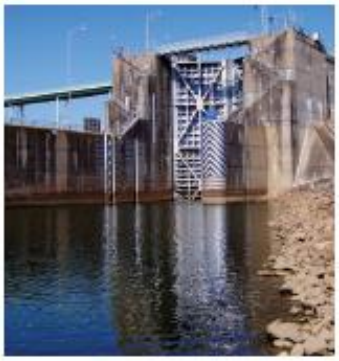
REPORT CARD FOR TENNESSEE'S INFRASTRUCTURE

2016



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EXECUTIVE SUMMARY

Tennessee, the "Volunteer State," the "Country Music Capital of the World," boasts the official slogan, "Tennessee – America at Its Best." Already, Tennessee has been named "Best place to move to." What would it take for Tennessee to be known as the "Home of America's Best Infrastructure"?

The American Society of Civil Engineers' (ASCE) 2016 *Report Card for Tennessee's Infrastructure* grades Tennessee's infrastructure a "C" – the same grade the state received in 2009. Considerable investments have been made across the state to improve our infrastructure. Funds from the 2009 American Recovery and Reinvestment Act initiated numerous projects. The Tennessee Department of Transportation's (TDOT) Better Bridges Program replaced, repaired, or rehabilitated 193 state-owned structurally deficient bridges. The Tennessee Department of Environment and Conservation (TDEC) received funding to upgrade facilities at two of the state's premier parks. However, these investments won't stop our existing infrastructure from aging, nor stop the need for infrastructure to keep up with dramatic population growth.

We rarely consider the impact infrastructure has on our daily lives, from the water we drink and the roads we drive on, to the power we use to light our homes and the food we put on our tables. Volunteers from the Tennessee Section of ASCE developed this *Report Card for Tennessee's Infrastructure* to help all Tennesseans understand the state of our infrastructure so we can work together to earn our next "Best of…" award: Tennessee – Home of America's Best Infrastructure.

HOW YOU CAN GET INVOLVED

- Share this Report Card with your elected leaders, civic clubs, neighbors, and youth groups at www.infrastructurereportcard.org/tennessee
- Find out the condition of the infrastructure near you on the Save America's Infrastructure app.
- Ask your elected leaders what they're doing to make sure your infrastructure is reliable for the future.

5 STEPS WE CAN TAKE NOW

The Report Card provides five recommendations to raise our grades:

- **Find sustainable solutions that will help us build a transportation network for the future.** Tennessee is at a crossroads of exploding population growth and a transportation system that lacks adequate funding. Our transportation system cannot support the expected growth projected for our state without an adequate funding source and innovative solutions, including mass transit, to effectively move people and relieve traffic congestion.

- **Leverage infrastructure investments to help manage impact of expected population growth.** Our infrastructure investments must be considered as a holistic system to keep up with demand from population growth. If we want to continue to lead the country we need to begin leading in these areas of infrastructure as well.

- **Leverage our state's central location as a transportation hub.** Our central location in the country coupled with the intersection of multiple interstates across the state and inland waterways make Tennessee a natural hub for movement of commerce. FedEx has already embraced our location as a natural location for its main headquarters. We have the opportunity to lead the nation in comprehensive freight management options.

- **Raise awareness for the true cost of water.** Current water rates do not reflect the true cost of supplying clean, reliable drinking water. Replacing the nation's antiquated pipes will require significant local investment, including higher water rates.

- **Lessen the uknowns about farm pond dams.** How do you manage a threat you can't even quantify? Tennessee needs more data on farm pond dams across the state. We know there are farm pond dams that protect the health and welfare of people downstream, but where are they? How often are the inspected? What maintenance schedule Is being used? Is anyone even doing any maintenance? Without adequate information we can't fully define the risk to the people of Tennessee.

ABOUT ASCE

Founded in 1988, the Tennessee Section of the American Society of Civil Engineers (ASCE) represents 1,600 civil engineers in Tennessee. As civil engineers dedicated to protecting public health and safety, it's our job to build and maintain infrastructure. We understand infrastructure's vital role in our economy, health, and natural environment. With this in mind, ASCE members throughout the state graded each infrastructure category according to 8 key criteria: capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation.

GRADES SUMMARY

1. AVIATION: B-
2. BRIDGES: B
3. DAMS: D
4. DRINKING WATER: C
5. INLAND WATERWAYS: C-
6. PARKS: C
7. ROADS: C+
8. SCHOOL: C-
9. TRANSIT: D+
10. WASTEWATER: D+

OVERALL G.P.A.: C

METHODOLOGY FOR DEVELOPMENT OF THE 2016 INFRASTRUCTURE REPORT CARD FOR TENNESSEE

A quantitative and qualitative approach to each of the eight fundamental criteria was used to develop the Report Card grades. The criteria are explained in Table 1.

Table 1. Eight Infrastructure Grading Criteria

Capacity	Evaluate the infrastructure's capacity to meet current and future demands.
Condition	Evaluate the infrastructure's existing or near future physical condition.
Funding	Evaluate the current level of funding (from all levels of government and the private sector) for the infrastructure category and compare it to the estimated funding need.
Future Need	Evaluate the cost to improve the infrastructure and determine if future funding prospects will be able to meet the need.
Operation and Maintenance	Evaluate the owners' ability to operate and maintain the infrastructure properly and determine that the infrastructure is in compliance with government regulations.
Public Safety	Evaluate to what extent the public's safety is jeopardized by the condition of the infrastructure and what the consequences of failure may be.
Resilience	Evaluate the infrastructure system's capability to prevent or protect against significant multihazard events and the ability to expeditiously recover and resume critical services with minimum disruption to public safety and health, the economy, and national security.
Innovation	Evaluate the implementation and strategic use of innovative techniques and delivery methods.

Tennessee's 2016 Infrastructure Report Card Committee comprised experienced professional engineers in the fields of facilities, water, wastewater, waterways, transportation, aviation, and dams. Committee members evaluated the infrastructure in each subject area according to the eight criteria and assigned a grade. Grades were assigned based on a traditional letter grade scale.

A = 90-100%
B = 80-89%
C = 70-79%
D = 51-69%
F = 50% or lower

In general, each subject area was evaluated using the following steps:

- Readily available, existing data sources were reviewed
- Data were compiled and analyzed, resulting in the development of a summary report
- A preliminary grade was assigned
- The summary report and grade were peer-reviewed and the final grade and assessment were determined

Grading Descriptions

The following grade descriptions have been defined as part of ASCE's Report Card methodology.

A EXCEPTIONAL: FIT FOR THE FUTURE The infrastructure in the system or network is generally in excellent condition, typically new or recently rehabilitated, and meets capacity needs for the future. A few elements show signs of general deterioration that require attention. Facilities meet modern standards for functionality and resilient to withstand most disasters and severe weather events.

B GOOD: ADEQUATE FOR NOW The infrastructure in the system or network is in good to excellent condition; some elements show signs of general deterioration that require attention. A few elements exhibit significant deficiencies. Safe and reliable with minimal capacity issues and minimal risk.

C MEDIOCRE: REQUIRES ATTENTION The infrastructure in the system or network is in fair to good condition; it shows general signs of deterioration and requires attention. Some elements exhibit significant deficiencies in conditions and functionality, with increasing vulnerability to risk.

D POOR: AT RISK The infrastructure is in poor to fair condition and mostly below standard, with many elements approaching the end of their service life. A large portion of the system exhibits significant deterioration. Condition and capacity are of significant concern with strong risk of failure.

F FAILING/CRITICAL: UNFIT FOR PURPOSE The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

Tennessee Infrastructure 2016 Report Card			
Infrastructure	**TN**		**USA**
AVIATION	B		D
BRIDGES	B		C+
DAMS	D		D
DRINKING WATER	C		D
INLAND WATERWAYS	C-		D-
PARKS	C		C-
ROADS	C+		D
SCHOOLS	C-		D
TRANSIT	D+		D
WASTEWATER	D+		D

AVIATION: B -

Introduction

Aviation infrastructure includes an interconnected network of airports within FAA-controlled airspace, operated by FAA navigational and communications systems. Capacity of an aviation infrastructure is defined by its capability to support safe and efficient operation of aircraft between departure and destination points and on airport facilities.

Tennessee's aviation infrastructure is comprised of 69 public use airports serving both commercial and general aviation needs. The network consists of:

- 2 medium commercial hub airports (Memphis & Nashville),
- 3 primary commercial-non hub facilities (Knoxville, Chattanooga, & Tri-Cities),
- 1 non-primary commercial facility (McKellar-Skipes Regional-Jackson)
- 64 general aviation facilities (McMinn County, Sumner County Regional)

Of the 64 General Aviation Airports, five are considered reliever airports to the commercial facilities and are designed to ease air traffic congestion and provide general aviation with improved access to the local area. Additionally, Memphis International Airport serves as a super-hub for the world's largest freight carrier, Federal Express. Consequently, FedEx is Memphis' largest employer.

Capacity

According to the most recent data available from the FAA, Tennessee was responsible for over 8.6 million enplanements (every time an airplane takes off) in 2014. This was an overall increase of 6% from 2013, despite a 21% reduction at the Memphis facility due to Delta Airlines' decision to relocate their Hub operations elsewhere. Specifically, Commercial Enplanements increased 6.8%, 1.6%, and 13.8% for Nashville, Knoxville, and Chattanooga Facilities, respectively. Among these, Nashville ranked 3rd nationally, among Medium Sized hubs. Additionally, Memphis ranked #1 overall in 2014 for amount of tons landed at U.S. airports. This was a 4% increase over 2013, and 43% more tonnage than the second ranked airport in the U.S. Given the increase in travelers through Tennessee's airports, capacity improvements at Tennessee's Airport Facilities will be vital to meet increasing demand and achieve adequate economic growth.

Condition

The FAA establishes Design Standards for Airport Infrastructure. These Design Standards are based on critical aircraft characteristics including approach speed, wingspan, height and aircraft weight. FAA standards include airport geometric requirements such as runway and taxiway width, length, and separation distances, including safety areas, and protection zones. Additional characteristics such as pavement surface, airfield lighting, navigational aids, signage and pavements markings are included in the standards as well. In order to relate the design standards to aircraft performance, the FAA created the Airport Reference Code system which categorizes airports based on their ability to accommodate certain size aircraft. The ARC is based on an aircraft approach speed (depicted by a letter), and aircraft

wingspan (depicted by a roman numeral). Airports expected to accommodate single-engine airplanes normally fall into Airport Reference Code A-I or B-I. Airports serving larger general aviation and commuter-type planes are usually Airport Reference Code B-II or B-III. Small to medium-sized airports serving air carriers are usually Airport Reference Code C-III, while larger air carrier airports are usually Airport Reference Code D-VI or D-V. Accommodations are then made to the Airport Reference Code by factoring in an aircraft approach visibility component.

Airport Infrastructure Project needs are evaluated through the FAA's National Priority Ranking system, known as NPR. The NPR is based on a specific project type with the emphasis on safety and security needs taking the most precedence. The projects are categorized as: Safety (obstruction clearing), Security (controlled access), Maintenance (lighting & preservation of facilities), Standards (upgrades to meet FAA requirements), Modernization (fuel systems & runway extensions) and Capacity (hangars, terminals, extensions).

Given their essential nature, airport pavement surfaces serve as the most prominent indicator of overall airport condition. A 2014 study of runway, taxiway and aircraft parking apron pavements at Tennessee General Aviation airports indicates a satisfactory system condition. However, it must be mentioned that pavement is constantly deteriorating with time and use. Airfield pavement surfaces require regular maintenance and repair to maintain their operability. Without this periodic attention, pavement conditions could deteriorate precipitously to Fair, Poor, Serious and Failed thus affecting airport condition.

Operation & Maintenance

Tennessee public use airports are owned and operated by local governments (city and county), and Airport Authorities. These entities oversee the daily operation and management of their respective facilities, as well as provide future planning and management of facility construction projects. These authorities collect and report all required data mandated by FAA and the State of Tennessee.

At the facilities where military operations exists, a joint-use agreement is negotiated between the Airport Sponsor and the Specific Military Branch of service. These agreements provide proceeds used for operation and maintenance costs, and are used as a mechanism for helping develop and fund future facility needs.

In 2015, the TDOT Aeronautics division developed a state-wide pavement management program to assess pavement conditions and analyze needs for pavement restoration and maintenance. Pavements were inspected and measured as a Pavement Condition Index (PCI) number ranging from 0 to 100. These indexes where juxtaposed against the minimum service level (MSL) defined by the Tennessee Aeronautics Division as the minimum pavement condition yielding a rating of Satisfactory. The target values for minimums are as follows: Runway – 65; Taxiway -60; and Apron- 60. The Division is currently working to fund projects for pavement repairs that fall below the minimum service level threshold. Beyond pavements, airports are host to a number of facilities such as terminals, hangars, fueling systems, etc. Regular maintenance and repair are necessary to preserve condition these vital infrastructure components.

Funding

Funding for airport capital improvement projects, including maintenance and repair of infrastructure comes primarily from two sources; the Federal Aviation Administration and the Tennessee Department

of Transportation. Tennessee is one of 10 states which participates in the FAA's Block Grant Program. This program provides Tennessee the flexibility to prioritize funding received by the state from non-airport specific Federal programs, as deemed necessary for the continued advancement of the State's Aviation Network.

While Tennessee's Aviation Network relies on the five Commercial Airports for the majority of its Economic Output, Tennessee also relies on the network of General Aviation Airports to provide a critical role of accessing the state's industry specific locations and cities where Commercial airports are not feasible for use. According to the 2012 FAA Asset report, 3 out of every 4 landings at U.S. Airports are conducted by General Aviation Aircraft. The strategic location of General Aviation Airports provide essential service for citizens and businesses throughout the state, which in turn provides a substantial contribution to the annual economic impact of Tennessee's Aviation Network.

