erosion evident with rills present
4 . Major erosion evident with potential structural failure
5 . Major erosion evident with culvert and roadbed failure

Seperation of Pipe
1 . Pipe in good condition
2 . 0.25"
3 . 0.50"
4 . 0.75"
5 . 1" or more

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
ENGINEERING SERVICES - ENGINEERING DEPARTMENT

Culvert Inspection Form   (CMP) Corrugated metal pipe

Completed By: Rani Katreeb, Jacob Spaulding , Jason Jones   Date: February 18th, 2020

Address / Location: 1143 Charlie Bolton Road

Culvert Type: (Circle one)   Box   Circular   Ellipsoid   Arch

Number of Barrels: 1   D1   D2

Diameter: D1 = 96''   D2 =

Additional Remarks:

Roadway Condition (Circle one) Crack seal Chip seal Alligator cracking Pot holes New pavement

Additional Remarks: Since 2019 and another patch added, road dipped 2.5''
Size is 96'' metal plate system (update from previous inspection sizing.)

(Circle one)   Score: 22/5 = 4.4

Deflection
1. No Deflection
2. 5%
3. 10%
4. 15%
5. 20%

Invert Condition
1. Good condition
2. Discolored only
3. Signs of oxidation
4. Oxidizing with holes
5. Completely rusted

Headwall:
1. Good condition
2. Shifting
3. Shifting and separating
4. Unattached and failing
5. Missing

Erosion
1. No Erosion present
2. Signs of soil loss or lack of vegetation
3. Minor erosion evident with rills present
4. Major erosion evident with potential structural failure
5. Major erosion evident with culvert and roadbed failure

Separation of Pipe
1. Pipe in good condition
2. 0.25''
3. 0.50''
4. 0.75''
5. 1'' or greater

Roadway Dipping

Upstream Invert

Culvert Invert

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS – ENGINEERING SERVICES, ENGINEERING DIVISION

Figure 39 – Filled out Inspection forms of CMP Asset 1 Year Apart

Rehabilitation Practices

Outside of direct replacements, ACC's Department of Transportation and Public Works is looking for rehabilitation and preventative maintenance practices they can conduct on their pipes. One technique they have dsicovered and started implementing with their corrugated metal pipes is the use of a spray-on geopolymer lining in the invert of the assets. The lining is designed to cover the interior of the asset and plug any holes or rusted areas that may have built up over the years. The contractor that performed the job in Figure 40 used golf tees to measure out how thick the geopolymer layer needed to be and then coated the pipe in two layers. The finished product can be seen in the second picture. The biggest concern with this practice is that it does constrict the diamter of the pipe, changing the amount of runoff that can be expected to flow through it.

Figure 40 – Before and After of Geopolymer Lining Pipe Rehabilitation.

Summary of Three Assets Visited

After the initial presentation, meeting, and discussion regarding ACC's Live Stream Pipe Replacement Program, the teams visited some examples of culverts and pipes around the county. One thing that separated the ACC visit from previous county visits was their willingness to show the UGA research team recently failed culverts. Three of the culverts/pipes that were visited had failed recently due to a large stormwater event in the previous month. All three of these assets were known to be failing, which allowed the county to more swiftly respond to their failure event. This provides excellent examples of both what happens when assets are left to deteriorate and are not maintained, but also shows that having even the start of a preventative maintenance plan makes a local government more prepared to address failure events when they occur.

Asset #1: Washed Out Corrugated Pipe Culvert and Road on Olympic Drive

The first asset visited by the teams was a large corrugated metal pipe located on Olympic Drive located about 10 feet underneath the roadway. The latest storm event completely overwhelmed the culvert. Even worse, the culvert was known to have deterioration in the inlet, allowing the water to seep outside of the pipe and into the soil around it. This resulted in the collapse of the soil surrounding the pipe and the roadway above it. In addition, the collapse resulted in trapping of a car and its passenger on the edge of the sinkhole when the event occurred. The passenger was able to safely leave the vehicle before more portions of the road collapsed and claimed the car, as can be seen in Figure 41**.**

Figure 41 – Road Damage Caused by Culvert Failure on Olympic Drive

The ACC team talked about the asset being one of their older assets and that many of the construction techniques used to make it are now considered outdated. One can see in Figure 42 the collapse and separation of the pipes that likely contributed to the failure of the system. It also shows the exposed utility lines the failure caused which makes the replacement and rehabilitation of the site that much more difficult and expensive. ACC is currently in the process of designing a replacement culvert and is considering a large box culvert.

Figure 42 – Culvert Failure on Olympic Drive

Asset #2: Deteriorated Corrugated Pipe Culvert with Sinkholes on Voyles Road

The second site that the teams visited was a double barrel asset located on Voyles Road. The asset was made of two corrugated metal pipes, one having a diameter of 48 inches and the other having a diameter of 42 inches. The road had to be closed down due to the development of a sinkhole next to the road, which can be seen in Figure 43**.** This sinkhole exposed a water utility line and signified that the road itself was in danger of collapse, even though no collapse of the road had yet occurred.

Figure 43 – Sinkhole Caused by Culvert Failure on Voyles Road

Major deterioration on the bottom portions of the culvert were cited as one of the major reasons for the asset's failure. In Figure 44 and Figure 45**,** one can see just how far the deterioration on the asset had occurred. The lack of headwall on the structure also was cited as a source of problems, as well as the scour underneath the assets. The project was in need of a full replacement and because ACC already had this asset listed on their LSPR program, the project was already in preliminary design stages with their partnership with the University of Georgia's senior capstone design. ACC has used this partnership to replace similar failing pipe assets before, including the next asset that the teams visited.

Figure 44 – Outlet of Voyles Road Double Barrel Culvert

Figure 45 – Inlet of Voyles Road Barrel Culvert Showing Full Deterioration

Asset #3: Small Plastic Pipe in Good Condition on Charlie Bolton Road

The teams were interested to see the failed assets, but it was also important to visit and discuss an example of a newer asset in better condition. The asset the team visited on Charlie Bolton Road was an asset that had been recently replaced and designed by the University of Georgia's senior capstone program. A view of the asset can be seen in Figure 46**.** The asset was only a few years old and still considered to be in great condition. During this visit, the UGA research team was able to walk through and discuss what a preventative maintenance and inspection would look like for an asset such as this. The team was shown what the inspection forms looked like on the tablets and how the inspection team would check for different values.

Figure 46 – Newly Installed Plastic Cross-Road Pipe Asset

Asset #4: Washed out Corrugated Pipe Culvert and Road on Charlie Bolton Road

The final asset the research team was able to observe was a large corrugated pipe asset whose failure had led to the collapse of Charlie Bolton Road. The site shared many similarities to the first asset visited by the team. Similar to Assets #1 and #2, this asset had been a part of the LSPR program for years, receiving regular inspections, depending on the severity of the latest inspection report. Up until 2019, it was receiving yearly inspection reports, but when its condition rating rose from 2.6 to 4.4 in the span of a year, the asset was then being given monthly inspection reports. The road collapse from the asset can be seen in Figure 47.

Figure 47 – Collapsed Road Above Corrugated Metal Pipe on Charlie Bolton Road

The asset itself had severe deterioration on the bottom portions of its barrel. However, the asset failed when the pipe was not large enough to withstand the runoff from nearby woods and the overflow from a nearby private pond during the most recent rain event. In Figure 48**,** one can see the portion to the right of the culvert, where the runoff washed away the soil above and to the side of the culvert.

Figure 48 – Interior of Asset #4 and Surrounding Collapsed Roadway.

Public Engagement and Funding Advocacy

In order to provide funds for the LSPR program and asset management in general, ACC participates in multiple strategies. As many counties are, ACC is heavily dependent on SPLOST and TSLPOST to provide extra funding for their projects. This means that they must engage in advocacy to help promote the work they do with those dollars. Simple advertisements or public slogans such as the one seen in Figure 49 can work, but the ACC team is looking to go further. They, like Fayette County, have purchased a time-lapse camera through which they plan to record construction projects for their departments and to use those to promote future projects. In addition to SPLOST, the county is expected to pass a TSPLOST measure in 2023 that is estimated to bring an additional budget of $3.5 million to the transportation and public works department.

Figure 49 – Advertisement Used by ACC to Advocate Stormwater Maintenance (Jones, 2022)

The county is also looking to take advantage of some state and federal grants. At the state level, they will apply for State American Rescue Plan Act (ARPA) Funds. On the federal level, they are making effort to take advantage of the Federal Infrastructure Investment and Jobs Act. Specifically, they hope to use the Resilience Grants, used for water quality, Major Infrastructure Grants, used for water quantity and capital maintenance, and the Water Grants, used for clean water projects.

Research Team's Opinion of Oconee County's Culvert Management

It is the opinion of the UGA research team that Athens-Clarke County's Public Works and Transportation Department has set itself up well for the future of maintaining and rehabilitation of its locally owned assets. While the program is not at its final stage, the strategy is clear to move towards a full preventative maintenance system. The county has or is working towards the three major components of a preventative maintenance system, with the inventory being developed by Arcadis, the condition rating system established in their inspection reports and the desire to see every asset be given that inspection on a regular basis. The handle the department has on its budgetary strategy is one of the more impressive and exemplary that the UGA research team has seen. It is easy to follow where they get their budgetary estimates for their projects and makes it easy on the budgetary decision makers outside of their department to justify sending funds their way. The inspection process and reports used are complete and thorough. The one minor criticism that can be brought forth is for assets to be given an ID outside of just the location. The lack of uniformity of what to name an asset can lead to problems identifying them in the future. Even assets that are named after the address of which they are located can be confusing, especially if they are not located near a clear building associated with that address. The mapping project Arcadis is undertaking appears to improve this aspect. Overall, Athens-Clarke county has a system by which they can be proud of and when it is fully operational, it will be a program that is sustainable for itself for the foreseeable future. Its prioritization mechanism and value engineering process – efficient review of new assets during the design phase to reduce costs and increase functionality– are admirable.

Fayette County

Introduction

Members of the research team of Research Project 21-02, between the Georgia Department of Transportation and the University of Georgia's College of Engineering, visited the Fayette County Environmental Management Department's office. This was done in order to help achieve the goal of highlighting best practices among county governments regarding the management and maintenance of small, locally maintained, bridges, culverts, pipes and other similar assets. In a previous phone call with Dr. Mi Geum Chorzepa, the county staff described their system for managing and maintaining these assets and the description matched many of the practices that the research project wished to highlight for other counties to consider adopting. This includes the practice of scheduling regular inspections of locally-owned assets, developing a condition rating system for their assets, preparing a system to prioritize repair and replacement projects depending on these assessments, and making a financial plan for SPLOST.

Meeting Participants:

Fayette County prepared a meeting with the two representatives from the University of Georgia: graduate student, Jared Palmgren and Associate Professor, Dr. Mi Geum Chorzepa. The county brought together a group of staff members who could give the best overview of the county's program. Bradley Klinger, the Assistant Director of the Fayette County Road Department, scheduled the meeting and brought with him his experience with other county systems along with Fayette's system, as well as the knowledge and connections he held as chapter president of the American Public Works Association. Bryan Keller, the Director of the Fayette County Environmental Management Department, and his team have been developing the asset management program in Fayette County since his hire in 2008. Richard Brooks, the Development

Permits Engineer for Fayette County, has been with Fayette County for roughly 16 months, and brings the knowledge of performing inspections on these assets and before Fayette County, and did similar work on the Northern Marianas Islands. Lastly, Troy Simpson, GIS Technician and Specialist for Fayette County, was included in the meeting in order to explain and answer questions regarding the development and use of the county's GIS platform.

Summary of the Meeting

The meeting began with introductions around the room, followed by a presentation from Bryan Keller on the history of the program and how it has evolved and developed during his time with Fayette County. This included what steps the staff had taken to develop their condition rating system, their transition to GIS technology and background of their policy and decision-making systems. From there, Mr. Keller and Troy Simpson presented the GIS system that the county used to inventory and keep track of history of assets. Afterwards, a discussion was had among the meeting participants regarding how funding has been secured for repair and replacement projects over the years and how public engagement, advocacy and education have played large roles in that success over the years. The conversation mostly focused around SPLOST funding; however, discussion was also over LMIG and other state programs, hazard mitigation funds, county general funds, and Community Development Block Grants.

Once the in-person meeting was concluded, Richard Brooks and Troy Simpson took Jared Palmgren and Mi Geum Chorzepa to visit a variety of culvert assets around the county and what the inspection process for each one would look like. This included assets ranging from 36in diameter corrugated metal pipes to a three-sided concrete box culvert that is inspected by the county. During this trip, the research team was shown what the inspection teams would look for in their assessment of each type of asset, what types of external factors are considered, how information is updated onsite to the GIS system, and what special equipment aids in the inspection of the assets. During the meeting, the Fayette County staff took extra care to point out potential areas of difficulty that smaller county governments could face, given their resources, in emulating their program. However, they took even greater care to identify potential solutions (e.g., free ESRI-Open Government) or workarounds for these smaller counties. Overall, the meeting covered all aspects needed for a successful asset management and maintenance program such as the one established in Fayette County and provided sufficient information to develop a case study by which other counties can develop their own programs.

History of the Program

Bryan Keller was hired as the Director of Fayette County's Environmental Management Department in May of 2008 and began the process of developing the asset management program for Fayette county's own transportation and stormwater assets. At the beginning, there was no inventory system for these assets. The staff then began logging the culverts, pipes and other similar assets through a paper log. This system held until the county could afford to move to a program known as ArcCAD, which was used for a long period of time until 2020. Once an inventory system was established, the next step was to determine how to develop a condition rating system for the assets. The county settled on a 5-tier system, which initially started with 5 being the best condition, and 1 being the worst. However, this reversed itself when Mr. Keller worked to adopt a system developed by the University of Montana. This system allowed the county to plug in a lengthy list of variables that would then be used to calculate a condition rating, rather than leave it up to suggestive interpretation. This system used a 5-tier system as well, however "1" indicated the best condition and "5" indicated the worst, which explains the reversal from the earlier system. This system was great for providing as objective of a scoring standard as could be achieved for the county and its assets. However, it came with a major drawback, which was the amount of time that needed to be taken in order to retrieve all the information needed for the calculations, which was beyond what a normal inspection would have included. Since then, the county has developed its own Standard Operating Procedure (SOP) for culvert inspection, which is closer to what a typical inspection process is with inspectors making assessments using both subjective and objective criteria. One thing that the county staff has made sure to emphasize in recent years in their inspections is to differentiate between an asset being structurally deficient and functionally deficient. An asset being structurally deficient or not deficient can refer to the ability of the asset to maintain its shape and safely provide its function. Functional deficiency will refer to the asset's ability to perform the task it was designed to do, especially when it comes to stormwater management under the public roads. For example, a clogged pipe with no cracks or breaks is structurally efficient, but functionally deficient. On the other end, a corrugated pipe that is clear, but shows signs of corrosion and damage is structurally deficient but functionally sound.

Summary of the Types of Assets

During the visit, the research team was able to observe the types of assets that Fayette County staff manages. The county assets are mostly concrete and metal pipes, with the older pipes being made of metal and newer pipes being made of concrete. Should a metal pipe be in need of replacement, it will be replaced with a reinforced concrete pipe (RCPs). The need for RCPs is derived from Fayette County's adherence to (MS4) permit. MS4 is a program under GDOT that provides guidelines by which public agencies can prevent excessive stormwater discharges, dumping, spills, erosion and other such issues from polluting and contaminating nearby natural waterways. Under MS4, all stormwater pipes within the right of way for county owned roads must be made of reinforced concrete pipes and assets. Once outside the right of way, stormwater pipes typically are changed to corrugated metal pipes. Plastic pipes are used sparingly, but work well on gravel roads. Fayette County refers to the Georgia Concrete Pipe Association (GCPA) to provide firms who can provide reinforced concrete pipes in accordance with MS4 standards. The research team was encouraged to contact Cecil Conner to learn more about the association and RCPs. Fayette County orders RCPs in 8 ft. length segments, but still manage old RCPs which are only 4 ft. in length. The county has the resources to replace assets up to 48in in diameter. Anything larger and they'll be contracting out the work. Fayette County avoids metal pipes for new assets due to the acidity of Georgia's soil making them corrode much faster than their advertised lifespans. The research team asked about the use of aluminized metal pipes, and the Fayette County staff said their county does not allow the use of that material for their assets. Aluminized pipes are advertised to last 30+ years, which is much longer than the expected time of a standard metal pipes. However, Fayette County has concerns regarding the environmental impact of these aluminized pipes, and they believe they already achieve longevity in their concrete assets, without having the added environmental risk of the aluminized pipes. During the visit, the research team was able to visit several example assets, including two 36in. corrugated metal pipes, which can be seen in Figure 50 and Figure 51 as well as a large off-system concrete culvert, which can be found in Figure 52.

Figure 50 - 36in. Corrugated Metal Pipe Emptying into Retention Pond

Figure 51 - 36in Corrugated Pipe Located in Residential Cul-de-sac

Figure 52 - Large Concrete Culvert Located on Lees Mill Road

Asset Management Software Usage

After using paper-logs to manage their stormwater and transportation assets, Mr. Keller and the Fayette County staff's next step was to move towards GIS software to aid in the management and tracking for condition ratings for their assets. Fayette County uses SchneiderGIS as their ArcGIS company of choice. The software uses the same base map as qpublic, another GIS software that makes transferring information from private to publicly available on qpublic easier. The county had been using Esri to log their information into the SchneiderGIS system, however, they'll be moving towards Field Master. The GIS software maps out all pipe systems in the Fayette County jurisdiction, including those within the MS4 guidelines and those outside of it. The map labels the inlet and the outlet locations of the asset and describes the type of system the asset is (single entry system, double entry, etc). The GIS software also describes geometric and material information of the asset, including whether there are structural elements attached to the asset, such as a wingwall. In addition, the software allows access to the previous 3 inspection entrants for an asset. This includes important information such as the previous condition ratings, notes from around the site, and whether or not maintenance activities had been performed on the asset. One thing to note is that Fayette County uses this system to report the conditions of their MS4 assets to the state. However, having to filter the MS4 assets from the county inventory takes additional time, since the inventory includes both MS4 and non MS4-assets.

One last item to note is the price associated with maintaining a GIS system such as this. The Esri software system has a free option (e.g., Open Government) that is open to anyone to use. However, it is not recommended as the features are limited and all information entered into it can be publicly accessed. It is recommended that county governments who go this route for their GIS software get a GIS license with a company such as SchneiderGIS in order to access more features and to keep their inventory private for the county use only. The Esri license costs $1,200 annually and should fit within most county government budgets. The far more expensive, but optional, investment is into a Spatial Database Engine (SDE) server. An SDE server provides counties increased security with their inventory systems, private account management, expanded ability to maintain larger inventory systems, and allows for real-time updates to be made from the field into the database system. Without an SDE server, updates and notes obtained in the field will need to be entered into the GIS system again once the staff member returns to the computer on which the GIS database is held. This server is estimated to cost $10,000. As mentioned above, this is an optional investment, especially for smaller counties with small inventory sizes. If a county can afford the time between inspection and when the data can be updated on the server next, then the need to invest in this system isn’t as dire.

Public Engagement and Funding Advocacy

Another important piece of creating a management and maintenance system for a county is the ability to have a reliable funding system and a way to engage with the public with the work the county staff is doing in regards to managing these assets. The Special Purpose Local Options Sales Tax is a popular mechanism that counties across Georgia have utilized in order to fund stormwater and transportation management and Fayette County is no exception. Fayette County passed their first SPLOST package in 2017 as part of a 5-year plan for the county, and it didn't come easily. The first effort to pass a SPLOST package in 2012 did not succeed and a large part of that had to do with a lack of outreach effort in order to engage with the citizens of Fayette in order to educate them on what kinds of projects can benefit from SPLOST funding. Having an organized public education effort in order to enact SPLOST is a must have for any county looking to pass a SPLOST or TSPLOST program. Fayette County's inspection program and condition rating system also helps them to be organized when it comes to deciding which projects ought to be prioritized for funding packages such as SPLOST. Fayette County works to include and stormwater and transportation assets that have been given a condition rating for 4 out of 5 or worse as part of the SPLOST budget for Stormwater projects. By estimating the funding for projects based on the condition rating of assets, it takes much of the guesswork regarding how to prioritize funds to different projects and allows for more time to be spent elsewhere when it comes to justifying and acquiring funding. For 2023, Fayette will once again have a SPLOST package up for vote and the county has already begun its work to put together the budget for it based on the condition rating system and continuing its education of the public regarding what it will cover.

On the ground public education is not the only method in which Fayette County is keeping its constituents engaged in its work. The Fayette County website provides an assortment of engaging interactions by which constituents can learn about what is being done with their tax dollars when it comes to these projects. The “2017 SPLOST” page provides voters with information regarding the previous SPLOST package and how those funds have been utilized. It divides every project into 4 categories: Stormwater, Transportation, Fire and Emergency Services, and Public Safety Radio System Projects. Each of those categories show their approved budget from the previous SPLOST package and then shows the number of projects that are in one of four stages. It shows how many are “Projects in Design”, “Projects Under Construction”, “Budget and Pending Projects” and finally, “Completed Projects”. Under each of these phases’ page, it lists all the different projects and the approved budget for each. When you click on a project, it lists a summary of the project, its approved budget, what category of priority it was given, its budget to date, its designer, and its contractor. The website includes all the information a constituent or anyone who is curious about the project could need. Recently, Fayette County has gone a step further and has purchased a time-lapse video camera, which is available for ~$100 on Amazon, and has begun a practice of recording the full length of some projects, when available. These videos, when the project is complete, are then attached to the project on the website for viewers to see the full process of construction for the project, providing an engaging way to visually see the work being done with the SPLOST dollars. The “2023 SPLOST” page provides all the information the public will need when deciding whether they want to continue funding the SPLOST program for Fayette County. While Fayette never explicitly says to vote for SPLOST, as that is against the law, the county has organized the page in such a way that information is easy to find both in how funds are distributed and towards what projects they’ll be put towards. For 2023, Fayette County has put together the stormwater budget by combining the expected repair/replacement budget of all assets rated 4 or 5 as their condition rating, which comes out to roughly $21 million. Having that information organized and available well ahead of the voting period makes it easier to educate the public on the program and an organized and carefully planned out program will make voters more likely to approve the plan. For larger projects, Fayette County is no stranger to using state funding programs such as the Local Maintenance Improvement Grant (LMIG). However, their success and organization of SPLOST allows them to be less dependent on programs that requiring applying and puts more power into their own hands for funding.

Equipment Used in During Inspections and Inspection Processes

The final portion of the meeting between the research team and the staff at Fayette County was a visual observation of inspection processes, led by Richard Brooks and Troy Simpson. The group visited three different assets. One was the sight of a sinkhole appearing near the right of way in a Cul-de-sac. The second was a large concrete culvert that was recently the subject of a large-scale replacement project. The third and final was a new pipe system located in a newly-developed residential area that emptied out into a retention pond area. During these visits, Mr. Brooks and Mr. Simpson walked through their process whenever they approach a site to inspect. The first thing the team does is assess the site for multiple things. First, they check the site for any kind of safety hazards, whether that be from traffic, wildlife, or any other natural phenomenon. Then, they take time to assess the pipe layout and the site itself. Using a mobile tablet, the team can access the GIS platform which will give them information regarding the system they will inspect, as well as any other systems around, so that they are clear as to what openings and manholes are included in the system of interest. They also make sure to note any kind of hydrological information on the site, including detention ponds or natural streams. Figure 53 shows Richard Brooks taking a member of the research team through this process while visiting the first asset.

Figure 53 - Richard Brooks Explains How to Assess the Site of an Asset Before Inspecting

Next, the process of inspecting the asset is described. Using a pole camera, such as the Quickview Enviorsight shown below in Figure 54, the inspection crew assesses the asset in two phases. Firstly, they look for structural damage and/or failure. This process includes inspecting the asset, as well as any structural members that are attached to it, such as a wingwall. The inspectors will look for cracks, spalling, puncturing from another asset such as a gas line, or any other sign of structural failure. This could also include checking for issues around the asset, such as scour and erosion leading to stability problems in the structure. Afterwards, once structural integrity is established and assessed, the inspectors switch over to evaluating functional integrity. This involved checking for things such as blockages within the pipe that could keep water from flowing through it. It also includes looking for separation between pipe segments or holes in the pipe that could lead to leakages of stormwater to undesirable locations.

Figure 54 - Quickview Envirosight Pole Camera in its Container

Once the asset has been assessed in both ways, the information is entered into the mobile tablet the inspectors have brought with them, which has access to the GIS platform so that it can be updated in real time. Any notes from the inspection, as well as any changes to condition ratings, can be done onsite. Photos from the inspection can also be uploaded to the GIS software in order to enhance explanation of a previous note and are highly encouraged for clarity purposes. The mobile tablets also include a copy of the county's standard operating procedures for inspection of assets, so that if any inspector ever had questions regarding how to proceed with an inspection assessment, they have the information they need right there on site.

Research Team's Opinion of Fayette County's Culvert Management

The visit by the research team to Fayette County's Environmental Management Department's office was successful in its goal of observing what a successful stormwater/transportation asset management program looks like. The research team found that the system was organized, efficient, and easy to carry out even on a reduced staff. The fact that Fayette County could accomplished so much in regards to inspection, repair and replacement in house without having to contract out work was most impressive. Fayette County is part of the Metro Atlanta area and benefits from having a larger budget due to a larger, much of what was observed and learned about can be applied to smaller counties when it comes to establishing their own programs for asset management. Fayette County was mindful of this in their presentation and took great care to suggest alternative ways for counties to go about setting up their programs, should they not have the resources to follow Fayette County's model. Either that, or they would make clear which features were great for efficiency, but not fully necessary in order to have a system that functions. Fayette County's technical inspection program meets everything that makes a successful asset management program, from its inventory management, to clear cut guidelines on how inspections are to be conducted, as well as methods of acquiring stable funding for its projects. In addition, Fayette County highlighted the importance of investing in small ways to increase engagement with your county's constituency in order to increase awareness and support for the work the staff does to maintain these assets. Learning about the public outreach and engagement program was one of the highlights of the visit, as it helped explore a side of inspection and maintenance programs that is often overlooked from an engineering perspective. The information provided by the Fayette County staff shows an excellent example for growing counties or counties of similar size to follow and the philosophical foundations that drive the program can be heavily incorporated into asset managements for any county staff, no matter what their size may be.

Gwinnett County

Introduction

Members of the research team of Research Project 21-02, between the Georgia Department of Transportation and the University of Georgia's College of Engineering, visited the Gwinnett County Department of Water Resources' office, located on 684 Winder Hwy, also shown on Figure 55. This was done in order to help achieve the goal of highlighting best practices among county governments regarding the management and maintenance of small, locally maintained, bridges, culverts, pipes and other similar assets. In a previous phone call with Jared Palmgren, the county staff described their system for managing and maintaining these assets and the description matched many of the practices that the research project wished to highlight for other counties to consider adopting. This includes the practice of scheduling regular inspections of locally-owned assets, developing a condition rating system for their assets, preparing a system to prioritize repair and replacement projects depending on these assessments, and as well as establishing a funding system to support the activities of the department.

Figure 55 - Front Face of the Gwinnett County Water Resources Department Building

Meeting Participants

The staff of Gwinnett County's Department of Water Resources scheduled a sit-down meeting with the UGA research team, which included graduate student, Jared Palmgren and associate professor, Dr. Mi Geum Chorzepa. The initial contact was made with Jeff Callaway, the Operations Division Director for the department, who oversees and supervises the day to day operations for the department. He scheduled the meeting and included his two construction managers, Justin Grier and John DeGiovine. All three had intricate knowledge of the culvert management system for Gwinnett County and were able to provide an overview of the system and answer any questions from the research team. Mr. DeGiovine was able to provide information regarding how the county used contracted inspectors in order to keep up with the 127,000+ assets in the county. Later, the research team met up with Mr. Fernando Zacarias, the County Contractor Inspector II, in order to visually observe the inspection process that would normally be conducted by the contracted inspection crews. The county currently employs Woolpert for the task.

Summary of the Meeting

The meeting began between all participants, except for Fernando Zacarias, at the Office of the Department of Water Resources. Brief introductions were made among the group before moving onto more substantive matters. The group then discussed an overview of the system, discussing what kind of philosophy and strategy there was behind the management system, as well as what kind of software and resources were necessary in order to keep up with the number of assets Gwinnett county owned. The team then delved into the Lucity asset management software the county uses and how it ties into their GIS system, arcmap. The team discussed how the department raises its own funds in order to pay for itself. They discussed their relationship with their contract inspection crew. A brief discussion was then held over how the program has evolved over the last 15 years it has been implemented.

