2020 MID-YEAR STATE OF MUNICIPAL INFRASTRUCTURE REPORT

SUBMITTED TO:

Patrick Furlong, P.E.
City of Shreveport
Department of Engineering and Environmental Services

PREPARED BY:

BONTON ASSOCIATES

IN PARTNERSHIP WITH:

VERDUNITY

June 11, 2020

Patrick Furlong, P.E.
City Engineer
City of Shreveport
Department of Engineering and Environmental Services

RE: 2020 Mid-Year State of Municipal Infrastructure Report – Executive Summary

Mr. Furlong,

We are pleased to present the following 2020 Mid-Year State of Municipal Infrastructure Report for the City of Shreveport. The primary objective of the evaluation documented herein was to identify and review available information on the inventory, condition, and capital planning policies for City-owned infrastructure and summarize the insights and findings from these data sources into a format that can be used by all community stakeholders. Infrastructure asset classes evaluated as part of this effort included buildings, water, wastewater, stormwater, and roadways.

Data Sources

The data relied upon for this evaluation include the following:

- City of Shreveport Annual Operating and Capital Budgets – Operating and Capital Budgets presented and adopted between 2011 to 2020 were pulled from the City's website and reviewed for operational, maintenance and capital planning trends.

- Inventory Data – Information on existing inventory for the various infrastructure asset classes was obtained from Annual Operating Budgets and prior evaluations conducted by others. Other datasets include sanitary sewer assessment data collected from the wastewater collections system, pavement condition index results from roadway assessments, and the Draft Water System Master Plan.

- Meetings and Workshops – Throughout this evaluation, there were several workshops and meetings held with personnel from the City Engineer, Water and Sewerage and SPAR, which provided a wealth of information and context for consideration.

Renewal, Replacement and Capital Planning of Municipal Infrastructure

The primary goal of any municipal infrastructure planning and investment strategy should be to meet or exceed the expected levels of service for each infrastructure asset class, while minimizing lifecycle costs, within the financially constrained environment of the public trust.

Expected levels of services are primarily driven by regulatory guidelines and population and land use patterns, which dictate the overall scale of various infrastructure asset classes. Engineering evaluations help us understand what infrastructure components are required and in what capacity and configuration.

Once initial infrastructure investments are made and the infrastructure is built or installed, the focus shifts to minimizing lifecycle costs through effective maintenance and operational procedures. Implementing effective asset management strategies ensure that scarce operational resources are leveraged in the most beneficial manner. Actual physical and operational condition data are the most useful tools when making decisions related to the renewal and replacement of municipal infrastructure. The City of Shreveport has made significant investments in the form of comprehensive physical evaluations of its water, wastewater, and roadway infrastructure. Results from these evaluations will help the City to prioritize projects and initiatives funded by its Operating and Capital Budgets. Information gleaned from these assessments can also help expose internal opportunities such as additional personnel, maintenance equipment, software, and training initiatives.

While the benefits of comprehensive physical assessments are many, it is worth noting these can be very expensive and time-consuming, not to mention they only provide a snapshot of system conditions at the time of the evaluation. Implementing system-wide monitoring strategies such as Supervisory Control and Data Acquisition systems (SCADA) and Intelligent Transportation Systems (ITS) can offer ongoing system performance and condition evaluation, thereby enabling real-time adjustments in resources and operational and maintenance procedures.

In the absence of physical and operational data, municipalities can use infrastructure inventory replacement cost amortized over an expected lifecycle duration (or useful life) as a proxy for actual condition data when planning and forecasting annual renewal investments, or annual renewal rates. The underlying premise of an annual renewal rate is it represents the ideal level of investment across the system annually to achieve the expected lifecycle duration of a given asset class. In theory, the more responsive a municipality's asset management and maintenance strategies are, the more useful life the municipality can extract from its infrastructure assets, which reduces the overall lifecycle costs of said assets. This report presents methodologies used in determining replacement costs and blended lifecycle durations for the City's water, wastewater, stormwater, roadway and building infrastructure and presents theoretical annual renewal rates for each of these asset classes. The theoretical annual renewal rates are compared to actual operational and capital expenditures to glean whether sufficient infrastructure investments are being made. This information is summarized in "Fact Sheets" for each asset class and is presented in the Section 2 of this report.

The report concludes with a business case for infrastructure investment in Section 3 and operational strategies for consideration in Section 4.

We appreciate the opportunity to be of service to the City of Shreveport and we remain available should you wish to discuss any element of this report or next steps related to strategies recommended herein.

Regards,

Darius Bonton, P.E.
Bonton Associates, LLC

TABLE OF CONTENTS

Photo courtesy of https://en.wikipedia.org/wiki/Shreveport–Bossier_City_metropolitan_area

1. Introduction

1.1. LEGISLATIVE ORDINANCE

Like many municipalities, the City of Shreveport (the City) has enacted legislation to help ensure effective management and investment in *city-owned infrastructure and assets* – water, wastewater, stormwater management (also referred to as drainage), streets, and buildings. Legislative oversight of this effort is administered by the Planning and Infrastructure Committee of the Shreveport City Council[1] (the Council). Information related to the state of the City's infrastructure is compiled in a report and submitted bi-annually by the City's Department of Engineering to the Planning and Infrastructure Committee[2]. This report will serve as the 2020 Mid-Year State of Municipal Infrastructure for the City of Shreveport.

1.2. SCOPE OF THIS REPORT

The advancement of any society depends on the physical infrastructure required to distribute resources and essential services to its public. The **level of service** provided by this infrastructure directly impacts the quality of life and the

LEVEL OF SERVICE

In the municipal context requires the following considerations:

- An expected level of convenience, capacity and reliability
- Environmental sustainability
- Financial and economic viability

[1] Shreveport Code of Ordinances, Chapter 2, Article II, Section 2-36, Part (b) and Part (c)
[2] Shreveport Code of Ordinances, Chapter 2, Article II, Section 2-36, Part (g)

continuity of economic and business activity. The same can be true in the opposite direction; the progression of economic and social development can parallel, or even follow, strategic investments in infrastructure development. Simply put, good infrastructure facilitates a higher quality of life.[3]

This evaluation did not include any organizational or operational audits, or any formal assessment of City-owned assets. Instead, this report aggregates and documents available information related to the inventory, condition and overall level of service for the City-owned assets referenced above. Existing asset management and capital planning policies and trends were also reviewed, along with the development of recommended concepts and strategies for consideration.

1.2.1. WATER SYSTEM

Municipal water systems provide the public with potable water for residential, fire flow and some commercial and industrial uses. The City, through the Department of Water and Sewerage, maintains and operates its own water system which includes raw water supply, raw water treatment, and finished water distribution and storage systems. Each component of the City's water system is being extensively evaluated as part of an ongoing Water System Master Plan revision. Available results and recommendations from the revised master plan are summarized herein, along with strategies for monitoring and maintaining critical components of the water system.

1.2.2. WASTEWATER SYSTEM

Municipal wastewater systems provide for the safe and sanitary collection, treatment, and discharge of residential and commercial sewerage flows. The City, through the Department of Water and Sewerage, maintains and operates its own wastewater system. The City is currently

[3] Uddin, Waheed. Public Infrastructure Asset Management, Second Edition. New York: McGraw Hill, 2013

under a Consent Decree[4] to identify and address system-wide deficiencies and bring its wastewater system into compliance with the Clean Water Act. An extensive assessment of the City's collections system has been initiated. Hydraulic conditions driving future remedial measures and capacity improvements to the system are being evaluated by the City's new Program Management Team.

1.2.3. STORMWATER MANAGEMENT SYSTEM

Municipal stormwater management systems provide drainage and flood control for people and property through the collection and conveyance of stormwater runoff from roadways, adjacent lands, and buildings. The City, through the Streets and Drainage Division of the Department of Public Works, operates and maintains a system of ditches, alleys, canals, culverts (including inlets and catch basins), flood control structures, water quality screening stations, and lift stations. The condition of the City's stormwater management system is being updated as part of a stormwater system master planning effort.

1.2.4. CITY-OWNED STREETS

The City, through the Streets and Drainage Division of the Department of Public Works, maintains a broad network of roadways for the safe and effective movement of vehicles. Traffic signs and signals throughout the City are designed, installed, and maintained by the Traffic Engineering Division of the Department of Public Works. In 2015, the City initiated a pavement condition assessment on many City-owned streets and roads. The results of this assessment provided a Pavement Condition Index (PCI)[5] score for each segment of roadway, which is used to prioritize capital projects for roadway improvements, which are implemented through the City's Engineering Department. In 2016, the Northwest Louisiana Council of Governments (NLCOG) prepared its 2040 Long Range Transportation Plan for the Shreveport Region. This plan

[4] The United States of America and The State of Louisiana v. The City of Shreveport, Louisiana; Case No. 5:13-cv-3065

[5] PCI is a numerical index between 0 and 100 used to indicate the general condition of a pavement. PCI surveys and calculations have been standardized for roadways in the ASTM D6433 – 11: Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys.

included a roadway needs assessment and accompanying financial analysis. Pertinent details of this plan, along with suggestions on how the City can best leverage its findings to improve capacity and level of service, are documented in subsequent sections of this report.

1.2.5. CITY-OWNED BUILDINGS

The City, through the Building Maintenance Division of the Shreveport Public Assembly and Recreation (SPAR) Department, maintains and operates approximately 2,000,000 square feet of public building space, including government offices, fire stations, assembly facilities, community centers, parks, athletic facilities, and swimming pools. Capital improvement projects at these facilities are administered through SPAR's Planning and Development Division.

1.3. TARGETED STAKEHOLDERS

There are several important stakeholders involved in the planning, operation, and maintenance of municipal infrastructure. This report aims to acknowledge some of these stakeholders (in no particular order) and ensure that the information important to each of them is exposed herein for their consideration. This section of the report will define the perspectives of certain stakeholders and highlight their roles, responsibilities and objectives in the planning, operation, and maintenance of the City's municipal infrastructure.

1.3.1. OFFICE OF THE MAYOR

Regarding public infrastructure, it is the role of the executive branch of government to implement policies that balance the needs of aging infrastructure with projected growth demands in a manner that maintains acceptable levels of service and encourages economic development – all within a fiscally constrained environment. The Office of the Mayor is responsible for appointing administrators with the appropriate level of experience and operational awareness to understand the demands placed on various asset classes. It is important that administrators are supported with the financial resources necessary to deliver acceptable levels of service, both currently and into the future. Finally, it is the responsibility of the Office of the Mayor to hold administrators accountable for their staff's performance, customer service, and fiduciary duties to the public trust.