Commercial Airports (excluding Memphis) in Tennessee utilize the FAA's Passenger Facility Charge (PFC) Program, which allows Commercial airports to fund FAA-approved projects that enhance safety, security, or capacity; reduce noise; or increase air carrier competition. These funds are vital to projects which help Commercial airports meet future needs. The Funds are restricted in that they cannot be used for revenue producing projects such as parking garages or terminal areas leased by specific air carriers. PFCs are capped at $4.50 per flight segment with a maximum of two PFCs charged on a one-way trip or four PFCs on a round trip, for a maximum of $18 total. The PFC cap was instituted in 2000 and was not indexed for inflation or growth. This limits local airports ability to fund projects that are needed for future expansion, safety, capacity, and innovation.

Maintenance and Capital Improvements are funded via Grants from the Tennessee Transportation Equity Fund (TEF). The TEF utilizes a 4.5% Aviation Fuel Tax as the primary mechanism for generating Funding. This tax is included in the fuel purchase price throughout Tennessee's Aviation Facilities. The TEF disperses its proceeds between Commercial Airports and General Aviation Airports.

Of the $48.5 million dollars of Fuel Tax proceeds collected in 2013-2014, FedEx Express operations in Tennessee accounted for over $32 million dollars or 66% of all revenue. During 2014-2015 Tennessee faced the threat that FedEx might relocate their operations to other states offering Reduced Fuel Tax Rates, or even Special Tax Exemptions to FedEx. These states included North Carolina which boasts a $2.5 Million Fuel Tax Cap, and Indiana which does not institute a Fuel Tax for Aviation Fuels. Tennessee Legislators estimated that the loss of FedEx would create a negative Economic Impact of $1.4 Billion, and the loss of 36,000 jobs from Memphis' largest employer.

In response, the Tennessee General Assembly passed SB 982 and it was signed into law on May 18, 2015. This legislation capped the amount of Fuel Tax that could be collected from a single corporation or individual. The Bill includes a 3 year incremental deduction in the capped amount, beginning with $23.375 Million in 2016, and concluding with $10.5 Million in 2018. While the benefits of this legislation outweighed the consequences, the legislation essentially created an unprecedented funding gap. Assuming Aviation Fuel Consumption remained constant, the Fuel Tax Cap promotes a 46% reduction in revenues (based on Fiscal Year 2014 Prices)

Additionally, some Federal Grants provided for Capital Improvements can require states to match a certain percentage of funds provided. The decline in Fuel Tax proceeds will directly influence the State's ability to provide the required match to federal funds, which will hamper the State's ability to fund future projects at the same level as prior years. Consequently, the National Priority Ranking System will become more critical to the State's ability to fund projects.

Future Needs & Innovation

According to the FAA, U.S. airlines served an estimated 756.3 million passengers in 2014, up by 2.3% from the 2013 level. Early reporting for 2015 indicates passenger travel has increased 7% from last year. The FAA forecast projects passenger growth to average 2% per year, reaching one billion passengers in 2029, and 1.14 billion by 2035.

The federal FAA bill that authorizes both airport funding and airlines has been under a series of multiple short-term extensions while the House and Senate come to resolution on a new bill. Recently, Congress passed the FAA Reauthorization act granting another short term funding extension through 2017. The need for a long term, comprehensive FAA Reauthorization Bill still exists, and is essential to maintaining our future infrastructure

The FAA is currently preparing and working to implement its NEXTGEN initiative, which is intended to modernize the outdated U.S. Air Traffic System. NEXTGEN includes 8 specific programs designed to improve Weather Interpretation, Air Traffic Management, Data Collection, System Integration, & Information Exchange. The NEXTGEN system hopes to use digital technologies such as GPS to reduce cancellations, weather delays, taxi & take-off delays, as well as improve safety through improved aircraft tracking and communication between ATC and pilots.

Increased passenger forecast combined with the need to implement a modernized system will continue to increase pressure and test the limits of Tennessee's Aviation Network and funding. Several projects related to runway improvements, facility access, and Air Traffic Control technology will need to be implemented in the near future in order to avoid falling behind our Future System needs. Additionally, with the cap in funding for AFT & the uncertain future of the National Aviation System's governing structure, Tennessee faces a serious dilemma on how these projects can be funded.

Public Safety & Resilience

Many of Tennessee's airport facilities have been in existence for over 50 years, and most of their roots trace back to simple Grass Landing strips, which evolved into Public Use facilities. As demand has and will continue to increase, these facilities face numerous challenges to meet user needs. In most cases, relocating and establishing a brand new airport facility to replace an aging facility simply isn't feasible. Therefore, a continuous investment in our current facilities must exist. This investment is vital in responding to several factors such as increases in threats to public safety & welfare, passenger travel & services, as well as aircraft size and capability. As always, maintaining Public Safety is a top priority and Protection against loss of life or injury and property damage is held paramount. Continuous improvement projects are working to sustain the majority of current needs however, the inevitable decrease in funding threatens the system's ability to meet future needs.

Recommendations to Raise the Grade

- Identify and Implement a replacement funding source for the loss of revenue resulting from the passage of (SB 982) which limits the amount of Fuel Tax Revenue that can be collected form a single source or corporation

- Accelerate and increase investment in Airport Improvement programs such as the pavement management program, and projects which increase capacity

- Implement & Enhance technology related to FAA's NextGen initiative, including safety improvements

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BRIDGES: B

Introduction

Bridges are a critical component of Tennessee's Infrastructure. With approximately 20,000 bridges within the state, their impact on connectivity, commerce, safety, prosperity and a myriad of other aspects is far-reaching. This report provides an overview of various aspects of Tennessee's bridges and offers an evaluation based on eight criteria (capacity, condition, funding, future need, operation and maintenance, public safety, resilience, and innovation) to help determine the overall grading of the state's bridges.

Capacity

A backlog of accumulated and deferred highway needs has occurred due to cuts in federal and state funding resources. The result is an ever increasing backlog of bridge repair/replacement projects.

Level of service (LOS) is a qualitative measure used to relate the quality of traffic service. LOS is used to analyze highways by categorizing traffic flow and assigning quality levels of traffic based on performance measures like speed, density, etc. Referring to the Highway Capacity Manual and the AASHTO Geometric Design of Highways and Streets, LOS is classified using letters A through F, with A being the best and F being the worst.

Bridges are segments within a roadway network. The capacity component of a bridge is typically associated with the approaching roadway to that structure. Current data show that 17% of all bridges on state routes and interstates in Tennessee have a LOS of D or worse. At this condition, average speeds are reduced and drivers experience delays. Projections twenty years into the future indicate that, by the year 2036, this number rises to 33% - a significant increase in traffic congestion.

Condition

At the time of last reporting (spring of 2016), Tennessee had a total of 19,793 bridges on public roads with a length greater than 20 feet and not maintained by a Federal Agency. Of those bridges, 978, or 5%, are classified as structurally deficient (SD). This means one or more of the key bridge elements, such as the deck, superstructure or substructure, is considered to be in "poor" or worse condition. Another 2,407 bridges, or 12%, are classified as functionally obsolete (FO). This means the bridge does not meet design standards in line with current practice. While these bridges do not require replacement, their outdated designs mean they could use modernization to increase safety and improve traffic flow.

The graph in Figure 1 shows the history of Tennessee's SD and FO bridge percentage over time. When comparison numbers were last available (fall of 2015), Tennessee has the lowest number of combined SD and FO bridges of all the Southeastern States. Additionally, Tennessee ranked #7 (Nationwide) in terms of having the lowest combined SD and FO percentage. As demonstrated in the chart, the trend of structurally deficient bridges has been decreasing significantly from the 1980s to today, thanks to a concerted effort to repair or replace these bridges.

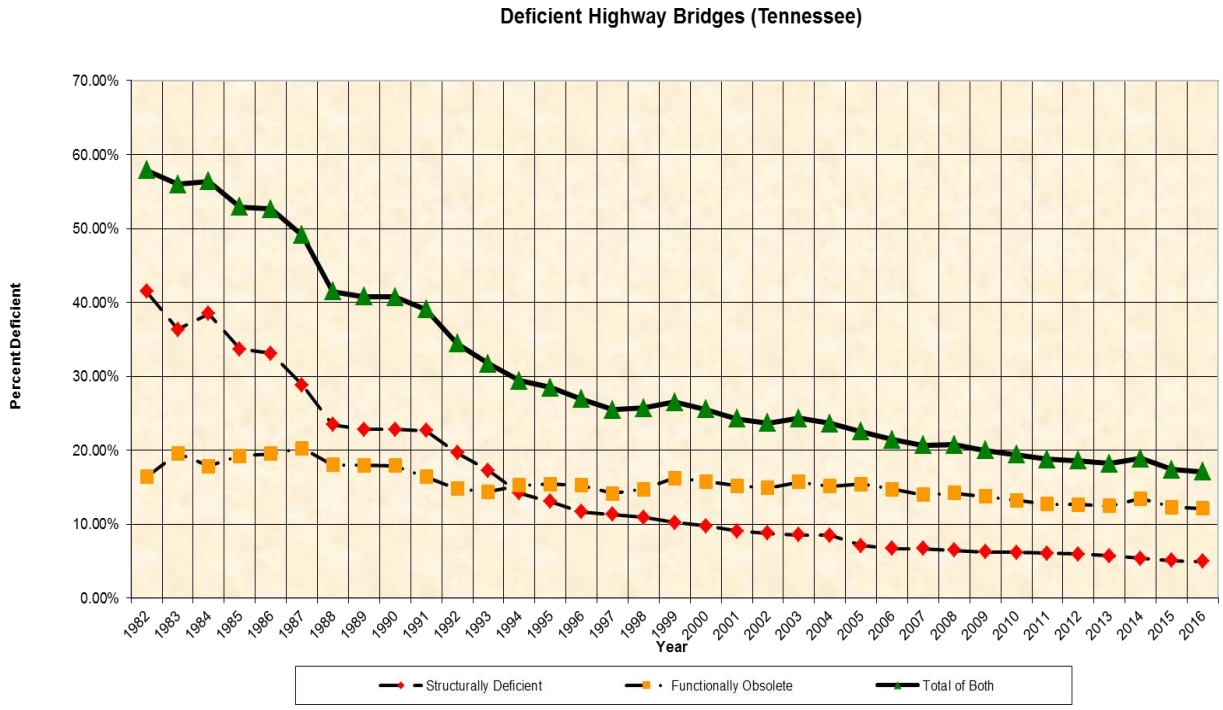

Figure 1. Tennessee's SD and FO bridge percentage over time.

Footnote: According to the Federal Highway Administration (FHWA), a bridge is classified as structurally deficient if the condition rating for the deck, superstructure, substructure or culvert and retaining walls is rated 4 or below or if the bridge receives an appraisal rating of 2 or less for structural condition or waterway adequacy. During inspections, the condition of a variety of bridge elements are rated on a scale of 0 (failed condition) to 9 (excellent condition). A rating of 4 is considered "poor" condition and the individual element displays signs of advanced section loss, deterioration, spalling, or streambed scour.

Funding

The latest transportation funding legislation passed in December of 2015 provides $305 billion during the next five years. Named FAST (Fixing America's Surface Transportation), the new, five-year, $305-billion bill represents the first federal highway deal for a period longer than two years to be signed into law since 2005.

Tennessee has traditionally been considered as a "pay as you go state" - one of the few states that funds transportation projects without taking on debt. Averse to debt for transportation spending, the federal funding will only go as far as the state can match. However, Tennessee typically maximizes the federal dollars and federal investment in Tennessee has supported $1.5 billion for capital improvements on more than 1,000 bridge projects between 2005 and 2014.

The current funding levels and revenue streams are being seen as only able to maintain the status quo. With an aging infrastructure and increasing construction costs, forecasts indicate that adequate funding (enough to simply maintain the current system) is coming to an end very soon.

Tennessee currently budgets approximately $130 million for its bridge program. The majority of these dollars are allotted to the Bridge Inspection, Repair, and Replacement Programs. Legislation has been proposed within the state government to "pay back" transportation funding that was taken from the state's highway fund from 2001 to 2007 and used for other state expenses. If passed, this could add a total of $262 million to the transportation budget over the next couple of years.

While the condition of state-owned bridges have been steadily improving (fewer SD and FO bridges), the condition of locally owned bridges has been slipping. To help with the funding challenges that local municipalities face, Tennessee passed legislation over the past two years that deceased the required local match for the State Aid Program from 20% to 2%.

Future Need

The Tennessee Department of Transportation TDOT does a good job of making the most out of its limited funding resources, including by keeping its administrative and operation costs to only 2% of the annual department budget.

While eagerly awaited, the latest transportation funding bill (FAST Act) allows funding to maintain the status quo. Additional funds are needed to offer improvements to the bridge inventory. The bridges in place now are aging and it is costing more to maintain and preserve them. Additionally, traffic volumes are increasing.

Operation and Maintenance

Tennessee Department of Transportation (TDOT)'s Structure Inventory and Appraisal (SI&A) office is primarily concerned with the safety and condition of the bridges in Tennessee. The SI&A office maintains a complete inventory of bridges and updates them with each inspection. The actual inspections are carried out by regional inspection teams spread throughout the state in each of the four regions. The information gathered in these inspections is used to manage bridge assets, including programming bridges for replacement or repair, at the State level. The inspection report information is also submitted annually to the Federal Highway Administration (FHWA) to help determine national highway funds needed for Tennessee. The inspection and bridge evaluation data is used to assess the need to post restrictive loading on bridges and, in some cases - when the public's safety is in question, close the structure.

TDOT's Bridge Repair Section is charged with the task of correcting structural deficiencies, vehicular collision damage, concrete or steel deterioration, and streambed scour problems on all state owned bridges. In an effort to maximize the efficiency of funding, TDOT's Bridge Repair Section strives to operate through the lens of "bridge preservation," going beyond simply addressing immediate needs. The work is carried out by TDOT in-house staff and consultant firms, which are under contract with the Department for four years. These repair projects are let to contract through the normal bid process and administered by the Regional Construction Office. During the actual construction, the Repair Section will assist the Regional Construction Office in construction inspection and in solving problems that develop.

Since 2004, over 1,000 new bridges have been constructed in the state; hundreds have undergone major reconstruction. While funding for rehabilitation for state-owned bridges has been stable, the

dollars available for locally owned bridges does not keep up with the need.