After the discussion period, Mr. Grier and Mr. DeGiovine showed the UGA research duo their Lucity program, which is their asset management program they use for stormwater culverts and pipes. They showed how the program works, how it manages the assets by alerting the necessary department should anything arise from inspections. Mr. DeGiovine also showed the team how he keeps track of the inspections and work orders of the assets throughout the year. The research team finished by meeting up with Fernando Zacarias in the field in order to be given demonstrations regarding the process by which the inspections are conducted. The team was able to view the inspection of three different assets, including one concrete pipe in a residential area, a culvert box containing three metal pipes/entrances running across a creek, and lastly, a flair end concrete culvert going under a major road leading to a junction box and a metal culvert at the outlet on the other side.

History of the Program

During the meeting, there was a brief discussion on how the culvert management system came to be in Gwinnett County and how it has evolved over time. Mr. Callaway and Mr. DeGiovine have been with the program since it began and Mr. Grier was hired a few years afterwards. The start of the system began when culvert maintenance was moved from the Transportation Department over to the Water Resource Department. The program was mostly a reactive maintenance program, responding to emergencies or calls from constituents. At the time, the county used a work order system known as SAP. Starting in 2009-2010, the county began its transition away from SAP and towards its new system in Lucity, which was a dedicated asset management software, combined with GIS capabilities. This allowed the system to move towards a more preventative maintenance approach, since it allowed for the inventorying and processing of inspection results by processing work orders. Since then, the system has not evolved too much beyond being updated to handle the growing number of assets in Gwinnett County. Over the years, the department has been able to establish specialized staffs for maintenance, GIS work, engineering and logistics. The GIS staff is made up of 3-4 personnel dedicated solely towards stormwater assets. The county has also developed a staff that is capable of handling driveway pipes and emergencies in house; otherwise, most repair and replacement work is contracted out. One last thing the county has learned to implement is that a thorough inspection of new stormwater systems on developed properties must be conducted per standards before the county signs off on claiming ownership over it.

Overview of the Strategy for the Inspection System

Gwinnett County's culvert system falls under Georgia's Municipal Separate Storm Sewer System (MS4) Permit, which mandates that the county conduct "eyes on" inspections on every asset in their jurisdiction at least once every 5 years. Gwinnett County contains over 127,000+ assets and 1,500 miles of pipes, so one has to image this is quite the daunting task that requires logistical planning and strategy. Gwinnett County does not have the manpower to conduct their own inspections, thus it contracts the inspection work out to a firm known as Woolpert. Woolpert sends out 2-4 two man crews every day to conduct inspections on assets within Gwinnett County and report their findings back to the Water Resource Department. Woolpert has their own software known as "Granite" that they use to gather the information. They then convert that information into usable files for Gwinnett County so that they can import it into Lucity. Gwinnett County spends roughly $1.5 million per year in their contract with Woolpert.

In order to make the assessment of these assets more manageable, Gwinnett County has divided its assets' up into two regions, section 1 and section 2. The goal of these two regions was to have each section contain roughly the same number of assets, while also trying to keep assets within the same catch basins with one another. Figure 56 shows these two sections within the context of a map of Gwinnett County.

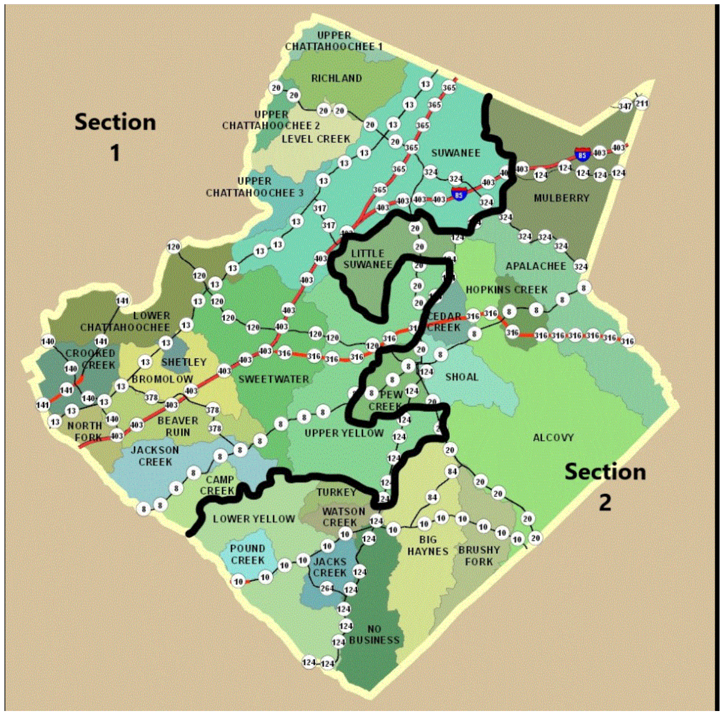


Figure 56 - Map of Gwinnett County and the Division between the Two Sections for Asset Inspection

The purpose of creating these two sections was to establish a two-tiered system of inspection processes for each section. One section would be given one level of inspection treatment, while the other would be given a more extensive inspection. Then, the two regions would alternate every 5 years. The first type of inspection is known as a “Level 1” inspection in Gwinnett county. This is the type of inspection that meets the bare minimum needed for MS4 permits, otherwise known as a “head in hole” inspection. The second type of inspection is known as a “Level 2” inspection, which is a full condition assessment of the assets. During these inspections, Gwinnett County has the inspection crews of Woolpert follow the guidelines laid forth in the Pipeline Assessment Certification Program (PACP), of which a copy of the reference guide can be seen in Figure 57. This includes following a 5-tier condition rating system, where 1 is considered the best condition and 5 is the worst.

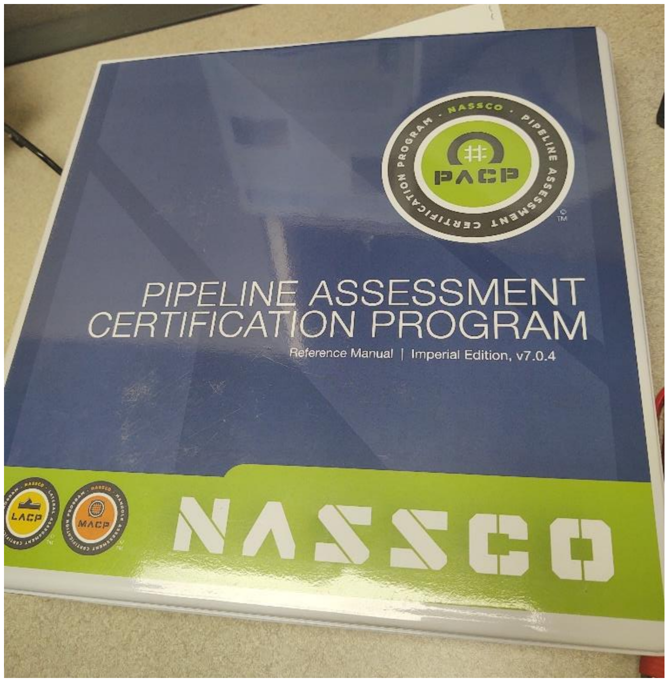


Figure 57 - NASSCO Pipeline Assessment Certification Program (PACP) Reference Manual

By using this system of splitting up the assets between two regions and conducting two types of inspections, the county has successfully made the challenge of maintaining all the assets more feasible while also not sacrificing the amount of work needed to be done to maintain MS4 guidelines and the integrity of their stormwater infrastructure. Mr. John DeGiovine keeps track of the monthly process of the inspection crews and how many assets the contractor is able to inspect every month. In his office, he keeps a chart that shows the goal number of assets to have inspected by a certain month in order to hit the 5-year inspection deadline.

Asset Management Software Usage

The asset management software used by Gwinnett County is known as Lucity. This program serves as both the inventory software, as well as where inspection report information is submitted and where work orders are issued for the Department of Water Resources. The program provides information for stormwater, sewer and other utility assets. However, the research team only focused on the stormwater assets. The menu options and the information one can get from the “Stormwater Inspections” tab in Lucity can be seen in **Figure 58**.

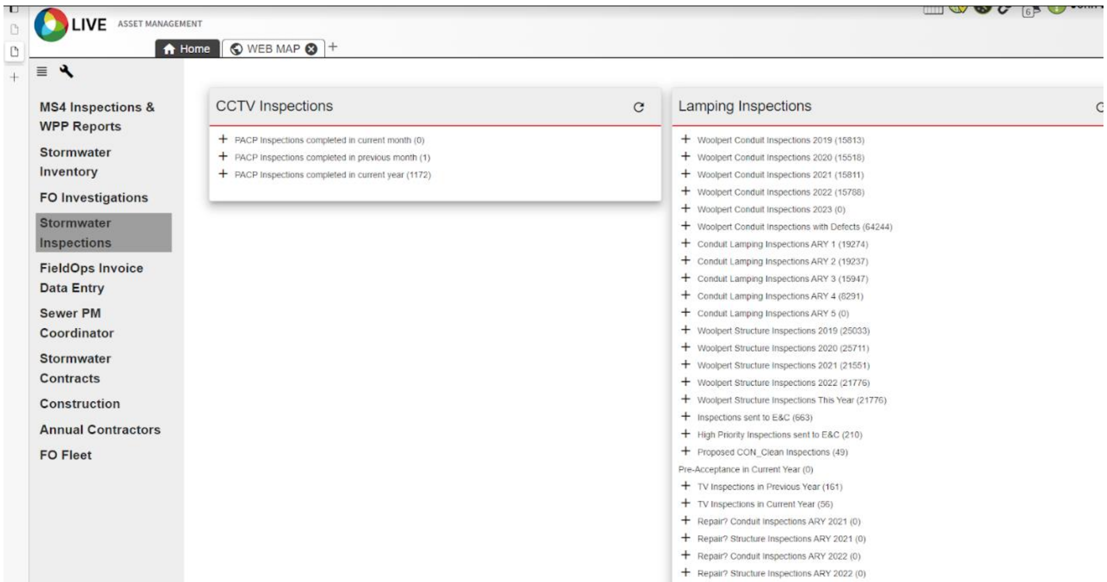


Figure 58 - Stormwater Inspections Menu in Lucity

Within the Lucity program, users can either access an asset by looking up its structural ID number, or they can use a GIS map with the assets overlaid in order to access it. The stormwater assets in the Lucity program are all black lines to differentiate them from other types of assets. Figure 59 shows what it looks like when one locates a stormwater asset using the map feature.

Figure 59 - Ariel Map Showing Stormwater Asset in Lucity

Should one click on the asset, they will be greeted with a table showing a summary. In this menu, one can access the previous inspection reports completed for the asset. The information in these reports includes structure ID, the inspection type, the date and time inspected, the crew which did the inspection, the weather on the day, the surface condition (dry/wet), the cover condition, the wall condition, the top condition, the ring condition, whether an wall infiltration has occurred, whether any debris, color, floatables or odor were present and finally the overall condition. The way the system works is that the condition rating is determined by the system based on the comments provided by the inspection crew. For example, if a crew notes that there are cracks in an asset, with no soil present, the system will take those comments and automatically rate the system as a 3. This takes out the subjectivisms of the process, rather than relying on the speculative judgement of the inspector as to what constitutes a 3 versus a 4 condition rating.

Inspection Processes and Equipment Used in During Inspections

Once the research team had been explained how the culvert management system was worked from the office, the next step was to observe how the inspections are completed in the field. In order to achieve this, the research rendevoused with Fernando Zacarias, the County Contract Inspector in order to view three different assets and how the inspection crews from Woolpert would conduct the inspections. The inspection crews from Woolpert were unavailable on the day of visit, thus Mr. Zacarias would be instructing the research team in the inspection process himself. Mr. Zacarias was more than qualified to do this, as his job revolves around monitoring the inspection crews as they conduct the inspections and making sure they are done within MS4 and PACP guidelines. The research team and Mr. Zacarias visited three different types of assets. First, they visited a residential stormwater pipe system, which was made entirely of concrete. Second, the group visited a culvert box containing outlets for three independent culverts. These were held in place by a reinforced concrete wingwall but were made of corrugated metal pipe themselves. The pipes also included recent lining installed into them. Lastly, the group visited a concrete flair end concrete culvert that fed into a junction box, which is also attached to a “failing” metal culvert pipe that crossed the road.

The research team requested to see both the Level 1 and Level 2 types of inspections conducted on the assets. The Level 1 inspection was the first shown and described to the research team. As a reminder, the Level 1 inspeciton is also described as a “head in hole” inspection. The main purpose of conducting a head in hole inspection is to look for anything that requires immediate attention. The inspection crew must open the asset if it contains a manhole cover and visually inspect the asset for any signs of ilicit discharge, major structural damage or any obvious sign of disfunction. Major structural damage can include punctures in the pipe from another utility line or a collapse of the structure. Signs of disfunction can include obvious blockages within the pipe or culvert, as well as stormwater flowing outward from the wrong end of the pipe. The Level 1 inspection is designed to be a quick assessment and is more about catching emergencies and keeping up with MS4 guidelines than it is used for full condition management and predicting slow building problems. A photo showing Mr. Zacarias conducting a level 1 inspection of a flair end culvert can be seen in Figure 60**.**

Figure 60 - Fernando Zacarias and Jared Palmgren conduct a Level 1 Inspection of a Flair End Culvert

The second level of inspection is the full condition assessment of a stormwater asset and is more conducive to what the research team would like to see counties adopt in their inspection practices when it comes to preventative maintenance and condition assetment of their assets. Rather than just be based on casual visual inspection, the Level 2 full condition assessment inspection has a step by step process. First, the inspeciton crew will measure from the reverse inlet to the top of the structure and record this value into their software, whether that be Lucity for Gwinnett county workers or Granite for Woolpert crews. Next, the crew will prepare a pole camera and a tablet attached to it either via bluetooth or by wired connection. The camera will be adjusted so that it will be able to be placed at the geometric center of the culvert end from the top of the structure where the inspectors would be. Next, the inspection crew will write down some information regarding the asset, either on the asset itself, or on a white board brought with the inspection crews. This information includes the following. First, the company providing the inspection which in the case of Gwinnett County is Woolpert shortened as "WLPT". Next, they list the Asset ID provided to the company from the Lucity system. Next, the crew writes the date of inspection and the initials of the crew members who are conducting the inspection. This is done for two reasons. One, it makes identification of the assets easier should they be written on the asset. Secondly, and more importantly, it is used to provide context of which asset is being inspected when videos of the asset are being recorded. An example of the markings can be seen in Figure 61.

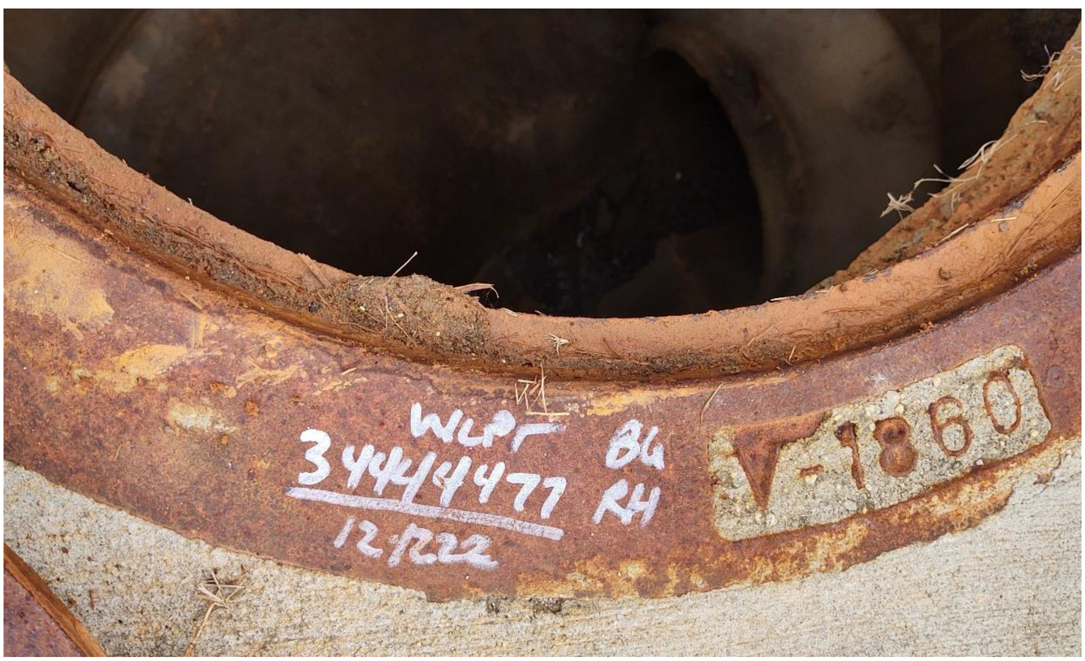


Figure 61 - Asset ID Written on the Edge of an Asset for Easy Identification Later or for Video

From there, two videos of the asset are taken. The first of which is an assessment of the environment and the structure that contains the asset. The video will start off with the camera pointed at the written information discussed previously, whether it be on the asset or on a whiteboard. It will then be placed above the asset and lowered slowly while spinning slowly. This allows the video to capture the location and context of the asset, while also providing an opportunity to assess the structure surrounding the asset. The lowering and spinning continue until the camera is lowered to where it is located at the geometric center of the asset, and the rotation concludes when the camera is at that level and points down the barrel of the asset the crew wishes to inspect. The second video taken is an assessment of the interior of the barrel of the pipe or culvert. A leveling rod is placed in front of the camera in order for the camera to see the depth of the barrel before entering the barrel. From there, the camera zooms into the barrel, making sure to capture all sides of the barrel until it sees as far as it can into the barrel. This process is then repeated on the opposite end of the asset, if accessible. A photo of this process can be seen in Figure 62.

Figure 62 - Jared Palmgren and Fernando Zacarias Conducting a Culvert Inspection using a Pole Camera

Once the videos of the asset have been taken, they can be used to assist in the assessment of the culvert or pipe. The information gathered from the videos can then be entered into the inspection software. As mentioned before, Woolpert Inc. uses Granite as their software, but the process is very similar to Lucity. The inspection team records the information needed as seen below in a sample inspection report in Figure 63.

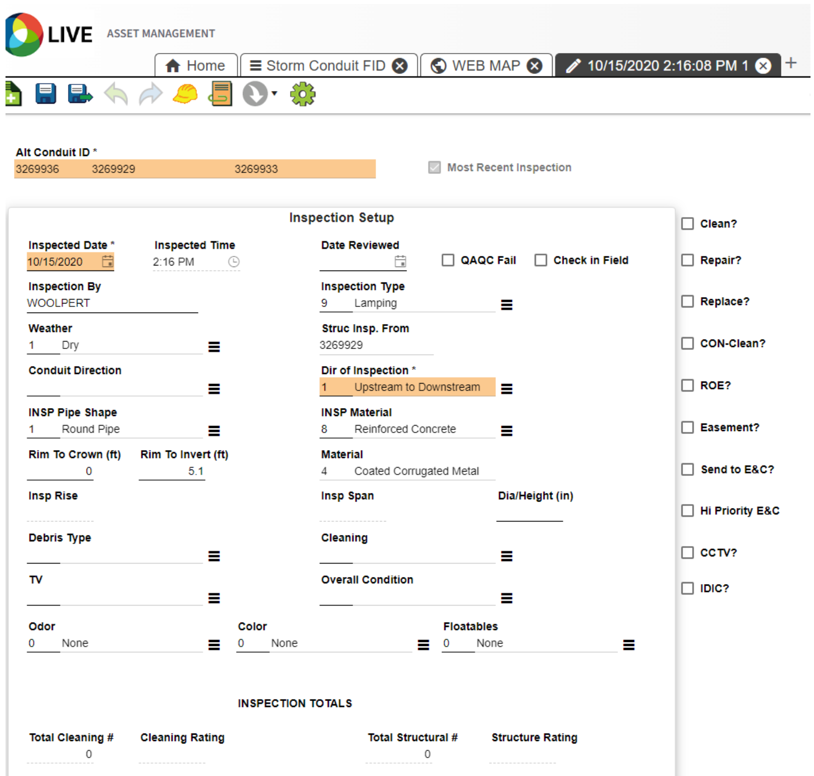


Figure 63 - Inspection Report Window in Lucity CMS

Should the inspection crew need to find previous information on the asset, accessing the previous information is simple. On the Lucity system, one can click on an asset using the map feature and a summary will be brought up containing crucial information on the asset. An example of this for the first asset the team visited can be seen in Figure 64.

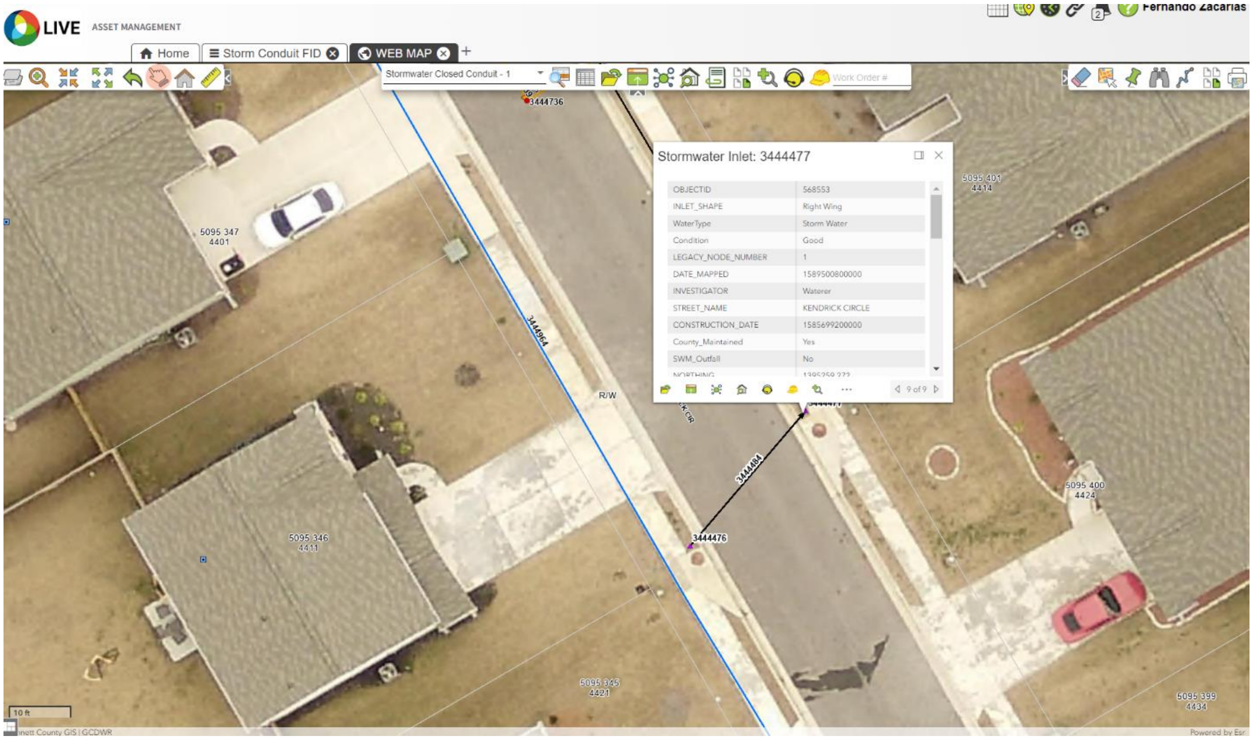


Figure 64 - Ariel Map View of a Pipe Asset in the Lucity CMS Program, including Previous Inspection Results

Summary of Three Assets Visited

The previous section provided an overview of the inspection processes for these culverts and pipes. The following will provide an overview of the assets and a general assessment of the asset based on the detailed inspection video taken at the site. The three assets all provided diverse scenarios in which a stormwater asset would be utilized and all three contained different elements that slightly change what the inspection crew is looking for when assessing the asset.

<u>Asset #1: Reinforced Concrete Stormwater Drainage Pipe in Residential Subdivision</u>

The first asset the research team and Fernando Zacarias visited was an asset located in a residential subdivision. The asset was a reinforced concrete pipe that was part of a larger stormwater drainage system for the residential neighborhood. Access to the pipe was provided by a manhole located off the sided of the road. A photo of this asset can be seen in Figure 65.

At this location, the research team was demonstrated both the level 1 and level 2 inspection practices. For the level 1, the team visually inspected for any evidence of illicit discharge, for which there was none. They also checked for obvious signs of structural damage of which there was also none. One member of the research team noted the material (mostly rocks and pieces of pavement) building up on the bottom of the pipe. Mr. Zacarias clarified that this is something the teams check for. However, it is only acted upon once the debris is blocking close to 30-40% of the pipe. For the level 2 inspection, the pole camera was lowered in spinning, checking for any structural damage. There was none that could be seen. Then, the camera zoomed down the pipe, checking for punctures, cracks and other causes for conditional concern. There was none that could be seen from the camera and when the research team checked Lucity for the latest inspection, which had been conducted earlier that day, the inspection team from Woolpert had also seen the same and gave the asset a "good" condition rating.

Figure 65 - Asset #1 Reinforced Concrete Stormwater Drainage Pipe in Residential Subdivision

Asset #2: Culvert Box Containing Three Lined Corrugated Pipes over Creek

The second asset the team visited was a culvert box located in an older residential area on a road with more traffic than the previous asset. The research team specifically requested to observe an inspection on an asset where the ends were open to the elements, rather than covered by a junction box. The culvert box was comprised of a reinforced concrete wingwall and provided structure to the outlets of three separate culvert assets. Each of these barrels in the culvert were corrugated metal pipes, which had been recently lined due to previous inspection results. The research team performed a sample inspection on the barrel asset furthest to the right in Figure 66. The main purpose of this asset was less focused on runoff and more geared towards allowing the continual flow of a stream through its neighborhood.

The detailed inspection processes showed that the recent lining maintenance performed on the asset helped the asset achieve a better condition than it otherwise would have. A previous video of the asset, available on the Lucity software, showed that before the lining had been placed, corrosion and deterioration had begun to negatively impact the bottom portion of the barrel. Comparing it to the inspection video the research team took, one could see the lining covered up those places of corrosion and helped to lengthen the lifespan of the asset without having a need to replace it. The research team did note some cracks along the side of the barrel, however Mr. Zacarias noted that those were cosmetic cracks in the lining, rather than structural cracks in the asset itself.

Figure 66 - Asset #2 Culvert Box Containing Three Lined Corrugated Pipes over Creek

<u>Asset #3: Flair-End Concrete Culvert with Corrugated Pipe Barrel Under Major Road</u>

The final asset that the research team and Fernando Zacarias observed was a corrugated pipe asset located on a major road. The research team had requested to see an asset on a highly trafficked public road. This asset contained a corrugated metal pipe, with one end connected to a junction box located off the side of the road and the other end was attached a reinforced concrete flair-end culvert structure. The asset was also the only one of the three observed to contain rip-rap surround the entrance to the asset. A photo of the asset can be seen in **Figure 67.**

The inspection of the asset showed that many of the elements, including the flair end structure, were all relatively new. The concrete asset did not show any evidence of cracking or spalling, or even any discoloration. The joint connection between the concrete entrance and the barrel asset looked to be secured with not separation present. There was minimal soil build up in the asset, which can be attributed to the rip-rap located around the entrance, whose goal is to minimize erosion into the asset. When the research team reviewed the asset on Lucity, the condition rating was labeled as "good" which matched the assessment the research team gathered at the asset.

Figure 67 - Asset #3 Flair-End Concrete Culvert with Corrugated Pipe Barrel Under Major Road

Public Engagement and Funding Advocacy

At previous county visits, how to navigate obtaining funding is always at the forefront of challenges for county governments, especially if a county is reliant on project-based funds, such as SPLOST, to complete its repair and replacement work. When departments are relying on general county funds or programs such as SPLOST which can be distributed to any county department, oftentimes the departments are competing for limited funding and can find themselves lacking in funding and resources as other departments are prioritized by superiors in the county. However, Gwinnett County's Water Resource Department has found a way around this challenge. Rather than be reliant on general funds, the county and department, starting in 2006, have implemented a Stormwater Service Fee. Rather than treating its culverts and stormwater pipes as transportation assets, they are considered as utilities. Every property owner in the county must pay an annual fee based on the amount of impervious land their property contains. As of 2022, this fee is calculated by taking the amount of square footage a property has and charging $2.46 per 100 square feet of impervious surface on the property. This stormwater fee is a major piece of building Gwinnett County's Water Resource Department its $30 million dollar budget every year. The fee is attached to the annual property tax bill as a line item. Should there be any questions, Gwinnett County has posted an FAQ and the resolution itself on their stormwater webpage.