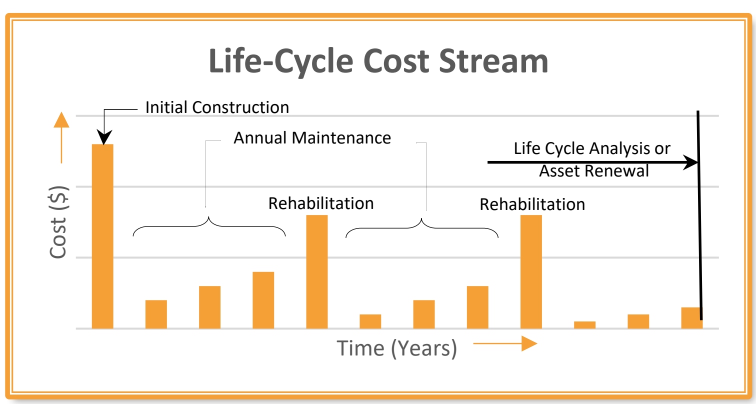
1.3.2. DEPARTMENT OF ENGINEERING AND ENVIRONMENTAL SERVICES

In the City of Shreveport, the Department of Engineering and Environmental Services is responsible for the design, bidding, and construction of capital improvements for all streets, stormwater, water and sewer projects. This department also monitors environmentally regulated matters affecting water, sewer, and public works utilities. The Engineering Division works closely with other City departments to understand existing and forecasted operational challenges impacting infrastructure reliability and levels of service. The Engineering Division administers capital budgets to procure design and construction services to build, replace or renew infrastructure required to meet expected levels of reliability and service. The Engineering Division also oversees the schedule and quality standards by which design and construction services are delivered to the City.

1.3.3. DEPARTMENT OF WATER AND SEWERAGE

It is the responsibility of the Department of Water and Sewage to monitor, operate, and maintain the City's water and sewer infrastructure in accordance with applicable regulatory guidelines. In addition, the Department assesses, collects, and allocates user fees for the provision of water and sewer services, debt service coverage, and maintenance of capital reserves.

The Department of Water and Sewerage is responsible for the development and implementation of an asset renewal and management strategy that establishes appropriate level of service expectations, and balances these with maintenance and rehabilitation techniques that reduce the **life cycle costs** of infrastructure within an acceptable level of risk. The Department of Water and Sewerage also works closely with the City Engineer to develop and implement capital planning strategies that ensure the appropriate level of investment is leveraged in the renewal of water and sewer infrastructure.



1.3.4. DEPARTMENT OF PUBLIC WORKS

It is the responsibility of the Streets and Drainage Division of the Department of Public Works to monitor and maintain the condition of the City's streets and stormwater infrastructure. Because of the high visibility and relatable nature of traffic and roadway surface conditions (compared to subsurface utilities), public demand for accountability and investment is intensified when it comes to roadways. For this reason, it is important for the Division of Streets and Drainage to actively monitor and forecast roadway conditions to ensure maintenance investments are deployed as judiciously as possible. Equally important is alignment between the City Engineer and the Director of Public Works regarding capital planning for major roadway pavement renewal projects.

It is also the responsibility of the Division of Streets and Drainage to monitor and maintain stormwater and floodplain management infrastructure to ensure resiliency and protection of Shreveport citizens and their insurable property. This responsibility extends beyond the management of stormwater and floodplain infrastructure and includes working with other community stakeholders to assist in the development of land use policies and hazard mitigation and emergency response plans.

1.3.5. SHREVEPORT PUBLIC ASSEMBLY AND RECREATION DEPARTMENT (SPAR)

The Building Maintenance Division of the SPAR Department is responsible for maintenance, repair and renovation (MRR) of more than 2,000,000 square feet of City-owned building space. The integrity of the City's buildings and related infrastructure is critical to the success of every organization across City government. Aging and general deterioration adversely affect the City's ability to meet its mission, thus resulting in an elevated risk of performing and delivering basic services. MRR activities, when planned effectively, can slow the performance degradation of building components while minimizing a building's life cycle costs. To help facilitate this, the Building Maintenance Division is responsible for developing and implementing an asset management strategy that separates buildings based on functional use or location, accounts for systems and components within those buildings, and monitors and tracks the conditions and performance of those systems. Insights gleaned from this strategy support the proactive and cost-effective provision of MRR activities for City-owned buildings and related infrastructure.

1.3.6. CITY OF SHREVEPORT COUNCIL

Council members represent the collective interest of the citizens in their respective council districts. Members of the council, by way of the Council's Planning and Infrastructure Committee, ensure that infrastructure investments deliver a return to their constituents in the form of acceptable levels of service that align with the long-term prosperity of the City. The extent to which council members understand the correlation between asset management strategies and capital planning greatly affects their ability to legislate appropriate returns on tax dollars invested in infrastructure on behalf of their constituents.

1.3.7. CITY OF SHREVEPORT CITIZENS

As taxpayers and ratepayers, the citizens of Shreveport fund the operation of city government. With respect to infrastructure, elected officials and administrators should engage with citizens as valued customers. It is becoming increasingly important for citizens to understand how their dollars are being used to operate and maintain the critical infrastructure they rely upon every day. Improved communications and increased transparency help facilitate this understanding and build consensus for long-term sustained investment in the City's infrastructure.

2. Status of Municipal Infrastructure

The following Fact Sheets present snapshots of inventory, replacement cost and capital investment strategies for each asset class covered in this analysis. In some cases, the data presented were extracted from existing sources. In other cases, the data were derived using theoretical methods of analysis. In either case, sources, assumptions and methodologies are explained and/or referenced. A sliding scale is also presented indicating the reliability of the data used in this analysis.

Water System Inventory

The City of Shreveport's Water System is comprised of the following major components:

- **Raw Water Supply** – Cross Lake is the City's primary raw water source. Demand is supplemented by water from Twelve Mile Bayou during summer months. Primary raw water supply infrastructure consists of the Twelve-Mile Bayou and Low Service Pump Stations (combined firm capacity of 91 MGD).
- **Raw Water Treatment** – Raw water from Cross Lake is treated at the T.L Amiss Water Purification Plant. The plant includes a pre-ozone contact basin, three separate treatment trains (Plant 1 – 36 MGD, Plant 2 – 16 MGD, Plant 2E – 34 MGD), post-ozone contact basins, 15 MG in-ground clear wells and three high-service pump stations.
- **Finished Water Storage and Distribution** – Finished water is pumped from the plant into 3 separate pressure zones (Main, West and Southeast) where pressure and capacity are maintained through a distribution network of approximately 1200 miles of water mains, 5 booster pump stations, 3 elevated storage tanks (6 MG, total) and in-ground storage wells (16 MG, total).

Replacement Costs

Replacement costs for major water system components were derived using industry standard and theoretical methods of construction costs estimating.

- **Raw Water Supply and Treatment** – **$455M**; based on an estimated capital investment of $5/gal-capacity/day for direct and indirect capital costs.
- **Finished Water Storage and Distribution** - **$359M**; based on a weighted estimated water main installation cost of $56/LF. Unit cost were derived from a representative distribution of water main sizes installed at assumed depth of 5'. Costs were comprised of RS Means™ work items for pavement removal, excavation, bedding, pipe installation, backfill and pavement restoration.

Data Reliability

LOW HIGH

Inventory data for raw water supply and treatment infrastructure is based on actual assessments performed in association with the Water System Master Plan Revision. Water main linear footage data was pulled from the City's 2018 audited financial report. In general, the reliability of inventory data presented herein should be considered **MODERATE to HIGH** due to extensive system evaluation efforts associated the master plan revision and the City's ongoing use of its City-Works computerized maintenance management system (CMMS).

T.L. AMISS WATER TREATMENT PLANT

PLANT 2E SEDIMENTATION BASIN

Water System Maintenance and Asset Management

According to the Department of Water and Sewerage's 2020 Annual Operating Budget, there are several initiatives recently completed or underway that will improve how the City's water system assets are managed.

- New asset management system for plant and distribution system maintenance.
- Implemented new leak detection systems to expedite the identification and repair of leaks in the distribution system.
- Implemented electronic record keeping system to replace physical maps and quarter section valve books.
- Updated City-Works CMMS system.
- Improve water valve operating and replacement program.

Water System Conditions

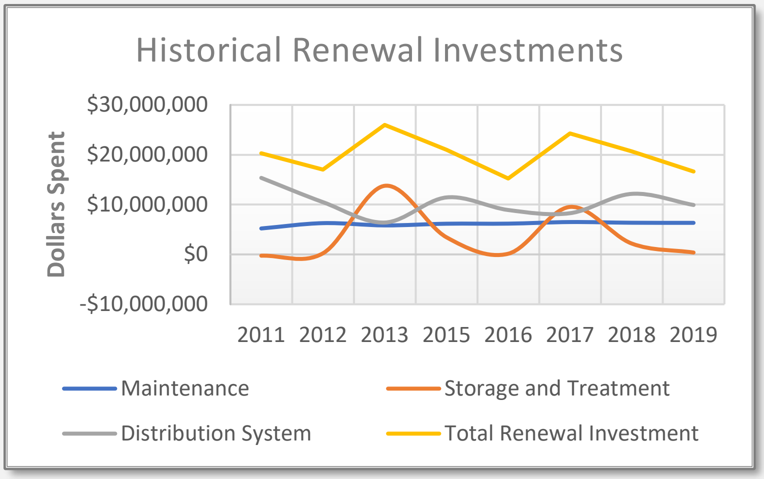
Existing conditions of the water system (as of 2016) are defined as follows:

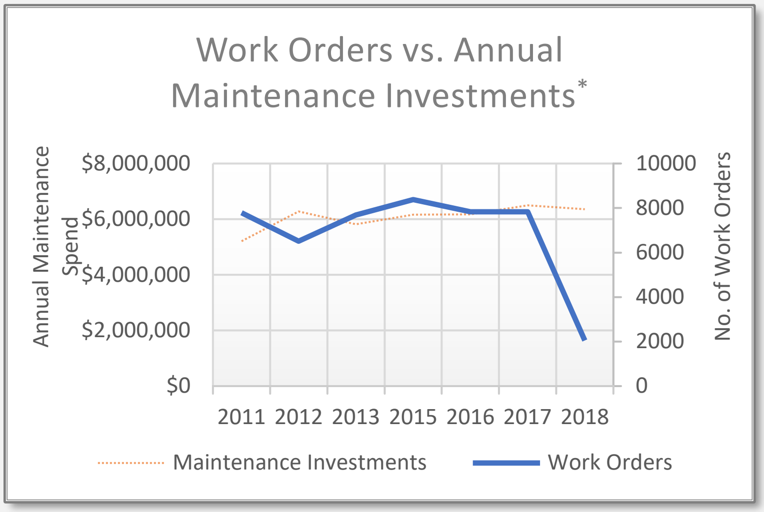
- **Raw Water Supply and Treatment** – Comprehensive improvements to Ozone and other treatment processes have been analyzed, designed and incorporated into a new construction package set to bid 1Q-2020.
- **Finished Water Storage and Distribution**

  a. **Main Pressure Zone** – The **McNeil Booster Pump Station (BPS)** is in overall good condition with minor repairs needed on the ground storage bubbler system and storage fill valve. Residual monitoring and security camera transmission should be also be improved at the McNeil BPS site. The **68th and Union BPS** should have the switchgear replaced and an auxiliary power source installed. Standing water was observed near the discharge piping header, and several gate valves should be replaced.

  b. **West Pressure Zone** – There are water aging concerns in the WPS zone due to a decrease in demand associated with the closure of the GM Plant. Water main replacement and looping should be considered to improve pressures and water quality in the WPZ. Conditions at the **70th and Pines BPS** include small pump leaks, deterioration of discharge piping, and inoperable security cameras.