Public Safety

Public safety is paramount. Bridge deficiencies can pose major inconveniences and safety hazards to the general public. Weight restricting of bridges can force safety and emergency vehicles to take lengthy detours. Substandard lane and shoulder widths cause increased congestion and accidents. Insufficient vertical and horizontal clearances can cause vehicles to take detour routes and can cause vehicle collisions with bridges. While the percentage of deficient bridges has declined markedly since the 1990's, these percentages have plateaued over the past 15 years.

Resilience

TDOT has contingency plans in place for seismic events and flooding. Additionally, FHWA and NHI is developing training for emergency response. The goal of these plans and training is to have a coordinated effort (between various state and local agencies) that would be to be led by federal agencies when one of these events occurs.

Innovation

TDOT has completed six accelerated bridge construction (ABC) projects to date and others are planned. In addition to the traditional design-bid- build method, in the last few years TDOT has also employed innovative project delivery methods including Design-Build and Construction Manager/General Contractor (CMGC).

To help further the materials and products side of innovation, TDOT sponsors research with universities. Recent examples included low permeability concrete (for improved durability of bridge decks) and use of thin bonded concrete overlays for bridge decks.

Recommendations to Raise the Grade

- Increase annual investment levels for transportation funding, specifically bridge repair and rehabilitation.
- Maintain and increase focus on bridge preservation.
- Continued focus on addressing and reducing the number of structurally deficient bridges.
- Support research and initiatives to in order to develop more resilient bridges.

Sources

- A Policy on Geometric Design of Highways and Streets
- Highway Capacity Manual (HCM 2010)
- Tennessee Department of Transportation

Dams: D

Introduction

Tennessee law defines a regulated dam as any artificial barrier, that holds or diverts water, and that either:

- is twenty feet (20) or more in height from the streambed at the downstream side of the barrier or
- has water holding capacity at maximum water storage elevation of thirty (30) acre-feet or more.

Any such barrier that is less than six feet (6) in height, regardless of storage capacity, or that has a maximum storage capacity not in excess of fifteen (15) acre-feet, regardless of height, is not considered a dam, nor shall any barrier, regardless of size, be considered a dam, if, such barrier creates an impoundment used only as a farm pond (Source: Tennessee Code(2010), Title 69 - Waters, Waterways, Drains And Levees). Tennessee law exempts farm ponds from inspection that are privately owned and not open to the public, regardless of size or hazard potential category. Tennessee ASCE believes that all dams, regardless of their purpose or owner type, present a potential hazard to people and property downstream and they must be designed, operated and maintained to accepted standards. Of the 661 state-regulated dams in Tennessee, all but 10 are in compliance with the state's safety standards. However, there are 576 farm ponds (about 41% in state's dams listed in the National Inventory of Dams (NID)) in Tennessee that are exempt and are not rated.

Based on the findings during this evaluation an overall grade of "D" was assigned to the dam infrastructure in Tennessee. This grade is largely based on the fact that farm ponds are not regulated by the state and there is a lack of information about those.

Condition

There are over 87,000 dams nationally and the average age is 58 years. Similar to the nation's dams, the average age of Tennessee's dams is also about 50 years, where about half of the regulated dams were built between 1950 and 1979 (National Inventory of Dams). About 93% of the dams in Tennessee are earth dams, 3% concrete dams, and the remaining 4% are gravity, masonry arch, and rockfill. As in most places across the country, dams in Tennessee are used for a variety of purposes. From hydropower generating, drinking water, flood control, to small agricultural and recreational facilities, dams are an integral part of life to many Tennesseans.

Generally, most recent information regarding all classes of state-regulate dams in Tennessee including High-Hazard Potential, Significant-Hazard Potential and Low-Hazard Potential dams is available through state dam safety office. According to the National Inventory of Dams, downstream hazard potential classifications dams are categorized as

- "High-hazard potential dam" that is dam whose failure or mis-operation will cause loss of human life and significant property destruction.
- "Significant hazard potential dam" is typically defined as a dam whose failure or mis-operation will cause significant property destruction.
- "Low-hazard potential dam" is defined as a dam whose failure or mis-operation will cause minimal property destruction.

As of 2013, there are a total of 1,223 dams in Tennessee identified in the National Inventory of Dams (NID). Of these, 273 dams are considered "high hazard potential", and 68 farm ponds are included in this category, 354 dams fall in "significant hazard potential" and 596 dams fall in "low hazard potential" categories. The State of Tennessee regulates 661 of these dams, with 148 dams considered "high hazard potential". The state-regulated dams in Tennessee are mostly classified as "Satisfactory" meaning, 'no existing or potential dam safety deficiencies are recognized." (Source: Tennessee NID, 2013 Condition Assessment Ratings; Association of State Dam Safety Officials' (ASDSO) 2013 report, Performance Report for the State of Tennessee).

Out of 1223 dams identified in NID, over 65% of the dams are owned by private, non-federal or utility entities, the federal government owns about 8%, the state owns about 12%, and the rest are owned by local agencies. Of the governmental or utility agencies, the three largest entities that own/operate/regulate a majority of the dams in Tennessee are: Tennessee Department of Environment and Conservation (TDEC), Tennessee Valley Authority (TVA), and the United States Army Corps of Engineers (USACE). Tennessee dams mostly rely on state dam safety programs for overall assessment. State Dam Safety programs have primary responsibility to issue permits, inspect the performance of existing dams, and work with local agencies and private dam owners on emergency preparedness. Tennessee State Dam Safety Officials are experts and are dedicated to ensuring the public safety. Dams that are regulated by the state get inspected regularly and almost all are in compliance with the safety regulations. Of the dams that are regulated by the TN Safe Dams program, high hazard potential dams are inspected annually, significant hazard potential dams are inspected every two years, and low hazard potential dams are inspected every three years.

Capacity

With respect to capacity, we generally attempted to evaluate ability of dams to serve their primary purpose. Figure 1 is a snapshot of Tennessee dams categorized by their primary purpose.

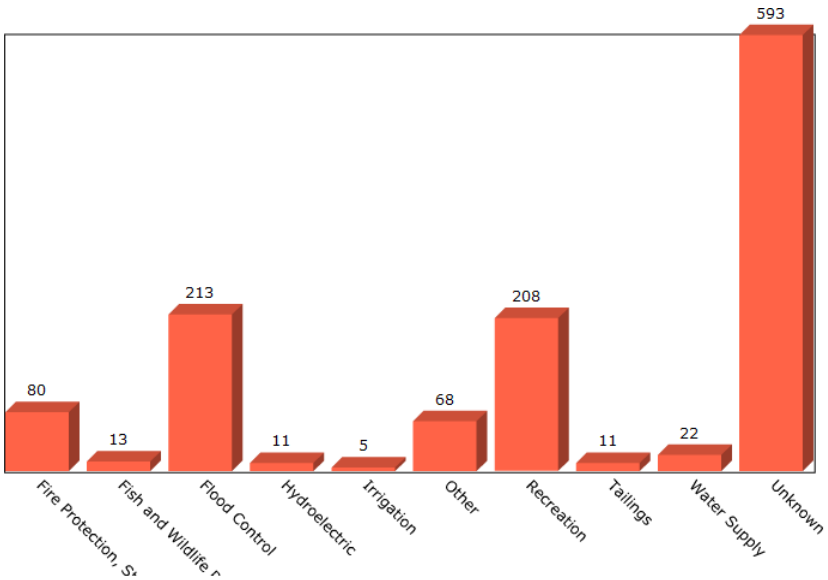

Figure 1: Tennessee dams categorized by their primary purpose.

As shown in Figure 1, over 200 of the dams' primary purpose is flood control. Historically, these dams

have performed well during significant storm events, with isolated, greater-than-usual storm events resulting in floods. However, as shown in Figure 1,611 dams are identified as having an "unknown" primary purpose. We assume farm ponds comprise the majority of the dams having "unknown" primary purpose. Tennessee law exempts privately owned farm ponds for any evaluation for hazard potential category. There are 68 "High-hazard potential dam" in Tennessee NID, 2013 that aren't regulated by the state. Thus, an adequate assessment of the overall statewide capacity is not possible.

Funding and Future Needs

The federal National Dam Safety Program (NDSP), which offers funds to states to develop and improve the inspection and research expired in 2011 but was reauthorized in 2014 through Water Resources Reform and Development Act. The NDSP currently benefits Tennessee by continuing to provide an annual federal grant of $97,000 to support the Safe Dams program (Source: TN Division of Water Resources, TDEC). The current Safe Dams annual budget is about $460,000, so the budget per regulated dam is $703/dam. The budget for the 148 regulated high hazard dams is $3,087/dam. Safe Dams staff is five full time equivalents of technical staff. (Source: TN Division of Water Resources, TDEC). Also the USACE and TVA assign significant budget towards dam safety and river management. According to the Civil Works Budget Details for the USACE, budget has been appropriated to address/upgrade their most critical facilities. The funds have been allocated and used for construction, critical operation and maintenance for restoring project dimensions to safe levels especially for infrastructure such as: Center Hill Dam, Cheatham Lock and Dam, Cordell Hull Dam and Reservoir, Dale Hollow Lake, J. Percy Priest Dam and Reservoir, and Old Hickory Lock and Dam. TVA's dam safety program manages a network of 49 river dams and is currently undergoing seismic and sustainable retrofits to several of their dams. However, funding for the state regulated dams has typically fallen below that of the national average (based on dollars/dam). Additionally, adequate staffing, training and further research are important to program performance, where the state shows the necessity for additional resources.

Operation and Maintenance

From the available data, more than 50% of dams in the state of Tennessee were built prior to 1979. Of the Tennessee dams listed in the National Inventory of Dams (NID), an overwhelming majority appear to be rated as satisfactory. This rating addresses only the high hazard potential dams within the state. It is unclear how the status/condition of non-state regulated facilities is reported. Since 2010, at least three high-hazard potential dams have been identified as needing some level of improvement. The details of these improvements are not known by the authors at this time.

Operations and Maintenance (O&M) is performed by the dam owner. In Tennessee, 65% of the dams are owned by private entities with the balance of ownership provided by State, Federal, or Local governments or utility agencies. The government and utility agencies have adequate O&M programs for their respective facilities. Most of the state regulated private dams have a satisfactory condition rating, and it can be assumed that they also have a sufficient O&M program.

Public Safety

The National Dam Safety Program, in cooperation with Association of State Dam Safety Officials (ASDSO), uses a benchmark called the 'Model State Dam Safety Program' to assist state officials in

initiating or improving their state programs. The model outlines the key components of an effective dam safety program and provides guidance on the development of more effective and sustainable state programs to eliminate the risks created by unsafe dams. Higher weighted percentages show greater arrangement of the state program with the model whereas the lower percentages can be suggestive of desired improvement in authority. Tennessee has an overall weighted percentage of 73% compared to 78% national average. Areas of concern where additional state authorities may be needed also suggested by the model, and as of 2014, Tennessee has a 44% compliance with the program where the national average is 77% for Emergency Action Planing (EAP) and Resonse. Emergency Action Planning (EAP) is a vital part of any dam safety program. Dam owners along with the state and local officials prepare and update existing EAPs to help mitigate consequences resulting from dam failures. They are prepared to aid in identifying when emergency conditions develop and also to outline actions to be taken that help prevent loss of life and minimize property damage. Tennessee only has authority for EAPs for "High Hazard Potential" dams built after 1987 and no authority for significant or for non-regulated farm ponds, which can be the reason for lower percentage in the EAP Model Program comparison. It should be note that, the State of Tennessee has an EAP for all 148 state regulated "High Hazard Potential" dams that contain all the elements from FEMA-64 "Federal Guidelines for Dam Safety: Emergency Action Planning." (Source: 2013 EAP Data for Regulated High Hazard Potential Dams).

Resilience

People who live, work, or own property downstream of a dam experience the most risk from dam failure or flooding. A resilient community should have the ability to recognize the benefits of a dam, but also should be able to assess, anticipate, and minimize potential threats from a failure. However it is difficult for the communities and stakeholders to understand/address these issues unless federal and state dam safety professionals provide adequate education and information. With limited budget allocated to Tennessee's State Dam Safety program, the ability of the state to collaborate with these communities is reduced. Additionally, the lack of regulation of farm ponds inhibits the ability to properly identify the risk some communities face.

TVA in recent years is evaluating subsurface conditions and the performance of each of their dams under static, seismic, and flood elevation conditions. TVA is moving forward in installing instrumentation to support their dam safety monitoring program. These efforts of retrofitting facilities to improve their performance under extreme conditions will help to minimize failure and improve the dams from undesirable consequences.

Conclusion

State staffing and budget have remained steady for several years. The state office reports that "dams that are regulated get inspected regularly and almost all are in compliance with the safety regulations. Of the dams that are regulated by the Safe Dams program, the "High Hazard Potential" dams are inspected every year, significant hazard potential dams every two years, and low hazard potential dams every three years.

Therefore, the Safe Dams program is functioning within the current authorities. But the 41% of non-federal farm pond dams are exempt from state regulation reduced the overall grade of Dam Infrastructure Report Card to a "D"

Recommendations

- Lessen the unknowns about Farm Pond Dams by gathering more data about the farm pond dams condition, and operating and maintenance.
- Establish a national dam rehabilitation and repair funding program to cost share repairs to publicly owned, nonfederal, high-hazard dams.
- Implement a statewide public awareness campaign to educate individuals on the location and condition of dams in their area.

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Drinking Water: C

Introduction

"Tennessee's available water includes 2 trillion gallons of surface water and 200 trillion gallons of groundwater. Nevertheless, of Tennessee's 6.2 million population (2008 estimate, U.S. Census Bureau), approximately 3.9 million people receive their water supplies from surface water sources. Two major river systems, the Tennessee and the Cumberland, and their tributaries supply the majority of the surface water. About 1.5 million are served by public water systems that use groundwater, and an additional 300,000 are served by systems that use both surface and groundwater" (English, 2010).