While smaller counties may not be able to achieve that level of budget using this method of fundraising, it can still be a successful venture as a source of funding. The method allows stormwater, public works, or any other department in charge of maintaining these assets to fundraise directly to itself, rather than rely on funds to go to the general county fund and then the larger budget be split to their respective department. Using this method would be like a company charging a fee for their services and because of this, it is not under the same category as a tax. This makes it easier to equitably enforce it on all properties, rather than deal with tax exemption from certain properties like churches and schools. One might be concerned with dropping such a large fee on constituents, and feeling their wrath in return. One way to avoid this or lessen the blow for constituents is to do what Gwinnett County did when implementing their fee. The end goal was to always charge $2.46 per 100 sqft. of impervious soil. However, the first year, they only charged $0.77 per 100 sqft of impervious soil. They then increased the fee incrementally over the course of 4 years, as seen in **Figure 68**.

Year	Annual Stormwater Service Fee ($/100 square feet of impervious surface)
2006	0.77
2007	1.41
2008	2.01
2009	2.46
2010	2.46
2011	2.46

Figure 68 - Tax Rates on Impervious Surfaces in Gwinnet County Evolution over Time (Gwinnett Co., n.d.)

Research Team's Opinion of Gwinnett County's Culvert Management

Gwinnett County's staff members were excited for the opportunity to share their system and what they have accomplished since 2009. The research team was able to observe the system from a philosophical standpoint by discussing it with Mr. Callway, Mr. Grier and Mr. DeGiovine. They then observed the process of management and organization that takes place at the office with Mr. DeGiovine and their use of Lucity, their asset management program. Lastly, they were able to observe the inspection process with the help of Mr. Zacarias and his demonstrations. The research team believes that the pride Gwinnet County has in their asset management and inspection program for culverts and pipes was well warranted. The system has everything it needs to continue to run at an optimal pace. It is organized in a way that information can be processed and alerted to the proper departments so that anything that needs to be taken care of, such as a repair or replacement, can be done so quickly. The knowledge the team has with their years of experience with the system is a huge benefit for the county, but the system is not so complicated that someone newly hired could pick it up quickly. The field crew has been trained by Mr. DeGiovine who manages the inspection program and thus demonstrated knowledge of design principles and typical problems with culverts. The research duo was able to understand the process after just visiting for one day. Many of the techniques and standards used by Gwinnett County, such as the two types of inspections and the use of PACP guidelines can be picked up by smaller counties, due to the universal nature of them. The fundraising option of establishing a stormwater fee is something that plenty of smaller counties can utilize to start building their own budgets for their counties. The one item that Gwinnett County has that is likely difficult for other counties to enact is their ability to contract out their inspections. Gwinnett pays Woolpert Inc. roughly $1.5 million per year to help inspect the assets and most counties simply don’t have that kind of budget. Overall, the system is successful and other county governments should find plenty of information and strategies to learn from it.

Summary of Systems from Case Study County Governments

At the conclusion of the visits for these four county governments, a table was developed summarizing the features of each system and how they differed from one another. The table focused on identifying the three major components that lead to successful inspection and preventative maintenance systems, which are an established inventory, scheduled inspection intervals, and condition rating systems. These results can be found in Table 6.

Table 6. Summary of Findings from County Government Visits

	Oconee County	Athens-Clarke County	Fayette County	Gwinnett County
Inventory	Uses work order system developed by Athens-Tech, which doubles as an inventory system, due to information gathered during each inspection.	Uses Live-Stream Pipe Replacement program to list out the assets with the most trouble. Currently partnered with Arcadis to build out the fully mapped inventory of all assets. This is a current work in progress.	Uses SchneiderGIS system as their GIS inventory system of choice. Includes both MS4 and non-MS4 assets. Along with inventory data, previous inspection reports are available. Costs approx. $1,200 annually.	Use asset management software known as Lucity. Serves as both an inventory and storage for inspection reports.
Inspection Schedules	County is divided into four sections and one section is inspected each year. Thus, assets will be inspected on a 4 year cycle.	Maximum inspection interval is 5 years for all assets, but assets on the Live-Stream Pipe Replacement program are inspected every 1-2 years depending on condition rating.	Meets MS4 guidelines by inspecting assets once every 5 years at a minimum.	Meets MS4 guidelines by laying eyes on assets once every 5 years and conducting inspection in accordance with MS4 guidelines. However, full conditional assessment are completed once every 10 years. County is divided in half and one section gets full conditional inspection while other gets MS4 inspection. They switch every 5 years.
Condition Ratings	Do not currently have fleshed out condition rating system but have stated they are in the process of developing one.	Assets are rated on a 1-5 scale with 5 being the worst condition and 1 being the best. Structure's overall condition is derived from an average of 5 scores from 5 criteria during inspection.	Assets are rated on a 1-5 scale with 5 being the worst condition and 1 being the best. Asset conditions are calculated through combination of subjective and objective measurements. Separate scores between functional and structural condition.	Assets are rated on a 1-5 scale with 5 being the worst condition and 1 being the best. Asset condition ratings are automatically calculated by Lucity based on feedback of inspectors in inspection checklist and reports.
Inspection Processes	Conducts inspection and maintenance on the same trip, whenever possible. Inspectors and maintenance crew travel together with equipment like excavators, jetters and jaws of life. If larger maintenance needed, a work order is scheduled.	Fill out in-house inspection form, which includes measuring vertical and horizontal diameter, checking roadway condition, and judging 5 criteria on a 1-5 scale: deflection/cracking, invert condition, headwall, erosion, separation of pipe.	Fill out inspection forms on tablet. First, assessing the site for external factors affecting the system, such as water features. Both ends are inspected using a pole-camera.	Inspections are carried out by a third-party, following expectations set forth in the Pipeline Assessment Certification Program. Pole cameras are used with enhanced zoom features to investigate interiors of assets.

Development Stages of Inspection Guide

Outline

Before the inspection guide could be written, it was important to gather examples from other states DOTs, to learn about current practices across the state of Georgia, and to work with some local governments to learn in-depth about their successful inspection programs within their jurisdiction through site visits and case studies. Once this was all complete, it was appropriate to begin writing the first draft of the inspection guide. This process began by building out an outline via powerpoint presentation, listing the sections that would be provided within the guide. Many of these section mirrored what has been found in other state DOT culvert inspection guides, like statement of purpose, providing definitions, suggest inspection equipment, suggest safety equipment, and potential hazards. Then, the guide would focus on best practices when establishing inspection systems for these assets. Three sections would be dedicated to the three major components of a successful inspection system: inventory establishment, inspection interval establishment and condition rating establishment. Each section would provide suggestions on different factors to consider with each and how they could vary depending on a local government's needs. The inspection guide would then describe an inspection process for both round pipes and box culverts. Two appendices would then be added. The first of which would include sample culvert inspection and inventory forms. The goal of which would be to be printable or copiable by local governments and be put in use immediately. Lastly, the second appendix in the guide would include 1-page case study summaries of the asset management and inspection systems in successful counties, in this regard, across the state of Georgia.

First Written Draft

After this outline was complete, the first draft of the inspection guide was written out. The goal was to provide as near complete a product content-wise as possible. Additional features like formatting would come in a later draft. This draft took the initial outlined developed and provided content to go along with it. The definitions section was filled with terms that were common defined in other state DOT inspection guides, as well as terms used with the guide that the research team had found needed to be identified when discussing these terms with counties during the survey phase of the research. The suggested inspection equipment was also combined with recommendations from other state GDOTs, MS4 guidelines, as well as the equipment used by counties who participated in the case study potion of the research. A similar process was used for the safety equipment. The sections on asset inventory management, inspection intervals and establishment of ratings systems were written so that each section would provide suggestions on different factors to consider with each and how they could vary depending on a local government's needs. These recommendations came from a combination of recommendations of other state GDOT guides, as well as what has worked for the counties involved in this thesis' case studies. The pipe inspection and box culvert inspection sections were written with MS4 guidelines in mind, while also considering the common maintenance items prevalent in the different types of assets which were taken directly from the survey phase of this study. The culvert inspection forms within this draft of the inspection guide were taken directly from the SCDOT Pipe and Culvert Field Inventory and Inspection Guidelines to serve as placeholders until such time the research team developed their own in the next draft. One page case studies were provided for Gwinnett County and Fayette County, as those were the only two case studies completed at the time of drafting. This draft of the Inspection Guide can be found in Appendix C.

Secondary Draft

The next draft of the inspection guide was developed after the Oconee County and Clark County case studies had been complete. Many of the elements, word for word, were taken from the previous draft as it was reformatted into a more visually appealing version of itself. However, several changes were made in the process of doing so. Firstly, the order in which information was presented was changed, with some topics being brought out of the appendices, like the case studies, and other topics like safety and inspection equipment, being pushed to the appendices. Secondly, between drafts, the research team had developed its own inspection and inventory forms to be included in the guide. The process by which the inspection forms were developed shall be explained in a further section. The inventory forms were developed to reflect the inventory suggestions made in the guide regarding the items necessary to keep track of when inventorying assets. Lastly, because of decisions made regarding the inspection forms, the inspection process and instruction section needed reorganization and an overhaul on its content.

Development of Inspection Processes and Forms

When developing the initial drafts for the inspection forms, it became apparent that the initial plan to divide the inspection processes between circular pipes and box culverts didn't adequately provide information for the variety of asset types a local government could face. While shape and relative size are important factors to consider, they were not enough to warrant differentiating their inspection process. Another variable that did become prominent enough to warrant differentiation was the material type of the assets. It was determined that the inspection processes section would rather be divided into section dedicated to material type of assets instead. Three sections would be dedicated to the three most common asset materials in Georgia, which are metal, concrete and plastic. This was determined using the results from the county survey. An additional section and form would be provided for miscellaneous materials, but the information will be intentionally vague. The section will provide three suggestions for these type of assets. First, the local governments can make their own inspection form for the asset type, using the provided ones as a guide, because if a county is using materials outside of the three most common, they ought to be familiar with that material's properties and how to inspect it. Secondly, they can use the "miscellaneous" form provided within the guide. Lastly, depending on the material, the provided forms for RCP, PCP, and CMP can be doubled in use for other materials. For example, masonry has a lot of similar properties to reinforced concrete, so the RCP form could be used as a substitute for masonry assets. After the asset types to have inspection processes developed for them were selected, the major stages of each inspection process were determined. Through analysis of previous inspection guides, two major types of inspection were needed for every asset: structural and functional inspection. In addition, there were two major physical areas of an asset that should received attention during an inspection: the inside of the barrel, and the inlet/outlet of the structure, which includes the area surrounding the asset. With these two things in mind, the inspection process what broken down into four stages: barrel structural assessment, barrel functional assessment, inlet/outlet structural assessment, and inlet/outlet functional assessment.

Once the type of assets were determined and the overall stages of the inspection process were determined, the criteria by which these assets would be inspected for needed to be developed. This was done in a six step process:

1. Review MS4 Guidelines
2. Review Other State DOT Inspection Guides
3. Review Survey Results for Common Issues
4. Determine Criteria that Addresses All Three

5. Determine Scalable Factors for Each Criteria
6. Place Criteria within one of the 4 Stages of Inspection

The first step involved reviewing the Municipal Separate Stormwater Sewer System (MS4) Guidelines. One of the goals of the guide is to help local governments develop inspection systems that will be thorough, while also meeting the guidance practices of federal programs such as MS4, so that they won't have to change their systems under the new guidelines. Thus, it was necessary to determine what an MS4 inspection requires inspectors to look for when inspecting pipe and culvert assets. From there, whatever criteria determined for the inspection forms and processes within the guide shall make sure to hit on at least one of the items from MS4. After review, there were 10 items of interest that MS4 guidelines required inspection towards: blockages/obstruction, corrosion, cracks/joint separation, root intrusion, collapse of pipe, leakage, lack of stabilization, bent/chipped ends, liner damage, and moderate/severe erosion.

The second step required a literature review of other state GDOT guides for inspection of culverts and pipes of local governments. This is an expansion of the review done for the literature for this project, however this time, the review would solely focus on the categories of items the state GOD guides recommended inspecting. This was done with the help of another member of the research who produced another document summarizing these guides. It was important to do this in order to make sure the guide covered every possible area by which a pipe or culvert could be reasonably inspected. Upon review, the 6 most common categories that the guides called to be inspected included embankments, waterways, end sections, walls/aprons, structural condition, and hydraulic performance. The criteria developed will altogether work to address each of these 6 areas.

The third step required the results of the survey taken earlier in this thesis' process. The part of the survey of interest was the results stating what are the most common issues local governments in the state of Georgia face when maintaining pipe and culvert assets. It was important to review this because the criteria for the inspection should help local governments in Georgia identify problems they commonly face and to help them identify what to look for so that smaller problems do not become larger ones down the line. After reviewing the results of the survey, 7 major areas of concern were identified, including brush/tree cutting, blockages, joint separation, erosion control, metal corrosion, scour/stability, and channel alignment.

Once review of these three types of resources was complete, 6 common criteria were selected that would be true across all types of assets. The six criteria chosen were pipe joint separation, sediment build-up, erosion, headwall, blockages and alignment. Table 7 below shows how each of these criteria address at least one component from the three sources of review described above.

Table 7. General Criteria for Inspection Process and Which Items They Address From Each Source

	Pipe Joint Separation	Sediment Build-Up	Erosion	Headwall	Blockage	Alignment
MS4 Guidelines	-Cracks/Joint Separation -Root Intrusion -Leakage	-Blockages/ Obstruction	-Moderate/ Severe Erosion -Lack of Stabilization	-Bent/ Chipped Ends	-Blockages/ Obstruction	-Lack of Stabilization
Other State DOT Guidelines	-Structural Condition	-Waterways -End Sections -Hydraulic Performance	-Embankments -End Sections -Structural Condition	-End Sections -Walls/ Aprons -Structural Condition	-Waterways -End Sections -Walls/Aprons	-Waterways -Embankments -End Sections -Hydraulic Performance
Common Issues in Georgia	-Joint Separation	-Blockages	-Brush/Tree Cutting -Erosion Control	-Joint Separation -Scour/ Stability -Channel -Alignment	-Brush/Tree Cutting -Blockages	-Erosion Control -Scour/Stability Channel Alignment

Table 8 shows the material-specific criteria to be included with each major type of asset, which are reinforced concrete (RCPs), corrugated metal (CMPs) and plastic corrugated (PCPs). Between all 8 categories for each type of asset, every component from the three sources of review will be addressed in one way or another.

Table 8. Material Specific Criteria for Inspection Process and Which Items They Address From Each Source

	RCP: Cracking	RCP: Deterioration	CMP: Deflection	CMP: Deterioration	PCP: Deflection	PCP: Deterioration
MS4 Guidelines	-Cracks/Joint Separation -Root Intrusion -Leakage	-Collapse of Pipe -Bent/Chipped Ends -Liner Damage	-Collapse of Pipe -Bent/ Chipped Ends	-Corrosion -Root Intrusion	-Collapse of Pipe -Bent/ Chipped Ends	-Corrosion -Root Intrusion
Other State DOT Guidelines	-Structural Condition -Walls/ Aprons -End Sections	-Walls/ Aprons -Structural Condition	-Waterways -End Sections -Structural Condition -Hydraulic Performance	-Walls/ Aprons -Structural Condition -End Sections	-Waterways -End Sections -Structural Condition -Hydraulic Performance	-Walls/Aprons -Structural Condition -End Sections
Common Issues in Georgia	-Joint Separation -Crack Repair	-Spalling Repair/ Patching -Blockages	-Blockages	-Metal Corrosion	-Blockages	-Corrosion

The process for the next two steps, which are determining scalable factors and placing the criteria within one of the four inspection stages, are explained next. It was important to consider what criteria would be used for inspecting the barrel as well as the inlet/outlet of the structure and how the criteria would impact either the structural or functional condition of the asset. Each criteria in the inspection form would have their own 1-5 scale associated with the criteria. This is strategy seen in both the SCDOT's Pipe and Culvert Field Inventory and Inspection Guidelines as well as

Clarke County's Live Stream Pipe Replacement Program. Suggestions made by other state DOT guides, as well as the areas of greatest issue in Georgia, which were determined through the most common maintenance practices from the county survey, were considered when determining these criteria. Six criteria were eventually chosen to be included in all the inspection reports.

For the structural assessment of the barrel, pipe joint separation was included. Separation between pipe joints can occur because of a number of causes, such as the earthwork shifting over time due to loads. When separation occurs, the asset begins to no longer work as a single structure, making it more susceptible to larger loads. In addition, pipe separation allows for the water within the asset to leak into the surrounding soil, making the earthwork erode and overall weaker. This makes the asset even more susceptible to shifting earthwork and forces from large flood events. Separation that is over 1in provides several structural and functional impairment, according to Michigan DOT's Non-NBI structure guide. Therefore, separation greater than 1in was given a 5 condition rating and each rating 1-4 was done in 0.25in increments.

For the barrel functional assessment, sediment build-up within the barrel was included. Within barrels, it is not as likely for debris to fully clog up the asset like it does for the inlets/outlets. However, it is quite common for sediment carried by the stormwater passing through the asset to build up and slowly impair the functionality of the asset. The standards from other agencies on this varies. Some states only recommend acting if full blockage is occurring. Some agencies use a percentage system to determine what the rating is. For example, if the asset is 40% clogged in Gwinnett County, they consider its condition rating on that criteria to be severe. The guide ultimately went with an even scale for its 5 categories, each representing 25% increase. However, it will also leave an additional point on the 5 for the category, stating that if sediment is causing blockage of flow, even if less than 75% full, then it shall be rated as a 5.

For the inlet and outlet structural assessment, the two criteria to be considered with every asset is erosion and the headwall condition. For erosion, almost any guide or standard that deals with rating erosion impact is done so on a professional opinion basis. To remove some of the guesswork, this guide will have whether erosion is compromising the structure/stability of the structure of the road as the primary indicators that the asset is in terrible condition. For headwalls, it was difficult to determine how to rate this criteria. When available, assets should have a headwall of some sort, in order to provide additional structure and stability to the asset. The INDOT Processes of Small Culvert Inspection and Asset Management guide states that assets over 48 in should always include a headwall. It is very common for smaller assets to not include headwalls. A similar suggestion within the guide was initially considered. However, as there is no similar requirement in the state of Georgia, such a suggestion would be seen as cumbersome. Therefore, if a headwall is to be added to an asset, it shall be done at the direction of professional engineering recommendation. Regardless, if a headwall is in place, the two things that determine its condition rating is the amount of shifting and separation from the rest of the asset is apparent. The condition ratings of 1-5 reflect this.

Lastly, the criteria to be used across all of the form types when it comes to the functional inspection of the inlet and outlet of the structure are blockages from debris and alignment. For blockages, the main criteria to determine its effect on the assets condition rating is how much is the blockage impeding the flow. Minor debris may be present but so long as the flow isn't impeded it will not score highly on this criteria's 1-5 scale. However, if the debris starts to cause backflow or just acts as a dam with the asset, then the score will be much higher. Alignment is the final criteria applied over all types of assets. Alignment is the concept that the longitudinal direction of the asset should align with the direction of flow of water entering and exiting the asset. If these values are off, the flow of water does not enter the asset as easily and the force from that water will not only lead to some backtracking, but also structural concerns at the entrance. The worst case scenario with alignment is that the asset and the flow of water are perpendicular to one another. This scenario was given the 5 score. A score of 4 was for anything between 45 degrees and 90 degrees, as this is when the misalignment will force the flow of water into the sides of the structure, leading to structural damage. From there, scores 1-3 are in equal 15 degree increments.

One criteria that was considered but did not make the final list of criteria for this guide is the Hydraulic function of the asset. While a culvert or pipe's ability to channel the amount of stormwater it is being asked to handle is very important, it is difficult to properly gauge this using the inspection strategies recommended in the guide for a number of reasons. Firstly, hydraulic function is best inspected whenever a large rain event has occurred. Most culverts are designed for 25 year rain periods. The goal of the guide is to encourage local governments to be regular with their inspections, and waiting on irregular events such as large rain events in order to conduct inspections goes against this philosophy. It is recommended in the guide that local governments continue to rely on reports of irregular flooding and professional engineering opinion when making judgment calls on whether a assets ability to meet its design capacity.

Once the criteria that would be included with all asset types was determined, it is important to determine which material-specific categories would be included with each assets. For concrete assets, cracking and spalling are the two most clear signs that structurally, something is wrong with the assets. A category for cracking was developed. The best condition was set to be no cracks were visible. A score of 2 represented longitudinal cracks, which are common and represent shrinkage within the concrete but aren't typically indicative of loads overwhelming the structure. A score of 3 involves transverse cracking within the asset, which are more indicative of a loading issue. A score of 4 is achieved when cracks are large enough to expose reinforcement within the structure. Lastly, a score of 5 is achieved when cracks are large enough to allow soil to penetrate the asset. The other criteria to consider with concrete is the deterioration of the material. For concrete, this is seen in spalling. The scale for this criteria involves looking at the discoloration of the material and then looking for spalling, which could compromise the structure of the asset.

For metal and plastic pipes, instead of cracking being a criteria, deformation or deflection of the asset was considered to be more appropriate. Because of their thin and bendable nature, metal and plastic corrugated pipes are subject to deflection due to the loads above them. According to Michigan DOT's Non-NBI Culvert Inspection guide, assets whose deflection is exceeding a 20% change in their vertical diameter are showing signs of potential collapse under their loads. In addition, this closing of the vertical diameter will impede the asset from being able to channel the amount of water it was engineered for, as its cross-sectional is lowered. Much like concrete, it is also important to include criteria referring to the deterioration of material within the barrel. For metal, oxidation and rust and its impact on the structure must be considered. For plastic, general deterioration due to acidity within the soil should also be considered and measure based on its impact on the structure of the assets.

Once the eight criteria for the assets had been determined, this impacted how the inspection process section of guide needed to written as in its current form, it did not match much of the material provided in the inspection forms. In order to fix this, the section was rewritten to focus on the criteria used in the inspection forms, with a page dedicated at the beginning of the section to the process of structural versus functional inspection.

Final Draft

The final draft of the inspection guide is available in Appendix F. This final version included the changes made to the inspection process section as described in the preceding sections. In addition, an iterative process of feedback between other members of the UGA research team, as well as local government officials, was used to fine tune the content.

Potential Implementation of Inspection Guide and Limitations

Initially, Evans County was to be included as one of the counties involved in a case study to explore their system for inspecting the culverts and cross-road pipes. It was very unique for a county of their small size to have a system that included inspection intervals, condition ratings and be in the process of building an inventory. Unfortunately, due to scheduling conflicts, the observation visit did not occur. This presented a problem, as the other 4 counties involved in the case studies were all of relatively large size and were all nearby either Atlanta, GA or Athens, GA, meaning the diversity of both geography and size among counties desired by this these was suddenly lacking. The other issue was that because Evans County was unique in its practices for a small county, there was not another small county readily available to visit, based on the results of the survey. This required the strategy to shift. Instead of promoting a smaller county government's current practices, it was decided that the research team would visit a smaller county and discuss with its public works and road officials the contents of the inspection guide and to discuss how feasible it would be to implement the practices and strategies contained within.

Sumter County

Introduction and Meeting Participants

Members of the research team of Research Project 21-02, between the Georgia Department of Transportation and the University of Georgia's College of Engineering, visited the Sumter County Public Works Department office, located on 321 McMath Mill Rd, Americus, GA, shown on Figure 69. Sumter County was selected as a case study candidate for a few reasons. Firstly, it is a relatively small county of roughly 29,000 residents. This would be the smallest county visited by the team so far. This allows us to converse with a county that does not have an urbanized areas and to see the restrictions in resources they may have compared to a larger county government. In addition, Sumter County is not part of any larger urban area, such as Atlanta, Savannah, Macon or Athens, GA. This again illustrates that this county is mostly left to its own resources, rather than working with larger city governments as well. The county is also the furthest south among the counties visited for the observation visits, allowing the research team to promote the geographical diversity for the project as well. The last major reason Sumter County was selected is because unlike the other counties selected for a case study, Sumter County does not already have any of the necessary components for a successful inspection program for culverts, pipes and other similar local assets. The team was invited down by Public Works Director, Jim Littlefield Jr., because he has expressed a desire to enhance the systems his county uses for maintaining their assets. Mr. Littlefield has lived in Sumter County all of his life and only recently has become the Director of Public Works for the county. His goal currently is to take advantage of new technology to make his departments work more efficient and the possibility of an inspection guide like the one this project as developed piqued his interest. Thus, the goal of this visit was to present the findings and suggestions within the guide and discuss the feasibility and helpfulness of the resource as a whole.

Figure 69 - Sumter County Public Works Office

Current State of Inspection Program

Before the research team could discuss the implementation of the suggestions, strategies and processes present in the guide, its important to understand the starting point that Sumter County is at before looking to change its system. One of the things that makes Sumter County such a successful case study is that their current system is reflective of many smaller county’s systems, based on the results gathered from the survey earlier in the process. Sumter County does not have a formal inspection process, including inspection intervals, condition ratings for assets, or an established inventory system. It is instead reliant on reports from constituents or issues the public works team sees while they are servicing other projects. From there, those reports are turned into paper work orders, which are then carried out and kept for record keeping. In this process, there is no electronic documentation of the work orders or the maintenance items performed because of them. Figure 70 below shows an example of one of the work orders present at the Public Works office during the visit, with redacted information for the sake of privacy for the Sumter County Public Works Office.

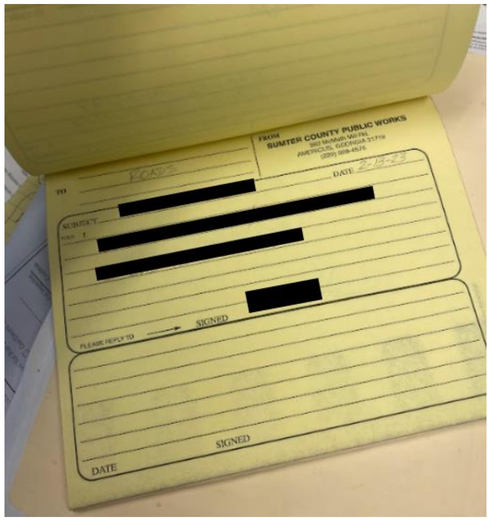


Figure 70 - Example of Sumter County Work Order Form, Information Redacted

While this system seems to work, it is incredibly inefficient. Because the record keeping is not entered electronically, it is difficult to establish otherwise clear patterns. In addition, because the only issues being taken care of are with assets whose issues are readily visible, many times assets which are not so visible go undermaintained. By the time the issue with the asset is more readily apparent, the county is often looking at the possibility of road closures and much more expensive pipe replacement projects. Sumter County attempts to conduct as much of their own maintenance as possible when dealing with these assets, however assets larger than 48in are contracted out.

Discussion of Inventory Establishment

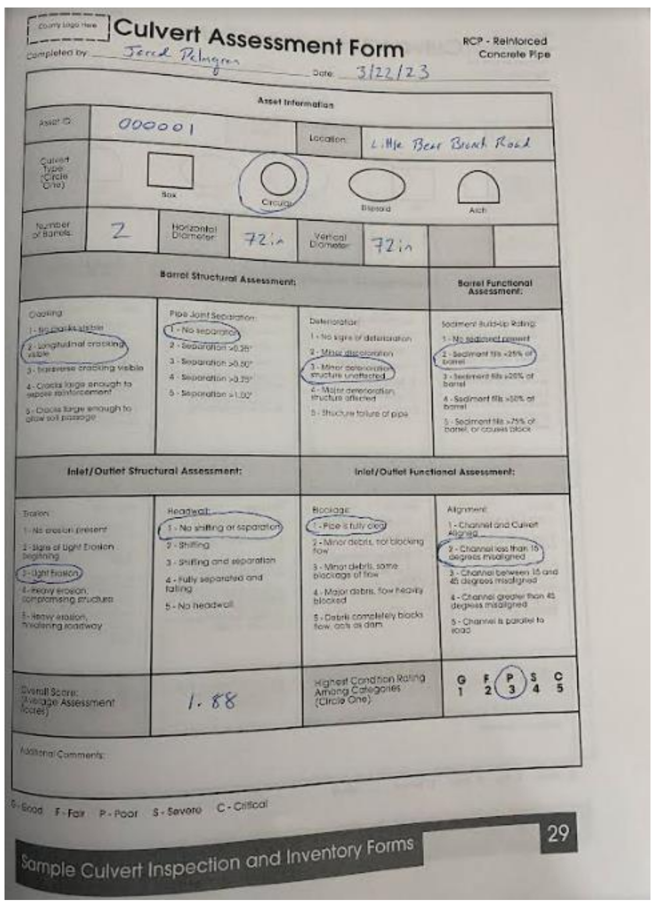
With regards to an inventory, Mr. Littlefield stated it was one of his major goals over the next several years is to establish a formal inventory. Currently, Mr. Littlefield is able to recall where most assets are located, but this is because he has lived in Sumter County his entire life and has worked with these assets during that time. In addition, this is mostly for assets who are regularly causing problems, meaning there are assets who don't regularly cause problems that are going without maintenance and could cause major problems in the future. Mr. Littlefield acknowledges these limitations, which is why he is looking to build out an electronic version of a culvert and pipe inventory, if nothing else for the next person who works as Public Works Director after him. The UGA research team wished to show Mr. Littlefield both the inventory forms developed for the guide as well as discuss the potentiality of an online version of the inventory form, which would automatically be uploaded to an online GIS database to be accessed by the county officials later. After reviewing the inventory form, Mr. Littlefield stated that the information asked for with each asset was reasonable to record and feasible to retrieve from each assets. The only piece of information he was hesitant about was the "Initial construction date" line item, which would be difficult to retrieve while out in the field and many assets are so old there is no written documentation as to when they were built. Mr. Littlefield expressed excitement when the research team described the online version of the inventory forms. He was especially enthusiastic that it would automatically map the location of the asset based on the GPS coordinates of where the information is filled out. In addition, he expressed excitement that the forms could be filled out easily over his inspector's phones.

