

**Performance Audit 17-05:
Street Paving**

February 2019

City Auditor

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OFFICE OF INTERNAL AUDIT

Stan Sewell, City Auditor

February 15, 2019

To: Mayor Andy Berke
City Council Members

Subject: Street Paving Audit (Report #17-05)

Dear Mayor Berke and City Council Members:

The attached report contains the results of our audit of street paving operations in the Chattanooga Department of Transportation (CDOT). Our audit found the Complete Streets Division staff are diligent in their efforts to keep the City streets in good condition. However, we noted an insufficient paving budget to prevent long-term deterioration of the streets. We also found opportunities to improve procedures to address their operations. We recommended a transportation asset management plan be developed, including a long-range plan. We recommended updating the paving software and inputting repair and street cut data into the system. We also recommended CDOT's Complete Streets Division request an increase in the paving budget.

We would like to thank the management and staff of the Department of Transportation and Public Works' CityWide Services Division for their cooperation and assistance during this audit.

Sincerely,

Stan Sewell, CPA, CGFM, CFE
City Auditor

Attachment

cc: Audit Committee Members
Stacy Richardson, Chief of Staff
Maura Sullivan, Chief Operating Officer
Blythe Bailey, Administrator, Transportation
Justin Holland, Administrator, Public Works
Jim Arnette, Tennessee Local Government Audit

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AUDIT PURPOSE

This audit was conducted in accordance with the Office of Internal Audit's 2017 Audit Agenda. The objectives of this audit were to determine if:

- The Chattanooga Department of Transportation (CDOT) has a comprehensive Transportation Asset Management Plan (TAMP) that incorporates paving best practices; and,
- CDOT's pavement management system, MicroPaver (Paver), has reliable data for developing pavement maintenance and rehabilitation plans.

BACKGROUND

City Code Sec 24-96 establishes the general duties of CDOT. In part, the department is responsible for planning, designing and constructing transportation facilities, creating and maintaining standards related to transportation and reviewing development projects relating to transportation issues.

The Complete Streets Division of CDOT has the following additional responsibilities:

- Coordinates with the Transportation Planning Organization (TPO) in the development and planning efforts for eligible projects under the Transportation Improvement Program (TIP);
- Maintains the City's 5 year capital plan that includes TIP and local projects;
- Manages contracts for design and engineering;
- Oversees development of bid and contract document packages;
- Administers construction through private contractors;
- Coordinates requests for service on paving and sidewalks with Public Works; and,
- Maintains and uses Paver software to analyze pavement preservation and future reclamation projects.

Several factors affect the quality of City roads, including weather, volume of usage, quality of construction, preventative maintenance, utility street cuts and funds available for preventive maintenance and paving. Three divisions are tasked with maintaining and preserving our roadways: Transportation's Complete Streets, Public Work's Street Maintenance and ECD's Land Development Office.

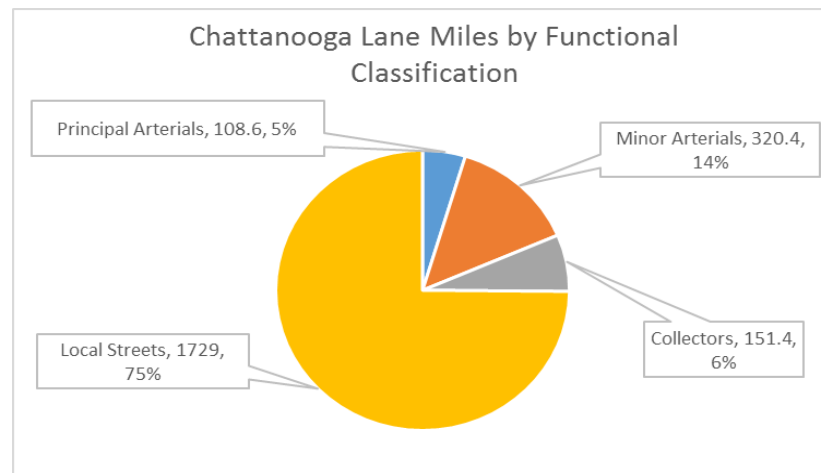
Public Works Street Maintenance Division repairs potholes and performs other repairs requiring less than 3 days of manpower. Contractor street cut permits and inspections are handled by the Land Development Office. Street cuts initiated by the Public Works

Department do not require a permit and are not inspected by Land Development Inspectors.