Tennessee has been granted primacy by the U.S. Environmental Protection Agency (EPA) to administer the drinking water protection requirements under the Federal Safe Drinking Water Act (SDWA). The state generally follows the federal rules under the SDWA but has some stricter requirements. For example, state has an MCL of 0.1 mg/L for nickel, and requires compliance with secondary MCLs.

Tennessee has adopted a Capacity Development Strategy to help public water systems improve their capacity. The most recent document dated September 2014 provides an assessment of the ongoing success and effectiveness of the state's regulatory efforts, which ultimately ensure capacity development of public water systems and Safe Drinking Water Regulations in Tennessee.

The Capacity Development Strategy report notes the issue of aging infrastructure and aging "population" of certified operators as the primary drinking water challenges in Tennessee. "The aging infrastructure replacement needs run into the billions of dollars and far outweigh the available funding. Not replacing critical aging infrastructure creates a domino effect which affects such things as operations, water quality, maintaining compliance and water loss" (Capacity Development Strategy, 2014). Furthermore, growth in urban areas in the state will generate water-supply challenges, and increase pressure on the region's water resources.

Data obtained from EPA lists Tennessee as one of the U.S. states reporting safe levels of lead in the water supply. As a requirement of EPA's Lead and Copper Rule, public water systems regularly test for lead in drinking water and minimize levels through operational practices and improvements in corrosion control.

As stated in the September 2014 State Capacity Development Program Implementation Report, "the statewide drought of record of 2007 and the May 2010 1,000-year flood event encouraged many water systems to work together and increase interconnections, examine regional approaches to water supply issues and collaborate more on compliance issues and new rules. At the heart of these activities is State oversight and assistance. Undoubtedly, such efforts represent increased opportunities for enhancing the capacity of systems to comply with the Safe Drinking Water Act and to better meet future drinking water needs."

Capacity

According to EPA's Enforcement and Compliance History Online website, currently 485 public water systems in Tennessee serve 6.9 million customers including industrial and commercial users. Approximately 90% of Tennessee's population is served by a public water system. Based on United States Geological Survey data, the western portion of Tennessee relies solely on groundwater supplies

for drinking water. Continued pumping by many industrial and municipal users from the underlying aquifer has caused significant water-level declines in several states including Tennessee. Memphis, Tennessee relies exclusively on groundwater for municipal supply. Large withdrawals have caused regional water-level declines, however, researchers claim water in the deep Middle Claiborne aquifer remains plentiful. A statement by the U.S. Army Corp of Engineers Nashville District indicates the lack of water has become a major factor limiting growth in certain areas (2011). State Rules encourage the Water Quality, Oil and Gas Board to incentivize the divergence of treated wastewater from surface water receiving streams to "land application and beneficial reuse." In the next 6 months, Tennessee should have specific guidance on the beneficial reuse of reclaimed wastewater. Tennessee is more frequently experiencing drought conditions that affect the availability of source water for drinking water treatment. Utilization of reclaimed water in a reuse model should preserve source water quality and help contain drinking water treatment costs.

Condition

Delivering high-quality, reliable water service requires significant investment in our water infrastructure to upgrade aging facilities. Tennessee utilities spent millions of dollars over the last 10 years to improve service to customers. Unaccounted for water, also known as non-revenue water, primarily occurring because of leaky pipes in the distribution system, is an ongoing issue that public water systems are working to improve. Unaccounted for water is a financial drain on a water utility. Utilities must constantly monitor and maintain their system and accounting procedures to maintain an acceptable level of unaccounted for water. In Tennessee, unaccounted for water losses of 40% or greater range are common. Public water systems in Tennessee are required to include in their annual audits the unaccounted for water percentage utilizing the American Water Works Association (AWWA) model when reporting data. There are at least two Tennessee state agencies collecting the audit reports. Compiled unaccounted for water loss data state-wide as well as water main breaks, age, and replacement would be extremely useful. Continued investment is necessary to ensure these facilities are able to produce and deliver safe water. The Tennessee Water Quality Assessment Report (2012) indicates 99.9% of domestic water supply as not threatened or impaired.

Operation and Maintenance

EPA's Enforcement and Compliance History Online website reflects drinking water compliance by Tennessee. Tennessee's community water systems were 99% compliant based on facility inspection and enforcement data.

Public Safety

Tennessee's water quality continues to improve as more stringent discharge standards are implemented. The state's public water systems are safe, reliable and the quality of life and economic vitality of the state depend on them. The professionals that operate and those that assist the operators are well trained and capable.

Funding & Future Needs For Tennessee's Drinking Water

Generally, the lack of funding for utility improvements from financial agencies and governmental programs may not be the biggest obstacle for most utilities. Instead, setting reasonable rates sufficient to meet financial obligations and stay compliant with state law appears to be a greater challenge.

Every city and utility district in the state of Tennessee submits an annual audit to the Tennessee Comptroller of the Treasury each year. There are approximately 325 cities and 185 utility districts. According to law, water and wastewater operations are to function as an enterprise fund similar to private businesses. All accounting of financial transactions in the water and wastewater utilities are separate from the general fund and must be self-supporting.

A tabulation by the Tennessee Advisory Commission on Intergovernmental Relations (TACIR) in 2014 considering 384 systems showed that average water rates ranged from $1.34 per 1,000 gallons to $15.55 per 1,000 gallons. The median rate was $6.03 per 1,000 gallons and the gross average was $6.49 per 1,000 gallons. Using the $6.49 per 1,000-gallon rate, for a four-person household using 80-100 gallons of water per person per day, the average monthly bill would be $62.30. These rates are assumed to include debt service and other costs. Since debt service costs may vary widely among systems, there is no direct correlation with the total rate charged to the customer and the average cost to operate and maintain the water systems on a daily basis. Compounding the problem, the cost to operate and maintain treatment facilities also has wide variability.

Adequate funding to meet the increasing need for infrastructure rehabilitation and replacement is lacking. Funding is generated through water rates. Borrowing is available but demands an additional burden on the rate structures of the systems in a time of ever increasing pressure to keep water rates affordable.

Funding is available through the state Drinking Water State Revolving Fund (DWSRF) Loan Program for improvements and upgrades. The Program maintains a Priority Ranking List for funding the planning, design, and construction of drinking water facilities. The Priority Ranking List forms the basis for funding eligibility and the subsequent allocation of DWSRF loans. DWSRF loans are awarded to those projects that have met the DWSRF technical, financial, and administrative requirements, possess the highest priority rank on the Priority Ranking List, and are ready to proceed. The Fiscal Year 2016 Intended Use Plan for the state DWSRF program indicates 21 funded projects for a total of $46,001,215.

Since its inception in 1996, the Tennessee Drinking Water State Revolving Loan Fund has awarded more than $276 million in low-interest loans for drinking water infrastructure projects. This program requires a 20 percent state match, so Tennessee contributed over $55 million in the 20-year period. Divided by the projected need of $3 billion for the same period, this investment is about 9 percent of the total need. Based on projected funds available to loan during Fiscal Year 2017, SRF allocation is increasing. Other funding sources that are also utilized for drinking water infrastructure projects include US Department of Agriculture, Rural Development (USDA-RD); TN Economic and Community Development Agency (ECD) from US Department of Housing and Urban Development (HUD) as Community Development Block Grants (CDBG) and other programs; Economic Development Administration (US Dept. of Commerce), and various other regional development agencies. Each program serves a specific category of needs and communities and up to a unique threshold of funding ability.

According to the Needs Survey and Assessment Fifth Report to Congress, the 20-year national infrastructure need estimated by the 2011 Assessment is $384.2 billion. The report outlined the Tennessee total 20-year drinking water infrastructure needs as $2.7 billion. In accordance with ASCE Policy 480, ASCE believes that both state and federal funding sources need to be greatly expanded to meet the 20-year need.

Water quality and supply issues are becoming more important in Tennessee as the state's population continues to grow. Additionally, there is an increased need for system resiliency to protect water

resources. Security and emergency response planning are a critical part of managing a drinking water system. Utilities must be prepared and continue to keep safety and security at the forefront of the operations. All community water systems in Tennessee are required to have an Emergency Operations Plan.

The anticipated effects related to weather and climate change include impacts on water quality and quantity. In Tennessee, proactive and collaborative management of flood and drought is necessary to keep communities resilient in future disasters. "Careful planning and preparation for flood and drought events by communities' subject to extreme climatic conditions will save money and lives in the long run" (AWRA, 2013). In accordance with ASCE Policy 360 on impact of climate change and ASCE Policy 500 on resilient infrastructure, strong coordination and collaboration across federal, state, and local-based government and investment in research is necessary to enable optimal preparation and response to mitigate impacts to our drinking water.

Recommendations

- Make addressing any drinking water violation a top priority.
- Continue to ensure proper operator training.
- Increase investment from all levels of government and the private sector, to repair, improve, and expand the Tennessee's public water systems.
- Develop more accurate, quantitative data on public water systems, including populations served, unaccounted use, water main breaks and replacement, and capital needs.
- Consider expanding resources for nonpotable water.
- In accordance with ASCE Policy 243, the state should consider regional solutions to more efficiently manage groundwater and effectively deliver drinking water throughout the state. Consider providing advantage to those with approved regional water plans when funding projects. Increased demands on Tennessee's water resources can be reduced by water conservation, recycling and reuse. These efforts to improve water conservation and improve water efficiency are supported by ASCE Policy 337, which recognizes conservation as important in managing drought and other extreme events.
- In accordance with ASCE Policy 360 on impact of climate change and ASCE Policy 500 on resilient infrastructure, strong coordination and collaboration across federal, state, and local-based government and investment in research is necessary to enable optimal preparation and response to mitigate impacts to our drinking water.

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Inland Waterways: C-

Introduction

The main changes from the last report card are that the number of tons has declined a small amount and the Chickamauga Lock replacement has been delayed. The grade for 2016 is the same as it was in 2009.

The state of Tennessee is located at the heart of the nation's inland waterway system. The state's three major navigable arteries, the Cumberland, Mississippi, and Tennessee Rivers and their tributaries, connect the state's four public river ports and over 170 private river terminals to river ports in 21 states and ocean ports along the Gulf Intracoastal Waterway.

The Mississippi River borders the western boundary of the state and contains the International Port of Memphis, the fifth largest inland port in the U.S. and the second largest shallow draft port on the River. Of the 68 water-fronted facilities, 37 are terminal facilities moving products such as petroleum, tar, asphalt, cement, steel, coal, salt, fertilizers, aggregates, and grains. The port created 7,145 direct and 12,835 indirect jobs according to an August 2014 Economic Impact Study. "Waterborne operations within The Port of Memphis handled 13.6 million short tons in 2012, the most recent year for which waterborne commerce statistics have been reported by the U.S. Army Corp of Engineers. The tonnage handled in 2012 remained down from the peak of 19.1 million short tons in 2006". "The period from 2006 to 2010 saw a 35% decrease in waterborne traffic in the Port of Memphis. However, an economic Impact study conducted in 2011 showed that the port's influence continued to grow as the annual economic impact on the region reached a record high of $7.1 billion dollars. The volume may have decreased, but the value of the products being shipped increased dramatically".

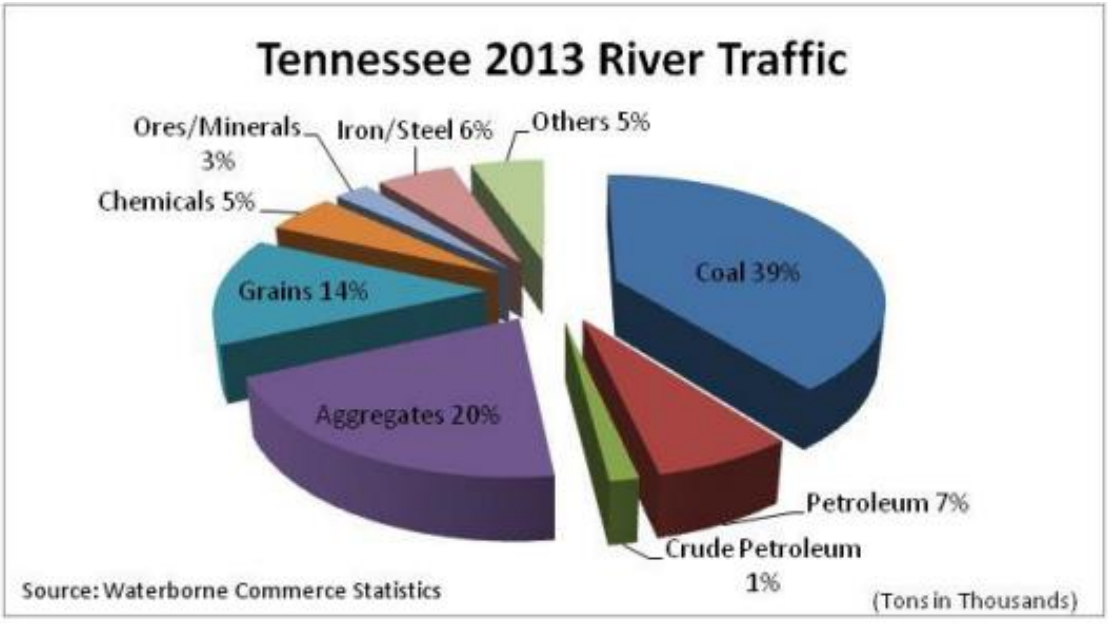

Figure 1. Goods moved on rivers in Tennessee.

Table 1. Commodities moved on rivers in Tennessee.

Tennessee 2013 Commodities Moved To, From and Within the State (tons in thousands)				
	Shipped	Received	Within	Total
TOTAL	7,439.3	26,237.3	1,815.8	35,492.4
Source: U.S. Army Corps of Engineers Waterborne Commerce Statistics				

The Cumberland River flows nearly 700 miles from east to west, through the northern section of Tennessee. The Tennessee River is formed at the confluence of the Holston and French Broad Rivers on the east side of Knoxville and then flows south through Chattanooga After briefly flowing through Alabama, it flows almost due north into Kentucky and finally empties into the Ohio River near Paducah, KY. The Clinch River is a tributary of the Tennessee River. Navigation on the river is limited to 61 miles from its confluence with the Tennessee River to Clinton, TN primarily providing development to the area between Oak Ridge and Knoxville.