Trial Run of Inspection Forms and Process

In order to test out the feasibility and intuitiveness of the inspection process expressed in the guide, the research team requested to have a trial run of the forms and process on one of Sumter County's assets. Mr. Littlefield selected a double barrel 72in reinforced concrete culvert located on Little Bear Branch Road. This asset had recently been replaced, but functionally was having problems due to the prevalence of beavers in that area and them building dams within the assets. Figure 71 provides a visual of the asset.

Figure 71 - UGA Research Assistant, Jared Palmgren, and Public Works Director, Jim Littlefield, Preparing to Inspect Asset

Once on site, the inspection process presented in the guide was carried out, using both the paper and the online version of the Culvert Inspection Form for RCPs. Mr. Littlefield filled out the form via the online version while a UGA research graduate filled out the form via paper copy. The filled out paper copy can be seen in **Figure 72**. The asset was given an Asset ID of 000001 as placeholder. The culvert type was listed as circular culvert and the number of barrels listed at 2. The horizontal and vertical diameter were both measured to be 72in, which is expected of a new RCP. From there, the conditional assessment began. First, cracking was given a 2, as there were come longitudinal cracks apparent deeper into the culvert. Pipe separations was given a 1, as there was no apparent separation between pipes. Deterioration was given a 3, as some minor spalling was occurring within the asset, but the structure is unaffected, as can be seen in Figure 73. Sediment Build-up was given a 2, as some sediment had started building up along the bottom of the barrels. Once the barrel was inspected, the team moved to inspect the inlet outlet of the structure. Erosion received the highest rating at a 3, since the concrete apron of the outlet has clear signs of erosion. However, this did not affect the structure or stability of the asset, therefore it did not receive a grade of 4. The headwall was given a rating of 1, as there were no signs of shifting or separation. Blockage was also given a 1, as there was no debris within the pipe, a relief to Mr. Littlefield and his beaver worries. Lastly, alignment was given a 2, as the flow of water outside of the culvert wasn't perfectly lined up with the culvert, but it was a minor difference of less than 15 degrees. After the inspection, the overall condition of the asset was calculated to be 1.88, with 3 being the highest condition rating present in the criteria.


County Logo Here

Culvert Assessment Form

RCP - Reinforced Concrete Pipe

Completed by: Jerod Pelmgren   Date: 3/22/23

Asset Information

Asset ID: 000001   Location: Little Bear Brook Road

Culvert Type (Circle One): Box, Circular, Elliptical, Arch

Number of Barrels: 2   Horizontal Diameter: 72in   Vertical Diameter: 72in

Barrel Structural Assessment:

Cracking:
1 - No cracks visible
2 - Longitudinal cracking visible
3 - Transverse cracking visible
4 - Cracks large enough to expose reinforcement
5 - Cracks large enough to allow soil passage

Pipe Joint Separation:
1 - No separation
2 - Separation >0.25"
3 - Separation >0.50"
4 - Separation >0.75"
5 - Separation >1.00"

Deterioration:
1 - No signs of deterioration
2 - Minor discoloration
3 - Minor deterioration, structure unaffected
4 - Major deterioration, structure affected
5 - Structure failure of pipe

Barrel Functional Assessment:

Sediment Build-Up Rating:
1 - No sediment present
2 - Sediment fills <25% of barrel
3 - Sediment fills >25% of barrel
4 - Sediment fills >50% of barrel
5 - Sediment fills >75% of barrel, or causes block

Inlet/Outlet Structural Assessment:

Erosion:
1 - No erosion present
2 - Signs of Light Erosion beginning
3 - Light Erosion
4 - Heavy erosion, compromising structure
5 - Heavy erosion, threatening roadway

Headwall:
1 - No shifting or separation
2 - Shifting
3 - Shifting and separation
4 - Fully separated and falling
5 - No headwall

Inlet/Outlet Functional Assessment:

Blockage:
1 - Pipe is fully clear
2 - Minor debris, not blocking flow
3 - Minor debris, some blockage of flow
4 - Major debris, flow heavily blocked
5 - Debris completely blocks flow, acts as dam

Alignment:
1 - Channel and Culvert Aligned
2 - Channel less than 15 degrees misaligned
3 - Channel between 15 and 45 degrees misaligned
4 - Channel greater than 45 degrees misaligned
5 - Channel is parallel to road

Overall Score: (Average Assessment Scores) 1.88

Highest Condition Rating Among Categories (Circle One): G 1, F 2, P 3, S 4, C 5

Additional Comments:

G - Good F - Fair P - Poor S - Severe C - Critical

Sample Culvert Inspection and Inventory Forms

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Figure 72 - Filled Out Sample Culvert Form Post-Inspection

Figure 73 - RCP Asset in Fair Condition, Some Material Deterioration Apparent

Feedback on Inspection Process

After the trial inspection was completed, the team and Mr. Littlefield discussed feedback he had for the process. First, he once again expressed his approval that this process could be carried out on mobile devices. Secondly, he noted that the form should include a spot to add additional comments. The last major piece of discussion was how to utilize the overall condition rating. The goal of having an overall condition rating is to make it easier to prioritize different assets in need of maintenance, repairs or replacements. However, the form gave both the option of calculating an average score and presented the highest score given in the set of criteria. Mr. Littlefield was unsure as to which score to use when determining priority. It was discussed that there is value in using both types of scores. Using the average score would allow for a better overall picture of an assets condition and indicate when multiple criteria are at issue. However, if an asset is in overall great condition, lots of 1s in different criteria, but one criteria has been given a 5, an overall average of the different criteria will hide that one criteria in bad condition. This isn't an issue if a local government were to solely go by the highest condition rating. However, if one were to prioritize solely by that value, it wouldn't make sense to prioritize an asset with only one bad criteria with a condition rating of 5, versus an asset who, for example, averages 3.9 as a condition rating, but its highest condition rating is a 4. The discussion was had between the two options and the site visit participants agreed that a system involving both scores would likely be the answer, such as prioritizing by overall condition first, and then highest condition rating on assets be the second prioritization factor. It was also determined that including the culvert shape type was not necessary for an inspection form and only for the inventory form.

Additional Asset Site Visits

After the trial run, the research team was shown two other types of assets that are common within Sumter County. This included an older small concrete box culvert with severe erosion issues, which can be seen in Figure 74, as well as a large corrugated metal pipe (CMP) asset located under a dirt road which recently collapsed. That asset can be seen in Figure 75. The research team did not conduct further trial runs of the inspection forms for these assets, as the team did not want to reiterate many of the same points again to Mr. Littlefield. Rather, discussion was centered around the differences in inspecting the different types of assets, as well as understanding the types of things Mr. Littlefield looks for when he comes across assets.

Figure 74 - Reinforced Concrete Asset with Severe Erosion and Stability Issues

Figure 75 - Collapsed Large CMP Asset Located on Dirt Road

Research Team's Opinion of Potential Implementation of Inspection Guide

The goal of the research team's visit to Sumter County was to gauge both the interest and feasibility of the inspection guide amidst a small county such as Sumter County. It is the opinion of the research team that the visit was a success on both accounts. When discussing the contents of the inspection guide, it was shown that the expectations for an inspection system at the local government level were both reasonable and clearly defined. It was stated that breaking down the foundations of a system into inventory, inspection intervals and condition rating made the initial process of building those systems not as overwhelming or complicated. The feedback on the expected inspection process was overall positive with some minor suggestions made, such as clearing up some vocabulary. Sumter County has agreed to continue to work with UGA as a part of the long-term RP 21-02 to test new guides, resources and other tools. It was discussed that as a future extension of this thesis' project, they will use the final version of the inspection guide to build out their inspection program, with the help of UGA resources to build their inventory.

Limitations of Inspection Guide

One final area to explore is to understand the limits of the inspection guide developed within this thesis. This helps to establish the scope of the guide. It also includes discussing topics that were considered to be included in the inspection guide but were ultimately left out. When establishing the scope of the guide, the goal was to focus on assets that are Non-NBI assets that are locally owned, which typically includes assets with a span less than 20 feet. However, there are some assets which fall into an in-between categorization, depending on the county, where they are still inspected by GDOT despite them not being NBI assets.. Usually these are larger concrete box culverts. The guide does its best to cover the inspection process behind these types of assets, but if a county has a pre-existing system with GDOT to have these type of structures inspected by them, there is no need to change that system. When it comes to solving the problems faced by counties when it comes to the establishment of these type of inspection systems, the guide addresses the knowledge gap so many local governments cited, especially when it comes to where to get certain resources from, such as inventory and GIS services. However, the guide does not directly help issues such as limited funding and manpower. The best the guide does for funding is help local governments set up systems that will make prioritization of limited budgets more efficient and decisions easier to make, as well as discuss what some other counties have done raise funds for their program. The guide does not have suggestions regarding how to increase the workforce of the team conducting inspections outside of the suggestions for funding in general.

When it comes to the inspection process itself, the guide is limited on two different categories. The first of which is hydraulic performance. Hydraulic performance refers to an asset's ability to handle the water that is flowing through it. This was not included as a major category for local government investigators to consider for a few reasons. Firstly, hydraulic performance is engineered into the design of the culvert during the design phase by a licensed professional engineer. This means in order to get an accurate gauge of hydraulic performance, inspectors will need access to those calculations, which are not always readily available, and you'd need to professional engineer's opinion to accurately state the culvert/pipe does not perform its hydraulic function. Secondly, one of the goals of the inspection guide is to keep local governments on a regular schedule with their inspections. To gauge hydraulic performance, you would only be able to gauge it on a day in which there was significant rainfall, which limits when local governments can inspect assets. Thirdly, inspectors may come across a culvert that looks like it is overwhelmed hydraulically, but not realize the recent storm even was more than the asset was designed to handle.

Most stormwater systems and events are designed to handle 25-year events, which means the worst storms that occur once every 25 years. By definition, there are also 50 year and 100 year events, which are usually much worse than the 25 year events. Thus, you could have an asset struggle to handle these events, but it is not fair to judge the asset's performance on those 50 and 100 year events, because it was not designed for it. In order to make sure inspectors could do what they could to make sure the culvert/pipe is performing its hydraulic function, several items that can impede hydraulic performance were included, such as blockages and sediment build-up, which can be seen any day the inspection occurs.

The other topic that was considered to be included in the inspection process was geotechnical issues, such as foundation and settlement. While this topic was not directly covered in the guide, items were included in the guide which should help cover any geotechnical issues the culvert/pipe may have. Sections on scour and erosion of soil around the asset directly talk about how the weakening of soil around an asset can lead to collapse both of the asset, as well as the road above. In addition, sections on cracks, deterioration and, pipe separation all discuss how leaks from the assets can weaken the soil around the asset. The section on headwalls, which can double as retaining walls for the assets, also addresses their shifting and separation, which can be caused by issues within the soil. So while geotechnical isn't directly addressed, the issues that could lead to geotechnical issues are addressed.

CHAPTER 7. SUMMARY OF FINDINGS, CONCLUSIONS AND FUTURE WORK

This investigation started out with two major questions: “Why are local governments in Georgia falling behind with maintaining their assets?” and “What resources can we develop to help them?” The assets in question began with locally own bridges, but also evolved into locally owned small bridge-like structures such as culverts and cross-road pipes. Through the process of literature review and interactions with local governments in the form of surveys and site visits, it was possible to determine the current state of affairs regarding Georgia local governments’ ability to maintain and manage their assets. Once this was complete, it was determined that two resources could be developed in order to aid local governments in the endeavor of upkeeping their local assets.

Firstly, in order to aid with locally owned bridges, the research team sought to develop a strategy plan to present to GDOT that identifies areas of improvement that can be achieved in order to build the relationship between GDOT and local governments when it comes to maintaining bridges. For smaller assets such as culverts and cross-road pipes, it was determined that an inspection guide for these type of assets would be developed. This guide would not only teach the local governments how to evaluate their assets and attach a condition rating to them, it would also encourage them to initiate an inventory system and regular inspection intervals, in order to make the job of evaluating these assets more feasible, which will help them prepare a quantitative data report for maintenance, repair, and rehabilitation (MRR). In addition, the guide would also explain how having all three components - inventory, inspection intervals and condition ratings - will make budgetary decision making easier. The following sections provides the findings that were determined from each of these steps within the process.

Findings from Literature Review

From the literature review, the research team was able to understand how preventative maintenance systems have become a staple of asset management for state and federal transportation departments, especially bridges. The NBI system and its requirements for regular inspections of bridges is the best example. When it comes to local governments and their roles in the maintenance of NBI bridges, some states have provided resources to their local governments to help them understand their role. For example, Arkansas provides a comprehensive guide to its local governments regarding where the jurisdiction of both the state agency and the local government begin and end when it comes to bridge maintenance. Other states such as Pennsylvania and California provide online services that help explain the responsibility of the local governments, but also provide links to resources and continuing education. Currently, GDOT provides the Local Administered Project (LAP) Certification program to encourage uniform practices for authorizing qualified Local Public Agencies (LPA) to manage core activities for Federal-aid funded projects. Additionally, when it comes to locally owned non-NBI transportation assets, state transportation departments have increased their interest in the practices surrounding them, since proper maintenance and management of such helps to keep transportation infrastructure safe at all levels. GDOT is the latest state transportation agency to encourage the state-of-the-art asset management practices including preventative maintenance practices for its local governments. Many states such as New York, Michigan, South Carolina, Minnesota, and Indiana have developed resources and guides for the purpose of encouraging these practices on their non-NBI assets. Georgia has yet to provide similar resources, or has not consolidated them as other states have. Georgia lacks a comprehensive and standardized guide for both local governments' role in maintaining bridges, as well as establishing transportation asset management plans for locally owned Non-NBI assets.

Specifically, a draft inspection guide as well as a strategy plan to develop resources for counties and GDOT is expected to close both of these gaps. The inspection guide helps counties document both the inventory and the inspection history of these assets in order to be better keep track of the condition ratings for them. It standardizes the expectations surrounding the information that needs to be documented in an inspection in order to adequately assign a condition rating to the asset. In addition, the development of the systems expressed in the guide would allow for local governments to better prioritize projects for budgetary decision making.

Findings from Interactions with Counties

Once those needs were identified through the literature review, in addition to the existing resources, the research team expanded their inquiry by reaching out directly to the local governments involved in the project. Through the survey developed and the on-site visits to observe best practices, the research team was able to identify resources and practices helpful to the end goals of the project. Firstly, there is a heavy reliance on GDOT for the maintenance of NBI bridges. Counties state that their largest struggle deals with funding and that GDOT's help in that department yielded mixed results. Furthermore, some counties did not appear to clearly understand constraints in federal/state funds and their responsibilities. Once again, communication problems lead to counties feeling unprepared to take advantage of funding resources. Overall, local governments are not confident in their ability to do their part for bridge maintenance at all three levels of funding, resources and knowledge, underscoring the need to improve the relationship between GDOT and local governments.

When it comes to smaller, locally owned, Non-NBI assets, the surveys and site visits provided insight into this as well. Most local governments rely on reactive maintenance systems which can lead to larger problems and greater budgetary burden as a practice. In order to move towards a preventative maintenance system and manage assets, local governments need three things: inventory systems, regular inspection intervals, and condition rating systems for budgetary planning. As it stands, out of 49 counties participated in the survey, about half of Georgia counties have inventory systems of some sort (e.g., an excel list or a GIS database), half keep regular formal or informal inspection intervals, and only a quarter apply condition rating systems. Creating a guide that instructs how to establish all three should help counties initiate or improve an asset management process and move towards adopting preventative maintenance systems. The team also found that in Georgia most Non-NBI assets are made of metal or concrete, with a smaller but notable number of plastic assets. There are a few wooden assets, but these are typically in the process of being replaced by the previously mentioned materials. Thus, the guide mainly focuses on inspection concrete, metal and plastic assets, but its core principle can be applied to other assets. Overall, counties feel more confident about the ability to manage and maintain their smaller locally owned assets. However, providing resources to make it easier to transition to a preventative maintenance system, specifically, by means of establishing a condition rating system and respective budgetary planning, is welcomed.

Findings from Development of Strategy Plan

During the surveys and observations, the research teams was able to identify findings that are crucial for developing project deliverables. For the strategic plan for improving the relationship between GDOT and local governments, there were three major areas which could strengthen the relationship between GDOT and local governments: improving communication, enhancing transparency and access, and promoting learning and engagement. The first finding regarding improving communication refers to the amount of time spent on delays in and broken communication. GDOT reports they have a difficult time knowing who to contact in counties for information either because of confusing information provided by the county or because of staff turnover. The research team witnesses this first hand when many of the phone numbers and contact names taken for the website and GDOT's contact database were well outdated. It also refers to county officials not being able to communicate with GDOT either because it is unclear who at GDOT they should contact for which questions. Either this, or they do contact the correct personnel, but then they do not hear back for an extended period. However, this goes both ways. County employees often work in the field or have limited work hours (e.g., 6am-3pm on Monday-Thursdays and/or not available on Fridays). It is also important that a diversified communication strategy be developed in order to better reach certain counties. This involves being comfortable contacting personnel and spreading information through a variety of means, such as phone calls, text messages, social media, email and even a phone application.

This lead directly into the second finding, which is the enhancement of transparency and access between GDOT and local governments. When counties report having a good system and understanding of bridge maintenance in Georgia, it typically comes with a glowing report of their relationship with GDOT and/or its inspectors. However, the opposite is also true. When counties express confusion or lack of confidence in bridge maintenance, they are willing to say they have not had good experiences with GDOT in the past and therefore are not as eager to look for their help on future projects. Earning this trust back and focusing on equity of treatment among local governments is a must for building an efficient strategy plan. This can be done in two ways. Firstly, the development of more resources for local government use. This includes highlighting best practices for bridge or asset maintenance through the use of case studies, as well as budgetary tools that help local governments learn to prioritize where their limiting funding goes. In addition, life cycle analysis tools can be developed to help local governments plan for the future regarding the life span of their assets, based on their maintenance actions of today. These tools and resources can be added to the newly formed local government page on the GDOT webpage, which is currently lacking information regarding bridge/culvert/cross-road pipes maintenance and management strategies.

The last major finding for the strategic plan was the ability to promote and learning and engagement. The first way it was determined this could be accomplished was through the development of training modules. GDOT already is in the practice of developing training modules for several of their other programs. It could continue this practice by developing on-board training for new local government officials in order to explain the relationship between GDOT and local governments. In addition, funding application training would also be beneficial to help local governments better understand the process by which applications are approved or rejected and what are some best practices when filling out the applications.

Lastly, training modules on how to better performance technical bridge maintenance will allow more local governments to do the maintenance items requested of them by GDOT in house, and therefore save budgets in the long run. Lastly, GDOT can promote learning and engagement through different levels of organized activities. This includes webinars between counties, in-person workshops and training at the district level, and even a state-wide awards ceremony for asset management. This does not just have to be between local governments and GDOT. The counties who may have lesser relations with GDOT often do not hold the same feelings for their peer county governments. This is likely due to a semblance of commonality as these counties often face the same struggles, as compared to state agencies such as GDOT. Encouraging inter-county cooperation will be beneficial in building a strategy plan for GDOT as a network effect can promote best practices and enable effective use of limited resources.

Findings from Development of Inspection Guide

Lastly, the research has presented findings crucial towards the development of the inspection guide. There are three main findings from the overall approach proposed. Firstly, local governments will need to understand the resources that will enable preventative maintenance and budgetary planning. Many county governments expressed that their reactive maintenance plans worked for their counties and no switch was needed for maintenance. However, these counties often cited funding and manpower as their major problems. Establishing an inventory of assets and a condition rating system, which enables preventative maintenance, will help reduce both. Another finding is that local governments need to understand the major components of an asset management system, which includes establishing an inventory, building out an inspection process and strategy, which includes condition ratings, inspection intervals and inspection process, and lastly, how to make budgetary decisions from these processes. Many counties have some of the components but do not understand why they must or how to implement them all. The inspection guide addresses all three major pieces.

Another major finding was the need to unify the practice of how to properly inspect an assets. Based on conversations with local officials, some are able to only inspect an asset once every 5 years while some state they can inspect all their assets in a single day. While nominal asset numbers do range widely between rural and urban counties, this also suggests that some of the inspections being given to these assets are not uniform or formal. Setting an base expectation for an inspection process should provide high quality inspections for these assets. Municipal Separate Storm Sewer System (MS4) guidelines do ask for assets to be condition rated, however these ratings are subjective. They are left up to the opinion of the inspector, rather than being based on other aspects within the inspection report. To remedy this, it was found that in order to standardize the condition rating systems, a calculated average of multiple criteria for the overall condition made the most sense because it provides a quantitative measure of the overall condition. The recommendation is that the 8 criteria (see Appendix D) selected to be evaluated for each pipe or culvert be weighted equally, but the guide leaves room for local governments to weight different categories differently based on their experience or professional opinion. The eight criteria included on the inspection forms varies slightly for different materials, as is necessary as different materials deal with different issues. For example, the reinforced concrete inspection form highlights cracking rather than deformation of structure, which is more common with metal and plastic pipes. The other categories that remain consistent across all pipes were chosen to be pipe joint separation, interior deterioration, sediment build-up, erosion, headwall, blockages and alignment. These categories were chosen due to their prevalence not only other guides of similar nature, but also their ability to help meet the inspection standards of MS4 guidelines. The most common maintenance items for these smaller assets, according to the survey conducted in this study, can also be prevented or made aware of earlier by inspecting these regions and potential sources of problems within the assets. Another finding when developing these categories was that while hydraulic function is an important aspect for a culvert or pipe asset, it is difficult to properly gauge this using the inspection strategies recommended in the guide for a number of reasons. Firstly, hydraulic function is best inspected whenever a large rain event has occurred. Most culverts are designed for 25 year rain periods. The goal of the guide is to encourage local governments to be regular with their inspections, and waiting on irregular events such as large rain events in order to conduct inspections goes against this philosophy. It is recommended in the guide that local governments continue to rely on reports of irregular flooding and professional engineering opinion when making judgment calls on whether a assets ability to meet its design capacity.

The last major finding ties into the third finding for the strategic plan. County officials are interested in learning from one another. Thus, this inspection guide will include a component not seen in any other inspection guides. It will include case studies from counties across Georgia of varying geography and population size who have successfully implemented preventative maintenance plans for their locally owned Non-NBI transportation assets or culverts. The 5th case study will shift in its focus, as it will provide a spotlight on a county without a formal inspection system for its assets but is interested in developing one. The study will focus on the feedback the smaller county had for the philosophy and tools within the inspection guide and how feasible it would be for a local government, even a smaller sized one, to implement them and ultimately benefit it budgetary planning for MRR. This will provide the relational touch for the guide, as local officials can identify with at least one of the counties and look how that other counties' plan and strategy for these assets could fit into their own needs to improve public roads and mobility for the transportation network in Georgia.

Conclusions and Future Work

While many in our country focus on the impacts the federal and state government have in their life, it is often forgotten the impact local governments have when it comes to maintaining assets that benefit everyday life. Local governments are often closest to the problems and therefore are oftentimes best equipped with the knowledge of how to fix issues that affect their constituents. Such aspects make it important to identify when local governments need help and what can agencies with more resources do to help make their jobs easier. When it comes to locally owned bridges, culverts and cross-road pipes, this thesis sets out to do exactly that.

This investigation started out with two major questions: "Why are local governments in Georgia falling behind with maintaining their assets?" and "What resources can we develop to help them?” The first was answered through the process of understanding the current state of affairs between GDOT and local governments, both through researching currently available resources and programs, as well as directly communicating with local governments and GDOT. Between the Strategic Plan to Strengthen Partnership with Local Governments and the Georgia Non-NBI Culvert and Pipe Structure Inspection Guide, this thesis has produced two deliverables that will look to improve the ability of local governments in the state of Georgia to better maintain and manage their locally owned assets. The Georgia Non-NBI Culvert and Pipe Structure Inspection Guide will be especially important for local governments who expect or wish economic growth over the next decade or longer, as it will provide them with the necessary foundations to keep up with their growing number of assets and budgetary planning, as well as deal with any new regulations that come their way, through MS4 or other programs, as they are urbanized. Finalized versions of both deliverables will need to occur with the support and approval of GDOT. The greatest step forward this project was able to show was that when the very entities you are looking to help, in this case local governments, are heavily involved in the development of said resources, it provides a better ground by which these entities can implement these resources into their existing structures. Whether it was their willingness to provide information through the survey or their willingness to share through interviews and site visits, the impact of Georgia’s local governments and their success stories are evident both in this thesis and in the final deliverables. This involvement has made both of these deliverables more personable to the entities they are trying to help and therefore will see more success, as was seen in the case study in Sumter County.

While these deliverables are the end result of this report, the concepts studied and researched provide excellent opportunity for future work. This is work that can be carried on by other members of the UGA research team currently involved and ones who shall join in the future.

Within the Strategic Plan to Strengthen Partnership with Local Governments are concept ideas for many future tools yet to be developed. This includes the budgetary tools to help local governments prioritize their limited funding in more efficient ways. It also includes the Life-cycle analysis tools to help local governments understand the impacts of their maintenance and inspection practices. The training programs proposed in the third part of the strategy plan are also in need of development. The University of Georgia has recently been granted funding to begin the development of the on-board, funding application and bridge-maintenance technical training modules. Lastly, when it comes to the Georgia Non-NBI Culvert and Pipe Structure Inspection Guide, the guide presents the overall inspection process by which to evaluate assets, as well as the components needed to fully develop an inspection and management system for these assets. However, there is still room to provide future resources tied to the guide. The research team is in the process of developing electronic versions of the culvert inspection forms present in the guide. These electronic versions of the form will be tied to a GIS system, through which counties can start building out their inventories and sustain themselves, rather than having to contract out this work.

Another opportunity for future work after this project is complete is through the technology and methodology of deep-learning algorithms. Once a database of assets values are gathered from local governments using the inspection system and condition rating system within this guide, those results can be used to teach an algorithm to predict an assets condition without the need for an inspector. The algorithm would utilized pictures taken by inspectors both as a way to train the model, and then pictures taken by inspectors would be shown to the model and the model would produce a condition rating based on what it had seen from previous assets. If counties volunteered to participate, the database could quickly grow to be more than enough to train such an algorithm.

Gwinnett County by itself has over 127,000 assets. By developing such a model, it would take a lot of the subjectivity of inspection out of the equation and remove the biases of inspectors.

Ultimately, the goal of any engineer is to provide solutions that create a safer world to live in for people and to make life easier for those who come after you. The deliverables presented in this report and the work that comes after, will go towards addressing the lag in management and maintenance of bridges, culverts and cross-road pipes in the state of Georgia. This will create safer roadways by which everyone travels on every day, and establish a more feasible system to maintain and manage for future generations. It is also my hope that these deliverables will inspire other states and municipalities to adopt the strategies and guidelines present within them, so that the impact is not limited to Georgia, but all across the country.

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APPENDIX A. SURVEY QUESTIONNAIRE

GDOT Research Project 21-02 Questionnaire

Start of Block: Please answer the following questions to the best of your ability.

N1 This is a survey designed by the University of Georgia's Civil Engineering research team (For questions, contact Dr. Mi Chorzepa at **chorzepa@uga.edu**). The survey should not take longer than 15-20 minutes to complete.

This project (21-02) is titled "Strategic Prioritization in Bridge Asset Maintenance through Data Driven Long-Term Asset Valuation with Additional Emphasis on Promoting GDOT's Partnerships with Counties" and is funded by the Georgia Department of Transportation (GDOT) to find ways to promote the partnership between GDOT and local governments regarding the development of bridge asset management plans.

To accomplish this, the UGA research team is contacting all 159 counties and wants to hear from your county regarding your current practices and situations. This is so that we're able to gauge what the current landscape is regarding how local counties handle and maintain their transportation assets (e.g., bridges, culverts, cross-drains, pedestrian bridges, etc), as well as which areas do you, as a local entity, think are obstacles to enacting your asset maintenance plans.

The survey will contain two main parts:
(1) The first part of the survey will examine **sizable bridges and culverts**. These are assets that are listed on the National Bridge Inventory (NBI) and are inspected by GDOT.
(2) The second part of the survey will examine **non-NBI bridges and small assets** (e.g. culverts, crossover pipes on public roads, cross-road drains, pedestrian bridges) that are not inspected by GDOT and are owned by counties or local governments.