The City has 2,311 lane miles (a mile of 2 lane street equals 2 lane miles) with an estimated value of \$2 billion. The paving program historically has followed a reactive approach by addressing the worst roads first. Industry best practices stress the philosophy of long term pavement preservation and a proactive approach to predicting future needs for poor and failed roadways in your system.

Statistics

The City’s infrastructure is predominately local streets as shown in the exhibit below:



Source: Paver Summary Data

FINDINGS AND RECOMMENDATIONS

A comprehensive transportation management plan is not in place.

The Moving Ahead for Progress in the 21st Century Act (MAP-21)¹ requires state transportation agencies develop risk-based transportation asset management plans (TAMP). The purpose of a TAMP is to develop a strategic asset management system within an organization that addresses the assets condition, performance, risk, and the organizations ability to manage the assets financial resources and long term planning. The City has received funds from MAP-21, but is not required to follow the statute associated with MAP-21. However, municipalities should follow the same exercise as a best practice.

¹ MAP-21 builds on and modifies previous federal surface transportation laws. MAP-21 was further strengthened by the FAST Act. States must follow MAP-21/FAST Act guidelines to receive federal funding for roads.

“Transportation Asset Management [comprehensive long-range plan] is a strategic and systematic process of operating, maintaining, upgrading, and expanding physical assets effectively throughout their lifecycle. It focuses on business and engineering practices for resource allocation and utilization, with the objective of better decision making based upon quality information and well defined objectives.”²

Development of a TAMP is a best practice among cities and transportation agencies. The city of Nashville and TDOT have implemented well-designed TAMP programs. We reviewed several sources to identify the TAMP standards and guidelines, including The American Association of Highway and Transportation Officials (AASHTO), Federal Highway Administration, and the National Cooperative Highway Research Program.

The benefits of developing a comprehensive long-range plan (i.e., Transportation Asset Management plan) include:

- Improving the condition of all roads in a logical and disciplined manner;
- Monitoring the progress of the Department and making appropriate adjustments;
- Extensive analysis and application of pavement preservation techniques that may extend the life of roads;
- Development of a 5 year plan;
- Provide a justifiable foundation for future funding requests;
- Systematic approach to determine which roads require major reconstruction; and,
- Provide a logical defense to complaints relating to the condition of specific roads and a basis for explaining the timetable for repair.

The basic TAMP outline should reflect the minimum requirements established by federal rules. This outline contains guidance on the following sections:

1. **Introduction:** Establish the overview of the mission, goals and content of the document, executive summary and explanation of how a TAMP was developed and ongoing implementation.
2. **Inventory and Condition:** Provide an overview of the assets, including an asset inventory and the condition of the assets.
3. **Objectives and Measures:** Provide an overview of the measures used for tracking and managing asset performance

² California Transportation Department.

- along with a description of what the organization intends to achieve with the plan.
4. **Performance Assessment:** Describe the performance with respect to measures, objectives, and level of service goals related to asset management.
 5. **Lifecycle Planning:** Describe the plan for asset lifecycle management, maintaining specific levels of service while minimizing costs.
 6. **Risk Management:** Discuss the concept of risk and how it was incorporated into the TAMP.
 7. **Financial Plan:** Detail the funding available for the TAMP activities.
 8. **Investment Strategies:** Describe the translation of data, objectives, measures and policies into decisions for spending of limited resources.
 9. **Process Improvements:** Provide a description of any methods for improvements to your TAMP.