In most of the United States, the U.S. Army Corps of Engineers (USACE) has responsibility for the operation and maintenance of commercial navigation projects, while the U.S. Coast Guard (USCG) ensures safe transportation on America's waterways and protection of the marine environment. On the Cumberland and Mississippi Rivers, the USACE is responsible for the direction of all water resource activities. This entails the operation and maintenance of four navigation locks on the Cumberland River. The USACE also maintains a commercial navigation channel along the segment of the Mississippi River that borders the State of Tennessee. Since there are no locks or dams on the Mississippi River below St. Louis, the USACE's responsibility on this portion of the river is primarily river maintenance for navigability.

On the Tennessee River however, the USACE also works in partnership with the Tennessee Valley Authority (TVA) and the USCG. The locks and dams are owned by the United States and operated by TVA and the USACE. In accordance with the TVA Act, TVA is entrusted with the possession, operation and control of the dams and all related buildings, machinery, and lands, with the exception of the navigation locks that are operated by the USACE. The USCG installs and maintains the navigation aids along the commercial channel, which it also does throughout the United States while TVA installs and maintains the navigational aids on the recreational channels across the Tennessee Valley.

Condition and Management

Tennessee's locks are often delayed due to unscheduled repairs. Repairs are often needed and can take multiple months to completely resolve. Delays may also occur due to low water; which results in light-loading barges and increased shipment costs. Table 2 below presents the percentage of vessels delayed and the average delay time for several of these locks in 2014.

Table 2. Delay times at selected Tennessee Locks.

Lock	Vessels Delayed (%)	Average Delay Time (hours)
Cheatham Lock	41	1.37
Nickajack Lock	18	10.34
Pickwick Lock	32	0.93

While the delay times are generally low, they highlight the infrastructure's inability to effectively meet current demands.

In the event of closures, shippers are often forced to make short-term, emergency arrangements with other product sources and transportation providers to the greatest extent possible in order to keep their generating stations and manufacturing plants operating. Transportation impacts associated with such closures are estimated in the millions of dollars. Unexpected closures were highlighted as a particular issue at both the Pickwick and Fort Loudon locks. At Fort Loudon, these closures affect both recreational and business (particularly those operating in the water-dependent and barge shipping industries) users of the lock.

Further, flooding and concrete expansion inhibit the effective use of the Cheatham Lock and the Chickamauga Lock and Dam, respectively. At present, Cheatham Lock is the only one within the Nashville district that is designed to withstand flooding. Even so, this lock was heavily damaged by floods. At Chickamauga, concrete expansion threatens the continued structural integrity of the lock walls and could result in catastrophic failure. Congress authorized a new lock measuring 110 by 600 feet. Construction began in 2004, and the project was initially projected to be completed by 2014. Due to a lack of funding, the date of completion was pushed back to 2023, thus only the smaller lock is serviceable today. Subsequently, the average locking time per tow for Chickamauga is eight hours, making it the slowest locking mechanism in the Ohio River system. When the new lock is completed, processing time should be reduced to less than an hour.

If the condition of Tennessee's locks is not improved, freight will have to be transported by highway and rail systems. This will raise transportation costs and place additional stress on pavement and bridge infrastructure and the highway system.

Funding and Future Needs

Tennessee's inland waterways are funded partly through the federal Inland Waterways Trust Fund (IWTF) levied as a diesel tax on commercial towboat operators and partly through general federal tax revenues, each intended to pay for half of any major rehabilitation of existing facilities or new construction of locks and dams. Once projects are completed, general taxes account for 100 percent of the revenue needed for daily operations and maintenance. Historically, the IWTF has collected approximately $90 million annually, but the fund itself has been nearly depleted due to the rising number of necessary upgrades and new projects. Some highly anticipated projects have yet to receive funding because of the backlog.

Contributions to the IWTF are generated by a tax on diesel fuel used by barge operators. This tax was previously 20-cents per gallon, but was raised to 29-cents per gallon in 2014 in order to increase the fund. Money generated by the 29-cent tax is placed in the IWTF and matched dollar-for-dollar with tax revenues.

Last year Congress approved nearly $6 billion in funding to the USACE earmarked for investment in water infrastructure – a record high. However, in a time of budget cuts, the USACE is expected to see a 23 percent decrease ($1.4 billion) in their budget for the 2017 fiscal year. Tennessee lawmakers claim that such a massive budget cut will send not only the state's, but the nation's water infrastructure back more than a decade. Per the proposed budget plan, the USACE is slated to receive less than what Congress appropriated in fiscal year 2006. The new Chickamauga lock, Tennessee's biggest water infrastructure project in dire need of funding, received $29.9 million from the USACEs' fund last year to boost construction, but the entire lock is estimated to cost $858 million to replace.

A study conducted for the National Waterways Foundation by researchers from the University of Kentucky (UK) and the University of Tennessee (UT) concluded that throughout the nation, the inland waterways system supports nearly 550,000 domestic jobs, $29 billion in corresponding income, and $125 billion in aggregate economic output annually. At the rate of funding provided before passage of Water Resources Reform and Development Act (WRRDA) 2014, completion of the nation's 22 planned major waterway projects will take 77 years. With the increase in the user tax provided by WRRA 2014, the time could decrease dramatically if Congress appropriates sufficient matching fund.

Recommendations

- Increase the USACE budget to maintain and operate the locks and dams.
- Complete the needed Chickamauga replacement locks
- Repair Melton Hill Locks, Nickajack Locks, Pickwick Locks, and Watts Barr Locks.

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Parks: C

Introduction

The Tennessee State Park system contains 56 State Parks on 62,073.42 acres and 85 Natural Areas containing 128,548 acres, for a total of 190,073.42 acres. Most of the Natural areas are contained within the boundaries of the State Parks, as are various historical and archeological sites. As throughout our nation, Tennessee State Parks prove to be an important resource. Every year, the State of Tennessee establishes a budget for the State Parks System. Additionally, the State Parks generate revenue. In the 2014-2015 budget year, Tennessee State Parks generated $37.5 million in revenue with 33,452,320 visitors, compared to an operating budget of $68.8 million, excluding maintenance and capital projects. The park revenue is added to the State General Fund and budget appropriations are made for the State Parks general operations. In addition to the State Park revenues, it must be noted that for every dollar spent on trips to State Parks, an additional $1.11 of economic activity is generated throughout the state. Direct and indirect expenses total $1.5 billion in total industry output. State park employees number close to 12,000 and prove to be another great asset of Tennessee State Parks. Tennessee State Parks offer diverse and varied natural landscapes, family-friendly recreational activities, affordable and varied lodging accommodations, volunteer opportunities and hundreds of interpretive programs and events. Tennessee State Parks are open to the public seven days a week, year-round. Access fees are not charged, however there may be fees associated with certain activities. From the cypress swamps of the Mississippi River at Meeman-Shelby Forest to the rugged ridge tops and waterfalls of Fall Creek Falls to the majestic mountains of Roan Mountain, the State Park system is designed to provide needed rest and relaxation facilities to its users. The mission of Tennessee State Parks is to "preserve and protect, in perpetuity, unique examples of natural, cultural, and scenic areas" affirming that the primary purpose of state parks is "to conserve natural, aesthetic, cultural, and historic resources, to provide opportunities for enjoying healthful outdoor recreation and to serve as outdoor classrooms for environmental and cultural resource education." This was to be accomplished "through a well-planned and managed system of state parks."

Background

In 1933, President Franklin Roosevelt established the Civilian Conservation Corp (CCC). When Tennessee State Parks was established through legislation in 1937, the CCC began work on the state park system establishing sites throughout the state. The term park, as written in the 1937 legislation, was "all areas of land acquired by the State, which by reason of having natural and historic features, scenic beauty or location, possesses, natural or potential physical, aesthetic, scientific, creative, social, or other recreational values; and is dedicated to and forever reserved and administered by the state for recreational and cultural use and enjoyment of the people." Thus, the visitor finds a deep cultural heritage embedded within state park sites as well as natural, scenic or recreational value. Today, The Tennessee State Parks are run by the Tennessee Department of Environment and Conservation (TDEC). The Tennessee State Parks contain approximately $704 million in building assets and furnishings. Recently three parks and several natural areas were added to the system, including Cummings Falls State Park, Seven Islands State Birding Park, and Rocky Fork State Park. Tennessee State Parks receives approximately $15.12 Million for annual maintenance and has a current $117 Million backlog of maintenance projects that were not funded. TDEC requested additional maintenance money for Tennessee State Parks for the 2015-2016 budget year to try to address some backlog issues, but only received the same amount as funded in the 2014-2015 budget year. For the 2016-2017 budget year

TDEC has requested $4 million for additional reoccurring maintenance that is in the current proposed Governor's budget, pending legislative approval. TDEC has also requested $54.65 Million in the 2016-2017 proposed budget that includes $30.4 Million to upgrade hospitality facilities at the two premier State Parks, Fall Creek Falls State Park and Montgomery Bell State Park. The State approved $30 million of that request. Upgrading these two parks would strengthen Tennessee State Parks chance of attracting a private company to run the parks with inns and conference centers. There are six parks with Inns and Conference centers, and 15 with meeting facilities. TDEC has issued a Request for Qualifications for private entities to operate the inns and conference centers, which would take 30% of the State Parks assets off TDEC's hands. To date, no Statements of Qualifications have been received. It is believed that until at least two of the parks are upgraded, privatization is not an option.

Private and municipal parks were not included in the analysis due to lack of data from those entities.

Adequacy & Condition

Tennessee State Parks have six parks with inns; 21 with conference centers or meeting locations; 20 with cabins; and 2,920 RV and campsites along with multiple recreational amenities. The parks are generally well maintained, although there are several instances of certain features of park facilities being closed due to lack of funding for maintenance. Several of the cabins were upgraded in the last two years. The parks are typically at or near full capacity during the three major summer holidays and during local festivals. Inns and campsites are adequately providing for visitors throughout the year. Over 80% of Tennessee State Parks are compliant to current Americans with Disabilities Act (ADA) requirements. With $704 million of building and furnishing assets, the parks have a maintenance budget of $2 to $4 Million each year to address maintenance within parks. Examples include HVAC replacements, roof replacements, etc. Additionally, approximately $4 Million is spent yearly in maintenance salaries for routine maintenance at Parks. This includes items like changing out filters, cleaning restrooms, repairs within the Inns, etc. Furthermore, approximately $3 Million is budgeted and expended for cleaning supplies and contracts (e.g. HVAC repair, pool services, etc.) The total budgeted expenditure to maintain the parks is approximately $11 Million per year. Some of the buildings and the infrastructure of the park system are nearing seventy years of age dating to construction by the CCC. Due to the historic value of these facilities, special care is needed in the maintenance and will be needed in the future for the preservation of these facilities. Many park employees have spent their careers working at a state park and have taken great pride in maintaining these facilities and sharing the park culture and history with visitors. Still, some state parks have an area of history that cannot be fully told to the visiting public because of inadequate funding for visitor and learning center improvements.

Funding

Federal funding comes to the state from the National Park Service (NPS) Land & Water Conservation Fund (LWCF) and supplemental apportionment pursuant to the Gulf of Mexico Energy Security Act (GOMESA). The 2015 LWCF apportionment for Tennessee was $807,457.The US Government's budget compromise in December 2015 reauthorized the LWCF for three years. However, it only allocated $450 Million for Fiscal Year (FY) 2016, only half of the full funding level of $900 million. It is not known how this will affect Tennessee's 2016 allotment. These federal funds can be designated for a particular capital project, or in times of shortfall, may be used to subsidize the maintenance budget. The past few years, federal funding has contributed to Tennessee State Parks between $700,000 and slightly over $800,000 yearly. Annual maintenance and capital budget requests are prepared each year by Parks

Operations. The past couple of years the capital funding request has been approximately $50 Million. This year it was over $125 Million, including $55 Million for hospitality operations (Inns, golf courses, restaurants, some cabins, and marinas). The rest was for maintenance of existing facilities (cabins, campgrounds) along with new items (Visitor Centers at Rocky Fork, Cummins Falls, and Fall Creek Falls State Park.) TDEC has not submitted for additional maintenance funding in the past. TDEC requested a $4 Million recurring increase this year to keep the maintenance budget from falling behind. The money must be approved by the state legislature. TDEC also requested $7 Million over the next 10 years to work on backlog, however, has already been informed that the $7 Million is not going to be funded. The current maintenance deficit of the State Parks is $117 Million. Outlays for new or replacement capital projects are inadequate; however TDEC is making strides to address some long-standing issues. Friends of State Parks provide some funding for "maintaining and enhancing the purposes, programs and functions of the state park system. "Although useful for “enhancement projects", funds provided by the 40 active and established Friends groups are not used for the maintenance or capital budget projects.

Future

In 2014, Management Plans for each park were developed to assist local park professionals to better provide services for visitors to Tennessee State Parks. Efficient maintenance with carefully selected capital improvement projects must be the continued yearly goal of Tennessee State Parks. The Natural Areas Program continues to expand to preserve Tennessee’s irreplaceable natural sites. Tennessee State Parks continues to partner with other agencies, communities, and private groups to provide awareness and experience to citizens of the natural and cultural resources provided by Tennessee State Parks. Privatization of some of the State Parks may be an option for the future. If privatization could occur without impacting the state budget allotments each year, the rest of the State Parks could stand to benefit from privatization of those with Inns and Conference Centers.

Recommendations to Raise the Grade

When the Parks were evaluated in 2009, they scored a D+ because the evaluation occurred at a time at the end of an economic turndown and lack of funding. Since then, the park system has been on a very positive track and the score has improved. However, due to the current backlog of maintenance needs and the continued shortfall in both maintenance and capital project funding, ASCE gives state park infrastructure in Tennessee a grade of C. The overall condition of Tennessee State Parks facilities infrastructure is stable and safe. Since the last infrastructure report in 2009, twelve park campgrounds have been reconstructed and upgraded (including 2 in current construction), 16 bathhouses have been replaced in 5 state parks (in current construction), and 7 parks have had significant utility improvements. These improvements, and others, account for approximately $94.5 Million worth of capital projects that have been completed or that are currently funded for construction. This funding over the past 7 years represents 45% of the previous outstanding capital projects, with the majority of this increased funding occurring over the past 5 years.