Additionally, the research team is interested in your approach (maintenance/rehabilitation/replacement) to both NBI and non-NBI bridges and culverts that are county-owned. Please note, your responses to this survey are not an evaluation for your performance as a county government, it is simply a method used to gain understanding of the current state of transportation asset management in Georgia counties.

We'll begin by asking for information regarding your county and personnel related to managing transportation assets in your local counties. Please fill out the information below to the best of your ability and **start the survey by clicking on the arrow button below**.

Q1-name Please provide your contact information in the spaces below. We understand that you are a point of contact for your county for this research project.

First and Last Name:

____

Q1-title Job Title:

____

Q1-county County Name:

____

Q1-phone Phone Number:

____

Q1-email Email:

____

Q2-asset manager Who is in charge of managing locally owned [both sizable and small] bridge/culvert assets in your jurisdiction? Management in this survey refers to inventorying and decision making for Maintenance, Repair and Replacement of these assets.

○ Same as the above (myself) (4)

○ I have a supervisor or another personnel. (5)

Display This Question:

If Who is in charge of managing locally owned [both sizable and small] bridge/culvert assets in your... = I have a supervisor or another personnel.

Q2-manager name Please provide the first and last name:

____

Display This Question:

If Who is in charge of managing locally owned [both sizable and small] bridge/culvert assets in your... = I have a supervisor or another personnel.

Q2-manager title Job title (For example: Public Works Director):

____

Page Break

N2-Part 1 L as Large **Part 1:** Sizable Bridges and Culverts
For the purposes of the questions below, "transportation asset" refers to **sizable bridges and culverts** that are owned by your county or local government, but are inspected by GDOT. The research team understands that Maintenance, Repair and Rehabilitation (MRR) is still the responsibility of the county for these transportation assets, even if GDOT is maybe involved in these processes.

Transportation **asset management** in this survey refers to a systematic process of maintaining, upgrading, and expanding physical assets throughout their lifecycle.

L1-TAM plan YN This page includes questions regarding a **transportation asset management plan**:

When it comes to sizable bridges and culverts (see the definition above) in your county, do you have a written asset management plan and/or procedure?

○ Yes (1)

○ No (2)

Display This Question:

If This page includes questions regarding a transportation asset management plan: When it comes to s... = Yes

L2-Y TAM plan text Could you briefly describe the plan?

____

____

____

____

____

Display This Question:

If This page includes questions regarding a transportation asset management plan: When it comes to s... = Yes

L3-Y TAM plan durat How long (in years) has your county had this transportation asset (sizable bridges and culverts) management plan in place?

____

L4-N TAM then how How are transportation assets (sizable bridges and culverts) managed in your jurisdiction?

____

Display This Question:

If This page includes questions regarding a transportation asset management plan: When it comes to s... = No

L4-N TAM then how How are transportation assets (sizable bridges and culverts) managed in your jurisdiction?

____

L5-how much on GDOT How much does your county rely on GDOT for **managing sizable bridges and culverts**? Again, these assets are inspected by GDOT but owned by your county. [Note: 0 below indicates no dependency. 100 indicates that your county relied on GDOT 100%.]

	0 10 20 30 40 50 60 70 80 90 100
Sizable Bridges ()	
Sizable Culverts ()	

L6-cmts on TAM Please enter any comments you may have regarding transportation **asset management plan and/or procedure** for sizable bridges and culverts in your jurisdiction:

____

Page Break

L7-TAM inventory In the previous page, we asked you about a written transportation asset management plan. This page includes questions regarding **a database of maintenance activities**.

Do you maintain a list (e.g., paper log or electronic database) of Maintenance, Repair and Replacement **activities** for sizable bridge/culvert assets in your county?

- ○ Yes (3)
- ○ No (4)
- ○ In process of compiling data (5)

Display This Question:

If In the previous page, we asked you about a written transportation asset management plan. This pag... = Yes

Or In the previous page, we asked you about a written transportation asset management plan. This pag... = In process of compiling data

L8-TAM invent items What information is kept on this list? Please select all that apply.

- ▢ Asset ID (4)
- ▢ Location information (5)
- ▢ Geometric information (i.e. shape, deck area) (7)
- ▢ Owner Information (city, county, etc) (8)
- ▢ Dates of Maintenance/Repair/Replacement (9)
- ▢ Date of Construction (14)
- ▢ Material Information (10)
- ▢ Maintenance Activity (11)
- ▢ Other: (13) ____

Display This Question:

If In the previous page, we asked you about a written transportation asset management plan. This pag... = In process of compiling data

L9-Duration TAM Inv How long (in months) do you think it may take to compile the list in your database (paper or electronic)? For example, enter 3 for 3 months.

____

Display This Question:

If In the previous page, we asked you about a written transportation asset management plan. This pag... = No

L10-MRR act manager Who keeps track of your Maintenance, Repair and Replacement **activities** for sizable bridge/culvert assets?

____

L11-MRR database YN If your county has (or were to establish) a database of Maintenance, Repair and Replacement activities for sizable bridge/culverts assets, would your county be willing to share your **list** with the GDOT & UGA research team only (not to distribute)?

○ Yes (1)

○ No (2)

L12-MRR act items Regardless of your answers so far, based on your experience, **rank** the following maintenance/repair activities performed on sizable bridges/culverts in your county, from being most (1) to least (14) commonly performed. If an activity is not performed, leave the space [on the left] blank. We understand that it's your opinion, not fact.

______ Approach Undersealing (1)
______ Undersealing of Approach Slabs (2)
______ Brush and Tree Cutting (3)
______ Erosion Control (4)
______ Repair of Existing Guardrail (5)
______ Bridge Joint Sealing (6)
______ Header Joint Reconstruction/Repair (7)
______ Deck Repair (8)
______ Bridge Curb/Rail Repair (9)
______ Culvert Repair (10)
______ Pile Replacement (11)
______ Repair Main Structure Members (12)
______ Bridge Painting (13)
______ Other Maintenance: (14)

Page Break

L13-TAM budget YN This page includes questions regarding **budget and funding**: [Reminder - Transportation asset management in this survey refers to a systematic process of maintaining, upgrading, and expanding physical assets throughout their lifecycle].

Does your county set aside an annual budget for **management** of sizable bridges and culverts?

○ Yes (1)

○ No (2)

Display This Question:

If This page includes questions regarding budget and funding: [Reminder - Transportation asset manag... = Yes

L14-Y budget $amount What is the annual budget in your county put towards maintenance, repair and replacement activities of sizable bridges and culverts?

If this year's budget is unknown, last year's or an average value is fine. For example, enter 100000 for $100,000.

____

L15-TAM fund option Rank the following funding options used to maintain sizable bridges/culverts from most (1) to least (9) commonly utilized. If a funding source is not used, leave the space blank.

______ Special Purpose Local Option Sales Tax (SPLOST) (1)
______ Transportation Special Purpose Local Option Sales Tax (TSPLOST) (2)
______ Local Maintenance and Improvement Grant (LMIG) (3)
______ Low Impact Bridge Program (LIBP) (4)
______ Local Bridge Replacement Program (LOCBR) (5)
______ Georgia Transportation Investment Bank (GTIB) (6)
______ State-based Funding (7)
______ Federal-based Funding (8)
______ Other: (9)

Page Break

L16-TAM resources This page includes questions regarding **resources for sizable bridges & culverts**:

Of the following statements below, please rate on a scale of 1-10 how much you agree with the statement, with **10 being "strongly agree"** and 0 being "strongly disagree". We understand that this is your opinion/impression, not fact.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0 1 2 3 4 5 6 7 8 9 10				
My county has the funds we need in order to adequately perform management for sizable bridges and culverts. ()					
My county has the resources we need in order to adequately perform management for sizable bridges and culverts. ()					
My county has the knowledge we need in order to adequately perform management for sizable bridges and culverts. ()					

L17-InspectX access GDOT uses a software known as InspectX in order for counties/local governments to view condition ratings/inspection reports of sizable bridges/culverts.

Has your county requested access to InspectX software and do you have access?

○ Yes (1)

○ No (2)

L18-TAM challenges What would you consider the biggest challenges to managing sizable bridges/culverts for your local jurisdiction?

____

L19-cmt on resources What resources do you currently not have that would be helpful for your local government to develop and/or execute your transportation asset management plan for sizable bridges?

____

N3-end of Part 1 You have successfully completed Part 1 (50% complete)! Part 2 contains similar questions.

Page Break

N4-Part 2 S as small **Part 2:** Small Bridges and Culverts
For the purposes of these questions below, "transportation asset" refers to **small bridges and culverts** that are owned by your county or local government and are **not** inspected and reported upon by GDOT. These assets often **include cross-road pipes**, straight drainage systems under public roadways, pedestrian bridges and the like. The Maintenance, Repair and Rehabilitation (MRR) is the responsibility of the county for these transportation assets.

For examples of what kind of assets we're talking about, please see the below figures.

N5-small example1 Example 1:

N5-small example2 Example 2:

S1-TAMP YN [Reminder - Transportation asset management in this survey refers to a systematic process of maintaining, upgrading, and expanding physical assets throughout their lifecycle].

When it comes to **small bridges and culverts** (see the definition above) in your county, do you have **a written management plan and/or procedure** for these assets?

○ Yes (1)

○ No (2)

Display This Question:

If [Reminder - Transportation asset management in this survey refers to a systematic process of main... = Yes

S2-Y TAMP text Could you briefly describe the plan?

____

____

____

____

____

Display This Question:

If [Reminder - Transportation asset management in this survey refers to a systematic process of main... = Yes

S3-Y TAMP duration How long (in years) has your county had this transportation asset (specifically, small bridges and culverts) management plan in place?

____

Display This Question:

If [Reminder - Transportation asset management in this survey refers to a systematic process of main... = No

S4-N TAMP how How are small bridges & culverts (see the definition above) managed in your jurisdiction?

____

S5-cmt on TAMP Please enter any comments you may have regarding transportation asset management plan and/or procedure for small bridges and culverts in your jurisdiction:

Please describe your small locally owned bridges and culverts (i.e. "70% of our assets are 16in corrugated pipes and we have 7 timber bridges")

____

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Page Break

S6-inventory YN This page includes questions regarding **inventory and inspection of small bridge and culvert assets** owned by your local government but **NOT inspected by GDOT**:

Do you maintain an inventory or database of small bridge/culverts assets (e.g., cross-road pipes) in your county?

- ○ Yes (1)
- ○ No (2)
- ○ In the process of compiling (3)

Display This Question:

If This page includes questions regarding inventory and inspection of small bridge and culvert asset... = Yes

Or This page includes questions regarding inventory and inspection of small bridge and culvert asset... = In the process of compiling

S7-Y invent items What information is kept on this list? Please select all that apply.

- ▢ Asset ID (4)
- ▢ Location information (5)
- ▢ Condition rating (6)
- ▢ Geometric information (i.e. shape, deck area) (7)
- ▢ Owner Information (8)
- ▢ Dates of Construction/Repair (9)
- ▢ Material Information (10)
- ▢ Other: (11) ____

Display This Question:

If This page includes questions regarding inventory and inspection of small bridge and culvert asset... = In the process of compiling

S8-Y inv compile dur How long (in months) do you think it may take to complete a list of small bridge/culvert assets including IDs and location in your database?

____

Display This Question:

If This page includes questions regarding inventory and inspection of small bridge and culvert asset... = No

S9-N inv who? Who keeps track of your small, locally owned bridge/culvert assets?

____

S10-inspect? Does your county regularly inspect **small bridge/culvert assets** (e.g., cross-road pipes)?

- ◯ Yes (3)
- ◯ No (6)

Display This Question:

If Does your county regularly inspect small bridge/culvert assets (e.g., cross-road pipes)? = Yes

S11-inspect freq How often (in years) do you inspect **small bridge/culvert assets** in your county? For example, enter 6 for inspecting every 6 years. Enter 0 for never.

____

Display This Question:

If Does your county regularly inspect small bridge/culvert assets (e.g., cross-road pipes)? = Yes

S12-insp.responsibie Who is responsible for these inspections? Please provide name and contact information (ex: John Smith, name@gmail.com, 555-3424). If the same as this survey's participant, please indicate so.

____

S13-database Do you maintain a database of condition ratings for small bridges and culverts?

◯ Yes (3)

◯ No (6)

S14-pedest brdg YN Do you have any pedestrian bridges in your jurisdiction?

◯ Yes (3)

◯ No (6)

Display This Question:

If Do you have any pedestrian bridges in your jurisdiction? = Yes

S15-insp ped brdg YN Do you inspect pedestrian bridges?

◯ Yes (3)

◯ No (6)

S16-cmts on insp Please enter any comments you may have regarding inspection of small bridges and culverts in your jurisdiction. If you have pedestrian bridges, please tell us how you manage them.

____

Page Break

S17-MRR activity YN In the previous pages, we asked you about a written transportation asset management plan and inspection. This page includes questions regarding **a database of maintenance activities**.

Do you maintain a list (e.g., paper log or electronic database) of Maintenance, Repair and Replacement activities for **small bridge/culvert assets** in your county?

- ○ Yes (3)
- ○ No (4)
- ○ In process of compiling data (5)

S18-MRR act database What information is kept on this list (or will be kept if you had one)? Please select all that apply.

- ▢ Asset ID (4)
- ▢ Location information (5)
- ▢ Geometric information (i.e. shape, deck area) (7)
- ▢ Owner Information (city, county, etc) (8)
- ▢ Dates of Maintenance/Repair/Replacement (9)
- ▢ Date of Construction (14)
- ▢ Material Information (10)
- ▢ Maintenance Activity (11)
- ▢ Other: (13) ____

S19-MRR compile dura How long (in month) do you think it may take to compile or complete a list [of small bridge/culvert assets] including IDs and locations in your database? For example, enter 3 for 3 months.

____

Display This Question:

If In the previous pages, we asked you about a written transportation asset management plan and insp... = No

S20-N MRR data who? Who keeps track of your Maintenance, Repair and Replacement activities for small bridge/culvert assets?

____

S21-MRR act items To best of your knowledge, rank the following maintenance/repair activities performed on small bridges/culverts from being most (1) to least (14) commonly performed. If an activity is not performed, leave the space blank.

______ Surface damage and/or spalling (1)
______ Crack (concrete) Repair (2)
______ Brush and Tree Cutting (3)
______ Erosion Control (4)
______ Corrosion (metal) Control (5)
______ Deformation and damage (metal) repair (6)
______ Scour and stability problems (e.g., missing soil around) (7)
______ Blockage within the culvert or pipe (8)
______ Curb/Rail Repair (9)
______ Pipe/channel alignment (10)
______ Settlement/rotation control (11)
______ Joint (e.g., separation) repair (12)
______ Painting (13)
______ Other Maintenance: (14)

S22-MRR datasharing If you have (or were to compile) a list of Maintenance, Repair and Replacement activities for small bridge/culverts assets, would your county be willing to share your list with the GDOT & UGA research team only (not to distribute)?

- ○ Yes (1)
- ○ No (2)

Page Break

S23-budget YN This page includes questions regarding **budget and funding**:
[Reminder - Transportation asset management in this survey refers to a systematic process of maintaining, upgrading, and expanding physical assets throughout their lifecycle].

Does your county set aside an annual budget for management of small bridges and culverts?

- ○ Yes (1)
- ○ No (2)

Display This Question:

If This page includes questions regarding budget and funding: [Reminder - Transportation asset manag... = Yes

S24-budget $ amount What is the annual budget put towards inventorying as well as maintenance, repair and replacement of small bridges and culverts in your county?

If this year's budget is unknown, the last year's or an average figure is fine. For example, enter 10000 for $10,000.

____

S25-fund options Rank the following funding options used to maintain small bridges/culverts from most (1) to least (9) commonly utilized. If a funding source is not used, please leave the space blank.
______ Special Purpose Local Option Sales Tax (SPLOST) (1)
______ Transportation Special Purpose Local Option Sales Tax (TSPLOST) (2)
______ Local Maintenance and Improvement Grant (LMIG) (3)
______ Low Impact Bridge Program (LIBP) (4)
______ Local Bridge Replacement Program (LOCBR) (5)
______ Georgia Transportation Investment Bank (GTIB) (6)
______ County-based Funding (needs-based budgeting) (10)
______ State-based Funding (7)
______ Federal-based Funding (8)
______ Other: (9)

Page Break

S26-resources This is the last page and includes questions regarding **resources for small bridges & culverts**:

Of the following statements below, please rate on a scale of 1-10 how much you agree with the statement, with 10 being "strongly agree" and 0 being "strongly disagree".

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	0 1	2 3	4 5 6	7 8	9 10
My county has the funds we need in order to adequately perform management for small bridges/culverts. ()					
My county has the resources we need in order to adequately perform management for small bridges/culverts. ()					
My county has the knowledge we need in order to adequately perform management for small bridges/culverts. ()					

S27-cmt on challenge What would you consider the biggest challenges to managing small bridges/culverts for your local jurisdiction?

____

S28-cmt on resources What resources do you currently not have that would be helpful for your local government to execute your transportation asset management plan for small, locally owned bridges and culverts?

____

S29-cmt on survey This concludes the survey. Are there any other comments/suggestions regarding our questions and anything else you would like to share with us?

____

Q66 **Clicking on the right arrow below concludes the survey.** Please feel free to go back and review your answers.

Thank you for taking the time to fill out this survey! Your answers, along with every other county in Georgia, will provide us the information we need to enhance the partnership between GDOT and local governments.

End of Block: Please answer the following questions to the best of your ability.

APPENDIX B. FINAL STRATEGY PLAN BOOKLET

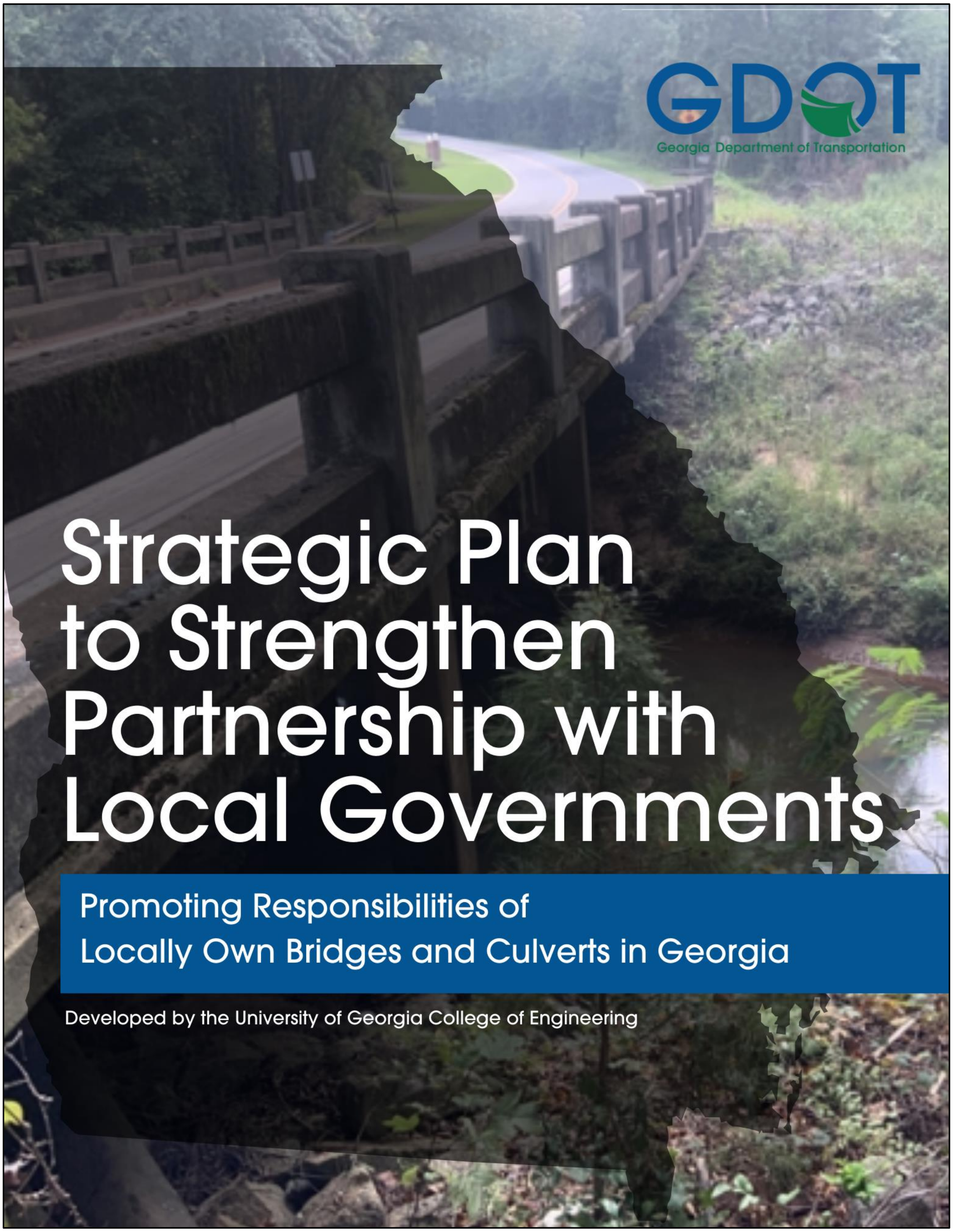


Table of Contents

Introduction

Foreword:

This strategy plan is developed by the University of Georgia's engineering research team under the direction of GDOT Research Project 21-02. This guide is developed with the goal of providing GDOT a multi-factor strategic approach to address one of the challenges facing GDOT when it comes to the maintenance of locally owned bridges and culverts, which is the working relationship between GDOT and the local governments responsible for these assets' management. The ultimate goal is to be as efficient as possible in maintaining bridges and culverts in order to continue to provide roadway and transportation safety for drivers in the state of Georgia.

Based on the feedback provided by counties across the state of Georgia and discussions with public works employees and GDOT, the research team believes that this strategic guide has accomplished this goal in the following document.

While working closely with both GDOT and local governments to develop this plan, the team has identified three main areas of improvement (Improving Communication, Enhancing Transparency and Access, & Promoting Learning and Engagement) that GDOT can move forward with to achieve the goals. Each section will provide examples of how to implement these improvements, as well as what assessment metrics can be used to measure progress in each strategy.

Purpose

Vision

Prepare, grow, and sustain resources and/or activities that safeguards locally-owned bridges and culverts and promote partnerships between GDOT and Georgia counties.

Mission Statement

To energize, promote, and coordinate a strong community working together to advance transportation asset management of locally-owned bridges and culverts.

GOAL 1:IMPROVE COMMUNICATION

The first goal set forth is to improve communication between local governments and GDOT. Enhancing communication between the two agencies is a must. Local governments often have large amounts of staff turnover, and thus GDOT spends time having to track down the contact information for these new staff members. On the other hand, counties have reported having a difficult time as to who to contact the right individual in the appropriate way when they encounter problems with GDOT-inspected assets and related projects. The first goal is to address these issues and find ways to make communication better between the agencies.

Promote Accountability

Establish Self-Reporting Systems

Establishing a self- report system allows for local government officials to hold other local employees and GDOT employees accountable and for GDOT to address issues in a timely manner.

Streamline Contact Information Updates

Building a web-portal by which local governments can update a list of preferred direct contact information for local officials responsible for bridge and culvert maintenance in a timely manner should be a priority.

Set Clear Leadership Expectations

Making clear both the expectations GDOT has for local government officials in charge of bridges and culverts, as well as who is in charge of bridge and culvert inspection for that local government's district.

Assessment Metrics: Quantify the reduction in cases of missing contact information and time spent on acquiring updated information. In addition, quantify the uses of the self-reporting system.

Diversify Communications

In addition to improving accountability among local government staff members and GDOT, GDOT may diversify how it communicates with counties and conveys information. This means being flexible between email, text, phone calls, social media, and other common forms of communication. However, it also means taking advantage of new media forms of communication. Examples of this are expanding social media operations to include more projects performed with local governments and taking advantage of social media video platforms such as YouTube Shorts and ArcGIS story maps to quickly spread short videos of information and stories to local government staff. Engaging with new media platforms can help to increase the amount of engagement from the staff members.

On top of everything else, GDOT developing their own app for the express purpose of engaging with local government staffs will help increase communication and provide a framework by which GDOT can set up several of the programs to be discussed later in the strategy plan. In terms of how to measure the success of this strategy, measuring the response rates of messages by different methods would be key. Methods that show higher response rates should be prioritized for that local government in the future.

Assessment Metrics: Measure the response rates or messages by different methods of communication. Methods that show higher response rates should be prioritized for that local government in the future.

GOAL 2: ENHANCE TRANSPARENCY & ACCESS

The second goal established in this strategic plan involves enhancing transparency and access for local governments in the state of Georgia, as well as GDOT providing resources in order to do so. Many counties have reported feeling as if some local governments have easier access to resources and information than others from GDOT. Thus, in order to build trust between GDOT and those other local governments, it is a top priority to finding ways to level the playing field in terms of resources and information.

Build Tools to Visualize the Results of Choices

DOT should invest into systems allow local governments to be able to visualize the consequences of their decisions regarding their assets and budgetary planning. It is challenging for most counties to think about the consequences of their actions. When the potential result of the choices is visualized and is easy to access, counties will break the automatic pilot and will make them aware of their choices. Three potential tools/resources GDOT could develop are listed below:

Case Studies: Using case studies to provide success stories for other local governments to read about and engage with are great ways to encourage best practices and make them appear more feasible to other local governments by providing a human element to them.

Budgetary Tools: Creating budgetary tools that help local governments better understand the cost of certain actions, as well as can help them plan for projects years down the line will be essential to enhancing decision making from local governments.

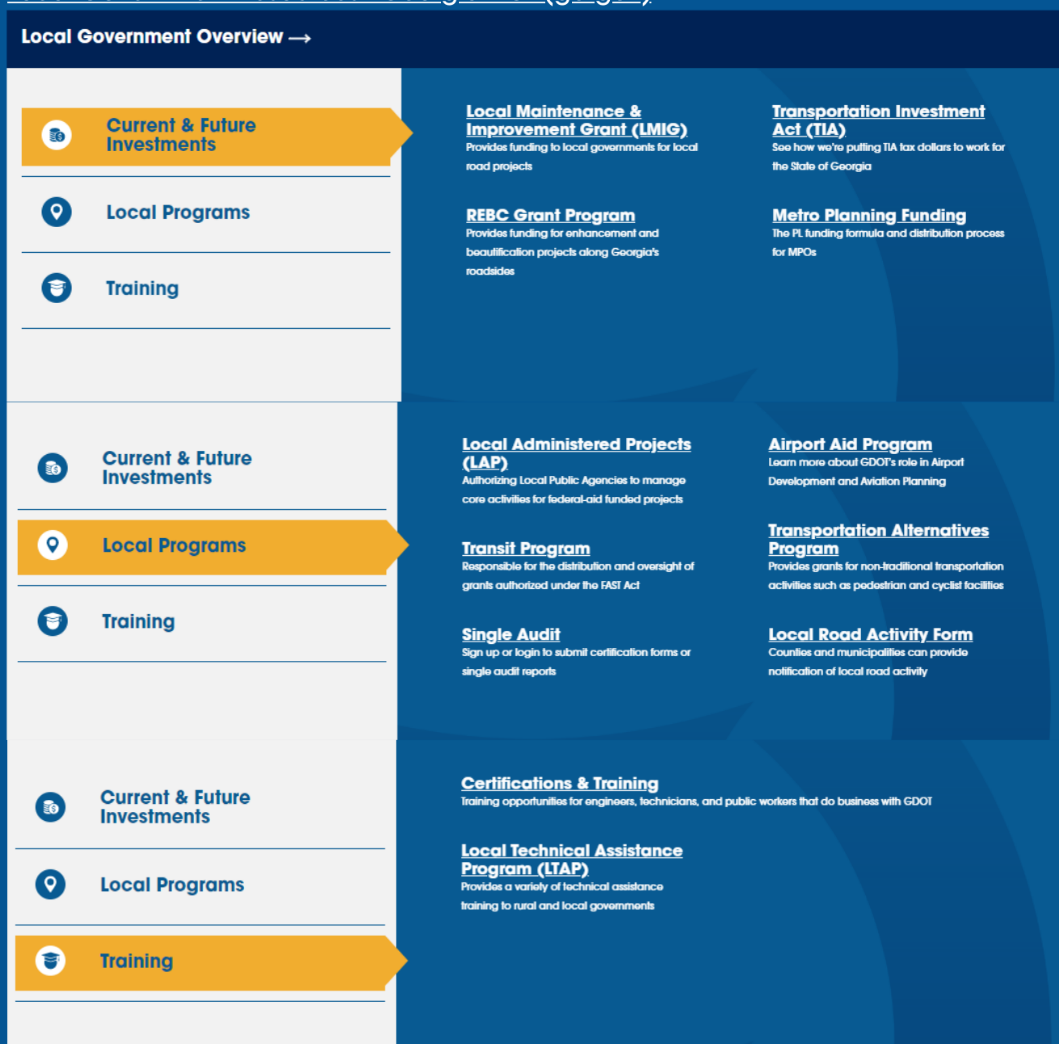
Life Cycle Analysis Tool: Developing a tool to explain the expected life span of certain types of assets, as well as the different stages of their life span would allow local governments to try "what-if" scenarios with their asset management and decide the best course of action.