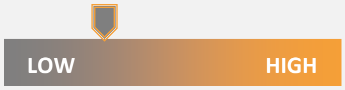
  c. **Southeast Pressure Zone** – The condition of assets in the SEPZ were in good condition. Analyses are underway to address increased water demand in the SEPZ.





*The data suggests there may be some statistical correlation between annual maintenance dollars spent vs the expected reduction in work orders performed. Additional analysis would be needed to confirm what maintenance strategies this correlation can be attributed to.

Data Reliability



Historical maintenance dollars spent were derived from actual operational budgets adjusted to remove non-maintenance and operations personnel, chemical and other expenses unrelated to maintenance of existing infrastructure. Other renewal investments were derived from year over year reconciliations of annual capital budgets and remaining balances on a per project basis.

The reliability of renewal investment data presented herein should be considered **LOW to MODERATE** due to inconsistencies between historical infrastructure reports and year over year project budgets vs. remaining balances presented in the and capital plans. The use of independently audited project expenditures and budget adjustments would greatly improve the reliability of the data used herein.

Maintenance and Capital Investments

In theory, annual maintenance and capital investments in the water system should align with the annual renewal rate of the assets comprising the system. **Annual Renewal Rate** is defined as the total replacement cost of the system divided by the expected life cycle of the assets (in years).

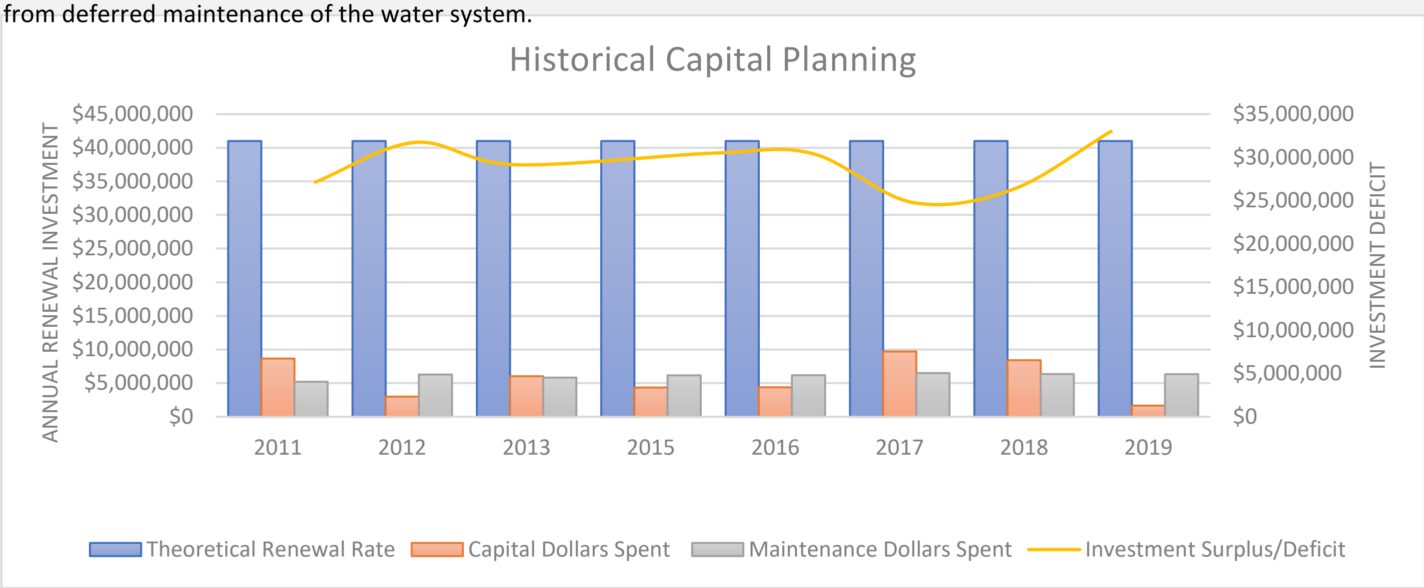
- **Expected Life Cycle** – It's common practice to assume the expected life cycle of water system assets in planning-level analyses. Typically, life cycle expectancies can range from 15-20 years for equipment and up to 80 years for water mains and appurtenances (previous Infrastructure Reports have used a 50-year renewal rate for water mains). Actual life cycles will vary depending on asset management and maintenance policies, level of service demands, materials, and other factors. **For this analysis, a blended life cycle expectancy of 50 years will be assumed.**
- **Historical Maintenance and Capital Investment** – Since 2011 (due to a gap in available capital budget 2014 capital data has been excluded), the City has invested an average of **$6.1M** in annual maintenance and **$6.3M** in annual capital investments in its water system.
- **Annual Renewal Rate** – Based on a life cycle expectancy of 50 years and a total replacement cost of $814M, **the theoretical annual renewal rate for the City's water system assets is $16.8M**.

According to the 2020 Operating Budget for the Department of Water and Sewerage, an annual renewal rate of $41M has been targeted. When compared to the average $12.4M invested annually in the renewal of the system, the targeted $41M renewal rate can be quantified as the premium resulting from deferred maintenance of the water system.

Capital Planning

In many systems annual capital plans are developed using information gleaned through ongoing monitoring of system conditions and performance, together with forecasts of system demand and projected level of service. Theoretically, there should be alignment between budgeted annual renewal investments and anticipated conditions of system components funded by those budgets. The following is a summary of the City's capital planning since 2011.

- **Raw Water Supply and Treatment** – **An average annual investment of $3.98M (63% of total capital investment in the system) has been made in the renewal of the City's water supply and treatment infrastructure since 2011.** It should be noted that the value of supply and treatment infrastructure is comprised primarily of mechanical and process treatment equipment, which typically has a shorter expected life cycle. It should also be noted that supply and treatment assets comprise 56% of the overall replacement value City's water system. A slightly higher actual rate of investment should be expected due to the compressed life cycle of specialty equipment, which is reflected in sustained levels of increased capital investments at the T.L. Amiss Water Treatment Plant dating back to 2000.
- **Finished Water Storage and Distribution** – **An average annual investment of $2.32M (37% of total investment in the system) has been made in the renewal of the City's water storage and distribution infrastructure since 2011.** With the pending improvements at the Amiss WTP, the disparity in targeted renewal investments should rebalance and align with the expecting funding distributions between supply, treatment and distribution system infrastructure.



WASTEWATER INFRASTRUCTURE

INVENTORY | REPLACEMENT COST | EXISITING CONDITIONS

Wastewater System Inventory

The City of Shreveport's Wastewater Collection and Treatment System (WCTS) is comprised of the following major components:

- **Wastewater Treatment** – Raw wastewater flows are collected and conveyed into one of two hydraulic basins, the North Regional Wastewater Treatment Plant (WWTP) and the Lucas WWTP. The North Regional WWTP is a 7MGD activated sludge plant with 12MGD of onsite storage and treatment components comprised of influent pumping, screening and grit removal, biological treatment, final clarification, UV disinfection and effluent pumping. The Lucas WWTP is a 30MGD activated sludge plant with 20MGD of onsite storage and similar treatment processes and components consistent with the North Regional WWTP.
- **Wastewater Collections –** The collections system is comprised of approximately 1,100 miles of gravity and force mains, 132 wastewater lift stations and 13,200 manholes. Existing sewer piping is fabricated from various materials including PVC, vitrified clay, concrete, and cast iron. Sizes range from 6" to 72" in diameter.

Replacement Costs

Replacement costs for major WCTS components were derived using industry standard and theoretical methods of construction costs estimating.

- **Wastewater Treatment** – **$185M**; based on an estimated capital investment of $5/gal-capacity/day for direct and indirect capital costs.
- **Wastewater Collections** - **$2.67B**; based on a weighted average installation cost of $435/LF collection system piping and a total of $130M in replacement cost for the City's 134 lift stations. The unit cost for piping was derived from a representative data set of 3500 segments of existing collection system infrastructure (approximately 1M linear feet) at actual sizes and depths ranging from 8"- 54" and 4' – 24', respectively. Unit cost was comprised of RS Means™ work items for pavement removal, excavation, bedding, pipe installation, backfill and pavement restoration.

Data Reliability

LOW HIGH

Inventory data for the WCTS is based on data collected as part of ongoing sanitary sewer assessments associated with the City's consent decree. In general, the reliability of this inventory data presented herein should be considered **MODERATE to HIGH**.

WCTS Conditions

Existing conditions of the WCTS are defined as follows:

- **Lucas and North Regional WWTPs** – The following remediation measures are summarized from the latest revision of the City's Sanitary Sewer Evaluation and Wastewater Master Plan. These measures are currently being reevaluated.
  a. New 100MGD headworks facility and 6th final clarifier at Lucas WWTP.
  b. Rehabilitate existing equalization basins at Lucas WWTP.
  c. Rehabilitate and expand the capacity of existing headworks facility and equalization basins at North Regional WWTP.
- **Wastewater Collections** – Assessment of the existing collections system assets was conducted as part of the City's ongoing consent decree. Sanitary sewer assessments (SSA) were broken into 5 phases, each including approximately 1M linear feet of collection system infrastructure. Defects were coded in accordance with National Association of Sewer Service Companies (NASSCO) guidelines. Results of the SSA effort is as follows:
  a. Phase 1 – 2,625 major defects in manholes; 22,230 major defects in gravity mains.
  b. Phase 2 – 6,218 major defects in manholes; 51,252 major defects in gravity mains.
  c. Phase 3 – 2,232 major defects in manholes; 31,059 major defects in gravity mains.
  d. Phases 4 and 5 – Aggregation of SSA data has not been completed.