The park facilities have made great strides, but could continue to benefit from additional revenue investment to provide a more optimum level of service and would undoubtedly reap positive economic gains from this investment. In order to raise the grade, the Park system needs to:

- Continue to raise funds for adequate maintenance and capital projects.
- Work down the backlog of maintenance needs.

- Suspend addition of new parks or Natural Areas until maintenance and capital needs are satisfied at existing parks and Natural Areas.

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Roads: C+

Introduction

Tennessee has over 90,000 miles of roadways and boasts superior roads when compared to neighboring and peer states. Tennessee consistently ranks in the top 5 states for overall roadway system quality since the poll in Overdrive magazine's annual survey of owner-operators' opinions began in 1996 (www.overdriveonline.com). However, due to inadequate funding levels, roads in Tennessee are beginning to exhibit some deterioration in performance. The efficiency of Tennessee's transportation system, particularly its highways, is critical to the health of the state's economy. Annually, $433 billion in goods are shipped from sites in Tennessee and another $266 billion in goods are shipped to sites in Tennessee, mostly by truck. The Road Information Program (TRIP) (http://www.tripnet.org/docs/TN_Transportation_by_the_Numbers_TRIP_Report_Jan_2016.pdf) estimates that Tennessee roadways that lack some desirable safety features, have inadequate capacity to meet travel demands, or have poor pavement conditions cost the state's residents approximately $5.6 billion annually. These costs come in the form of additional vehicle operating costs (including accelerated vehicle depreciation, additional repair costs, and increased fuel consumption and tire wear), the cost of lost time and wasted fuel due to traffic congestion, and the financial cost of traffic crashes.

Population increases and economic growth in Tennessee have resulted in an increase in the demand for mobility as well as an increase in vehicle miles of travel (VMT). From 1990 to 2013, annual VMT in Tennessee increased by 52%, from 46.7 billion miles traveled annually to 71.1 billion miles traveled annually. Based on population and other lifestyle trends, TRIP estimates that travel on Tennessee's roads and highways will increase by another 30 percent by 2030. Since a large portion of the miles traveled are on TDOT (Tennessee Department of Transportation) maintained roads, and better records are available through TDOT, this study is primarily based on such roadways.

Condition

The condition of Tennessee roads is indicated by the quality of its pavement surfaces. TDOT's Pavement Management System, which was instituted in 1997, incorporates ride smoothness and distress data (cracking, rutting, patching, etc.). These are combined into a Pavement Quality Index (PQI), which is based on a scale of 0-5, with 5 being very good. As can be seen in Tables 1 and 2, more than 80% of TDOT-maintained roads are in the good to very good categories. However, locally maintained roads do not fare as well. When all roads in Tennessee are considered, 11 percent of Tennessee's major locally (those under city, town, and county jurisdictions) and state-maintained urban roads and highways have pavements in very poor to poor condition, while 29 percent are in fair condition and the remaining 60 percent are in good to very good condition.

Table 1. 2014-15 PQI Averages for Interstates

Percentage	Values
0.0%	Very Poor (0.00 - 0.75)
0.0%	Poor (0.76 - 1.75)
5.7%	Fair (1.76 - 3.25)
32.3%	Good (3.26 - 4.25)
62.1%	Very Good (4.26 - 5.00)

Table 2. 2014-15 PQI Averages for State Routes

Percentage	Values
0.0%	Very Poor (0.00 - 0.75)
1.0%	Poor (0.76 - 1.75)
16.6%	Fair (1.76 - 3.25)
54.0%	Good (3.26 - 4.25)
27.8%	Very Good (4.26 - 5.00)

Capacity

Capacity is a key consideration when assessing roads because it aids in determining if the roads can accommodate present and future VMT (vehicle miles of travel) demand. A good measure of capacity is level of service (LOS). LOS values are based on a volume-to-capacity ratio. Population and economic growth in Tennessee have resulted in increased demand on the state's major roads leading to increased wear and tear on the transportation system, increased congestion, and deteriorating levels of service (LOS). Tennessee's population reached approximately 6.5 million in 2014, a 34 percent increase since 1990. Increasing levels of traffic congestion cause significant delays in Tennessee, particularly in its large urban areas, resulting in long commute times and negative impacts on commerce. Traffic congestion robs commuters of time and money and imposes increased costs on businesses, shippers and manufacturers, which are often passed along to the consumer. The average driver in the Chattanooga area loses 28 hours to congestion annually, while each driver in the Knoxville urban area loses 35 hours each year. Drivers in the Memphis area lose 43 hours annually due to congestion and drivers in Nashville/Davidson lose 45 hours annually.

The table below (Table 3) shows the costs due to deficient roads to the average motorist in Tennessee's four largest urban areas in the form of vehicle operating costs, congestion-related delays, and traffic crashes. The table also indicates that congestion-related delays in the form of lost time and wasted fuel constitute a significant proportion of this total cost, ranging from 50% to 71%.

Table 3: Average annual motorist costs in Tennessee

Location	Congestion Cost	Total Cost
Chattanooga	$730	$1,440
Knoxville	$849	$1,282
Memphis	$1,080	$1,821
Nashville	$1,168	$1,632

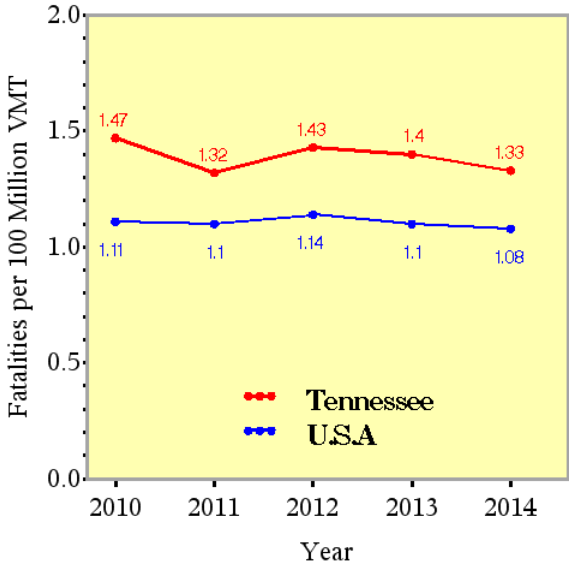
Operation & Maintenance

TDOT prides itself as a "fix it first" organization by being proactive in identifying problem areas that arise in various portions of its infrastructure and responding with a maintenance solution that is often more cost-effective than a complete replacement. TDOT uses various pavement preservation techniques such as surface seals, crack/joint sealing, microsurfacing, and 1.25" asphalt overlays to extend the life of Tennessee's roads. Hot-mix asphalt resurfacing can add an additional 11 to 12 years to the life of a roadway. TDOT uses a Maintenance Rating Index (MRI) to assess the condition of its roads from a maintenance perspective. The current MRI values indicate that TDOT is meeting or exceeding its targets with current budget allocations. Recognizing the increasing needs for

maintenance due to the aging infrastructure and increasing demands on the road system due to population and economic growth, TDOT has ensured adequate resources are available to meet current and future roadway maintenance and operation needs. This has resulted in being able to maintain high quality roads in Tennessee and contributed to the excellent national reputation enjoyed by roads in Tennessee.

Safety

In 2014, NHTSA reported a traffic fatality rate of 1.33 (per 100 million VMT) in Tennessee compared to the national average of 1.08. In 2014, there were 14.69 fatalities (per 100,000 population) compared to 10.25 for the national average, ranking it 40th in the nation. According to the Fatality Analysis Reporting System (FARS), Tennessee ranked 10th in the nation in probability of dying in a car crash. TRIP estimates that TN roadways that lack certain desirable safety features cost drivers more than $1.5 billion annually. Since the safe movement of people and goods is a high priority in Tennessee, TDOT has embarked on aggressive strategies and set ambitious goals to reduce traffic fatalities and serious injuries rates in the state. The 2014 SHSP (Strategic Highway Safety Plan) adopted its "Toward Zero Death" Plan that calls for reducing the number of fatalities and fatality rates by 10% within the next five years. To achieve these goals, TDOT has implemented a number of programs and infrastructure improvement measures.



Three main factors are associated with fatal vehicle crashes: driver behavior, vehicle characteristics, and roadway features. It is estimated that roadway features are likely a contributing factor in approximately one-third of fatal traffic crashes. Roadway features that impact safety include the number of lanes, lane widths, lighting, lane markings, rumble strips, shoulders, guard rails, other shielding devices, median barriers and intersection design. Detailed strategies are being implemented in the areas of keeping vehicles in the proper lane, intersection safety, work zone safety, motor carrier safety, and driver behavior.

Resilience

A resilient transportation system can anticipate, function, and recover from external disruptions as well as withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents. TDOT does not have any specific plans or policies dedicated solely to resiliency, even though there are programs and policies in place that overlap with the ideas and concepts of resiliency. Tennessee's intelligent transportation system, TDOT SmartWay, improves resilience by using advanced information technologies to improve safety and operation.

Some key features of TDOT SmartWay are: roadway traffic sensors, camera video surveillance, dynamic message signs, HELP freeway service patrols, incident management, and information on weather-related road conditions. Benefits of the system include:

- Providing live video to local television stations (used during their rush hour traffic reports).
- Website access to current construction and incident information.
- Shorter crash response time by emergency response agencies including TDOT HELP trucks.
- Using the system to assist in AMBER ALERTS.
- Radio reports of current construction and incident information available on the highway advisory radio (HAR) system.
- Using the system to complement Homeland Security evacuation plans.
- Warning messages on dynamic message signs about crashes to allow traffic to divert to other routes, while also reducing the potential for secondary crashes caused by drivers running into unanticipated backups.

Examples of recent events that have exposed the lack of a TDOT plan for resiliency include: the record flooding along the Mississippi River in 2011 that submerged many sections of major roadways; the 2010 Nashville flood which impacted travel on numerous interstates; the 2013 rockslide that shut down 20 miles of I-40 near the Tennessee/North Carolina state line; and the 2010 sinkhole that shut down eastbound lanes of I-24 in Grundy County. These events negatively impacted the movement of goods and services across the state. The good news is that TDOT has reacted to this deficiency by sponsoring a study whose findings are guiding the development of a resiliency plan for transportation.

Funding

TDOT had a budget of $1.84 billion for fiscal year (FY) 2014-2015. For FY2016 -2019, the budget is essentially flat except for onetime funding increases in FY 2017. This budget encompasses four general areas: Operation and Management; Maintenance; Highway and Bridge Construction; and Transit, Air, Water and Rail. TDOT's budget over the last 10 years was $18.7 billion. For the next 10 years, from 2017 to 2026, anticipated revenue available to TDOT from both federal and state sources is $18.2 billion, which equates to a shortfall of over $0.5 billion compared to the prior 10 years. At current funding levels, $8.4 billion will be available for highway construction over the next 10 years, but projected needs show a shortfall of $2.91 billion over the next 10 years, or $291 million per year. As for maintenance, the current budget of approximately $210 million annually will be needed to continue maintaining the transportation system in a state of good repair over the next 10 years. For the Interstate system, the data show that current funding levels (approximately $64 million) will be adequate to meet the resurfacing needs across the state and keep the Interstate system at an acceptable PQI. However, when it comes to state routes, the current budget (approximately $141 million) will fall short of the needs over the next 10 years due to the increasing age of such a vast system. In fact, it was estimated that approximately $475 million would be needed annually to keep up the current state of good repair on state-maintained roadways as measured by the PQI.

Tennessee was one of only five states that did not use debt as a funding source for highways, instead using pay-as-you-go (PAYGO) strategies exclusively. Between 2007 and 2012, Tennessee was more dependent on federal highway funds than the national average, with 42% of all receipts coming from federal highway funds (versus the national average of 26%). In Tennessee, around 78% of all highway funds are reliant on either federal or state motor fuel taxes—state motor fuel taxes provided 37% of all funding for state roads. An insolvent federal Highway Trust Fund, or decreasing state motor fuel tax receipts (due to increasing fuel efficiency and the adoption of alternative fuel sources), would therefore have a direct impact on the state's ability to maintain or build upon its existing highway system. Tennessee's gas tax is 21.4 cents/gallon (20-cent gasoline tax + 1.4-cent special petroleum fee) and was last raised in 1989

Although the highway system is generally well-maintained, funding uncertainty will hinder the state from keeping pace with the rapid increase in highway travel, at a time when an expanding and aging infrastructure will demand more money for maintenance and upkeep. On average, TDOT's budget will not be able to accommodate the projected transportation needs of the state. This will result in deteriorated highway conditions and roadways which are over-capacity. Adequate funding is essential to maintain Tennessee's high standards.

Innovation

Realizing that it cannot build its way out of congestion, TDOT created a new division called the Traffic Operations Division. The purpose of this division is to investigate, plan for, and fund projects and technologies that help to maximize the capacity and safety of the existing infrastructure. This occurs through the use of technological innovations, standardized traffic management procedures and practices, and strategic partnerships with local and state agencies. This division is responsible for the state's Intelligent Transportation System (ITS) and HELP truck program in the four largest urban areas of Chattanooga, Knoxville, Memphis, and Nashville. The current funding levels for investment and maintenance of these systems, at $35 million annually, is considered adequate to meet current and projected needs.

Recommendations

The Tennessee Section of ASCE offers the following recommendations for improving roadways in the state:

- Pursue additional funding for highway safety and expansion by considering strategies such as levying taxes on VMT and special assessments on alternative-fuel vehicles.
- It is time to increase the gas tax, which was last raised in 1989. The tax per gallon of gasoline in Tennessee is lower than the national average tax per gallon. Tennessee's state gasoline tax (inclusive of excise tax and other state taxes) is currently 21.4 cents per gallon. Nationally, the average state gasoline tax is 28.1 cents per gallon
- Encourage the use of cost-benefit analysis and value engineering to reduce overall costs.
- Document progress made towards the implementation of the Long Range Transportation Plan.
- Continue researching and applying new pavement preservation techniques.