Assessment Metrics: Analyze the changes in local government policy for maintenance practices by observing improvements in GDOT's bridge inspection data.

Enhance Local Government Webpage

In early 2023, GDOT launched the new "local government" webpage on its website. The launch of this resource was an important first step in strengthening cooperation and coordination with local governments. Currently, the content available provides minimal insight into information and resources regarding bridge and culvert maintenance for local governments.

Local Government Resources - Georgia DOT (ga.gov)



The following section will provide suggestions on what types of information/ resources for locally owned bridge and culvert assets could be added to each of the main three sections of the webpage. The website should be organized and easily navigable in order to enhance ease of information. Another tab labeled "resources" could also be added that would include additional local governments tools and resources developed by the RP 21-02 team and others beyond.

In the "Current and Future Investments" section, information and applications for the Low Impact Bridge Program (LIBP) & Local Bridge Replacement Program (LOCBR) should be available. Information on the criteria for these programs to apply to an asset should also be clearly stated as well as realistic timetables and status updates on the application process.

Under "Local Programs", there is an opportunity to provide a link to a resource that explains the services GDOT provides when it comes to the inspection of locally owned bridges, as well as clearly state the expectations of local governments regarding their maintenance.

Under "Training", one can find the training modules regarding bridge maintenance that are described in "Goal 3: Promote Learning and Engagement."

Assessment Metrics: Observe and analyze the website traffic analysis data. This data will provide both which local governments and how often they are using the website and its resources.

GOAL 3: PROMOTE LEARNING & ENGAGEMENT

The last major goal of the strategy plan is to promote learning and engagement among the local government staff members. This is the portion of the strategy that not only looks to enhance the partnership between GDOT and local governments, but to encourage inter-county relationships. The two strategies suggested to accomplish this goal are centered around actions GDOT can take. However, the suggestions are made so that there is room for local governments to step up and provide leadership and opportunities for learning and engagement themselves.

Develop Training Modules

As part of the additions to the "local government" GDOT webpage, a series of training modules for new and old local government officials in charge of local bridge maintenance should be provided. Below are some expected courses, but additional training courses are encouraged based on need.

On-Board Training: When a staff member at a local county is hired on to handle the local bridge assets, a series of introductory videos explaining the relationship between GDOT's services and the local government's responsibilities will ease learning curve new officials.

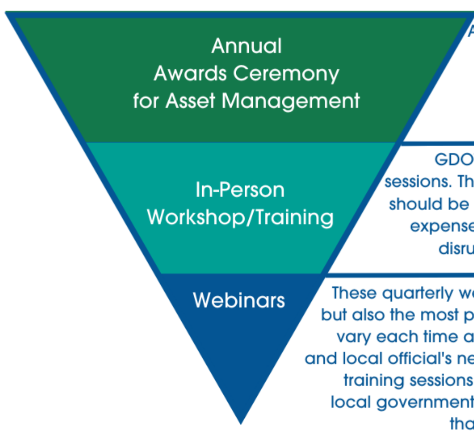
Funding Application Training: Funding applications and their criteria can be difficult to navigate and understand. Modules that walk through the application process for common state funding programs create opportunities for equity among local officials for funding.

Bridge Maintenance Technical Training: The jargon around some technical terms when it comes to bridge maintenance can make things difficult to communicate from the inspectors to the local officials. Training on these technical terms will clear this up.

Assessment Metrics: Count the number of counties that have at least one member of their staff who has completed each course of the training.

Organize Team-Building Activities

The first strategy to accomplish the goal of learning and engagement is to organize team-building activities between local governments, as well as their GDOT district representatives. This can be done on multiple levels, which can be seen in the graphic below. GDOT should work to build a stronger partnership with the American Public Works Association (APWA) to accomplish these activities, as the APWA already runs their own similar program with similar goals, but GDOT can easily add additional resources for local bridge and culvert assets. For example, the Carl Vinson Institute of Government at the University of Georgia administers the Georgia Certificate of Public Works Management (CPWM) program in cooperation with the Georgia Chapter of the APWA. Promoting interactions between the counties and creating a sense of enthusiasm for their public work allows team success.



An annual event in which all local governments can attend and promote successes when it comes to asset management and maintenance. Awards could be given to specific jurisdictions, personnel or a project.

GDOT should be able to schedule in-person training sessions. These can be held at a district or state level. They should be coordinated in advance with notice and travel expenses for the events should be covered to minimize disruption to local official's schedules and budgets.

These quarterly webinars are the smallest events, personnel-wise, but also the most personable. The purpose for these webinars can vary each time and are designed to be flexible based on GDOT and local official's needs. They can cover policy updates, be online training sessions for non-physical programs, or opportunities for local governments to ask questions of their GDOT representatives that can be applicable for others in their region.

APWA AMERICAN PUBLIC WORKS ASSOCIATION

GDOT Georgia Department of Transportation

Assessment Metrics: Keep a record of attendance and participation by local government representatives at each level of event. Look for these metrics to grow over time as the programs grow.

Concluding Remarks

This strategy plan provides the guiding principles by which GDOT RP 21-02 will move forward with in order to accomplish the goal of improving the working relationships between Georgia local governments and GDOT. However, the goals and suggestions can go beyond just what can be accomplished with RP 21-02.

The goals stated in this plan provide three philosophies that can serve as a launching point for further research, development and distribution of resources and tools. They are designed to be long lasting principals that GDOT and their partners can continuously apply not just in the area of bridge and asset management, but any other areas of working relationships with local governments. Therefore, creating a plethora of opportunities to continue to move forward with ultimate goal of keeping the drivers and citizens of Georgia safe on their transportation network.

Acknowledgements

The initial draft for this strategic guide was prepared by a UGA graduate student, Jared Palmgren with guidance from Dr. Mi Guem Chorzepa and Dr. Stephan Durham. The iconography used in the guide were provided by GDOT and canva.com resources. Images of bridges and culverts used were taken from GDOT bridge inspection reports.

APPENDIX C. FINAL STRATEGY PLAN BROCHURE

Front

Introduction

This strategy plan is developed by the University of Georgia's engineering research team under the direction of GDOT Research Project 21-02. This guide is developed with the goal of providing GDOT a multi-factor strategic approach to address one of the challenges facing GDOT when it comes to the maintenance of locally owned bridges and culverts, which is the working relationship between GDOT and the local governments responsible for these assets' managment. The ultimate goal is to be as efficient as possible in maintaining bridges and culverts in order to continue to provide roadway and transportation safety for drivers in the state of Georgia.

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Mission Statement

To energize, promote, and coordinate a strong community working together to advance transportation asset management of locally-owned bridges and culverts.

For a more detailed look at the Strategy Plan and what kinds of resources it looks to provide, scan the code above.

GDOT
Georgia Department of Transportation

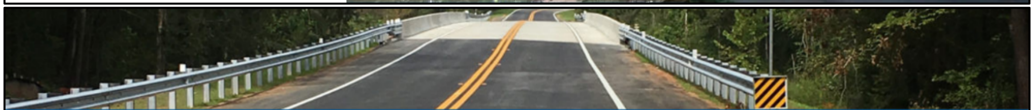
GDOT
Georgia Department of Transportation

Strategic Plan to Strengthen Partnership with Local Governments

Promoting Responsibilities of Locally Own Bridges and Culverts in Georgia

Developed by the University of Georgia College of Engineering

Back



IMPROVE COMMUNICATION

The 1st goal of the project is to significantly improve communication, often caused by high staff turnover, as well as lack of information regarding who best to contact in each agency.

Promote Accountability

- Establishing Self-Reporting Systems
- Streamline Contact Information Updates
- Set Clear Leadership Expectations

Diversify Communications

ENHANCE TRANSPARENCY & ACCESS

The 2nd goal of the project is to increase the equity between local governments regarding tools available to them. Whether it's making previously available resources more accessible or developing new ones.

Build Visual Tools

- Case Studies
- Budgetary Tools
- Life Cycle Analysis Tool

Enhance Webpage

In early 2023, GDOT launched the new "local government" webpage on its website. Use the code below to view this webpage. The project looks to enhance to include additional resources to enhance local governance of bridges and culverts.

PROMOTE LEARNING & ENGAGEMENT

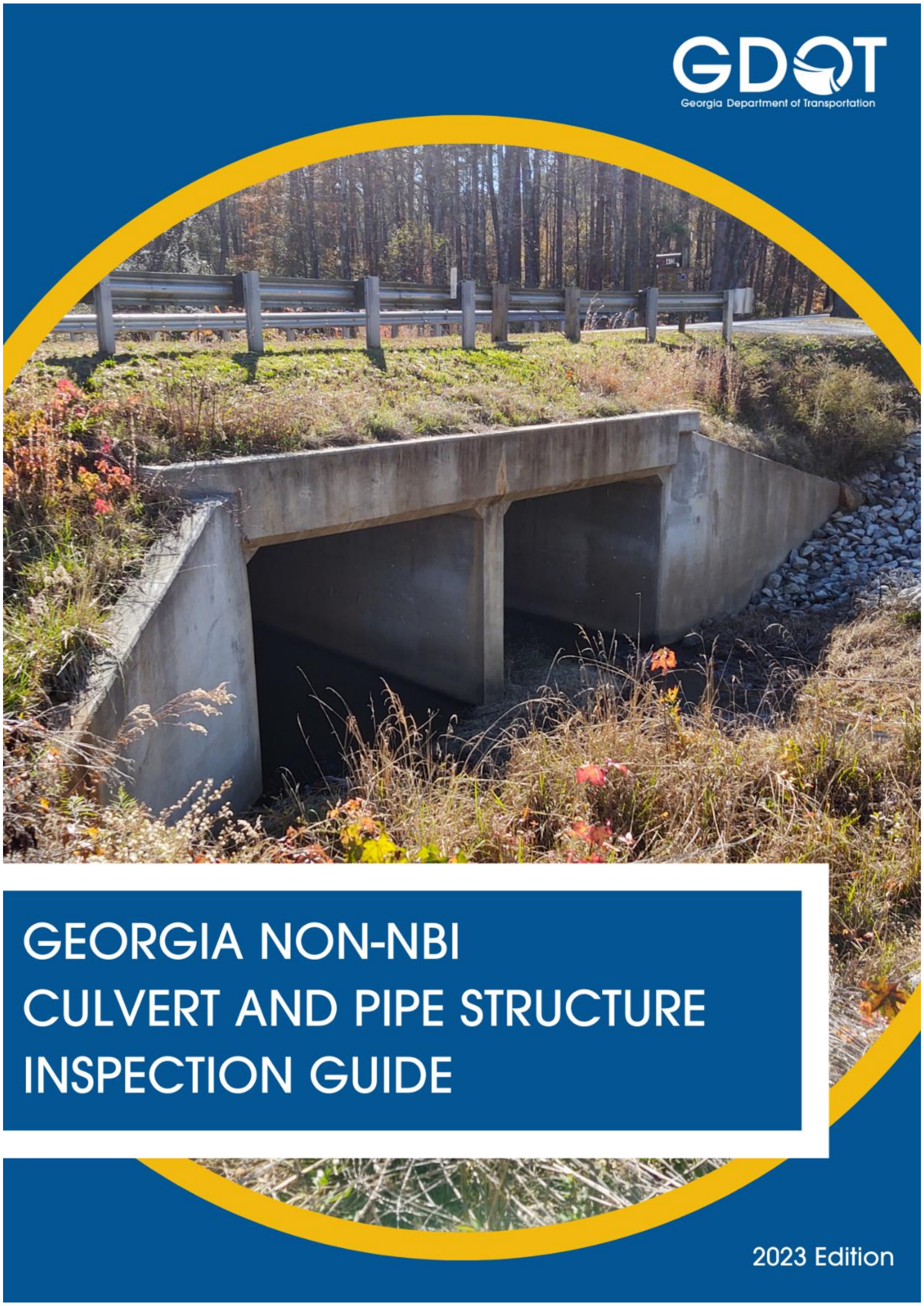
The final goal of the project seeks to building engaging programs for which local government staff members can be a part of, which will enhance both knowledge and cooperation between agencies.

Develop Training Modules

- On-Board Training
- Funding Application Training
- Bridge Maintenance Technical Training

Organize Activities

APPENDIX D. FINAL INSPECTION GUIDE



GDOT RP No. 21-02

GDOT GEORGIA CULVERT AND PIPE MANAGEMENT AND INSPECTION GUIDE

by

The University of Georgia

April 2023

Table of Contents

1. INTRODUCTION

1.1 Background and Scope

Georgia counties are familiar with GDOT role in inspecting large bridges and culverts that fit the NBI description, which is an asset with a span larger than 20 feet. GDOT often goes a step further and is willing to inspect and inventory bridges smaller than that if the asset is clearly a bridge. However, assets that are Non-National Bridge Inventory (NBI) assets, meaning less than 20 feet in span, are ultimately the responsibility of the local government agency that owns them. Assets such as culverts and cross-road pipes can be considered transportation assets that support public roads in the same way bridges are, even though, often times, these assets are filed under stormwater or public works.

Best practices involve developing an inspection schedule for these assets, as well as having a condition rating system by which to measure these assets in order to better maintain and manage Non-NBI assets, which will save local government agencies time and funds and promote safety, sustainability, and mobility on the public roads. This guide is not just for an inspection process alone but includes instruction and recommendations for other supporting elements of a culvert and pipe asset inspection and management. This includes how to establish an inventory system, determine inspection intervals for these assets, and creating condition rating systems for the purpose of assisting maintenance and budgetary prioritization.

The contents and goals of this guide are recommended to not only make management and maintenance of these assets easier and more efficient for local agencies, but also helps GDOT and the FHWA accomplish their goals of delivering a transportation system that promotes safety, mobility, sustainability and economic growth for the benefit of local communities, the state and the nation.

1.2 Objectives

This guide provides local government agencies the base information they need to develop a management and maintenance for the inspection of Non-NBI culvert and pipe assets, in order to promote safety, mobility and reliability of Georgia's transportation system and its assets. More specifically, this document will cover the following topics:

1) Describe the overall strategy of managing these types of assets, including how to establish inventories, inspection intervals, and rating systems for work orders or action prioritization. See Section 2.

2) Provide a detailed description as to how to inspect culverts and pipes and how this could change depending on the type of pipe. See Section 3.

3) Provide information on the type of equipment needed for inspections and how inspectors should conduct themselves regarding safety and the environment around assets. See Appendix B.

Figure 1 - Washed Out Culvert and Collapsed Road in Georgia

1.3 Culvert Identification

This section will provide summaries of common culvert and pipe types in the state of Georgia. This section will help to clarify whether an asset owned by a local agency is applicable for the contents of this guide. These assets often are used as small bridges under roadways to allow the passage of small natural waterway, or for the directing of stormwater runoff. These assets come in different shapes, the most common in Georgia being round pipe and box-shaped culverts. In this guide, they are referred to as "round pipes" and "box culverts", respectively.

Circular Pipes/Culverts

Circular Pipes/Culverts are the most commonly used on public roads in the state of Georgia. These assets are often used solely for the purpose of stormwater management and the benefit they provide to public roads is often based in controlling erosion from the roads. The pipes can be made from many different materials. The most common of which are Reinforced Concrete pipes (RCP) and Corrugated Metal pipes (CMP). However, some agencies use plastic for their assets, which can be High Density Polyethylene (HDPE) and Polyvinyl Chloride (PVC). Measurement is recorded as the inside diameter of the pipe in inches. In the state of Georgia, these assets typically have a diameter from 12˝ to 108˝ in 6-inch increments. These assets may have headwalls, but it is not always so. For round pipes, the most common type of headwalls in Georgia are concrete; however, it is not unexpected to see headwalls made of metal, masonry, stone or rip rap. These assets can also include those of which that are attached to junction boxes as part of a larger system. Visual examples of these types of assets are shown below.

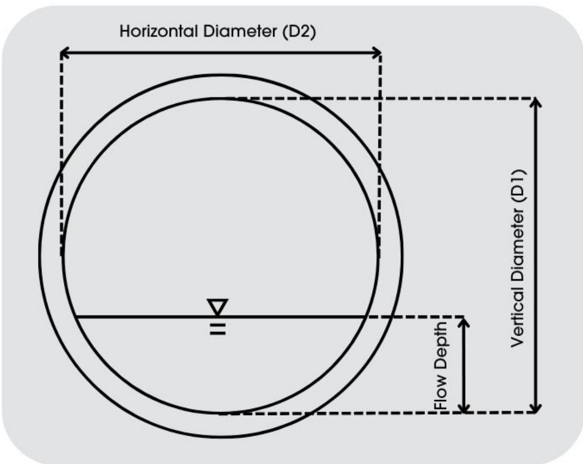


Figure 2 - Diagram of the Common Measurements of a Circular Pipe/Culvert

Box Culverts

Box culverts are the other common type of culvert and pipe asset in the state of Georgia. Functionally, these assets are similar to the pipe barrels and accommodate an expansion of flow. Pipe barrels are solely concerned with stormwater management and avoiding erosion of roads and their vicinity. Box culverts go a step further by not only providing those benefits for the road and its vicinity, they are relied upon for structural support. Thus, this shows their “bridge-like” nature. These assets are often used whenever a road needs to overpass a smaller natural waterway, such as a creek or a stream, when a full bridge is not necessary to do so. Measurements of these structures are performed by measuring the width and the height of the structure. The size of these box culverts can vary, but are typically done in half foot spans and are typically less than 20 feet for their width. Box culverts require headwalls, which are typically done in the same material as the culvert itself. Reinforced concrete is the most common material for these culverts in Georgia, although metal box culverts can be found sparingly. While the box culverts typically have 4 sides, some have only the sides and top sides built, leaving the bottom portion to be made by the natural terrain. These are known as bottomless culverts, and are very common for larger creeks or any other areas of which there may be environmental concern, such as safe passage of local fish.

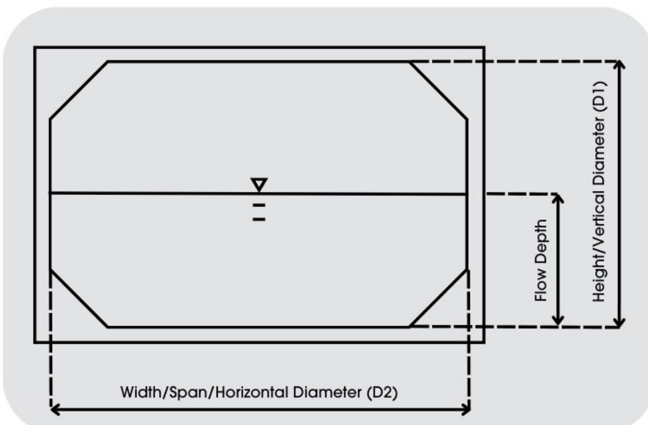
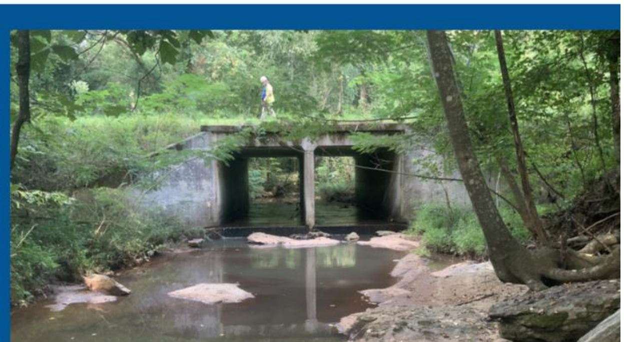


Figure 3 - Diagram of the Common Measurements of a Box Culvert



Other Types of Pipes/Culverts

While circular and box culverts/pipes make up the vast majority of locally owned assets of that type, it is possible to encounter other types, although they typically are modifications of the circle/box types. Ellipsoid culverts/pipes are a modified version of the circular design and are used when a roadway is in need of a greater flowrate within the culvert, but there is limited vertical space to place a larger circular asset. Arch culverts are modified versions of the box culverts, typically used in larger spans, as well as when a more aesthetically pleasing design may be required for a design. Similar to box culverts, Arch culverts typically are made of structural materials such as concrete and masonry, and they also have a "bottomless" alternative, which is useful when spanning natural streams/creeks.

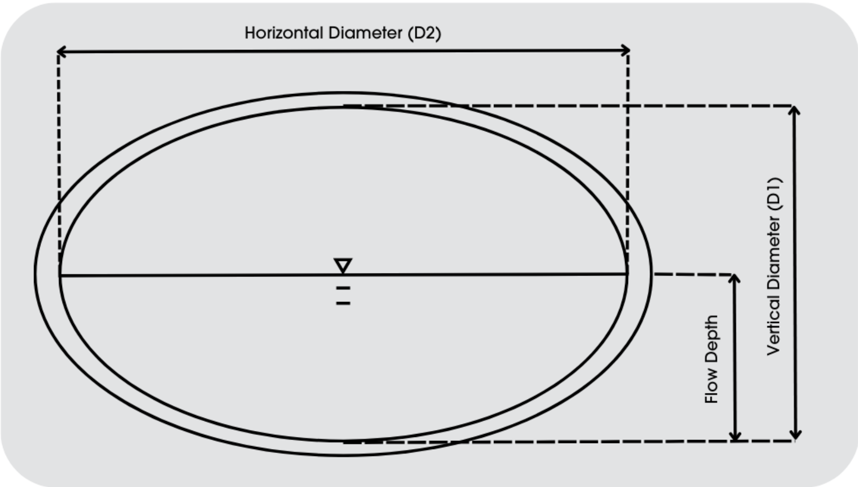


Figure 4 - Diagram of the Common Measurements of an Elliptical Pipe/Culvert

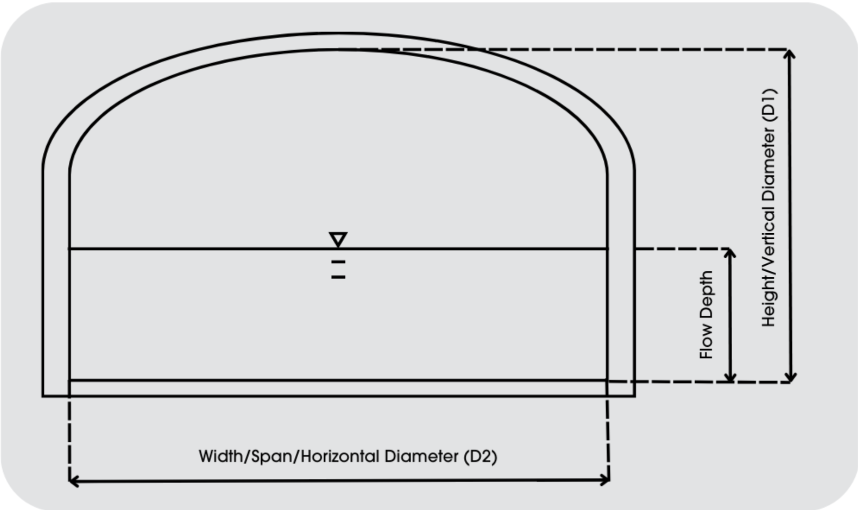


Figure 5 – Diagram of the Common Measurements of an Arch Culvert

2. Best Practices for Asset Management and Inspection

There are a few complimentary pieces and systems an agency must establish in order to have a successful inspection program for pipes and culverts and maximize the effective use of inspection data.

This section presents best practices for:
(a) Establishing an inventory system for the assets owned by an agency and the components that should be included with it;
(b) Developing inspection schedules and intervals; and
(c) Selecting condition rating systems and how they can apply for developing a maintenance strategy of the assets as well as a budgetary prioritization.

2.1 Asset Inventory Establishment

The last but foremost important feature an agency inspecting pipes and culverts should establish is an asset inventory system. An asset inventory system will standardize where the agency will record the latest, as well as the past, information regarding their assets, and give an agency an overview of the number and kind of assets the agency needs to maintain. Using an inventory system, it will make it easier for agencies to pull data, analyze their assets, and make strategic decisions based on the information available to them from the inventory.

While how this database or inventory is built can vary, there are four main ways of establishing an inventory:

1. Spreadsheet

2. GIS database

3. Work order system with (or without) the GIS-mapping capability

4. Comprehensive asset management system including a GIS-supported database and a work order system

While it is possible to maintain an inventory on a paper file, it is highly recommended that agencies use a software application to build an inventory. For example, using any kind of spreadsheet software can provide the format by which agencies can easily record their asset's information into and are widely available already in many agency's software packages for their computer systems.

An agency can also purchase or develop their own asset management software, something many agencies in the state of Georgia at all sizes have been able to accomplish and are considering. The benefit of choosing this option is that an agency can specify what features they deem necessary for their own unique challenges or systems.

While not required, it is highly recommended that whatever system that an agency develops is tied to a GIS-supported map system of the county. This will allow more precise information regarding the location of assets, but also provide the added dimension of being able to visually see where assets are located (which helps inspectors locate possibly hidden assets), but also allows agencies to analyze their assets by region should they need to. An example of a program such as this can be seen in the County Case Studies available in Chapter 6 of this guide.

In the inventory, counties should record a variety of information regarding their assets. The following list will provide a set of recommended items to record and the reasoning why an agency would find them important.

<u>Asset ID</u> – Every asset in the database must contain some unique signature name that differentiates it from every other asset in the system. This is usually a set of numbers or letters, which can be randomly generated or follow a pattern.
Location Information – The ability to know where an asset is located is key for future inspection and analysis of the asset. This information can be the road on which the asset is located in combination with GPS coordinates for a more precise location.

<u>Type of Asset</u> – An inspector should know what type of asset they are looking for when they arrive on a site. This should refer to the structure of the asset, i.e. whether it is a pipe barrel or a culvert. It should also distinguish what kind of structural components are included with the asset. For example, a Pipe with a wingwall might be labeled as PWW.

<u>Geometric Information</u> – As discussed in section 1.3, different types of assets have different geometrical information gathered about them. There should be a space in the inventory to record these values as well as the length of the structure.

<u>Material Information</u> – What materials an asset is comprised of helps to determine how the asset is to be inspected as well as how it is maintained, as different materials have different properties that warrant special treatment.

<u>Owner Information</u> – Understanding who owns the asset will help clarify responsibility of maintenance, regardless of who inspects the assets. Some agencies inspect assets they do not own (for example, a county government may inspect a city-owned culvert), and in those cases, being able to differentiate between their own assets and other agency's asset is imperative.

Previous Inspection Reports – Providing a copy of the previous inspection reports allows for an agency and its inspectors to understand the history of an asset, and helps for them to catch an emerging patterns regarding an asset and its condition.

Dates of Last Maintenance – Separate from inspections, Maintenance dates of activities performed on assets help inspectors understand when something noted on a previous inspection has been acknowledged and taken care of.

Maintenance Activity Performed – Maintenance activities performed on assets help inspectors understand whether or not something noted on a previous inspection has been acknowledged and taken care of.

Date of Initial Construction – Age of an asset is important to keep track of as it allows agencies to understand how close an asset is to its designed life cycle age and whether that warrants a replacement project.

2.2 Inspection Intervals and Schedules

Once an agency establishes an inventory system for its assets, it then needs to decide how often it will expect its inspectors to perform an inspection on the same asset. This is essential for any agency looking to provide preventative maintenance on their assets, rather than rely on reactive maintenance. By making an inspection mandatory based on the time frame from the last inspection, the agency is more likely to catch issues before they become larger, and more expensive, problems further down the timeline.

There is no definitive correct answer on inspection intervals. Each agency should determine their inspection schedule based on the number of assets they have, the amount of funds they have for the department and the number of inspectors they have access to, whether they are on staff or contracted out. The schedule should be manageable for the county so that they can stay on schedule and not fall behind. There are three main options for selecting inspection periods, although elements from all three can be incorporated into a local governments' management plan.

1. 5-year fixed period consistent with MS4

2. Dual periods for 2 inspection types - detailed and simple

3. Varying periods based on condition ratings

This guide recommends that every asset be inspected at least once every 5 years. This is consistent with GDOT's Municipal Separate Storm Sewer Systems (MS4) permits program (5), which is required for urbanized regions in Georgia. The word "Municipal" refers to a unit of local government responsible for the administration of a developed area. This means that an inspector should physically be in the presence of the asset once every 5 years in order to at least gauge if there are any immediate problems.