WCTS Maintenance and Asset Management

According to the Department of Water and Sewer's 2020 Annual Operating Budget, there are several initiatives recently completed or underway that will improve how the City's WCTS assets are managed.

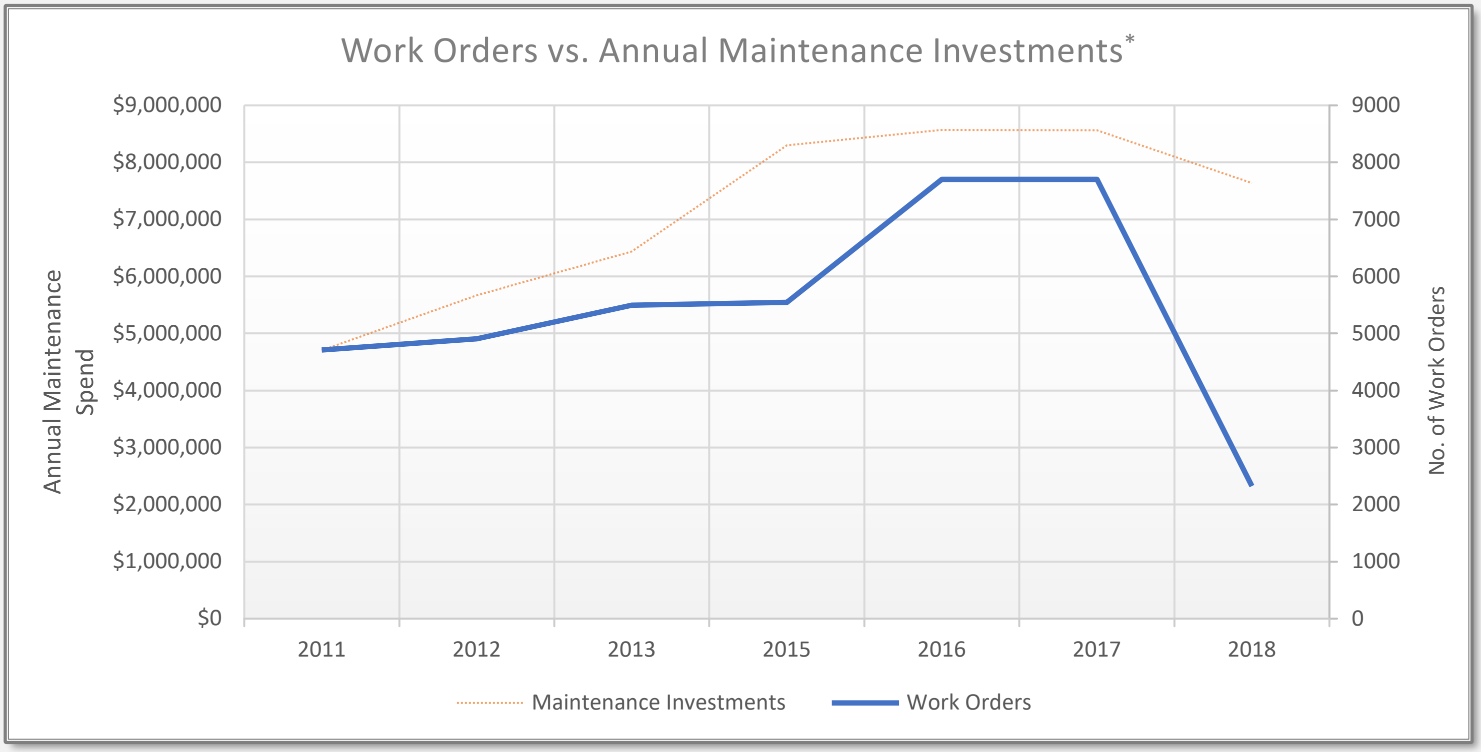
- New asset management system installed at Lucas and North Regional WWTP, sludge field, wastewater lift stations and pre-treatment facilities.
- Installed new bar screens at Lucas and North Regional WWTP.
- Install Supervisory Control and Data Acquisition (SCADA) at all 132 wastewater lift stations for active monitoring potential overflow conditions.

Data Reliability

LOW HIGH

Historical maintenance dollars spent were derived from actual operational budgets adjusted to remove personnel, chemical and other expenses unrelated to maintenance of existing infrastructure. Other renewal investments were derived from year over year reconciliations of annual capital budgets and remaining balances on a per project basis.

The reliability of renewal investment data presented herein should be considered **LOW to MODERATE** due to inconsistencies between historical infrastructure reports and year over year project budgets vs. remaining balances presented in the and capital plans. The use of independently audited project expenditures and budget adjustments would greatly improve the reliability of the data used herein.



*The data suggests a negative correlation between annual maintenance dollars spent vs the expected reduction in the number of work orders performed. This would indicate that the dollars being invested in the ongoing maintenance of the system are not yet translating into improved conditions. Instead, large capital investment in the system is needed to stabilize existing conditions.

Maintenance and Capital Investments

Similar to the water system, annual maintenance and capital investments in the WCTS should align with the annual renewal rate of the assets comprising the system. **Annual Renewal Rate** is defined as the total replacement cost of the system divided by the expected life cycle of the assets (in years).

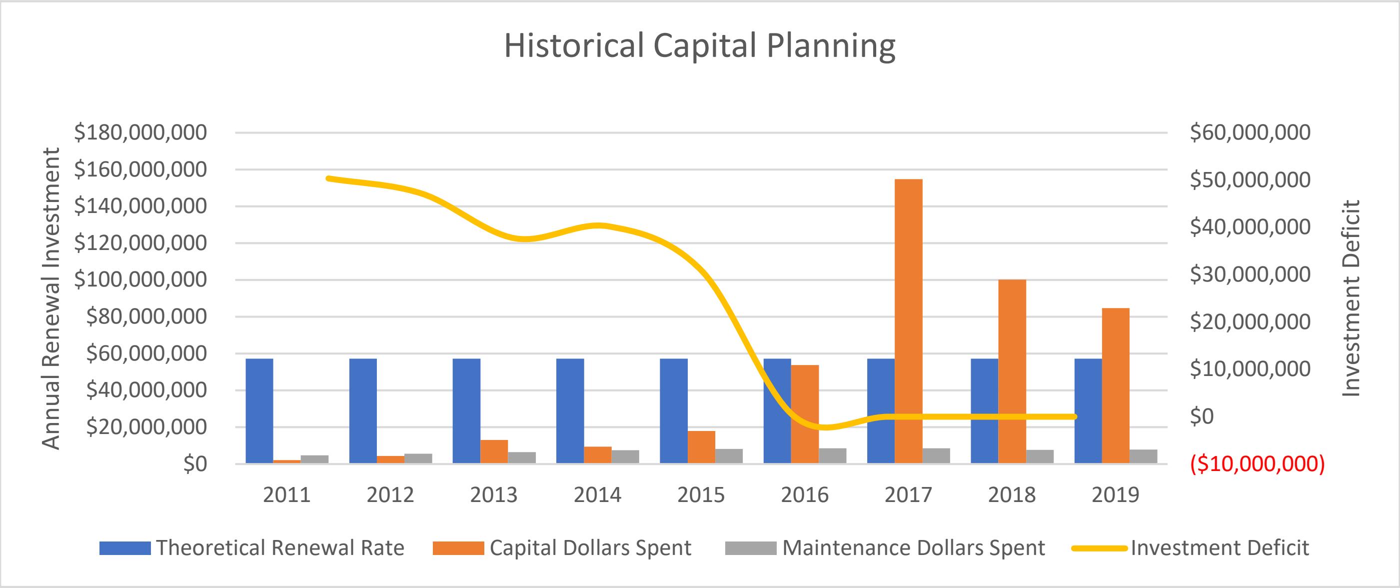
- **Expected Life Cycle** –Typically, life cycle expectancies can range from 15-20 years for equipment and up to 80 years for wastewater structures and pipelines. Actual life cycles will vary depending on asset management and maintenance policies, level of service demands, materials, and other factors. For this analysis, a blended life cycle expectancy of 50 years will be assumed.
- **Historical Maintenance and Capital Investment** – Since 2011 (due to a gap in available capital budget 2014 capital data has been excluded), the City has invested an average of **$8.1M** in annual maintenance and **$48.9** in annual capital investments.
- **Annual Renewal Rate** – Based on a life cycle expectancy of 50 years and a total replacement cost of $2.73B, the theoretical annual renewal rate for the City's WCTS assets is $57.2

  According to the 2020 Operating Budget for the Department of Water and Sewer, an annual renewal rate of $34.3M has been targeted. When compared to the average of $48.9M invested annually in the renewal of the system, the additional investment can be directly attributed to the City's efforts to address deficiencies in the collection system to comply with the consent decree and its accelerated timeframe for completion.

Capital Planning

Annual capital plans are typically developed using information gleaned through ongoing monitoring of system conditions and performance, together with forecasts of system demand and projected level of service. Theoretically, there should be alignment between budgeted annual renewal investments and anticipated conditions of system components funded by those budgets. The following is a summary of the City's capital planning strategy since 2011.

- **Lucas and North Regional WWTPs** – More than $70M in improvements were at the City's wastewater treatment plants between 2001 and 2008. **This in addition to an average annual investment of $5.5M (11.2% of total capital investment in the system) that has been made in the renewal of the City's wastewater treatment infrastructure since 2011.** It should be noted that wastewater treatment assets comprise 13% of the overall replacement value of the WCTS. A lower actual rate of investment should be expected due to this disparity.
- **Wastewater Collection System Infrastructure** – **An average annual investment of $43.4M (88.8% of total investment in the system) has been made in the renewal of the City's wastewater collections system infrastructure since 2011.** Pending improvements at the treatment plants, together with the sunsetting of collection system capital investments, distribution of funding between WCTS assets should realign with the expectations.