CDOT's *Paving Methodology* serves as the transportation asset management plan. We compared this document to the best practices for designing a TAMP and found CDOT's *Paving Methodology* does not contain the information required for a TAMP.

CDOT has developed a draft policy *Pavement Management Prioritization Methodology*. It explains the steps and timing to determine the paving schedule each year, and the types of paving. It does not address objectives, measures of asset performance, lifecycle planning, 5 year plan, etc.

Recommendation 1:

We recommend CDOT develop and implement a TAMP document, including a five-year paving and major repair plan that is updated annually.

***Auditee Response:** CDOT has been conducting an asset management programming meeting regularly for more than two years. These meetings address many of the exact points that the Auditor raises in this recommendation and its purpose is to move towards a fully-defined program (which one could label as a TAMP). While there may be some confusion about the specific nomenclature at use ("TAMP," which is an acronym that may be used by some other municipalities, as opposed to "asset management planning"), it should be acknowledged that CDOT is fully aware of the need for this kind of long-term strategic planning and has already been engaged in these efforts.*

Auditor Comment: CDOT’s Engineering Manager advised us they have begun development of a *Pavement Management Prioritization Methodology* plan that is currently in draft form and has not been approved by the City Council. While meetings take place to discuss planning within CDOT, there is no document that formalizes the plans. The policy consists only of steps taken to determine the sections of road to be paved in the current year. It does not contain objectives, measures of asset performance or lifecycle planning. Financial planning, such as a five-year plan, has not been developed. Per the draft policy “CDOT plans paving only on a year-to-year basis, and does not complete a long-term paving plan.” We reviewed our recommendation and the related finding with the City Transportation Engineer, the CDOT Engineering Manager and the Engineering Pavement Manager on December 5, 2018. All three agreed with the finding and recommendation at that time. We affirm our finding and recommendation.

Sufficient funding is not available to adequately pave City streets.

According to the U.S. Department of Transportation, “[t]he antithesis of Asset Management is neglect of assets until they deteriorate and require reactive maintenance treatments to restore at least minimal functionality without regard to long-term need or performance ... [f]or today’s transportation agencies, it’s not just about the short-term construction and rehabilitation of roads and bridges, but about results and accountability, as agencies use transportation asset management to implement a data-driven framework for the long-term management of their highway networks.”

The City is responsible for 2,311 lane miles (excluding state routes and interstates) within the City. Well-maintained roads can have a lifecycle of 20-30 years. Advanced maintenance methods, such as crack seal and slurry sealants, can extend the serviceable life of most pavement to around 40 years.

City budget available for paving normally allows for 20-30 lane miles to be paved in a fiscal year. In the past six fiscal years (including current year projections) the average lane miles paved is 27 miles per year. At this rate it would take approximately 84 years to repave all roads in the City. To repave all roads within 40 years, an average of 60 miles per year must be paved.

The cities of Knoxville and Chattanooga have comparable lane miles. We reviewed paving details from Knoxville’s Paving Department for FY2014-FY2018 and compared them to the BFO for Chattanooga and calculated the funds expended per lane mile. Even though Chattanooga’s paving budget has increased substantially over the past few years, it was consistently lower in terms of lane miles paved per year compared to Knoxville. See chart on the following page:

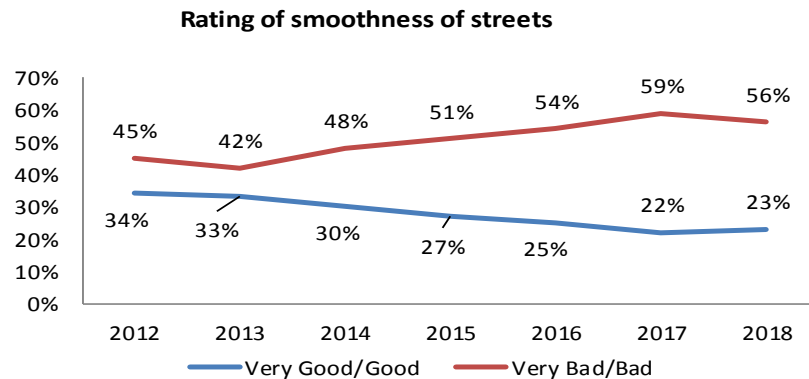
**Chattanooga and Knoxville
Fiscal 2014-2018
Cost per Lane Mile Paved**