While this type of inspection is the bare minimum expected for the practice, it is still expected of agencies to then schedule full condition assessment inspections for the assets in an appropriate time period.

For example, it is possible for a county to provide smaller inspections for immediate problems every 5 years, while having full condition assessments of the asset once every 10 years. For an example of this, see Section 6.4 Gwinnett County.

The other thing to consider is how the inspection intervals change for an asset based on a variety of factors. The criteria should always look to establish when the inspection interval should be shortened from the maximum inspection interval established by the county, rather than lengthen it. There are several ways to consider this and this table provided by the Michigan Non-NBI Culvert Inspection Guide(4) is an excellent example.

Below is a list of criteria by which inspection intervals can be reduced if an asset warrants it.

Non-NBI Culvert Inspection*	Maximum Inspection Interval (in months)			
	≤12	≤24	≤48	≤72
Condition Rating				
Good				X
Fair			X	
Poor		X**		
Severe	X**			
Size (inches)				
≤24				X
>24 and ≤48				X
>48 and ≤120			X	
>120 (10 feet) and <240 (20 feet)		X		
Material				
No material-specific concerns				X
Material-specific concerns			X	
Age**				
Consider reducing frequency as appropriate				
ADT**				
If limited resources require an agency to exceed the above recommendations for some structures, ADT maybe used to prioritize which culverts pose the least risk to extended frequencies.				
* Culvert structures that meet the National Bridge Inspection Standards (NBIS) definition of a bridge MUST be inspected per the NBIS and the *Michigan Structure Inspection Manual* (MiSIM) ** In the case of poor and severe condition in-depth inspections or structural analysis may be required; use engineering judgment to obtain culvert-specific frequencies				

Figure 8 - Recommended Maximum Inspection Intervals (4)

Condition Rating – If an agency knows that an asset's condition is deteriorating, the possibility of failure increases with every stage. Thus, assets that are in increased danger of failure should receive more attention in the form of more inspections if the agency is not able to perform maintenance on it due to time or budget constraints.

Size – Assets that are larger have by definition have more material that is prone to deterioration and failure. These larger assets tend to be in areas of higher traffic and thus there is a greater risk of impact on the community should the asset fall into failure.

Material – Certain materials are prone to quicker deterioration than others. For example, reinforced concrete is expected to have a longer lifespan than a corrugated metal asset, and concrete deterioration occurs slower than metal assets. Thus, an agency might consider giving metal assets a shorter inspection interval than their concrete assets.

Age – When assets are engineered and built, they are each given an expected life span in years. When assets become close to those life span values, it is important to reduce the inspection interval, as this is when assets are more prone to deterioration, failure and need of replacement.

Average Daily Traffic (ADT) – Assets that are located on roads with more traffic need reduced inspection intervals for two reasons. Firstly, the impact of these assets failing would be bigger on the community than less used assets. Secondly, the forces on the assets felt from the increased amount of traffic makes them more prone to fatigue and deterioration.

2.3 Establishing Condition Rating Systems

The first component that agencies need to establish when creating a culvert and pipe asset inspection program is a condition rating scale for its assets. These ratings should range from "good" to "critical" with every appropriate category in between, depending on how many tiers an agency chooses to have for their system. There is no correct way to determine the number of tiers. This guide recommends that any agency have at least 3 tiers of ratings for their assets, representing a good, poor and severe assets. If possible, additional tiers can help provide additional nuance in inspections. The sample inspection forms provided within this guide take into consideration 5 tiers.

This helps to capture the nuance of assets of different stages of condition, while also keeping it intuitive for anyone reading the condition ratings. If an agency already has a condition rating system for a different kind of asset such as pavement, it is recommended that the agency look to mirror this condition rating system onto its culvert and pipe assets, in order to keep systems, uniform in the county and make communication easier between departments regarding the condition of different kind of assets.

Table 3–1: General Condition Ratings and Descriptions

Condition	New	Good	Fair	Poor	Inoperable
Condition Description	• Asset is considered almost as if it is new. • Few or no signs of deterioration of material of asset. • No signs of structural inadequacy. • Provides stormwater or natural resource preservation function it was designed for without issue. • Action: No action needed.	• Asset is beginning to show signs of aging and exposure to elements. • Somes signs of deterioration. • Structure unaffected by aging or minor deterioration. • Provides functions designed for, with few minor issues. • Action: Make notes and continue to monitor.	• Asset is showing signs that future repair or maintenance is needed. • Deterioration is present and material needs to be monitored for further issues. • Structure soundness concerns are arisen. • Functionality is inhibited in noteworthy way. • Action: Schedule for future maintenance.	• Asset is in need of immediate attention. • Deterioration is severe. • Structurally unsound. • Functionality of asset is severely limited. • Action: Schedule maintenance and repair ASAP.	• Asset presents a danger to public. • Deterioration makes repairs impossible. • Structural integrity is gone. Sinkholes likely. • Asset is functionally defunct. May as well be a dam. • Action: Schedule replacement of asset. Explore possibility of road closure.

Figure 7 - Example of a General Condition Rating Table

Establishing a condition rating system as part of an asset management and inspection system is important on two fronts. First, condition rating systems helps agencies understand the overall health of their assets and which need to be prioritized for maintenance. When counties prioritize assets, having numerical values tied to the condition of the assets makes the decision-making process easier, as an agency should provide maintenance to the "severe" assets first and if those are all adequately taken care of, they then can move onto the next tier of assets which are poor. Condition rating changes over time can also provide an agency with valuable information regarding which assets are deteriorating at faster rates and what patterns could be the cause of this. For example, it can help show assets in a certain area, or assets of a certain material, or any other criteria, are more likely to deteriorate quickly.

The other front on which condition ratings are valuable is from a budgetary perspective. It has been discussed how condition ratings help prepare budgetary plans. In addition to developing an annual budgetary plan, many agencies rely on funding systems such as SPLOST that are project-based rather than the general budget of the county. Thus, condition ratings data helps limit which assets should be proposed for funding on these programs and limit the number of assets that a case needs to be built and budgeted for. Assets that are given a severe condition state or poor provide a more convincing case for the project to be included in such funding packages.

3.Inspection Practices by Material Types

The following section will provide expected inspection procedures and what to look for with each type of asset. The section will provide in-depth looks at the three most common materials in Georgia: corrugated metal, reinforced concrete, and corrugated plastic. This is followed by an additional section to provide comments on other less-common miscellaneous materials. For the in-depth looks, the inspection process is divided into two sections: (1) barrel inspection and (2) inlet/outlet inspection, and those are each broken down further into functional inspection and structural inspection. Both evaluation should be kept in mind at all times during inspections, as the failure of one can greatly impact the other. Sample Inspection Forms are located in Appendix A. When possible, inspections should involved physically inspecting the interior of the asset. When this is not possible due to hazards or the size of the pipe, inspection should be conducted through a camera, whether it is located on a pole camera, or a mobile drone.

Philosophy and Necessity of Structural Inspection

When evaluating any roadway asset, it is important to inspect both how the asset is when performing its structural duties, as well as its functional duties. Some agencies focus solely on the functionality of the asset, but not consider its structural condition, which, if left unchecked, will lead to functional deficiencies, as well as endanger roadway users.

Recall that many of these assets serve as small bridge structures. Thus, their ability to withstand the loads from both the vehicles that travel over it, as well as the earthwork that weighs down on it from above or surrounding it, is of upmost importance. This is especially important when assets are approaching the end of their expected life cycles.

Philosophy and Necessity of Functional Inspection

When culverts and crossroad pipes are built, they are built with a function in mind. Most often, they are part of a larger stormwater management system. Other times, they are built to serve as small bridge, so that small natural waterways, like creeks and streams, can pass through uninterrupted by the roadways. Evaluating how well the assets are performing these functions not only is important in order to make sure the asset is returning the value an agency put into building it, but also maintains safety for the roadway users. Assets that are blocked and not performing their function can lead to areas nearby the roadway, as well as private property becoming flooded. In addition, assets that have stormwater or natural water leaking into the surrounding soil risk destabilizing the earthwork around them, making them more likely to be susceptible to failure in large rainfall events. Regardless, the capacity of a culvert operating under hydraulic pressure and associated hydraulic conditions should be evaluated by a licensed engineer.

3.1 Corrugated Metal Pipe Culvert Inspection

Asset Type Summary

Corrugated Metal Pipes (CMPs) are the most common agency owned assets under public roads. CMPs are often used for the purpose of stormwater management and erosion control of public roads and typically are not considered to provide significant structural function to the roads, by themselves. However, failure of the assets can lead to structural problems for the roads they are beneath. CMPs are typically on the smaller side of assets, going as small as 18 inches in diameter, but can be as large as 108inches in diameter under paved roads. They are commonly used because they are an economical option and easy to maneuver and install. A variety of design approaches, including riprap, concrete aprons, turf reinforcement mats, gabion baskets, and other structural measures are expected to be observed at outlets to reduce erosion or scouring.

Structural Condition Inspection of Barrel

There are three main areas in which an inspector can assess the structural condition of the barrel of a CMP: The deflection of the vertical diameter, the separation of the pipes at different joints, and the deterioration of the interior, specifically, rust.

Deflection - Deflection is the measure of the difference between the vertical diameter of a pipe/culvert when it was designed/installed and it is currently. For example, a pipe with a 30-inch vertical diameter now has a vertical diameter of 27 inches upon inspection. That amounts to a 10% deflection. Deflection is a key indicator that the asset is losing its ability to structurally withstand the loads being placed upon it. Deflection is also an indicator that portions of the asset are experiencing stresses they were not designed for and thus could be at risk for failure.

Pipe Joint Separation - Separation between pipe joints can occur because of a number of causes, such as the earthwork shifting over time due to loads. When separation occurs, the asset begins to no longer work as a single structure, making it more susceptible to larger loads. In addition, pipe separation allows for the water within the asset to leak into the surrounding soil, making the earthwork erode and overall weaker. This makes the asset even more susceptible to shifting earthwork and forces from large flood events.

Interior Deterioration - For CMPs, the interior deterioration that an inspector should be most concerned with is rust, due to the metal's constant contact with water. Oxidized portions of the barrel can lead to holes developing, allowing water to leak into the surround earthwork or pollutants to enter the runoff, in addition to the rust itself. Eventually, if left untreated the entire bottom of a culvert can rust out, effectively compromising the structure of the asset.

Functional Condition Inspection of Barrel

When evaluating the functional condition of a CMP, many items are covered when you inspect for holes and leaks while inspecting the structural condition. However, an inspector must also consider the build up of sediment within the barrel.

Sediment Build-Up - Blockages within the barrel are the most common causes of functional failure for CMPs, especially since they are typically smaller assets. Within the barrel itself, you are unlikely to find one large object causing the block, but overtime sediment carried in by runoff water will settle and build, eventually clogging portions of the pipe and decreasing the flowrate of the asset to below its design, which could lead to backflow and flooding.

Structural Condition Inspection of Inlet/Outlet

After the barrel has been inspected, in the inspector should also assess both the inlets and the outlets of the asset and check for signs of structural compromise. This is especially important, as these portions of the asset are the most exposed to the elements. For CMPs and most assets, the two main criteria remain the same: erosion levels and the headwall.

Erosion - Erosion around the asset can cause a multitude of problems for a pipe/culvert asset. It can expose more of the asset to the elements than was designed for. If erosion occurs underneath the asset, it can cause the structure to settle due to the weak soil underneath and create sags/sinkholes in the road above. In addition, erosion beneath the asset can cause the runoff or natural waterway to not be able to enter the inlet, thus leading to flooding and more erosion.

Headwall - All assets should contain a headwall of some type, as they are essential to holding assets in place, thus preventing shifting, settling and more. The headwalls also serve to protect the asset from erosion and can even serve as a barrier to help guide waterways into the asset. Any sign that the headwall and the barrel are separating should be evaluated. .

Functional Condition Inspection of Inlet/Outlet

When it comes to evaluating the functional condition of the inlets and outlets of CMPs and other culvert/pipe assets, the two main criteria to be focused on are objects creating blockages, as well as the alignment between the culvert and the channel.

Blockages - While the barrel is more susceptible to sediment buildup, the inlets and outlets of a pipe/culvert asset can be blocked by any number of things. This could be vegetation that has grown around the ends of the asset. It could also be large rocks or soil eroded into the asset, or it could even be wildlife, such as beavers. The inspector should evaluate how these items are affecting the flow of water within the asset. This includes blockages in screens and guards before the inlet or after the outlet.

Alignment - Alignment is the measure of difference between the direction of the culvert/pipe and the direction of the flow of water, otherwise known as the channel. Ideally, these two directions would be 0 degrees difference, but channels can shift direction over time, leading to shifts compared to when the asset was designed. The greater the difference, the more likely areas around the asset will be susceptible to erosion and the flow rate of water within the asset will be less than the designed value.

3.2 Reinforced Concrete Culvert Inspection

Asset Type Summary

Reinforced Concrete Pipes/Culverts (RCPs) are the other main type of agency owned assets under public roads. Many of the items discussed with the inspection of RCPs also apply to RCPs. However, one of the function of RCPs is to provide additional structural support to the road that crosses it, so extra attention should be paid to the structural inspection of the asset. Culverts are typically larger assets than pipes, with spans being as large as 20 feet, although this is not common.

Structural Condition Inspection of Barrel

As discussed, the inspection of structural condition for reinforced concrete assets is even more important than other types of assets. There are three areas in which an inspector can assess the structural condition of the barrel of an RCP: Cracking, the separation of pipe joints, and deterioration of the concrete in the form of spalling or other chemical processes.

<u>Cracking</u> - When working with concrete assets, the cracks appearing on a structure can tell one a lot about the structural integrity of the asset. Surface level cracks are considered normal. However, when cracks are large enough to expose reinforcement within the asset or allow soil and other pollutants to enter the barrel, the structure of the asset can become compromised quickly.

<u>Pipe Joint Separation</u> - Separation in concrete pipes is more common than in metal pipes, due to them being manufactured in shorter lengths. Separation between pipe joints can occur because of a number of causes, such as the earthwork shifting over time due to loads. When separation occurs in RCPs, additional spalling can occur on the ends of the pipe segments, leading to larger holes by which the stormwater can infiltrate the surrounding soil, making the earthwork erode and overall weaker. This makes the asset even more susceptible to shifting earthwork and forces from large flood events.

<u>Interior Deterioration</u> - Much in the same way as CMPs, inspectors should evaluate the health of the material of the assets, in this case, concrete. Concrete can deteriorate in several ways, from freeze-thaw cycles to sulphate and alkali attacks. The inspector should look for signs of discoloration, or chunks or sheets of concrete falling off. They should be especially concerned if clearly structural damage and deformation is occurring, or if reinforcement is exposed to the air.

Functional Condition Inspection of Barrel

When evaluating the functional condition of a RCP, many items are covered when you inspect for holes and leaks while inspecting the structural condition. However, an inspector must also consider the buildup of sediment within the barrel.

<u>Sediment Build-Up</u> - Blockages within the barrel are the most common causes of functional failure for RCPs, especially since they are typically smaller assets. Within the barrel itself, you are unlikely to find one large object causing the block, but overtime sediment carried in by runoff water will settle and build, eventually clogging portions of the pipe and decreasing the flowrate of the asset to below its design, which could lead to backflow and flooding.

Structural Condition Inspection of Inlet/Outlet

After the barrel has been inspected, the inspector should also assess both the inlets and the outlets of the asset and check for signs of structural compromise. This is especially important, as these portions of the asset are the most exposed to the elements. For RCPs and most assets, the two main criteria remain the same: erosion levels and the headwall.

Erosion - Erosion around the asset can cause a multitude of problems for a pipe/culvert asset. It can expose more of the asset to the elements than was designed for. If erosion occurs underneath the asset, it can cause the structure to settle due to the weak soil underneath and create sags/sinkholes in the road above. In addition, erosion beneath the asset can cause the runoff or natural waterway to not be able to enter the inlet, thus leading to flooding and more erosion.

Headwall - All assets should contain a headwall of some type, as they are essential to holding assets in place, thus preventing shifting, settling and more. The headwalls also serve to protect the asset from erosion and can even serve as a barrier to help guide waterways into the asset. Any sign that the headwall and the barrel are separating should be evaluated.

Functional Condition Inspection of Inlet/Outlet

When it comes to evaluating the functional condition of the inlets and outlets of RCPs and other culvert/pipe assets, the two main criteria to be focused on are objects creating blockages, as well as the alignment between the culvert and the channel.

Blockages - While the barrel is more susceptible to sediment buildup, the inlets and outlets of a pipe/culvert asset can be blocked by any number of things. This could be vegetation that has grown around the ends of the asset. It could also be large rocks or soil eroded into the asset, or it could even be wildlife, such as beavers. The inspector should evaluate how these items are affecting the flow of water within the asset.

Alignment - Alignment is the measure of difference between the direction of the culvert/pipe and the direction of the flow of water, otherwise known as the channel. Ideally, these two directions would be 0 degrees difference, but channels can shift direction over time, leading to shifts compared to when the asset was designed. The greater the difference, the more likely areas around the asset will be susceptible to erosion and the flow rate of water within the asset will be less than the designed value.

3.3 Corrugated Plastic Pipe Culvert Inspection

Asset Type Summary

While less common than CMPs or RCPs, Plastic corrugated pipes (PCPs) are common enough in the state of Georgia to warrant their own guidelines. Many of the inspection criteria presented for PCPs will mirror that of CMPs and RCPs. However, due to PCPs' small size typically, some criteria may have more emphasis placed on it, such as sediment build-up and blockages.

Structural Condition Inspection of Barrel

There are three areas in which an inspector can assess the structural condition of the barrel of an PCP: Cracking, the separation of pipe joints, and deterioration of the plastic.

Deflection - Deflection is the measure of the difference between the vertical diameter of a pipe/culvert when it was designed/installed and it is currently. For example, a pipe with a 30-inch vertical diameter now has a vertical diameter of 27 inches upon inspection. That amounts to a 10% deflection. Deflection is a key indicator that the asset is losing its ability to structurally withstand the loads being placed upon it. Deflection is also an indicator that portions of the asset are experiencing stresses they were not designed for and thus could be at risk for failure.

Pipe Joint Separation - Separation between pipe joints can occur because of a number of causes, such as the earthwork shifting over time due to loads. When separation occurs, the asset begins to no longer work as a single structure, making it more susceptible to larger loads. In addition, pipe separation allows for the water within the asset to leak into the surrounding soil, making the earthwork erode and overall weaker. This makes the asset even more susceptible to shifting earthwork and forces from large flood events.

Interior Deterioration - Inspectors should evaluate the health of the material of the assets. With plastic, the causes for deterioration will depend heavily on the material of plastic used. The inspector should look for discoloration within the plastic, and any holes that have developed and if they're causing any part of the asset to collapse.

Functional Condition Inspection of Barrel

When evaluating the functional condition of a PCP, many items are covered when you inspect for holes and leaks while inspecting the structural condition. However, an inspector must also consider the buildup of sediment within the barrel.

Sediment Build-Up - Blockages within the barrel are the most common causes of functional failure for RCPs, especially since they are typically smaller assets. Within the barrel itself, you are unlikely to find one large object causing the block, but overtime sediment carried in by runoff water will settle and build, eventually clogging portions of the pipe and decreasing the flowrate of the asset to below its design, which could lead to backflow and flooding.

Structural Condition Inspection of Inlet/Outlet

After the barrel has been inspected, in the inspector should also assess both the inlets and the outlets of the asset and check for signs of structural compromise. This is especially important, as these portions of the asset are the most exposed to the elements. For RCPs and most assets, the two main criteria remain the same: erosion levels and the headwall.

Erosion - Erosion around the asset can cause a multitude of problems for a pipe/culvert asset. It can expose more of the asset to the elements than was designed for. If erosion occurs underneath the asset, it can cause the structure to settle due to the weak soil underneath and create sags/sinkholes in the road above. In addition, erosion beneath the asset can cause the runoff or natural waterway to not be able to enter the inlet, thus leading to flooding and more erosion.

Headwall - For larger PCPs a headwall of some sort should be present as they are essential to holding assets in place, thus preventing shifting, settling and more. The headwalls also serve to protect the asset from erosion and can even serve as a barrier to help guide waterways into the asset. Any sign that the headwall and the barrel are separating should be evaluated.

Functional Condition Inspection of Inlet/Outlet

When it comes to evaluating the functional condition of the inlets and outlets of RCPs and other culvert/pipe assets, the two main criteria to be focused on are objects creating blockages, as well as the alignment between the culvert and the channel.

Blockages - While the barrel is more susceptible to sediment buildup, the inlets and outlets of a pipe/culvert asset can be blocked by any number of things. This could be vegetation that has grown around the ends of the asset. It could also be large rocks or soil eroded into the asset, or it could even be wildlife, such as beavers. The inspector should evaluate how these items are affecting the flow of water within the asset.

Alignment - Alignment is the measure of difference between the direction of the culvert/pipe and the direction of the flow of water, otherwise known as the channel. Ideally, these two directions would be 0 degrees difference, but channels can shift direction over time, leading to shifts compared to when the asset was designed. The greater the difference, the more likely areas around the asset will be susceptible to erosion and the flow rate of water within the asset will be less than the designed value.

3.4 Miscellaneous Types of Culverts and Pipes

In addition to CMPs, RCPs, and PCPs, there are other types of materials that can be used for culverts and crossroad pipes. The three above were chosen to be described in-depth because they are the most common types. Other types of materials that could be used include masonry, as well as High Density Poly-Ethylene (HDPE). Inspection Agencies should be prepared to encounter assets that exist outside of CMPs, RCPs, and PCPs, even if that is all they are allowed to install. It is possible that past members of the agency installed these unique types of assets, and it is still the agency's responsibility to maintain and manage these assets. Thus, it is recommended by this guide that, in addition to having inspection process for CMPs, RCPs and PCPs, they also develop a process for any miscellaneous types of assets they may encounter.

4. County Case Studies

This section provides general overviews of culvert and pipe inspection systems developed by county governments in the state of Georgia, representing a variety of regions, population size and resources. Each one will cover how that system applies the strategies and recommendations placed within this guide and how those have made it to where their system can be successful.

Along with the single-page case study documents are QR codes that are links to ArcGIS story pages that further explain the systems and what was learned during on-site visits.

Athens-Clarke County

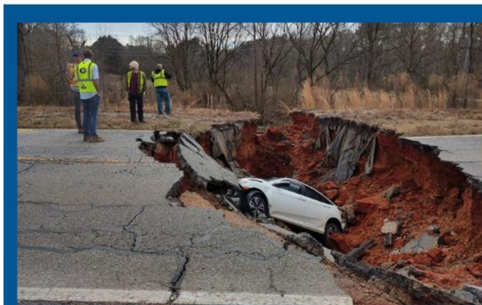
Oconee County

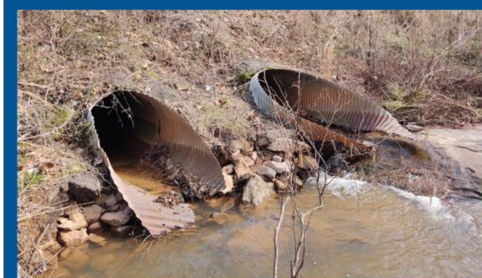
Fayette County

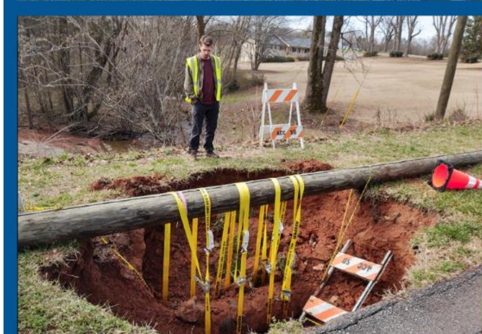
Gwinnett County

Sumter County

4.1 Athens-Clarke County

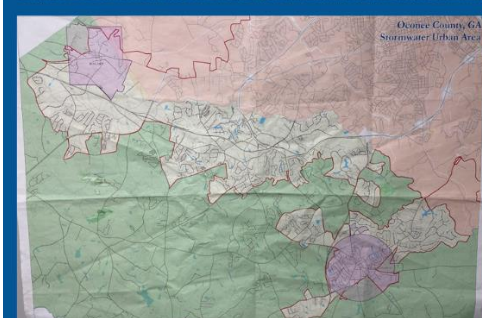






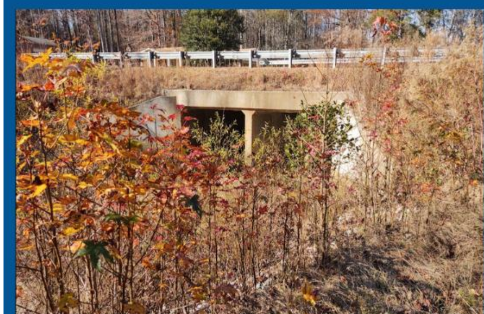
Athens-Clarke County (ACC) is located in North-east Georgia and is home to the University of Georgia and Athens, Georgia. The size of the county is medium to large, with a population of 127,358 residents. ACC manages their assets through a joint-venture between their Department of Transportation and their Department of Public Works. The types of assets commonly used in ACC are all reinforced concrete pipes (RCP) for newer assets, but many older assets in the county are corrugated metal pipes (CMPs), as construction practices within the county have shifted over time. ACC falls fully under the MS4 guidelines and thus must visually inspect all assets at least once every 5 years. The county has developed a separate program for dealing with these assets, known as the Live-Stream Pipe Replacement Program (LSPR). By making a separate program for the assets, it makes it easier to include it as a budget line for the general county budget. The program is still in its infancy, as it was established in 2018 and many aspects of the program are still being developed. For their inventory, ACC has hired a firm known as Arcadis to map out and develop their inventory system, and this process is still ongoing. Until the full inventory is complete, ACC has compiled a list using the LSPR program of known troublesome assets, which have been collected either through public complaints or through their own regular field experience. ACC has condition ratings for their assets, which are determined by averaging scores ranging from 1-5 on a multitude of criteria. Using these condition rating scores and the LSPR list, ACC has been aware of multiple assets in risk of failing and has been building funds and developing engineering plans to replace these assets, or, worst-case scenario, be prepared should the asset fail. In early January 2023, the latter occurred when a large rainstorm washed out two roads in ACC and caused sinkholes in another. Because of their program, the replacement projects for these disasters are well ahead of schedule, both construction-wise and funding-wise. The ultimate goal of the program is to help the county catch up on its lack of funding for these assets in previous decades and eventually move to a fully preventative maintenance system.

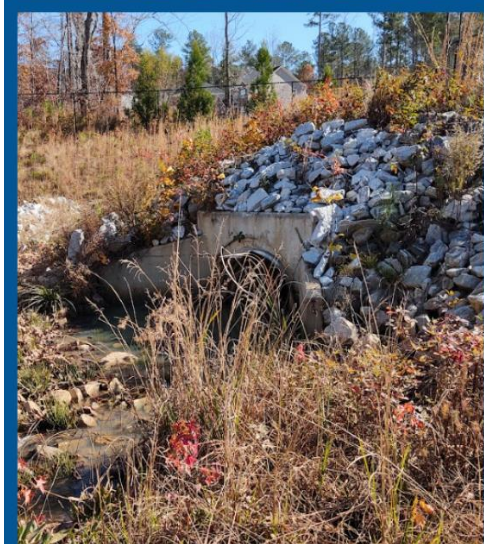
4.2 Oconee County



Oconee County is located in North-east Georgia. The size of the county is considered medium with a population of 43,023 residents. Oconee County makes for an interesting case study, as the northeastern portions of it are under MS4 guidelines, but the rest is not. For the assets under MS4 regions that aren't under Watkinsville or Bogart city limits, Oconee County contracts those inspections out to a firm known as Bureau Veritas. Any maintenance for the MS4 assets will then be carried out by the county staff. The type of assets seen in Oconee County are as follows. Under MS4 regions, they are mostly RCPs, but outside of those regions, one will find mostly CMPs. Oconee County has successfully implemented a system by which they regularly inspect their locally owned transportation assets such as culverts and cross-road pipes using a work-order system. Their own standard for maintaining and managing these assets is to divide their county into 4 sections and to provide inspections and maintenance on every asset within one section each year. Their extensive work order system also doubles as their inventory. One thing that separates Oconee county from the other observed county systems is that they invest more effort in maintaining driveway pipes for roadway safety. For all these assets, the inspection and maintenance crews are one and the same, making repairs as they inspect the assets, when appropriate. The notes from the inspection, as well as any maintenance items done during the inspection are then documented through a work-order system developed for the county's use by the Athens Technical College. For these assets, there is no conditional rating system applied to the asset. It is simply a pass-fail system. The equipment used by the county maintenance/ inspection staff was of note, as they often repurposed equipment from other departments, such as a "Jaws of Life" tool they procured from the fire department they use to reopen flattening metal assets, as well as a "Jetter" from the Utility and Road department, which they use to clear out the interiors of pipes. The county has also obtained a miniature excavator which travels with the crew.