STORMWATER INFRASTRUCTURE

INVENTORY | REPLACEMENT COST | MAINTENANCE | CAPITAL PLANNING POLICIES

Stormwater System Inventory

The City of Shreveport's Drainage system is comprised of the following major components:

- **Roadside Ditches** – 930 miles
- **Storm Drain and Appurtenances** – 370 miles
- **Flood Lots** – 136 Total
- **Drainage Canals** – 409 miles

Replacement Costs

Replacement cost for storm drain sewers is **$153.6M**; based on a weighted average installation cost of $78/LF. This unit cost was derived from a representative data set of 8,500 linear feet of existing storm drains ranging from 15-inches to 36-inches in diameter. The dataset was obtained from the City's GIS Department and is representative of distributions of actual sizes and associated linear footages. A 5-foot installation depth was assumed for installation costs. Unit cost was comprised of RS Means™ work items for pavement removal, excavation, bedding, pipe installation, backfill and pavement restoration.

Stormwater System Maintenance

According to the Department of Public Works' 2020 Annual Operating Budget, there are no significant operational or maintenance initiatives planned at this time. There are several capital improvement projects listed below which are underway.

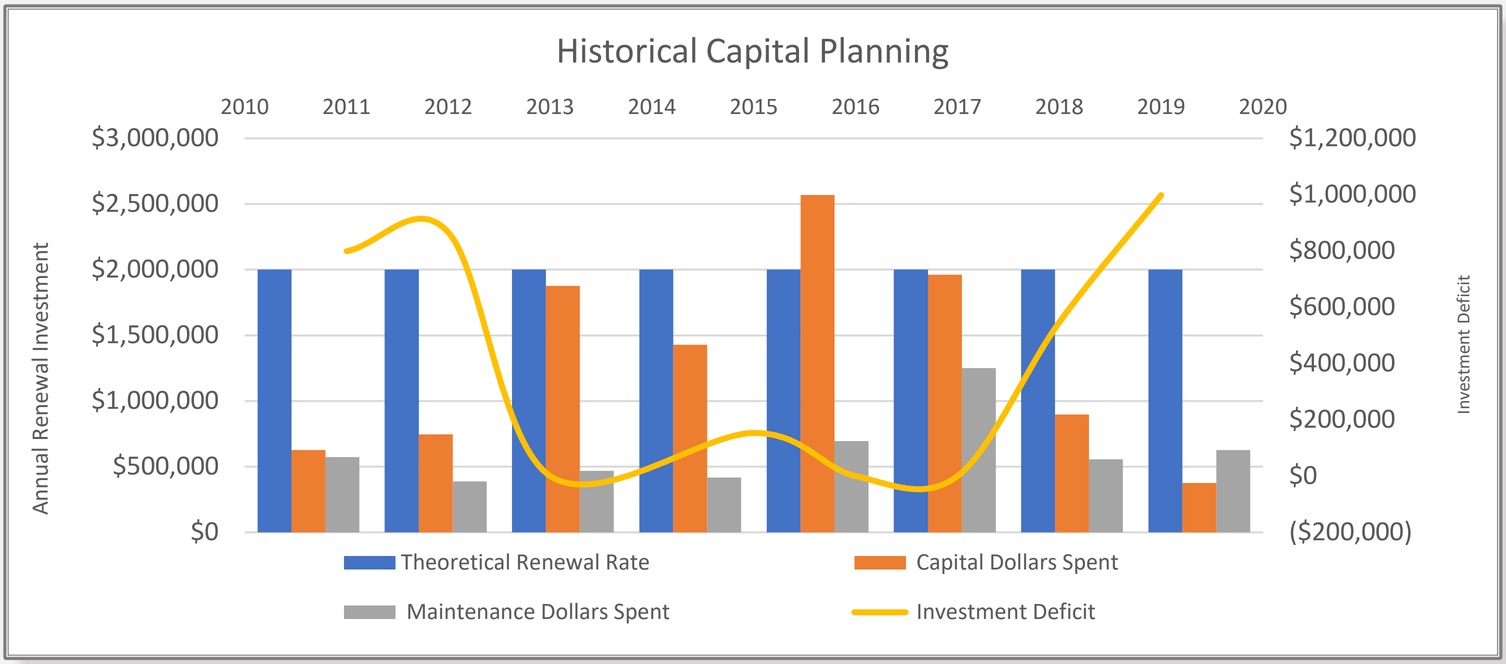
- City-Wide Drainage Improvements (2011 Bonds)
- Paved Ditch Repair (2011 Bonds)
- FEMA Hazard Mitigation Grant

Maintenance and Capital Investments

Annual maintenance and capital investments in the drainage system should align with the annual renewal rate of the assets comprising the system.

- **Expected Life Cycle** –Typically, an 80-year life cycle for storm drain sewer and appurtenances can be expected. Actual life cycles will vary depending on asset management and maintenance policies, level of service demands, materials, and other factors.
- **Historical Maintenance and Capital Investment** – Since 2011 (due to a gap in available capital budget 2014 capital data has been excluded), the City has invested an average of **$620K** in annual maintenance and **$1.4M** in annual capital investments towards its drainage system.
- **Annual Renewal Rate** – Based on a life cycle expectancy of 80 years and a total replacement cost of $153M, **the theoretical annual renewal rate for the City's drainage assets is $2M.**

While the Department of Public Works has not targeted an annual renewal rate like other departments, the $2.02M average maintenance and capital spend aligns with the theoretical annual renewal of $2M. As the drainage master plan is updated, drainage data can be digitized and incorporated into the City-Works CMMS system. This will allow for better decisions on how to leverage drainage dollars to improve flood resiliency and capture the maximum benefit.



ROADWAY INFRASTRUCTURE

INVENTORY | REPLACEMENT COST | MAINTENANCE | EXISTING CONDITION

Roadway Inventory

The Streets and Drainage Division maintains more than 1500 miles of concrete streets and 1200 lane-miles of asphalt streets, including 120 miles of state highways.

Replacement Costs

Replacement costs for different roadway types were derived using industry standard and theoretical methods of construction costs estimating.

- **Concrete Roadways** - $1.9B; based on a weighted estimated construction cost of $388/LF. An average roadway width of 33-feet was assumed. The typical section assumed an 8-inch pavement thickness with a 12 feet stone base and 2 feet subbase. The unit cost was comprised of RS Means™ work items for existing concrete removal, excavation, subbase scarification and compaction, geotextile fabric, stone base, and concrete pavement and reinforcement.
- **Asphalt Roadways** - $694M; based on a weighted estimated construction cost of $123/LF and an average lane width of 11 feet. The typical section assumed a 3-inch wearing course with a 12-inch stone base and 2-foot subbase. The unit cost was comprised of RS Means™ work items for existing asphalt removal, excavation, subbase scarification and compaction, geotextile fabric, stone base, and asphalt overlay.

Roadway Maintenance

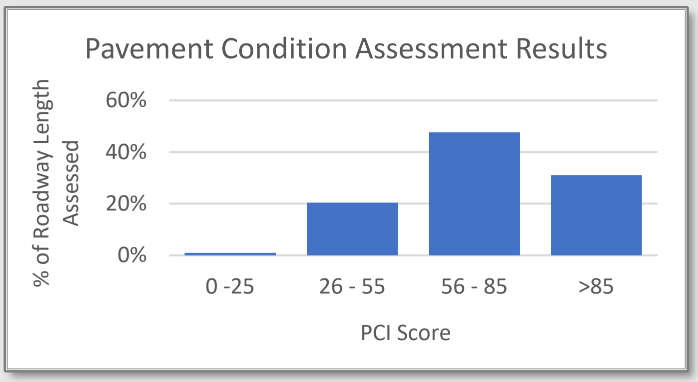
According to the Department of Public Works' 2020 Annual Operating Budget, there are no significant operational or maintenance initiatives planned at this time. The 202o Capital Budget indicates there are several capital improvement projects recently completed or underway that are intended to improve the condition of City's roadway assets.

- Concrete Street Improvements – A general project providing funds for the repair of concrete panels.
- Complete construction of repairs at Pierremont and Southern Avenue bridges.
- Sidewalk Program and Curb Cuts – A general project providing funds for the repair of various sidewalks throughout the city.
- Develop and Implement a GIS Mapping and Pavement Management System
- Neighborhood Street Improvements – A general project providing funds for various street, curb, drainage system and sidewalk improvements throughout the city.
- City Wide Street Improvement Program - A general project providing funds for various street, curb, drainage system and sidewalk improvements throughout the city.
- Ongoing pavement restoration and patching in coordination with other City departments.

Roadway and Transportation Network Conditions

For this evaluation, there were 2 primary sources of existing condition data cited. The first is the NLCOG 2040 Long Range Transportation Plan (Alliance Transportation Group, 2016). The second source came from a partial dataset of a pavement condition assessment performed by Transmap Corp.

- **2040 Long Range Transportation Plan** – The goal of the 2040 LRTP was to prioritize short/long term investments in the Shreveport-Bossier regional transportation system. This was done by assessing the physical and operational conditions of the system, together with community growth trends. The result of the analysis was a list of current stage (2016 – 2020), short-term stage (2021-2030, and long-term stage (2031-2040) priority projects that address capacity, condition and safety needs throughout the regional transportation system.
- **Pavement Condition Assessment** – In 2015, Transmap Corp. began performing pavement condition assessments of Shreveport's roadway network. The assessment generated a Pavement Condition Index (PCI) score for each segment of roadway analyzed. PCI scores range from 0 for failed pavements to 100 for pavements in perfect condition. A distribution of the PCI scores presented in the dataset provided are included herein.



Maintenance and Capital Investments

In theory, annual maintenance and capital investments in the roadway network should work to extend the expect life cycle and drive down the annual renewal rate of the assets comprising the network. Annual Renewal Rate is defined as the total replacement cost of the system divided by the expected life cycle of the assets (in years).