- Place more emphasis on intermodalism.
- Continue the expansion of TDOT SmartWay across the state.
- Maintain up-to-date records and reports about Tennessee's roadways.

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Schools: C-

Introduction

National and state research consistently correlates the success of public education with good infrastructure of sufficient capacity to serve the student population. Physical infrastructure, such as classrooms, cafeterias, gymnasiums, and libraries, make up the majority of the infrastructure needed to foster education. The University of Tennessee acknowledges the importance of infrastructure in their Master Plan 2011 document, which states, "Having sufficient and appropriate facilities is an absolute prerequisite for increased actual and perceived quality…" The Tennessee Advisory Commission on Intergovernmental Relations (TACIR) report titled "Do K-12 School Facilities Affect Education Outcomes?" from January 2003 states: "Almost all of the studies conducted over the past three decades, including two in Tennessee, have found a statistically significant relationship between the condition of a school, or classroom, and student achievement. In general, students attending school in newer, better facilities score… higher on standardized tests than those attending in substandard buildings."

Overall the public school system in the State needs to add new schools or additions, or needs to renovate existing facilities to meet current and future attendance needs. The average daily membership of elementary and secondary school-age children in the state for the 2014-15 school year was 959,536 students, which is an increase of about 1.5% from the 2008-09 school year. While the statewide growth rate is relatively low, there are local variations in daily membership by county or school system based on local changes in population. Fast-growing cities and counties have experienced as much as 3.2% growth from 2007 to 2013, and these areas contribute greatly to the overall need for new schools, additions, and renovations or maintenance.

The State reported a total need for education infrastructure improvements across K-12 and Post-secondary classifications of about $8.5 billion for the period from July 2013 to June 2018. That total is comprised of about $3.9 billion for K-12 public schools and $4.6 billion for Post-secondary education. The projected cost for K-12 public schools includes about $1.7 billion for new schools or additions to address capacity needs. About $1.4 billion are needed for new buildings or additions at Post-secondary institutions.

As of July 2013, 82 of the State's 1,746 elementary and secondary schools, about 5%, were in fair or poor condition. Those schools were distributed across the state and across school districts of all sizes. Those schools comprise approximately $560 million of renovation or replacement cost, which is about 26 percent of the $2.12 billion total needed to renovate, replace or upgrade existing schools. Post-secondary schools need $3.17 billion over the same period to renovate, replace or upgrade existing buildings and grounds. However, almost 85% of the total need for K-12 schools is not fully funded, and the amount of need (for new schools and renovations) that is not currently funded at all is almost 73% of the total. Post-secondary needs are similarly underfunded, although there are more funding options for those schools

than the K-12 schools, which rely entirely on State appropriations for funding. Historically in Tennessee, needs that are not fully funded usually remain unfunded. Therefore, we expect future funding for the majority of public school infrastructure needs in the State will also likely not be met.

The cost to operate the K-12 schools has remained relatively consistent during the prior seven years, but maintenance costs have increased by about 20% during the same period. The K-12 schools generally receive a passable grade with respect to providing public safety, based on the School Safety Index declining only slightly over the prior three years.

Condition & Management

Public education is required by state law to maintain average class sizes according to the age/grade of the student. Based on student counts and the required averages, the State needs at least 40,404 classrooms (Table 1). The 2014-15 inventory shows 61,129 permanent or portable classrooms in the state, and another 10,283 classrooms categorized as "other classrooms." The number of permanent and portable classrooms reported is almost 33% more than required based on statewide application of totals and averages. The definitions of classrooms used in the inventory are not available. The "other" category includes rooms like cafeterias, gymnasiums, auditoriums, and libraries which are needed to support education of the student body but are not strictly a classroom for instruction.

Table 1. Required Classrooms.

Grade Level	Required Average Class Size, students per class	Required Maximum Class Size, students per class	Average Daily Membership (ADM), students	Minimum Classrooms Required (ADM/Average Size)
Elementary School	20	25	450,097	22,505
Middle School	25	30	216,929	8,677
High School	30	35	276,673	9,222
Other (special education, vocational, etc.)	N/A	N/A	15,837	N/A
Totals			**959,536**	**40,404**

Naturally, the distribution of students across the state does not equal the distribution of classrooms in the state, and consequently additional classrooms are needed. School systems in Davidson, Williamson, Rutherford, Montgomery, Sumner, and Wilson Counties had increases of more than about 2,000 students from 2007 to 2013, and those six systems estimated a total need of $779 million for new schools. That total is 56% of the statewide total estimated need for new schools. For the 5-year period from July 2013 to June 2018, school systems in the state project a need for 67 new schools. As many as 69 of the State's 135 school systems report a need for new schools, additions, or replacement schools. However, 55 of the school systems report no need for at least one of the improvements. The distribution of the

number of systems projecting a need is shown in Table 2.

Table 2. Distribution of School Needs.

Capacity Need	No. of Systems	Cost (millions)
New School	28	$1,385
Additions	69	$333
Replacement	14	$345
No Need	55	N/A

Another indicator of the capacity of the school system is the number of portable classrooms in use. In 2013, there were 2235 portable classrooms in use across the state. More than half of these (57.3%) are used in school systems that have projected a need for new schools.

About 95% of the State's 1,746 public school buildings are in "Excellent" to "Good" condition according to the 2013 inventory. The distribution of the condition of existing schools in the state is shown in Table 3.

Table 3. Condition of Existing Schools.

Condition	Number of Schools	Percent of Total
Excellent	679	38.9%
Good	985	56.4%
Fair	77	4.4%
Poor	5	0.3%

Four schools dropped from Excellent to Good condition and another 28 improved to Good condition during the period from 2012 to 2013. The number of schools listed as Fair or Poor condition dropped by 40 during the same time frame, which suggests some schools were replaced or taken out of service. The 82 schools listed in Fair or Poor condition have been listed in this condition for some time.

Schools reported in fair or poor condition typically had average ages in the range of 52 to 62 years. Half of the schools in use in the State today were built between 1950 and 1980, and therefore are 36 to 66 years old. As these schools continue to age, we should expect future reductions in overall school condition or continued increases in the cost needed to maintain Excellent or Good condition.

In spite of the raw numbers of schools listed in Excellent or Good condition, the cost of infrastructure improvements needed at existing schools continues to increase compared to prior years. The State projects a total of $1.87 billion is needed to renovate or replace existing public schools buildings, and another $250 million is needed for "other needs," which comprise technology updates and State mandates. Of the renovation or replacement total, $1.31 billion (70%) are needed for renovations to schools rated as Excellent or Good condition, and another $560 million (30%) are needed to renovate or replace schools rated as Fair or Poor condition. While the increased cost of improvements is mainly affected by the physical condition of the schools, a smaller percentage of the cost is needed to address technology improvements or

State or Federal mandates. The projected cost to improve technology is $130 million. State and Federal mandates, such as the Education Improvement Act (EIA) of 1992 class size limits or the needs to meet building and fire codes or to reduce environmental hazards, such as asbestos or lead, are projected to cost $120 million for the 2013 inventory.

The needs and costs discussed above relative to the capacity and condition of the schools do not explicitly account for costs for operation and maintenance of the schools. Review of the State's Annual Statistical Reports for the years ending 2007 through 2015 shows the cost of Operations has remained relatively unchanged during this period, with an average annual cost of about $530 million. During the same period, the cost of Maintenance has increased by at least $36 million to a 2015 total near $210 million. Within both categories, most of the costs are related to things that are not physical infrastructure, such as salaries, fixed charges, contracted services, and miscellaneous costs.

Data are not readily available to directly assess the extent to which public safety is jeopardized by the condition of the State's public schools. The rating of a school condition from Excellent to Fair includes the expectation that the structural integrity of the school and its components are sound. Schools rated as Poor condition therefore represent the highest risk to the public, and as noted above only 5 schools in the state were rated Poor during the 2013 inventory.

In 2007, the State enacted the Schools Against Violence in Education (SAVE) Act, which requires annual reporting related to violent incidents and other safety-related issues in schools. The annual reports document numbers of incidents of various types, ranging from possession of weapons to assaults against staff and students, at each public school in the state. These incidents are then converted to a School Safety Index, which expresses the number of incidents reported as a percentage of the Average Daily Membership (number of students) in the schools. For the 2008-09 school year the statewide School Safety Index was about 1%, and for 2014-15 the statewide index was about 0.6%. Infrastructure does not strongly correlate to the types of incidents that contribute to the index, but some elements of infrastructure, such as video monitoring systems, for example, may help improve overall safety at a school. The School Safety Index is relatively low and is gradually trending downward. Spending for safety-related issues at public schools was about $4.6 million in 2009-10 and rose to about $6.3 million in 2014-15.

Funding & Future Needs

The current inventory shows a need for $8.49 billion of infrastructure improvements over the 5-year period from July 2013 to June 2018. This projected need is comprised of $4.57 billion for Post-secondary Education (College and University), $2.12 billion for renovations and replacements of existing public school (K-12) infrastructure, $1.72 billion for new schools and additions (K-12), and $880 million for system-wide and other infrastructure needs.

Funding for education infrastructure improvements comes primarily from the local public school systems. Overall funding for public schools comes from the State through the Basic Education Program (BEP) funding formula, which is based on State law requiring free public

schools for all students. The funding formula provides funds for all aspects of the operation of the public school systems, including salaries for staff, food service, and other expenditures. Funds for capital improvements, which typically are intended to address needed infrastructure improvements, are part of the BEP, but there is not a requirement to use those funds solely for capital expenditures. Consequently, funding for infrastructure improvements has historically been used for other aspects of the overall education budget, and many infrastructure needs go unfunded. Historically in Tennessee, needs that are not fully funded usually remain unfunded. See Table 4 for a summary of funding of selected categories of needed improvements.

Table 4. Funding Status for Needed Improvements.

Infrastructure	Need (billions)	Fully Funded (billions)	Not Funded (billions)	Partially Funded (billions)
Post-secondary	4.57	0.01	0.01	4.55
New schools and adds	1.72	0.28	1.26	0.18
System-wide	0.012	0.004	0.008	0.000

Resilience is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents and the ability to expeditiously recover and reconstitute critical services with minimum damage to public safety and health, the economy, and national security. Considering that more than half of the public school buildings in the system were built long before building codes addressed many of the concepts now routinely required (such as seismic risk or ADA requirements), we subjectively concluded that education infrastructure is not very resilient. Innovation is the implementation and strategic use of innovative techniques and delivery methods. The inventory includes a small percentage of need for technology improvements in the public schools, but those do not necessarily reflect innovation. We considered the schools were about average with respect to innovation, considering that many school systems are now utilizing mobile communication systems and internet-based social media to enhance communication (such as text alerts for school closures, or "amber" alerts) with students and parents.

- **Build new schools and additions to address capacity needs, but make new schools sustainable in their designs** to lengthen their service life to reduce future maintenance, energy, and life-cycle renovation/replacement costs.

- **Use creative solutions and methods to increase funding for infrastructure improvement projectS.** School facilities could be considered for additional uses and revenue opportunities to support the school whether through dual-use or cohabitation with other local services, private operations contracts with daycare providers or even special event fees.

- **Incorporate reliance on innovations and technology to reduce need for/cost of new or replacement physical infrastructure.**

- **Consolidate or eliminate services that require physical infrastructure and re-purpose those spaces for classrooms.**

Every school has a cafeteria for preparation of meals on site. Consider a central kitchen to make the meals and then a delivery service to distribute the meals to the schools where the students could eat in their classrooms. The cafeteria spaces at each school could then be converted into added classroom space. Most schools have a library which can almost be replaced entirely by internet-based resources. Consider renovating libraries to provide smaller space with computers for internet access and use the remaining space for added classrooms.

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Transit: D+

Introduction

Mobility is important to Tennessians. It is an essential part of life in the state and for some, transit is their only option. That is reflected in the Tennessee Public Transportation Association report from 2012, "Nearly 35 million trips were taken on public transportation in Tennessee, an 11% increase since 2010."[1] During the same time period there were over 71 billion miles traveled in Tennessee. Tennessians log over 11,000 vehicle miles per capita annually.[2]

The 2016 Mobility Policy Paper drafted as part of the Tennessee Department of Transportation's 25-year Strategic Plan notes that in Tennessee ridership as of 2010 was at 0.7%.[2] The same study also indicates "in 2012, just under 1.7 million Tennessee residents lived within the service area of one of the four largest transit agencies in the state, and hundreds of thousands more live within the service area of smaller urban transit agencies. Rural transit service operates in all 95 Tennessee counties, thus every Tennessee resident has access to at least some level of transit service."[3]

Condition & Management

The condition and management of Tennessee's Transit systems can be measured through the activities maintaining the vehicle fleet and through projects and programs to provide a safe, efficient and reliable system. According to the Survey of State Funding for Public Transportation Final Report 2014, Tennessee has 26 transit systems statewide[4] and can be classified as: Urban (4), Small Urban (12) and Rural (10).