	2014	2015	2016	2017	2018
Chattanooga					
Budget *	\$ 2,571,633	\$ 3,000,000	\$ 3,219,000	\$ 3,576,000	\$ 3,900,000
Miles Paved	20.12	27.84	22.89	30.12	22.22
Cost per Lane Mile Paved	\$ 127,815	\$ 107,759	\$ 140,629	\$ 118,725	\$ 175,518
Knoxville					
Expended *	\$ 5,572,352	\$ 5,920,257	\$ 5,755,667	\$ 6,021,714	\$ 7,738,624
Miles Paved	45.64	47.45	46.10	45.48	49.51
Cost per Lane Mile Paved	\$ 122,094	\$ 124,768	\$ 124,852	\$ 132,404	\$ 156,304

Source: Knoxville Paving Department.
Chattanooga BFO documents

* Funds represent street paving only. Pothole repair, bridge repair or roadway/slope failure expenditures are not included.

Funding is insufficient to effectively pave City roadways for optimal long-term conditions. Citizens are progressively less satisfied with the condition of the roadways. In the OIA 2018 Community Survey, only 23% of citizens expressed opinions that roads are in good or very good condition, while 56% expressed opinions the condition of streets were in bad or very bad condition. See chart below:



Source: 2018 Chattanooga Community Survey

Recommendation 2:

We recommend CDOT’s Complete Streets Division request an increase in the paving budget to be more in line with comparative cities, and as necessary, to prevent further deterioration of the streets.

***Auditee Response:** Isolating the Complete Streets Division for an increase in funding does not accurately reflect the coordination between CDOT’s three divisions and other departments that is required for an effective and efficient asset management program. This report also fails to adequately acknowledge the fact that CDOT has requested increased funding for six consecutive years. There are twice as many dollars allocated toward paving in the City’s FY19 budget as there were in the FY13 budget -- the highest such allocation in the City’s history.*

Auditor Comment: We acknowledge the paving budget has increased significantly in the past few years. (See the 4th paragraph of the finding, as well as the above cost per lane mile paved chart detailing funding amounts for the past 5 years.) However, even with the increases, it would take 84 years to pave all City streets at the current annual funding level. The maximum serviceable life of pavement is generally 40 years. If other departments/divisions are not performing at their maximum level of effectiveness, the serviceable life will be less. As presented in the referenced chart, Chattanooga paves approximately half as many miles as Knoxville, which has the same number of lane miles. We reviewed our recommendation and the related finding with the City Transportation Engineer, the CDOT Engineering Manager and the Engineering Pavement Manager on December 5, 2018. All three agreed with the finding and recommendation at that time. We affirm our finding and recommendation.

Recommendation 3:

We recommend CDOT's Complete Streets Division develop a detailed plan of action (*see* discussion regarding increased costs when PCI drops below 40 in the following finding) to support a request for one-time funding to address roadways currently in need of rebuilding and paving (generally those with a PCI below 40).