- **Expected Life Cycle** – Typically, life cycle expectancies for asphalt and concrete roadways are estimated at 15 and 30 years, respectively. Actual life cycles will vary depending on asset management and maintenance policies, level of service demands, materials, and other factors. For this analysis, a blended life cycle expectancy of 22 years will be assumed.
- **Historical Maintenance and Capital Investment** – Since 2011 (due to a gap in available capital budget 2014 capital data has been excluded), the City has invested an average of $2.4M in annual maintenance and $6.6M in annual capital investments.
- **Annual Renewal Rate** – Based on a life cycle expectancy of 22 years and a total replacement cost of $2.6B (according to Transmap analysis), the theoretical annual renewal rate for the City's roadway assets is $118M. ***It should be noted that this renewal rate does not account for the effectiveness of existing maintenance policies.***

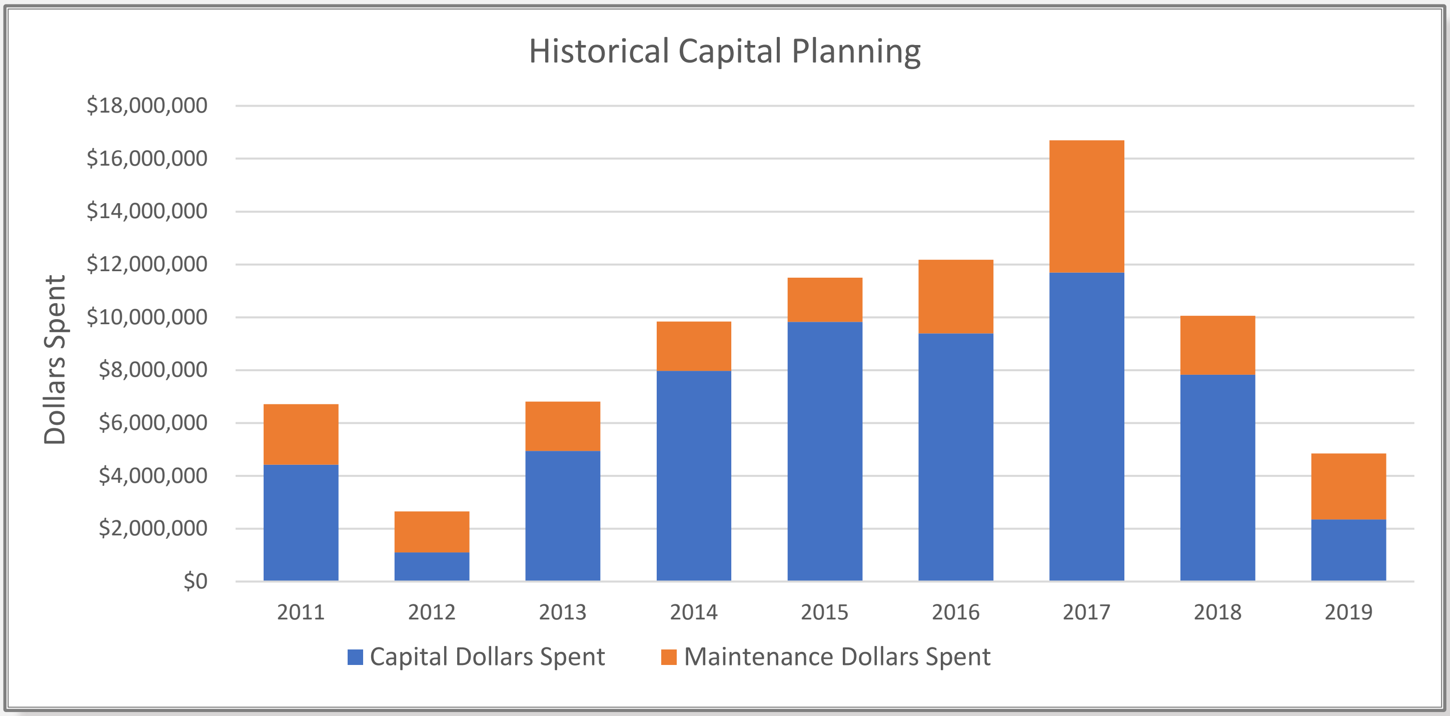
Roadway Network Management and Capital Planning

Annual capital plans for roadways are typically developed using information gleaned through ongoing monitoring of system conditions and performance, together with forecasts of system demand and projected level of service. This is especially important with roadways, due to the high cost and inconvenience of major rehabilitation or full replacement.

For pavements with PCI scores less than 30, implementing a network pavement management policy focused on localized stop-gap rehabilitation methods can keep pavements operational in a safe condition.

For those pavements with satisfactory PCI scores, implementing a pavement management policy focused on localized and globalized preventive rehabilitation methods, such as crack sealing, patching or overlays, can slow the rate of pavement deterioration.

Whether pavement management policies are focused on stop-gap or preventative rehabilitation strategies, it's critical that they are supported with a continuous pavement assessment protocol. This will expose the rate of pavement deterioration which will allow for smarter forecasting of pavement conditions and capital planning to address those conditions.



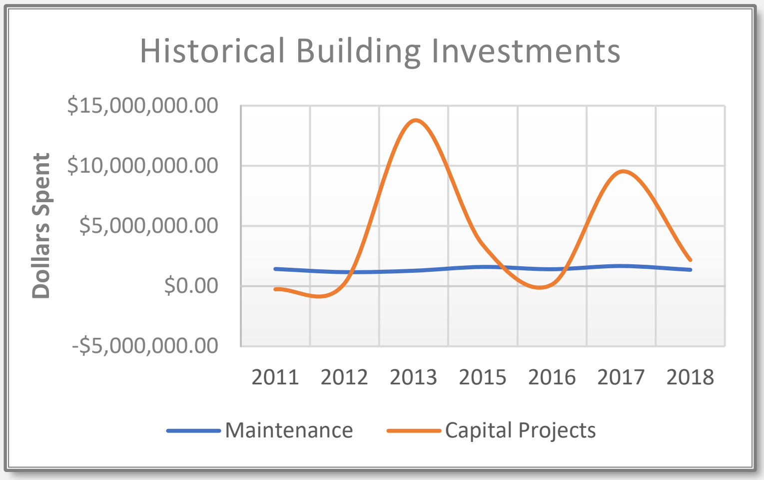
Building Inventory

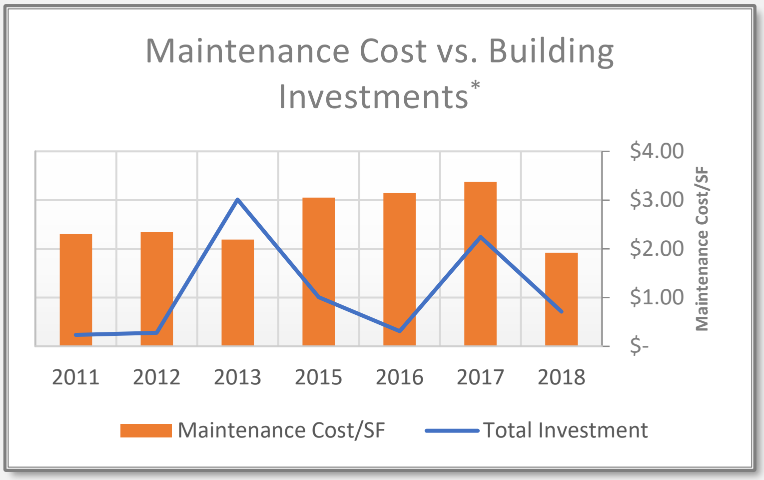
The Shreveport Public Assembly and Recreation Department (SPAR) manages and maintains more than 2,000,000 square-feet of building space, including community centers (16) and other City-owned buildings (52).

Building Maintenance

The Building Maintenance Division oversees the maintenance, repair and renovation of mechanical systems, plumbing and electrical systems, roof repairs and replacements, painting and various other maintenance requirements for City-owned buildings. In addition to routine management and maintenance, SPAR has initiated and/or completed the following projects to extend the life cycle of building components:

- Plans to implement a technology-based work order system.
- Completed renovations and upgrades at the Randle T. Moore, Sunset Acres, Lakeside and Bilberry Community Centers.
- Completed upgrades at the Riverview Hall and Theatre.
- Completed elevator and lighting upgrades at Independence Stadium. Continue plans for new upgrades of concession and restroom areas.
- Installed new HVAC at A.B. Palmer Gym.
- Updated 85% of the City-owned swimming pools
- Continue plans to replace Fire Station #8
- LED lighting conversion throughout the city.
- Continue preventative maintenance program for HVAC systems.
- Develop and implement processes for systematic equipment replacement.





*The data suggests there may be some statistical correlation between annual building investment dollars spent vs the expected reduction in maintenance cost per square-foot. Additional analysis would be needed to confirm what maintenance strategies this correlation can be attributed to.

Maintenance and Capital Investment Strategy

Buildings require periodic infusions of capital throughout their life cycle to restore and modernize them, otherwise they become obsolete and incapable of fulfilling their intended purpose. In addition to periodic infusions of capital, building components also require continuous funding for maintenance and operating expenses.

In order to optimize a strategy for capital and maintenance investments and maximize building performance, it's important to consider the type and intended purpose of the facility, the size of the facility, operational tempo (daily, seasonal, as-needed, 24-hrs, etc), and the prevailing rates for energy, water, labor, materials and equipment. Data collection and performance analysis of building components will provide a consistent and objective basis upon which to develop a building maintenance and capital investment strategy. SPAR's commitment to implement a technology-based work order system is a first step in the right direction.

Photo courtesy of http://pat-aviewfromtheedge.blogspot.com/2013/04/s-is-for-shreveport.html

3. A Business Case for Infrastructure Investment

The general premise of a business case is the idea that the consumption of resources should contribute to a return commensurate to the cost of those resources. In the case of infrastructure, this return is captured intrinsically through the acceptable level of service provided by a utility, or the access to economic opportunity provided by robust transportation networks, or the quality of life provided by amenities such as parks, community centers and theatres. The costs, or resources, associated with the construction, operation and maintenance of these vital assets and services are borne by the citizens of a community through property taxes, sales taxes and user fees (etc.). After these resources are collected by the government (i.e. consumption of resources) and compiled as tax and enterprise revenues, they are allocated towards operating and capital budgets for the provision of essential services through which they generate the intended return to the citizens of the community.