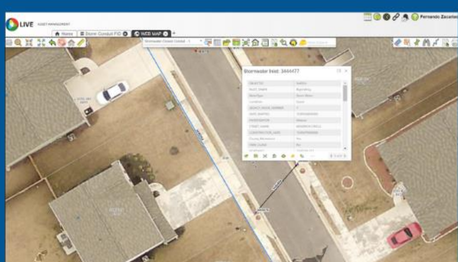
4.3 Fayette County

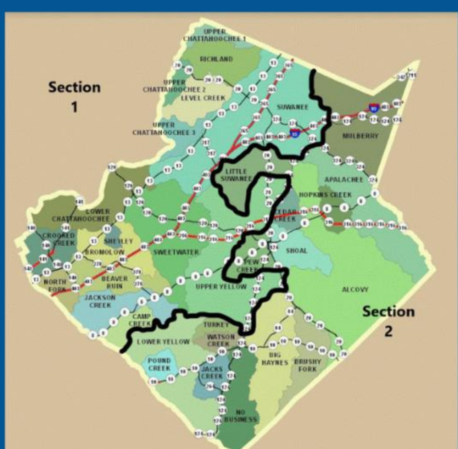




Fayette County is a county located in the southwest portion of the Atlanta Metro-Area. The size of the county is considered medium to large with a population of 114,421. Fayette County manages the assets under their Department of Environmental Management. The assets within the county are mostly comprised of reinforced concrete pipes underneath the right-of-way of public roads, which can become corrugated metal pipes once outside the right of way. The county also has several larger culvert assets made of reinforced concrete. The inspection and safety equipment used by the county for inspections matches that which is recommended in this guide. The mobile camera of choice for this county is a pole camera that is physically inserted into the asset, rather than relying on enhanced zoom features. Their inventory management system is a GIS system that allows both inventory management and the reporting of inspection reports. The program costs the county roughly $1,200 annually. For inspection intervals, Fayette County is within the MS4 permit, which means they must inspect each of their assets once every 5 years. Their condition rating system ranges from 1 to 5, with 1 being brand new and 5 being failing. The department staff use these ratings to determine which assets are proposed for the 5-year SPLOST plan, which is where funding for larger projects in Fayette County comes from. Any asset given a 4 or 5 is added to the request for budgeting. Because of their reliance on the publicly elected SPLOST program, Fayette county takes extra care to promote its projects to the public and to find ways to engage the public with the work they do. The inspection process conducted on the assets is consistent with the recommendations made in this guide. The server the county has purchased allows for updates to the inventory and inspections reports to be made live in the field.

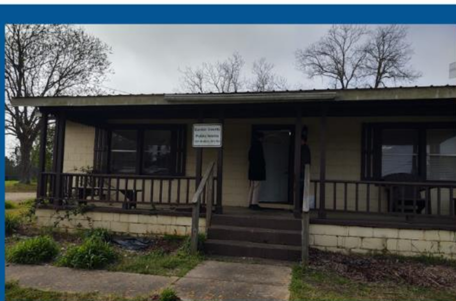
4.4 Gwinnett County





Gwinnett County is Georgia's 2nd largest county with a population of 936,250 residents and manages 127,000+ Non-NBI county owned assets underneath public roads. The assets are managed under Gwinnett County's Water Resource Department are mostly pipes located under public roads. The inspection equipment used by the inspection crews is in accordance with the recommendations within this guide. Their mobile camera of choice is a pole camera, with enhanced zoom capabilities, such that it doesn't need to be inserted physically into the asset to assess it. One thing that separates Gwinnett County's process is that they contract out their inspections using a private firm they train and work closely with to make sure the inspections and data gathered from them are workable for their asset management program. Their asset management software is one that was developed in-house. It is a GIS based system that allows for inventorying of assets, as well as the recording of inspection results. It also goes a step further by issuing work orders within the system to the appropriate department automatically. Gwinnett County is also under MS4 permit guidelines, which means they inspect their assets once every 5 years. However, they have two levels of inspection, the first of which is a base inspection for obvious defects and issues. The second level inspection is done once every 10 years and is a full condition assessment of the asset. The county is split into two zones, and each zone is given one type of inspection and they switch every 5 years. Their rating system is a 5-tier system, with 1 being a brand-new asset and 5 being a failed asset. The condition system is based heavily on the defects present, rather than the severity of the defects. The inspection process conducted on the assets is consistent with the recommendations made in this guide. For funding, Gwinnett County does not rely on the county's SPLOST program or the general funds from the county budget. Gwinnett County's Water Resource department generates its own budget by classifying stormwater assets as utilities and instituting a stormwater utility fee as a part of annual property taxes. This fee generates roughly $30 million for the department's budget annually.

4.5 Sumter County



In addition to providing case studies of existing programs in local governments in the state of Georgia, the research team behind this guide felt it was best to visit a smaller county government and present an early draft of the guidelines, recommendations, and resources presented in this guide and to see how feasible it was to implement. Sumter County is located in southwest Georgia, has a population of 29,283 and contains the city of Americus, GA. Sumter County's system for managing and maintaining their locally owned assets mirrors many in smaller rural local governments in Georgia. They use a reactive maintenance approach, relying on reports from residents or their own observations when out in the field. From there, the reports generate paper work order tickets to be issued and enacted upon. Sumter County's Public Works Department has worked to move this system to an online system, similar to that of Oconee County. In addition to this, Sumter County has also expressed a desire to move towards a preventative maintenance strategy for their assets. When presented with the contents of this guide, Sumter County Public works officials expressed their appreciation for the inspection forms and guidelines, which standardize the inspection process for each asset. The team also showed that online versions of the forms can be developed and filled out via cellular devices and reported back to the office. This inspection system could also be synergized with their developing online work order system, so that when an issue is reported or an asset reaches a certain condition rating, a work order is automatically generated. The Public Works officials also expressed that having a standard system to organize their assets by their condition or priority level makes it easier for them to report their needs to head county officials who control their departments funding. They also noted that the assets inspection criteria being broken down into 8 categories makes training of future inspectors easier.

Appendices

A. Sample Culvert Inspection and Inventory Forms

B. Inspection Equipment and Safety

C. Glossary

A. Sample Culvert Inspection and Inventory Forms

Inserted into the next few pages of this guide are a set of sample culvert inspection and inventory forms that are free to use by local governments in order to help standardize the process by which they take in data, both for their inventory purposes and their inspection purposes. The forms cover all the inspection criteria discussed in Chapter 4 of this guide, as well as the typical measurements to be taken upon each visit. The forms also provide three different ways that an assets overall condition can be determined. The first way is to average the 8 different criteria's' scores into one score. The other option is to list the highest score determined among the 8 different criteria. Lastly, it is recommended that the inspectors provide a 1-5 condition rating of an asset based on their own experience and assessment of the asset, outside of the what has been calculated by the other two scores. It is recommended that inspection agencies keep track of all three in their inventories.

Culvert Assessment Form - Reinforced Concrete Pipe (RCP)

Culvert Assessment Form - Corrugated Metal Pipe (CMP)

Culvert Assessment Form - Corrugated Plastic Pipe (PCP)

Culvert Assessment Form - Miscellaneous

Culvert Inventory Form

County Logo Here

Culvert Assessment Form

RCP - Reinforced Concrete Pipe

Completed by: ______________________________ Date: ______________________________

Asset Information							
Asset ID:				Location:			
Number of Barrels:		Horizontal Diameter:		Vertical Diameter:			

Barrel Structural Assessment:			**Barrel Functional Assessment:**
Cracking: 1 - No cracks visible 2 - Surface Longitudinal cracking visible 3 - Surface Transverse cracking visible 4 - Cracks large enough to expose reinforcement 5 - Cracks large enough to allow soil passage	Pipe Joint Separation: 1 - No separation 2 - Separation >0.25" 3 - Separation >0.50" 4 - Separation >0.75" 5 - Separation >1.00"	Deterioration: 1 - No signs of deterioration 2 - Minor discoloration 3 - Minor spalling, structure unaffected 4 - Major spalling, structure affected 5 - Structure failure of pipe	Sediment Build-Up Rating: 1 - No sediment present 2 - Sediment fills <25% of barrel 3 - Sediment fills >25% of barrel 4 - Sediment fills >50% of barrel 5 - Sediment fills >75% of barrel, or causes block
Inlet/Outlet Structural Assessment:		**Inlet/Outlet Functional Assessment:**	
Erosion: 1 - No erosion present 2 - Signs of Light Erosion beginning 3 - Light Erosion, 4 - Heavy erosion, compromising structure 5 - Heavy erosion, threatening roadway	Headwall: 1 - No shifting or separation 2 - Shifting 3 - Shifting and separation 4 - Shifting and separation leads to flow impedement 5 - Fully separated and falling N - No headwall	Blockage: 1 - Pipe is fully clear 2 - Minor debris, not blocking flow 3 - Minor debris, some blockage of flow 4 - Major debris, flow heavily blocked 5 - Debris completely blocks flow, acts as dam	Alignment: 1 - Channel and Culvert Aligned 2 - Channel less than 15 degrees misaligned 3 - Channel between 15 and 45 degrees misaligned 4 - Channel greater than 45 degrees misaligned 5 - Channel is parallel to road
Overall Score: (Average Assessment Scores)		Highest Condition Rating Among Categories (Circle One):	**N 1 G 2 F 3 P 4 I 5**
Inspector's Impression of Condition (Circle one):	**N 1 G 2 F 3 P 4 I 5**		
Additional Comments:			

N - New G - Good F - Fair P - Poor I - Inoperable

County Logo Here

Culvert Assessment Form

CMP - Corrugated Metal Pipe

Completed by: ______________________ Date: ______________________

Asset Information							
Asset ID:				Location:			
Number of Barrels:		Horizontal Diameter:		Vertical Diameter:			
Barrel Structural Assessment:						Barrel Functional Assessment:	
Deflection: 1 - No measurable deflection 2 - Vertical diameter reduced >5% from original 3 - Vertical diameter reduced >10% from original 4 - Vertical diameter reduced >15% from original 5 - Vertical diameter reduced >20% from original		Pipe Joint Separation: 1 - No separation 2 - Separation >0.25" 3 - Separation >0.50" 4 - Separation >0.75" 5 - Separation >1.00"		Interior Deterioration: 1 - No signs of deterioration 2 - Minor discoloration 3 - Minor signs of oxidation 4 - Oxidation apparent with holes forming 5 - Oxidation leading to structure compromising		Sediment Build-Up Rating: 1 - No sediment present 2 - Sediment fills <25% of barrel 3 - Sediment fills >25% of barrel 4 - Sediment fills >50% of barrel 5 - Sediment fills >75% of barrel, or causes block	
Inlet/Outlet Structural Assessment:				Inlet/Outlet Functional Assessment:			
Erosion: 1 - No erosion present 2 - Signs of Light Erosion beginning 3 - Light Erosion, 4 - Heavy erosion, compromising structure 5 - Heavy erosion, threatening roadway		Headwall: 1 - No shifting or separation 2 - Shifting 3 - Shifting and separation 4 - Shifting and separation leads to flow impedement 5 - Fully separated and falling N - No headwall		Blockage: 1 - Pipe is fully clear 2 - Minor debris, not blocking flow 3 - Minor debris, some blockage of flow 4 - Major debris, flow heavily blocked 5 - Debris completely blocks flow, acts as dam		Alignment: 1 - Channel and Culvert Aligned 2 - Channel less than 15 degrees misaligned 3 - Channel between 15 and 45 degrees misaligned 4 - Channel greater than 45 degrees misaligned 5 - Channel is parallel to road	
Overall Score: (Average Assessment Scores)				Highest Condition Rating Among Categories (Circle One):		N G F P I 1 2 3 4 5	
Inspector's Impression of Condition (Circle one):		N G F P I 1 2 3 4 5					
Additional Comments:							

N - New G - Good F - Fair P - Poor I - Inoperable

County Logo Here

Culvert Assessment Form

PCP - Plastic Corrugated Pipe

Completed by: ______________________ Date: ______________________

Asset Information							
Asset ID:				Location:			
Number of Barrels:		Horizontal Diameter:		Vertical Diameter:			

Barrel Structural Assessment:			Barrel Functional Assessment:
Deflection: 1 - No measurable deflection 2 - Vertical diameter reduced >5% from original 3 - Vertical diameter reduced >10% from original 4 - Vertical diameter reduced >15% from original 5 - Vertical diameter reduced >20% from original	Pipe Joint Separation: 1 - No separation 2 - Separation >0.25" 3 - Separation >0.50" 4 - Separation >0.75" 5 - Separation >1.00"	Interior Deterioration: 1 - No signs of deterioration 2 - Minor discoloration 3 - Minor signs of detreрioration 4 - Deterioration apparent with holes forming 5 - Deterioration leading to structure compromising	Sediment Build-Up Rating: 1 - No sediment present 2 - Sediment fills <25% of barrel 3 - Sediment fills >25% of barrel 4 - Sediment fills >50% of barrel 5 - Sediment fills >75% of barrel, or causes block

Inlet/Outlet Structural Assessment:		Inlet/Outlet Functional Assessment:	
Erosion: 1 - No erosion present 2 - Signs of Light Erosion beginning 3 - Light Erosion, 4 - Heavy erosion, compromising structure 5 - Heavy erosion, threatening roadway	Headwall: 1 - No shifting or separation 2 - Shifting 3 - Shifting and separation 4 - Shifting and separation leads to flow impedement 5 - Fully separated and falling N - No headwall	Blockage: 1 - Pipe is fully clear 2 - Minor debris, not blocking flow 3 - Minor debris, some blockage of flow 4 - Major debris, flow heavily blocked 5 - Debris completely blocks flow, acts as dam	Alignment: 1 - Channel and Culvert Aligned 2 - Channel less than 15 degrees misaligned 3 - Channel between 15 and 45 degrees misaligned 4 - Channel greater than 45 degrees misaligned 5 - Channel is parallel to road
Overall Score: (Average Assessment Scores)		Highest Condition Rating Among Categories (Circle One):	**N 1 G 2 F 3 P 4 I 5**
Inspector's Impression of Condition (Circle one):	**N 1 G 2 F 3 P 4 I 5**		
Additional Comments:			

N - New G - Good F - Fair P - Poor I - Inoperable

County Logo Here

Culvert Assessment Form

Misc. - Miscellaneous

Completed by: ______________________________ Date: ______________________________

Asset Information							
Asset ID:				Location:			
Number of Barrels:		Horizontal Diameter:		Vertical Diameter:		Material:	

Barrel Structural Assessment:			Barrel Functional Assessment:
Deflection: 1 - No measurable deflection 2 - Vertical diameter reduced >5% from original 3 - Vertical diameter reduced >10% from original 4 - Vertical diameter reduced >15% from original 5 - Vertical diameter reduced >20% from original	Pipe Joint Separation: 1 - No separation 2 - Separation >0.25" 3 - Separation >0.50" 4 - Separation >0.75" 5 - Separation >1.00"	Interior Deterioration: 1 - No signs of deterioration 2 - Minor discoloration 3 - Minor signs of detrerioration 4 - Deterioration apparent with holes forming 5 - Deterioration leading to structure compromising	Sediment Build-Up Rating: 1 - No sediment present 2 - Sediment fills <25% of barrel 3 - Sediment fills >25% of barrel 4 - Sediment fills >50% of barrel 5 - Sediment fills >75% of barrel, or causes block
Inlet/Outlet Structural Assessment:		**Inlet/Outlet Functional Assessment:**	
Erosion: 1 - No erosion present 2 - Signs of Light Erosion beginning 3 - Light Erosion, 4 - Heavy erosion, compromising structure 5 - Heavy erosion, threatening roadway	Headwall: 1 - No shifting or separation 2 - Shifting 3 - Shifting and separation 4 - Shifting and separation leads to flow impedement 5 - Fully separated and falling N - No headwall	Blockage: 1 - Pipe is fully clear 2 - Minor debris, not blocking flow 3 - Minor debris, some blockage of flow 4 - Major debris, flow heavily blocked 5 - Debris completely blocks flow, acts as dam	Alignment: 1 - Channel and Culvert Aligned 2 - Channel less than 15 degrees misaligned 3 - Channel between 15 and 45 degrees misaligned 4 - Channel greater than 45 degrees misaligned 5 - Channel is parallel to road
Overall Score: (Average Assessment Scores)		Highest Condition Rating Among Categories (Circle One):	**N G F P I** **1 2 3 4 5**
Inspector's Impression of Condition (Circle one):	**N G F P I** **1 2 3 4 5**		
Additional Comments:			

N - New G - Good F - Fair P - Poor I - Inoperable

County Logo Here

Culvert Inventory Form

Completed by: ______________________ Date: ______________________

Asset Information								
Asset ID:				Road Location:				
Inlet GPS Coordinates:		Latitude:	Longitude:	Outlet GPS Coordinates:		Latitude:	Longitude:	
Owner:				Initial Construction Date:				
Culvert Type: (Circle One)	Box		Circular		Ellipsoid		Arch	
Number of Barrels:		Horizontal Diameter:		Vertical Diameter:		Length:		

Barrel Material: (Circle One)		Liner Material: (Circle One)	
PCP	HDPE	CMP	Plastic
CMP	Masonry	Concrete	Other
RCP	Mixed/Other	Fiberglass	

Inlet: (Circle One for each)			Additional Notes:
Pipe End Type:	**Inlet End Treatment Type:**	**Apron Material:**	
Beveled	Headwall	Concrete	
Flared	Wingwall	Asphalt	
Flat	Rip Rap	Stone	
	None	Other	
		None	
Outlet: (Circle One for each)			
Pipe End Type:	**Outlet End Treatment Type:**	**Apron Material:**	
Beveled	Headwall	Concrete	
Flared	Wingwall	Asphalt	
Flat	Rip Rap	Stone	
	None	Other	
		None	

B. Inspection Equipment and Safety

B-1 Suggested Inspection Equipment

The following section contains a checklist of equipment that any inspector from an inspection agency should have when visiting an asset in the field for the purpose of adequately being able to perform an inspection. Not all of this equipment will be used in every inspection. However, it is recommended that the following are included in the inspector's vehicle, should a need arise.

- ☐ Pencil/Pen
- ☐ Flashlight
- ☐ 20' Measuring Tape
- ☐ 100' Measuring Tape
- ☐ Clipboard
- ☐ GPS Device
- ☐ Probing Pole
- ☐ Binoculars
- ☐ Level
- ☐ Digital Camera
- ☐ Crack Gauge or Ruler with1/16" increments
- ☐ Sharpie/Paint Marker
- ☐ Pole Camera
- ☐ Tablet
- ☐ Portable Charing Blocks for Tablet
- Culvert Inventory Forms*
- ☐ Culvert Inspection Forms*
- ☐ Previous Inspection Reports*

*Agency staff members may also have electronic versions of these forms on their portable tablet.

B-2 Suggested Safety Equipment

Having equipment needed for the purpose of inspecting the assets is important. However, safety must be of the highest priority of anyone working for an inspection agency. In order to assist, a list of safety equipment that any inspector should have easily on hand during inspections is provided below. Similar to the inspection equipment, some of these equipment pieces will be used more often than others, however that does not change the importance of having them all close at hand.

☐ Safety Vest

☐ Hard Hat

☐ Safety Glasses

☐ Hearing Protection

☐ Working Gloves

☐ Steel-Toed Boots

☐ Rain/Hip Boots

☐ Personal Flotation Devices

☐ Flashing Vehicle Lights

☐ Traffic Cones/Signs

B-3 Common Potential Hazards

In addition to the equipment, it is important to understand the common hazards that an inspector could encounter on the job. Before heading towards a job site, inspectors should take note of any known hazards on the site, which should be noted in any established inventory system (See Section 3.1). It is not possible to foretell all potential hazards; thus, inspectors should always exercise caution when navigating sites.

The first major hazard that inspectors will need to consider is the traffic of the area. Inspectors should always wear high visibility gear, but should never assume this is enough for traffic to notice them. Inspectors should look to park as far away from public roads as possible while still being safe. The next major hazard to consider is the possibilities of slips and falls. By nature of their function, the areas around culverts and pipe openings are both wet and contain slopes down to the asset from the road. The combination of the two makes for an environment where slips and falls are primed to occur. Inspectors should wear appropriate boots with plenty of grip, and should exercise caution on wear they step, especially if the area is clearly sloped or wet. Another major hazard is whenever an asset is close to a body of water such as a stream or a body of water created by a recent flash flood. If inspecting an asset such as this, the inspectors must exercise caution should they need to enter the body of water and must wear their personal flotation device. Oftentimes, the water is opaque and its difficult to impossible to tell what lies beneath, especially when trying to gauge depth. In this case, probing the waterway before entering is highly recommended. If the body of water is flowing, its even more imperative, as flowing water can lead to inspectors loosing control of their movement and places inspectors in even greater danger. The last major hazard to consider is the wildlife of the area. Inspectors should be familiar with the types of local wildlife they should expect to encounter and how their agency is trained to deal with them. Culverts and pipes have been known to be harbors for all sorts of animals, including snakes or rodents. Insects such as mosquitoes are also often found near the wet areas of culverts, which can carry disease. Inspectors should have protective spray applied. Lastly, inspectors need to be careful of the vegetation they come into contact with, as poisonous plants are known to be present in the vicinity of these assets.

Figure 6 - Inspectors Minding Traffic Hazards and Standing a Safe Distance Away.

C. Glossary

In order to clarify any potential confusion about the terms commonly used in this guide, the following section will contain standardized definitions for these terms.

Barrel: The pipe or box section that carries the water under the roadway.

Bridge: Structures on public highways carrying traffic that span 20 feet or more measured from the center of the roadway. These structures must be inspected per the NBIS and the MiSIM, regardless of the structural configuration.

Cross-Road Pipe: A linear drainage conduit(s) underneath a public roadway that are not considered a “bridge(s)” by the Federal Highway Administration (FHWA). Cross-road pipes are differentiated from culverts by being typically smaller in size, not designed for the structural support of the earth above it, rather solely designed on stormwater management and being connected to intermediate drainage structures like junction boxes, manholes or catch basins.

Corrosion: The deterioration of a metal as a result of chemical reactions between it and the surrounding environment. Can come in many forms depending on the type of metal and the environmental factors.

Cracking: A complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

Culvert: A structure that conveys water or forms a passageway through an embankment and is designed to support a super-imposed earth load or other fill material plus live loads. For the purposes of this manual, a culvert will consist of all of the following even though they may support traffic loads directly:

1. Any structure with a span, diameter, or multi-cell structure, having a total span of less than 20 feet when measured parallel to the centerline of the roadway.

2. Any structure that forms a passageway or conveys water through an embankment not inspected according to the definitions and terms of the Georgia Department of Transportation Bridge Inspection Manual.

Drainage Ditch: A man made waterway to drain a low area or to channel water to a desired place.

Inspection Agency: The group of inspectors, whether private consultant or public owner, that has been assigned inspection responsibility for one or more culverts. Private consultants may perform the inspections for multiple owners.

Headwall: A structure placed at the inlet or outlet of a culvert to protect the embankment slopes, and prevent undercutting, usually a concrete structure. Headwalls are perpendicular to the line of the barrel.

Owner: The public entity responsible for the highway carried by the culvert.

Scour: Degradation of the culvert's outlet channel due to erosive velocities. This means wearing away of the channel bottom due to the flow of water. You will see a hole in the bottom of the channel, often near the end of the culvert.

Sediment: Soils and other materials that settle out of suspension and build up on the bottom of an asset.

Alignment: Angle measured between the centerline of the culvert and a line indicating the direction of flow of the stormwater.

Spalling: The breakaway of concrete surface which often extends to the top layers of reinforcing steel.

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APPENDIX E. COUNTY SURVEY CONTACT LIST

County Name	Contact Name	Job Title	Email	Phone Number
Atkinson	James Gore	Road Superintendent	N/A	912-422-3459
Baker	Randy Johnson	County Manager	comanager@bakercountyga.com	229-734-3000
Baldwin	Carlos Tober	County Manager	ctobar@baldwincountyga.com	478-363-1976
Banks	Charles Turk	Board Chairman	cturk@co.banks.ga.us	706-677-6904
Barrow	Chris Yancey	Public Works Director	CYancey@barrowga.org	770-867-7640
Ben Hill	Tim Kegebein	Road Superintendent	Tim.kegebein@benhillcounty.ga.gov	229-426-5170
Burke	Merv Waldrop	County Manager	Merv.waldrop@burkecounty.ga.gov	706-554-2324
Butts	Kip Washington	Public Works Director	kwashington@buttscounty.org	770-775-8213
Catoosa	Jeremy Bryson	Director of Transportation	Jeremy.bryson@catoosa.com	706-935-3574
Clarke	Rani Katreeb	Transportation and Public Works Assistant Director	Rani.katreeb@accgov.com	762-400-6712
Cobb	James Hudgins	CCDOT Pre-Construction Manager	James.hudgins@cobbcounty.org	678-575-2136
Dade	Billy Masengale	Public Works Director	N/A	423-298-6565
Dodge	Conner Bearden	County Manager	Conner.bearden@dodgecounty-ga.com	478-374-4361
Evans	Kenny Hicks	Public Works Director	roads@evanscounty.org	912-237-5997
Fannin	Zack Ratcliff	Public Works Director	zratcliff@finnincountyga.org	706-632-5481
Fayette	Phil Mallon	Public Works Director	pmallon@fayettecountyga.gov	770-320-6010
Franklin	John Phillips	County Engineer	jphillips@franklincountyga.gov	706-384-3686
Glascock	Mike Lyons	Road Superintendent	ema@glascockcountyga.com	706-829-4428
Glynn	Dave Austin	Public Works Director	daustin@glynncounty-ga.gov	912-554-7746
Gwinnett	Edgardo Aponte	Deputy Director of Traffic Engineering	Edgardo.aponte@gwinnettcounty.com	770-822-7433
Haralson	Terry Edwards	Public Works Director	terryedwards@haralsoncounty.ga.gov	770-646-3278
Irwin	TJ Wallace	Assistant Road Supervisor	irwinroads@icloud.gmail.com	229-325-2025
Jasper	Michael Walsh	Public Works Director	mwalsh@jaspercountyga.org	706-595-2112
Jeff Davis	Eddie Bush	Road Foreman	N/A	912-347-5363
Johnson	Mickey Wright	Road Supervisor	mwright@johnsonco.org	478-864-4434
Lamar	James Rigdon	Public Works Director	jrigdon@lamarcountyga.com	770-358-5090
Lee	Danny Keener	Public Works Director	Danny.keener@lee.ga.us	229-854-6261
Lowndes	Robin Cumbus	Public Works Director	rcumbus@lowndescounty.com	229-671-2701
Miller	Andy Moore	Road Superintendent	N/A	229-758-4115
Newton	Chester Clegg	Transportation Director	cclegg@co.newton.ga.us	678-625-1300
Oconee	Jody Woodall	Public Works Director	jwoodall@oconee.ga.us	706-769-2937
Oconee	Michael Weathers	Road Superintendent	mweathers@onconee.ga.us	N/A
Paulding	George Jones	County Director	George.jones@paulding.gov	770-445-4759
Randolph	Edward Murphy	Road Superintendent	Rcroaddepartment@gmail.com	229-310-3746
Richmond	Hameed Malik	Director of Engineering	hmalik@augustaga.gov	706-796-5068
Rockdale	Brian Kelley	Director of Transportation	Brian.Kelley@rockdalecountyga.gov	470-827-7271
Spalding	Kevin King	Construction Supervisor	N/A	770-467-4774
Stewart	Gene Hayes	Road Superintendent	ehaynes@stewartcountyga.gov	229-938-7799
Sumter	Jim Littlefield	Public Works Director	jlittlefield@sumtercountyga.us	229-928-4576
Talbot	Peter Nolan	Road Superintendent	talbotpnolan@pstel.net	706-665-3140
Thomas	Tony Bodiford	Public Works Director	tbodiford@thomascountyga.gov	229-226-4389
Toombs	Chris Keene	Road Superintendent	ckeene.toombsco@gmail.com	912-526-3311
Treutlen	Terry Jackson	Road Superintendent	terry.jackson@treutlengov.us	912-682-4262

Troup	James Emery	County Engineer	jemery@troupco.org	706-298-4705
Upson	Jason Tinsley	County Manager	jtinsley@upsoncountyga.org	706-741-7012
Warren	John Graham	Chairman	John@WarrenCountyGA.gov	706-465-2171
Washington	Robert Holmes	Road Director	rholmes@washingtoncountyga.gov	478-232-1208
Wayne	Elton Aspinwall	Public Works Director	easpinwall@waynecountyga.us	912-202-4064
White	Derick Canupp	Public Works Director	dcanupp@whitecounty.net	706-865-2510
Wilkinson	Charlie Palm	Road Superintendent	road_dept@wilkinsoncounty.net	478-946-2904