Auditee Response: *City streets which currently have PCI scores below 40 may display a wide range of characteristics and issues. The approach of requesting a single expenditure of funds to all of them is not the most responsible or effective method for elevating all of the streets in this category. While a one-time infusion of funds may be helpful, CDOT strongly recommends that any such resources only be considered as part of its ongoing asset management plan development in order to get the most bang for our buck.*

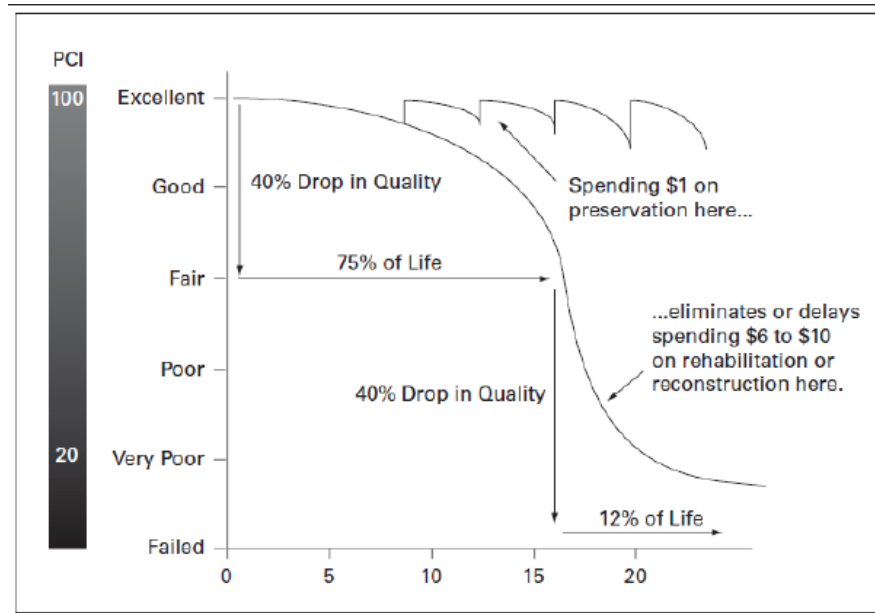
Auditor Comment: We agree with the auditee's response which matches the intent of our recommendation that CDOT's Complete Streets Division exercise diligence in developing a detailed plan to support a one-time infusion of funds.

PCI scores need to be refreshed more frequently.

The Pavement Condition Index (PCI) scoring methodology was developed by the Corp of Engineers. It is an overall rating of street conditions on a scale from 0-100, with zero being a pothole-riddled, crumbling street, and 100 being a newly surfaced roadway. The City primarily bases its paving decisions on the PCI, (81-100 Excellent, 61-80 Good, 41- 60 Poor, <40 - Fail). PCI provides a comprehensive record of pavement distresses at the time of the evaluation. The

number is a composite value representing both structural integrity and serviceability, with higher numbers reflecting better pavement.³

Between 12-15 years most pavement begins to deteriorate at a faster rate. The chart below shows at around 10 years the decline becomes steeper and by year 15 the decline has accelerated sharply with cost of repair increasing dramatically.



Source: GHD Engineering

The engineering firm that performs the City of Nashville's PCI surveys indicated the optimal way to perform PCI calculations is to do 1/2 or 1/3 of the road system each year on a rotating basis. For example, a complete PCI update is performed on Nashville's roadways every two years, completing 1/2 each year. TDOT inspects high priority roads annually and secondary roads every two years. Using that method, all roadways are surveyed every two years, with all PCI calculations updated. Performing 1/3 of the PCI survey each year would spread the expense of the survey equally over a three year period.

The PCI calculated by the system should be the major factor in determining what streets are paved each year. Chattanooga strives to pave roads with a PCI in the 40-60 range. However, funding is not available to pave all roads in that category. Busier streets are given priority for resurfacing. If the PCI falls below 40 the roadbed must be rebuilt, increasing the expense of refurbishing the road by over 50 percent (see chart above). If a roadway PCI falls below 40 it then falls

³ American Association of State Highway and Transportation Officials TAM Guide: A Focus on Implementation (January 2011)

into a category of being rebuilt when funds are available, which can often take many years.

Recommendation 4:

We recommend CDOT ensure a complete PCI study is conducted on all the City's roadways at a maximum of a three year period.