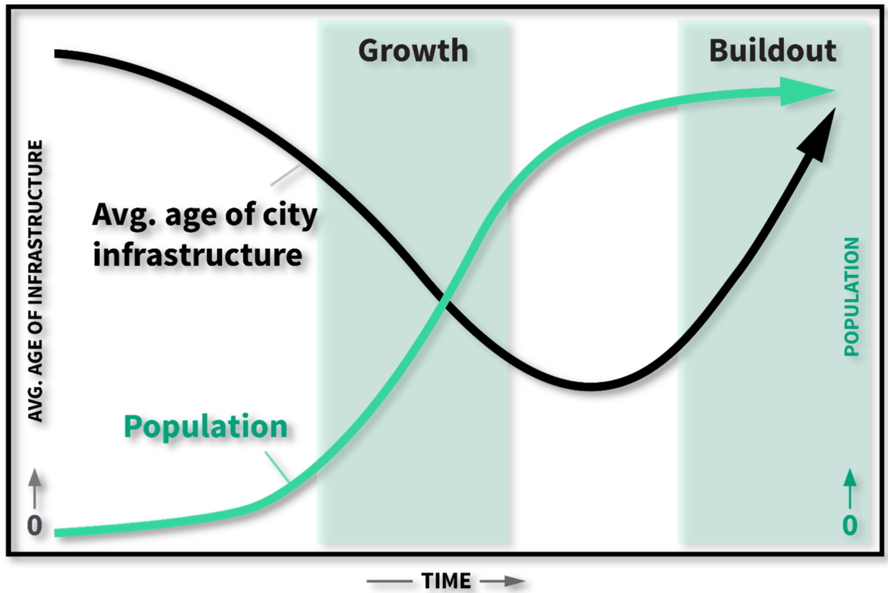
Economic prosperity is achieved when revenue drivers and cost drivers are optimized for sustainability. To begin, it is important to note the inherent connection between the resources available to fund essential services and the costs to provide these essential services. The integration of land use planning and capital planning, when implemented through policy, offers a pathway to economic prosperity by way of sustainable public services.

3.1. INTEGRATING LANDUSE PLANNING WITH CAPITAL PLANNING[6]

Most cities say they want to be fiscally responsible, environmentally resilient, and socially inclusive. The reality however is the daily decisions and investments we make do not always align with these desires. Since the 1950's many communities have prioritized auto-centric development patterns and short-term financial gains without fully considering the long-term impacts. This approach creates liabilities that may not emerge for many years after the development occurs. While new development will increase tax revenues in the near-term, it also increases a city's liabilities for services and infrastructure maintenance. While many of these costs do get accounted for in city budgets, infrastructure maintenance (and especially street maintenance) are rarely fully accounted for. And, even when cities have quantified the maintenance needs and when they're due, the amount of funding allocated for these needs is only a fraction of what is needed. The result is maintenance being deferred year after year, and eventual decline of older neighborhoods that aren't maintained.

The chart below illustrates the relationship between a city's growth and the age of its infrastructure. Every city starts with a small population and a small area where people live and work. Prior to World War 2, cities grew incrementally out, up and more intense as population growth dictated and resources allowed. After World War 2, many cities across the country, including Shreveport, experienced a growth boom where acres of new residential development were built in a short amount of time. As the new development comes in, the average age of the city's infrastructure decreases because the amount of new infrastructure is far greater than the amount in the older, original part of the city. This growth phase produces a large amount of new revenue through new tax base and development fees, which cities often use to invest in things like new parks, rec centers and other amenities. Many times, elected officials will use the surplus

[6] This section of the report was researched and prepared by Verdunity Inc.



situation to lower tax rates and reduce the burden on citizens. The combination of this revenue bump and the new neighborhoods, schools, businesses and parks creates an illusion of wealth and fiscal health. Many of the high growth suburbs and "best places to live/work/play" are in this phase. However, as cities mature and move further to the right on the chart, population growth slows down and revenues from new development slow down with it. At the same time, much of the infrastructure built by developers in previous decades reaches the end of its life cycle and maintenance needs increase rapidly. The costs quickly begin to outpace the revenue available to cover them, and as a result, maintenance gets deferred, streets and parks begin to deteriorate, and eventually the people and businesses in these neighborhoods leave. Sometimes the people and businesses move to a new development on the edge of the city, or sometimes they choose to leave and move to a new city.

3.1.1. USING FISCAL ANALYSIS TO INFORM DECISIONS ON GROWTH, DEVELOPMENT AND INFRASTRUCTURE INVESTMENTS

Shreveport, like almost every city in the U.S., has a significant funding gap to maintain its infrastructure. Maintenance and service costs needs for existing neighborhoods are increasing; meanwhile the city is still expanding its development footprint outward, which adds additional service liabilities and infrastructure to maintain over time.[7]

[7] An example of this phenomena is the expansion of development in the southeast portion of the city. As a result, the provision of adequate water pressure has been a challenge during summer months.

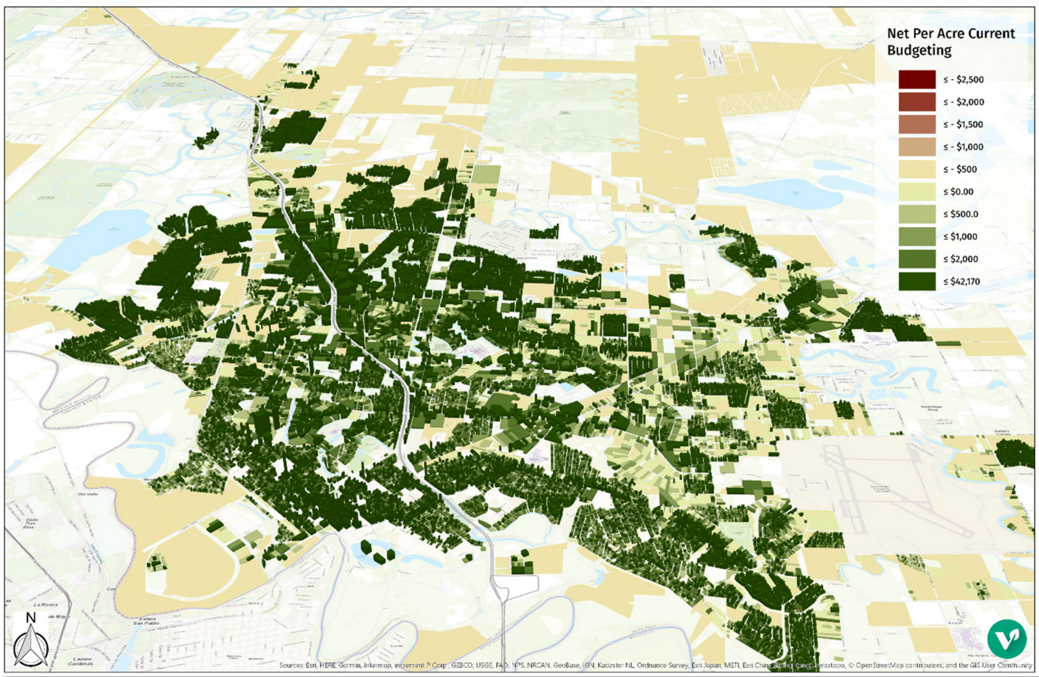
Continuing business as usual is only going to make the problem bigger. In order to bridge the gap between available revenues and service costs, cities must align their development pattern and service cost model with what residents and businesses are willing and able to pay for. Some of the strategies involve looking at tax rates, utility rates, fees, and other funding sources (federal and state funds, grants, etc.). These are best suited for water, wastewater and stormwater. Another strategy that has been overlooked until recently is to evaluate the revenue generation potential and service costs of specific development patterns and create a strategy that encourages more of the patterns that have a higher net return. Additionally, any new development that requires extension of infrastructure or current services (police, fire, sanitation, etc.) should be heavily scrutinized through a fiscal lens to evaluate if the additional development generates enough to cover the long-term costs. Ideally, new development would not just break even, but generate additional positive revenue that can be focused into maintaining other parts of the city. Some cities that are in similar situations have even gone so far as to de-annex land to better align their service area with the revenues available. Memphis, TN is an example where this is being done intentionally and they are experiencing a revitalization of their downtown and core neighborhoods as a result.

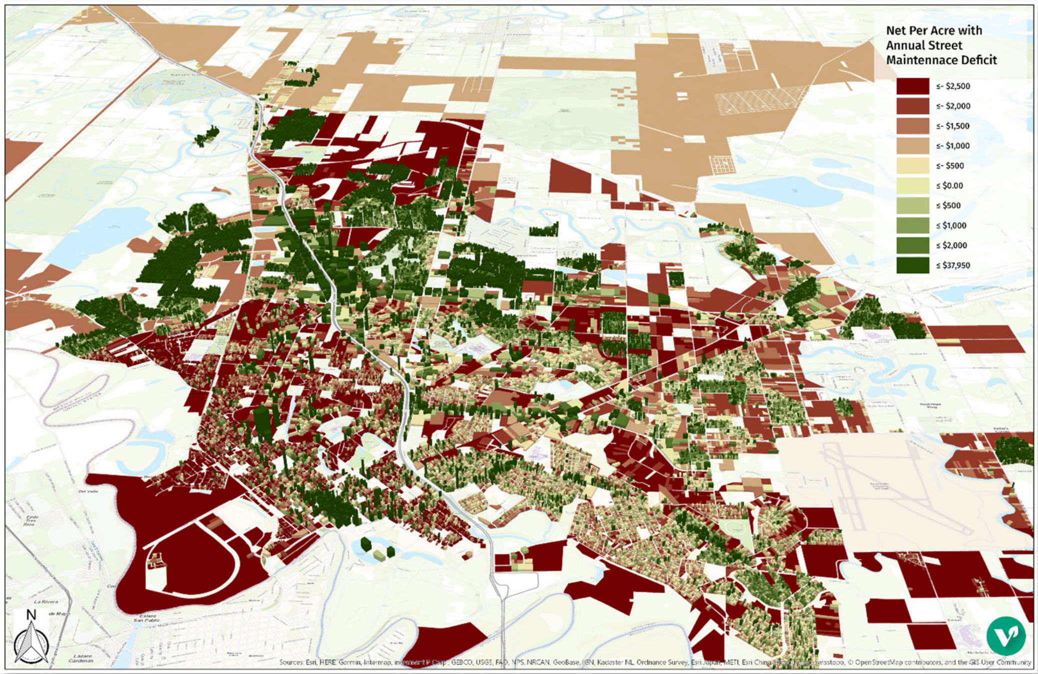
Accomplishing this in today's environment requires transparency and data-backed decisions that can be communicated to a broad group of stakeholders, from citizens to business owners to developers. To do this, we encourage cities to complete a land use fiscal analysis that helps to quantify and map how individual parcels and development patterns are performing fiscally in terms of revenue they generate vs the costs to serve them. This type of information can help city leaders identify many helpful data points, including:

- how different parcels and development patterns (land use, zoning, density, etc.) perform fiscally
- how population and economic activity is shifting around the city

- where there are opportunities to generate a quick revenue bump just by filling in vacant lots or adding density (people and businesses) in areas with existing services
- where strategic infrastructure investment could help preserve or increase quality of life, thereby retaining and attracting residents and businesses in the area.

The maps below illustrate what this looks like for Brownsville, TX. The first map shows the net revenue/acre for the current budget. The second map shows the net revenue/acre when unfunded street costs are added in. In Brownsville, their street funding deficit was $1.3B.





In addition to just illustrating how net revenue changes when unfunded street liabilities are accounted for, the Brownsville maps also reflect a similar trend to what is happening in Shreveport in terms of an expanding geographic footprint, and the population and economic shift happening within the city. In Brownsville's case, the area to the north along the highway with the green is an area with lots of new housing and commercial development. The city's older core neighborhoods and downtown are the bottom left part of the map (downtown is reflected by the small block of dark green at the bottom). The city's overall population has been relatively flat, so by incentivizing new development on the edge of the city, it has expedited a process where current residents are moving from the older neighborhoods in the core to the new ones, and the businesses are following the people. This has led to a population (and revenue) decline in the core, but the city is still on the hook to provide services to these older areas. This same thing is happening in Shreveport.

The silver lining in this situation is that there are an increasing number of people of various ages and demographics who are looking for the walkable, mixed-use lifestyle that older neighborhoods and downtown environments offer. These areas are also the ones with the oldest infrastructure that needs to be replaced. Strategic infrastructure improvements and other policy and funding mechanisms can be used to incentivize infill and redevelopment in these older neighborhoods. With this approach, cities like Shreveport and Brownsville have an opportunity to add population and businesses in these older areas, thereby increasing the revenue generating potential without adding much in terms of additional service costs.

4. Additional Strategies for Consideration

In addition to the integrated land use and capital planning policies highlighted in Section 3, there are other strategies that help secure a return on the resources invested in municipal infrastructure and the essential services provided by these critical assets. The strategies highlighted herein focus on opportunities to evaluate and realign organizational and operational frameworks to deliver sustainable levels of service.

4.1. WHAT DOES SUCCESS LOOK LIKE?

To fulfill their mission, organizations must be willing to assess themselves objectively and continuously against the very definition of that mission. But before an assessment can be of any use to an organization, it is important to first identify the attributes that define success for that organization. For public works agencies charged with building, operating, and maintaining municipal infrastructure, it is important that the interests of all stakeholders[8] are represented as part of this effort. Some examples of attributes that define success for water and wastewater utilities are presented in the lists that follow[9]. It is also worth noting that while the attributes

---

[8] See Section 1.3 of this report

[9] EUM Utility Leadership Group; Effective Utility Management – A Primer for Water and Wastewater Utilities; January 2017

defined below are focused on water and wastewater utilities, they can be adapted and applied to other public works utilities and organizations.

- **Water Quality**
  - The system needs to produce "fit for purpose" water and other recovered resources (e.g., energy, nutrients, biosolids) that meet or exceed full compliance with regulatory requirements and are consistent with customer, public health, ecological, and economic needs. These products include treated drinking water, treated wastewater effluent, recycled water, stormwater discharge, and recovered resources.

- **Customer Satisfaction**
  - Reliable, responsive, and affordable services delivered in alignment with customer service expectations is what makes successful water and wastewater systems.
  - The system needs to utilize a mix of evolving communication technologies to understand and respond to customer needs and expectations, including receiving timely customer feedback and communication during emergencies.
  - With tailored customer service and outreach to traditional residential, commercial, and industrial customers, utilities can better provide these services to their end users.

- **Stakeholder Understanding and Support**
  - With understanding and support from all stakeholders (including customers, oversight bodies, community and watershed interests, and regulatory bodies) the system can function in harmony with the community. Engaged stakeholders actively promote an appreciation of the true value of water and water services, and water's role in the social, economic, public and environmental health of the community. An effective partnership ensures the involvement of all

stakeholders in the decisions that will affect them and positions the utility as a critical asset to the community.

- **Financial Viability**
    - Understanding and plans for the full life-cycle cost of utility operations and value of water resources.
    - Establishes and maintains an effective balance between long-term debt, asset values, operations, maintenance expenditures, and operating revenues.
    - Establishes predictable rates—consistent with community expectations and acceptability—adequate to recover costs, provide for reserves, maintain support from bond rating agencies, plan and invest for future needs, while considering affordability and the needs of disadvantaged households.
    - Implements sound strategies for collecting customer payments.
    - Understands the opportunities available to diversify revenues and raise capital through adoption of new business models, including revenues from resource recovery.

- **Operational Optimization**
    - Ensures ongoing, timely, cost-effective, reliable, and sustainable performance improvements in all facets of its operations.
    - Makes effective use of data from automated and smart systems while learning from performance monitoring. This helps minimize resource use, loss, and impacts from day-to-day operations.
    - Maintains awareness of information and operational technology developments to anticipate and support timely adoption of improvements.

- **Employee and Leadership Development**
    - Recruits, develops, and retains a workforce that is competent, motivated, adaptive, and safety focused.

  - Establishes a collaborative organization dedicated to continuous learning, improvement, and innovation.
  - Ensures employee institutional knowledge is retained, transferred, and improved upon over time.
  - Emphasizes and invests in opportunities for professional and leadership development, considering the differing needs and expectations of a multi-generational workforce.

- **Enterprise Resiliency**
  - Ensures utility leadership and staff work together internally, and coordinate with external partners, to anticipate and manage system challenges.
  - Proactively identifies, assesses, and effectively manages a full range of business risks consistent with industry trends and system reliability goals.

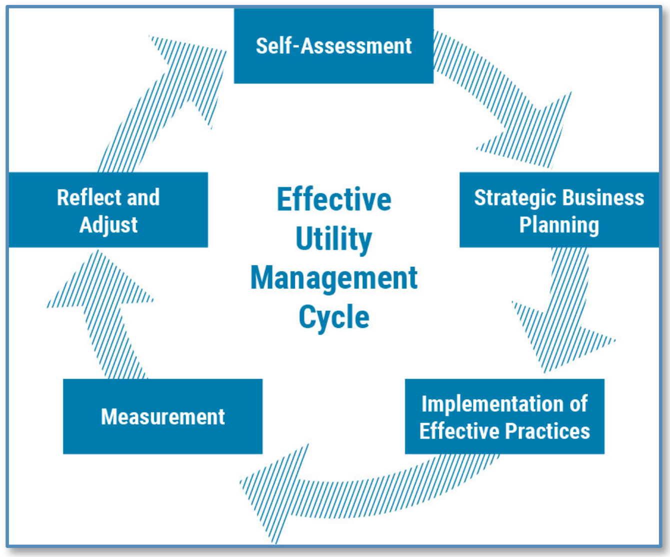
- **Infrastructure Strategy and Performance**
  - Understands the condition of, and costs associated with, critical infrastructure assets.
  - Plans infrastructure investments consistent with community needs, anticipated growth, system reliability goals, and relevant community priorities and adaptation strategies (e.g., for changing weather patterns and customer base).
  - Maintains and enhances the condition of all assets over the long-term at the lowest possible life-cycle cost and acceptable risk consistent with customer, community, and regulator-supported service levels.
  - Assures asset repair, rehabilitation, and replacement efforts are coordinated within the community to minimize disruptions and other unintended consequences.

- **Community Sustainability**
  - Takes an active leadership role in promoting and organizing community sustainability improvements through collaboration with local partners (e.g.,

transportation departments, electrical utilities, planning departments, economic development organizations, watershed and source water protection groups).

- Manages operations, infrastructure, and investments to support the economic, environmental, and social health of its community.

Once the barometer has been set for what defines success, the next step is to assess and measure the organization's current level of achievement against those attributes. This can be performed as a self-assessment or an independent assessment, such as a third party-performed organizational or operational audit. From there, findings are adopted, priorities are established, plans are chartered, resources are allocated, plans are implemented, and performance is measured. Organizations hold themselves accountable by executing this loop[10] in perpetuity - continuously improving and adjusting to shifts in regulatory, fiscal and technological conditions.



4.2. USEFUL RESOURCES

In conjunction with industry experience and general exposure to industry best practices, there was a host of useful guidance and resources that were cited and researched in association with this report. These have been itemized for the reader's use herein.

[10] Image source: EUM Utility Leadership Group; Effective Utility Management – A Primer for Water and Wastewater Utilities (Section V – Getting to Work – Implementation of Effective Utility Management); January 2017

4.2.1. WATER & WASTEWATER SYSTEMS

- Design of Municipal Wastewater Treatment Plants (5th Edition); Water Environment Federation, American Society of Civil Engineers, Environmental & Water Resources Institute, 2010
- Effective Utility Management – A Primer for Water and Wastewater Utilities; January 2017
- Prioritizing Wastewater and Stormwater Projects Using Stakeholder Input, U.S. EPA – Office of Wastewater Management
- Integrated Decision Support System for Optimal Renewal Planning of Sewer Networks; Mahmoud R. Halfawy; Leila Dridi; and Samar Baker

4.2.2. ROADWAYS

- Report to the City Council by the City Internal Auditor; Internal Audit Office, Shreveport, LA, April 2019
- Northwest Louisiana Mobility 2040|Long Range Transportation Plan; Alliance Transportation Group in Association with C.H. Fenstemaker & Associates

4.2.3. BUILDINGS

- Knowledge-Based Optimization of Building Maintenance, Repair, and Renovation Activities to Improve Facility Life Cycle Investments; Michael N. Grussing, P.E., M.ASCE, and Liang Y. Liu, Ph.D., M.ASCE

4.2.4. GENERAL – ASSET MANAGEMENT

- Public Infrastructure and Asset Management; Waheed Uddin, W. Ronald Hudson, Ralph Haas, 2013
- Decision Support Model for Integrated Risk Assessment and Prioritization of Intervention Plans of Municipal Infrastructure; Hany Elsawah, Ibrahim Bakry, and Osama Moselhi, F.ASCE
- Method for Generating Multiple MRR Solutions for Application in Cost-Leveling Models; Yoojung Yoon, A.M.ASCE, Makarand Hastak, M.ASCE, and Kyuman Cho
- Integration of Municipal Infrastructure Asset Management Processes: Challenges and Solutions; Mahmoud R. Halfawy, Ph.D., P.Eng.
- Large-Scale Asset Renewal Optimization Using Genetic Algorithms plus Segmentation; Tarek Hegazy, M.ASCE, and Roozbeh Rashedi, S.M.ASCE
- Identifying Rehabilitation Options for Optimum Improvement in Municipal Asset Condition; Zafar Khan, Osama Moselhi, F.ASCE, and Tarek Zayed, M.ASCE
- Report Card for Louisiana Infrastructure 2017; Louisiana Section – American Society of Civil Engineers