***Auditee Response:** A mandate to update the PCI study every 3 years is arbitrary and establishes a specific policy direction from an entity that lacks the adequate technical expertise to do make that recommendation. Note also that a study of this kind is extremely expensive and would require resources from CDOT that could otherwise be used for paving. CDOT recommends that the PCI database should be updated within the next 1-2 fiscal years and that our asset management plan and program then define the cadence of renewal of that database. Our methodology currently uses our existing database quite effectively, in concert with in-person visual technical analysis of our staff, as a relative scale of need. While we agree that new data is always better than old data, we also believe that a statement about frequency of updates of this data affects the balance of the overall city budget such that less money may be available for actual constructed improvements. In other words, CDOT will always defer towards using our money for actual paving over studies.*

***Auditor Comment:** PCI calculations on a rotating 2-3 year basis represents the industry standard. Both the Federal Highway Association and the National Academy of Sciences recommend PCI studies be performed no less than every three years. Chattanooga could perform PCI studies on 1/3 of the city streets for approximately \$75,000 annually.⁴ With an estimated value of \$2 Billion, the City's roads are likely its most valuable asset. The annual cost of a PCI survey represents four thousandths of a single percent of that value and two percent of the annual paving budget. This represents a relatively modest investment by the City to ensure the millions of dollars spent on paving are properly prioritized. Per Complete Streets Division staff, the PCI is the major tool they have to evaluate road conditions. The current PCI data was developed in 2010. Complete Streets Division management agreed PCI is considered the best method to determine road conditions. We reviewed our recommendation and the related finding with the City Transportation Engineer, the CDOT Engineering Manager and the Engineering Pavement Manager on December 5, 2018. All three agreed with the finding and recommendation at that time. We affirm our finding and recommendation.*

⁴ Estimate developed based on Nashville's actual expenditures per lane mile for PCI.

Sufficient data is not input into Paver to allow proper calculation of PCI.

The PCI data is stored in a Paver software package. The version used by the City is out of date and no longer supported. The *Paver User Manual* shows current information for pothole repairs, street cuts, rutting, cracking, roughness, raveling, or any other distress to the pavement that cause loss of serviceability must be uploaded or manually input for the algorithms to calculate the PCI properly. The only changes CDOT has made to the data in Paver since PCI was last calculated in 2010 is information related to newly paved streets.

Much of the information needed to make the best paving recommendations is available, but not interfaced with Paver. Paver has an interface to Cityworks that is not installed. Pothole repairs and street cuts performed by the City are entered into tablets, but not geocoded prior to being uploaded to CityWorks. The entries could be geocoded allowing the data to be posted to a corresponding geocode in Paver. Contractor street cut information is posted to Accela. An interface can be developed with Accela allowing contractor street cut data to be downloaded, geocoded and uploaded to the proper geocode in Paver.

The system will produce reports that provide the optimum sections to pave or repair, as well as the type of treatment most economical for the area. If the reports are followed, roadway maximum life is extended, while also providing maximum value to the City at the lowest cost.

Currently, the 2010 PCI score for each section is downloaded to an Excel spreadsheet. The data is decremented by 2% for each year that has passed, using the (invalid) assumption pavement deteriorates at the same rate every year. Adjustments are made for wear related to the different types of roads, main arteries, minor artery, local, etc.

Recommendation 5:

We recommend CDOT develop, and implement, processes to allow current information to be input into Paver to produce high-quality information. This would require a minimum of installing the available interface between Paver and CityWorks, and developing an interface between Accela and Paver for street cuts to be interfaced. Finally, all associated information should be geocoded to allow uploading to the proper section in Paver.

Auditee Response: No Comment.

Recommendation 6:

We recommend CDOT upgrade the Paver software to the current version.

Auditee Response: No Comment.

An asset as large and complex as the City's road system calls for dedicated management.

CDOT manages one of the most expensive, valuable assets of the City. Sufficient manpower must be allocated to large assets to ensure the asset is managed as well as possible. The Engineering Pavement Manager estimates spending 15% - 20% of his time on pavement projects. The Paver asset management system is not fully functional for one of the City's largest assets, partly due to the Complete Streets Division staff having multiple responsibilities besides the management of the City's paving program.

Knoxville, a city of similar size, has a full-time staff engineer managing their paving program. A dedicated employee has not been assigned to manage the City's paving program to ensure current data is available, collected and loaded properly. Interfaces have not been developed, nor information gathered, to provide appropriate information for PCI calculation. As stated previously, Paver currently lacks the proper information to be a useful tool.

Recommendation 7:

We recommend CDOT devote sufficient human capital to ensure all aspects of pavement management are addressed on a continuous basis. One possibility for consideration may be devoting a full-time staff member to pavement management.

***Auditee Response:** CDOT's asset management plan should include recommendations for the best way to staff the department to assure that proper levels of technical expertise, training, and adequate full-time equivalents are dedicated to asset management.*

Incidentally, CDOT has been working towards an improved organizational structure which we intend to submit as a budget offer for fiscal year 2020. Currently we have four project management staff and one manager responsible for a wide range of projects at a yearly value of approximately \$5 million per project manager, which already represents an extremely heavy workload, especially considering the responsibilities associated with managing federal funds. On a full-time equivalent (FTE) basis, roughly half of the time of that project management staff is devoted to asset maintenance, whether that be in coordinating with Public Works staff on repair requests, performing site visits and evaluations on various asset issues, such as bridge abutment repairs, slope repairs, or other complicated structural issues that cannot be managed solely by street repair crews, or in the management of contracts that are devoted to asset management (such as our yearly paving contract). Despite the recommendation to dedicate a single staff person to asset management, we believe that our staff FTE dedicated to asset management already exceeds the equivalent of one staff person. Due to the heavy workload of both capital projects and asset management, we will be submitting within our budget offer a request to fund a new subdivision dedicated to asset

management so that we can improve the performance of our staff to both of these endeavors. This new subdivision, if funded, would be responsible for establishing and maintaining a new performance measure that reflects the core goal of the asset management program which is to responsibly maintain our infrastructure for safety and long-term fiscal prudence. Our goal in the establishment of this new performance measure is that it would reward utility and fiscal responsibility so that our success is not simply judged by total funds programmed.

APPENDIX A: SCOPE, METHODOLOGY AND STANDARDS

Based on the work performed during the preliminary survey and the assessment of risk, the audit covers Transportation Department operations with regards to the paving program from April 19, 2017 to November 15, 2018. When appropriate, the scope was expanded to meet the audit objectives. Source documentation was obtained from Transportation, Public Works, LDO and City records. Original records as well as copies were used as evidence and verified through physical examination.

Judgmental sampling was used to improve the overall efficiency of the audit.

To achieve the audit's objectives, reliance was placed on computer-processed data contained in CityView and PCI data within the Paver system. We assessed the reliability of the data contained in the systems and conducted sufficient tests of the data. Based on these assessments and tests, we concluded the data was sufficiently reliable for the purposes used in meeting the audit's objectives.

We conducted this performance audit from May 2017 to December 2018⁵ in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

⁵ Audit work was suspended from November 27, 2017 to May 31, 2018 due to the need for temporary allocation of auditor resources to another project. The audit was further delayed when the auditor in charge accepted a position with another City effective July 5, 2018.

City of Chattanooga Fraud, Waste, and Abuse Hotline

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Internal Audit contracts with a hotline vendor, The Network, to provide and maintain the reporting system. The third party system allows for anonymous reports. All reports are taken seriously and responded to in a timely manner. Reports to the hotline serve the public interest and assist the Office of Internal Audit in meeting high standards of public accountability.

To make a report, call 1-877-338-4452 or visit our website:

www.chattanooga.gov/internal-audit