Each of the systems has replaced transit vehicles as needed or has performed modifications that reflect the needs of the community it serves. Shelby County, for example, recently completed a project that retrofitted 60 older-model Memphis Area Transit Authority buses with equipment designed to restrict emissions of hydrocarbons, particulate matter and carbon monoxide.[5] The Metropolitan Transit Authority in Nashville, as a result of the 2010 Flood replaced over 70 flood damaged vehicles in 2011.[6]

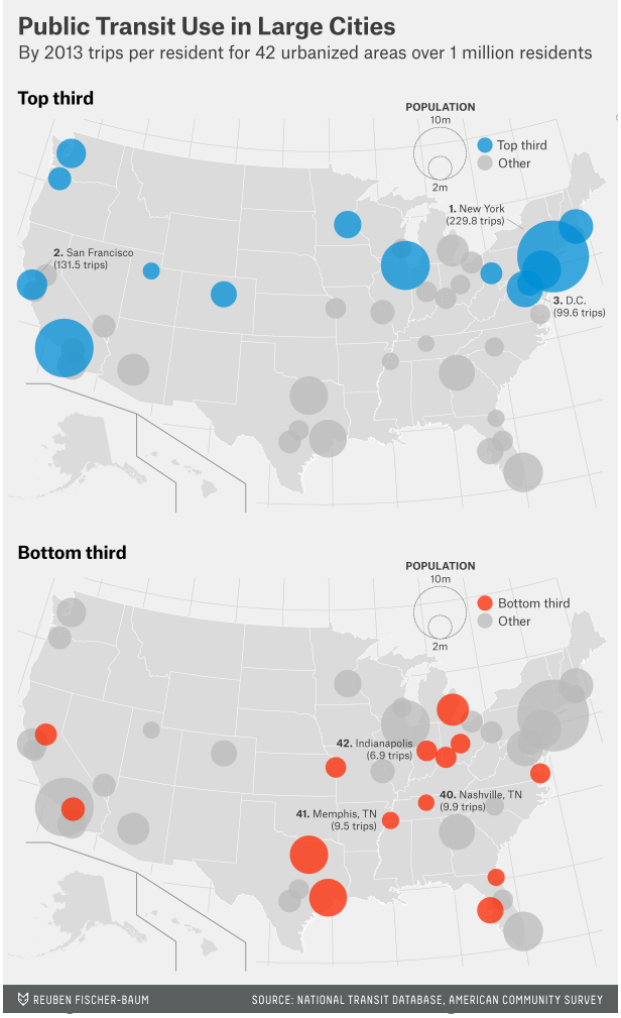
The Memphis MPO is currently studying the use of Bus Rapid Transit (BRT) and Light Rail Transit (LRT) on corridors with particularly high transit usage and potential.

Knoxville Area Transit (KAT) has continued to develop its presence in the City of Knoxville with opening the John J. Duncan Jr. Knoxville Station. This state of the art station was designed and built as a multimodal terminal and was the city's first LEED certified government building.

In Chattanooga, the TPO has recently completed a Multimodal Transit Center Study and is currently working with a TIGER Grant to look at rail transit in that community.

Transit in Tennessee has the opportunity to perform well in comparison to other systems nationwide and does in the rural systems. The majority of rural transit providers operate on a demand response basis, meaning they respond to individual requests for transit service rather than providing a number of fixed routes within the service area. It is important to note that ridership within these rural areas has grown by over 16% between 2010 and 2012.[7]

In 2010, the Regional Transportation Authority in conjunction with Franklin's TMA Group and Gray Line began to offer express bus service with the 91X and 95X service from Franklin and Spring Hill/Thompson Station respectively and downtown Nashville. RTA expanded the express service to 7 additional routes serving communities far outside the Nashville urban core. Those express services have continued and now promote 10 express routes and the Music City Star.



Although some positive programs for transit are occurring at the state level, there are many areas where the momentum has been stifled, such as the Nashville Amp. The Bus Rapid Transit project was a 7.1 mile route intended to connect the West End of the city to Five-Points. The project pitted some external political pressure against proponents of the system who took on the challenge of promoting Nashville Mayor's Amp project. The Project had substantial support on both sides of the issue, but was eventually struck down by the Tennessee State Senate in 2243.[8] (SB 2243)

In 2013, trips per resident were evaluated in the 42 largest urbanized areas in the United States with populations over 1 million residents. (Figure 1) Tennessee's two largest cities, Nashville and Memphis are 40th and 41st respectively out of the 42 cities evaluated. Nashville logged 9.9 trips per capita while Memphis logged 9.5. The remaining 2 Urban systems in Tennessee were Chattanooga at 7.8 trips per capita and Knoxville at 6.0 trips per capita.[9] In Chattanooga, the city is "at the bottom of the list, - where only 22.5 percent of working age residents have access to public transportation."[10]

FUNDING & FUTURE NEEDS

There are significant efforts in various areas of the state to improve the access and availability within the state. An example is the Tennessee Department of Transportation's partnership with the Rockefeller Foundation, which commissioned the "Transportation Process Alternatives for Tennessee; Removing Barriers to Smarter Transportation Investments" in 2012, to look at revision of some of the planning areas to include Context Sensitive Solutions, road diets, and funding formulas for new partnerships.[11]

Across the state, individual agencies are engaging in various studies to advance transit into the minds of Tennessee commuters. The Nashville MTA/RTA Strategic Plan, called "nMotion" is a 25-year comprehensive plan designed to meet the Nashville area's vision for transit. The plan will look at how the transit system works today and identify opportunities to enhance the transit system, improve service, attract and retain new riders and meet the growing needs of the Nashville region. Throughout

the project, the public will engage in developing the blueprint of actions to make the best opportunities a reality.

Transportation investments in America are largely paid for by fuel taxes levied at the federal, state, or local levels. In general, about 40% of the cost to operate transit comes from fare-box returns and advertising sales, leaving about 60% to be covered by some other local, state, or federal revenue sources. By comparison, about 50% of the cost to build and operate our roadways system is covered by fuel taxes. The remainder of costs are covered by some other tax or toll. Between 2013 and 2014 Transit funding has increased by 24.5% in total funding.[12]

Lawmakers and civic leaders are making progress in advancing transit options and accessibility across the state. Other work in the area of transit for the Nashville Metro region is the Transit Alliance of Middle Tennessee who operate the Transit Citizen Leadership Academy. This education endeavor provides civic leaders with the ability to lead discussions with regard to transit in their local areas.

Public Chapter 975 was signed by the governor on May 2, 2016 and offers opportunities for public-private partnerships to finance, build and maintain transit systems across the state. Some of the legislation's provisions: [13]

- Allows city, county and state governments to accept both solicited and unsolicited proposals for transportation projects from private entities
- That also extends to government entities and agencies, like TDOT and Nashville MTA and RTA
- For these types of contracts approved by TDOT, the Legislature's Fiscal Review Committee must review any project within 20 days.
- Gives private entities broad authority in structuring terms and conditions for needed solutions

Signed into law in December 2015, the Fixing America's Surface Transportation (FAST) Act, provides modest increases in federal highway and transit spending. The five-year bill also provides states with greater funding certainty and streamlines the federal project approval process. But the FAST Act does not provide adequate funding to meet the nation's need for highway and transit improvements and does not include a long-term and sustainable funding source.

While the modest funding increase provided by the FAST Act will be helpful, numerous projects to improve the condition and expand the capacity of Tennessee's roads, highways, bridges and transit systems will not be able to proceed without a substantial boost in state or local transportation funding. If Tennessee is unable to complete needed transportation projects in the state it will hamper Tennessee's ability to improve the condition and efficiency of its 26 transportation system and to enhance economic development opportunities and quality of life in the state.[14]

For significant change in the Transit Systems, it is recommended that Tennessee address the areas of accessibility to transit systems, provide more funding opportunities for the systems and integrate transit into all current and future roadway projects. In addition technologies for transit, such as Transit Signal Prioritization projects should be considered for improve reliability within the transit corridors. It is these efforts that will create substantive change within the Transit systems.

Recommendations

- Increase access to transit in urban, suburban, and rural communities so that all Tennesseans have more and better transportation choices
- Adequately fund maintenance of transit vehicles and facilities to keep systems in state of good repair and reduce life-cycle costs
- Require transit systems to adopt comprehensive asset management systems to maximize investments
- Include transit in state and local project development processes and metrics to track performance of transportation systems
- Local, regional, and state government entities – especially in smaller urban and rural areas – should prioritize transit investments that can enhance sustainable land-use decisions

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Wastewater Collection and Treatment: D+

Introduction

The previous Tennessee Report Card (2009) had a grade of "C" for Water and Wastewater systems. ASCE revised its evaluation process in 2015 to include 8 objective grading criteria, and separated water and wastewater into separate chapters. The change in the grade is primarily due to implementing the new criteria, not a dramatic change in wastewater systems' conditions.

Tennessee has 242 municipal sewage treatment and collection systems regulated by National Pollutant Discharge Elimination System (NPDES) permits, and they serve about two-thirds of the state's population. The Division of Water Resources (DWR) of the Tennessee Department of Environment and Conservation (TDEC) issues NPDES permits under the authority and review of the US-EPA. Additionally, there are 60 State Operating Permits (SOP) issued by the DWR for municipal collection and treatment systems which do not have a direct discharge to the environment and are not regulated by EPA. Based on reports submitted by the NPDES permitted systems, they handle about 266,181 million gallons of sewage annually (about 728.8 mgd).

Like most states, Tennessee suffers from aging infrastructures. About 45% of the annual sewage flow treated in wastewater facilities originates from groundwater or rainwater leaking through deteriorated sewage pipes, joints, or manholes This clear water leakage is generally called Inflow and Infiltration (I/I) and represents the most significant and fundamental problem for sewage treatment and sewage collection systems. The effect of I/I is to steal capacity from treatment facilities and piping systems. It also may cause or exacerbate sanitary or combined sewer overflows, releasing untreated or partially treated sewage to watercourses and the environment. Finally, this additional flow results in both increased capital and annual O&M costs. It is estimated that I/I O&M costs are about $217 million annually in Tennessee.

There was a decrease in the number of orders requiring corrective action in 2015, which may have been affected by cutbacks in Division staff and time required to respond to EPA audits that year. By comparison, the Division has already issued the same number of orders in the first three months of 2016 as issued in 2015. Additionally, the Division has initiated programs to promote treatment plant optimization and nutrient removal without constructing new facilities.

The American Society of Civil Engineers believes that broad adoption of the principles of performance-based-ownership will lead to significant reductions in the life-cycle cost of all civil infrastructure, increased public safety, and improved sustainability (ASCE Policy #543).

Condition & Management

Inflow and infiltration (I/I) is a measure of excess flow that represents lost capacity for piping systems and wastewater treatment facilities. It also is an indirect indicator of collection system deterioration since dry weather infiltration and rapid rainfall dependent I/I enters systems through pipe and manhole defects. The annual average level of I/I leakage (45.4%) measured in systems across the state indicates significant deterioration in many wastewater collection systems. Two-thirds of the systems had greater than 50% I/I. Additionally, the survey of MORs (monthly operating reports) for 12 months revealed that 165 systems would likely experience flows that exceed the treatment capacity (as listed in NPDES permits) for the 2-year, 24-hour rainfall event — that's roughly 3.4 inches in 24 hours. Reports

submitted by 55 systems show that they experienced peak-day flows that exceeded facility capacity more than 60 days in a year.

The Enforcement and Compliance History Online (ECHO) database maintained by the US-EPA shows that 42 systems are currently in significant non-compliance with their permits. An additional 73 systems have "reportable non-compliance." Over the past three years, 87 systems have had 20 or more effluent violations. Gross numbers of effluent violations may indicate a potential for public health problems. However, without a detailed analysis of the pollutant parameters, locations, and patterns of violation, and violations for facilities that discharge to impaired waters it is premature for this report to define a level of public safety related to wastewater discharges in Tennessee.

Funding & Future Needs

Generally, the lack of funding for utility improvements from financial agencies and governmental programs may not be the biggest obstacle for most utilities. Instead, setting reasonable rates sufficient to meet financial obligations and stay compliant with state law appears to be a greater challenge. A tabulation by the Tennessee Advisory Commission on Intergovernmental Relations (TACIR) in 2014 for 227 systems showed that average sewer rates ranged from $1.86 per thousand gallons to $12.85 per thousand gallons. The median rate was $5.59 per thousand gallons and the gross average was $6.07 per thousand gallons. These rates likely include debt service and other costs. Since debt service costs may vary widely among systems, there is no direct correlation with the total rate charged to the customer and the average cost to operate and maintain the wastewater systems on a daily basis. Additionally, the cost to operate and maintain treatment facilities may vary widely. For example, Tennessee has 61 lagoon systems (25%), which likely cost less to operate than more advanced treatment processes (which were selected to meet more stringent discharge standards).

All 325 cities and 185 utility districts in the state of Tennessee submit an annual audit to the Tennessee Comptroller of the Treasury each year. According to law, water and wastewater operations are to function as an enterprise fund similar to private businesses. All accounting of financial transactions in the water and wastewater utilities are separate from the general fund and must be self-supporting.

The accounting of utility systems is regulated by state law. The law regulating cities is found in Tennessee Code Annotated § 68-221-1010, and the law regulating utility districts is found in Tennessee Code Annotated § 7-82-401. Each of these has three main criteria when evaluating the financial stability of the utility:

- Deficit total net assets
- In default on an indebtedness
- Has a negative change in net assets for two (2) consecutive years

The one criterion that appears to be more problematic for utilities is the change in net assets. Out of the total 510 utility systems in Tennessee, approximately 25% have at least one year of negative change in net assets or have circumstances that would cause a negative change in net position the following year if rate adjustments are not made. A negative change in net position indicates insufficient revenue to cover operating expenses, depreciation and interest on debt. In most cases, utilities will have enough revenue to cover expense and interest, but not depreciation.

Funding depreciation is key to the financial health of any utility. When a utility funds depreciation, it is replacing cash used in the purchase of a capital expense or improvement such as equipment, vehicles, tanks, pumps, water lines and sewer lines. If depreciation is fully funded, when a capital item needs to be replaced the utility would have sufficient funds to replace it. Accumulated cash from funding depreciation can also be used to pay for new capital expenses or improvements. Many utilities that fully fund depreciation are now self-funded and have little to no assistance from financial agencies or funding sources.

Rehabilitation of sewers to stop leakage is estimated to cost about $1.1 billion to eliminate half of the I/I in Tennessee. The good news is that the cost of rehabilitation could be recaptured through Operation and Maintenance (O&M) savings over a period of 11 to 13 years.

Combining the above estimate of $1.1 billion (to cut I/I leakage in half) with additional data in the US-EPA Clean Water Needs Survey (CWNS) shows an overall need of $2.6 billion for Tennessee. About half of that total could be self-funded based on cost recovery for regained capacity and Operation and Maintenance (O&M) savings. No information was available about likely future funds or loans from government sources to pay for the remaining needs. It is also likely that many communities do not charge adequate rates to cover the full cost of prudent O&M. Therefore, those communities would not see cost recovery for I/I elimination (by sewer rehabilitation) in the same time-period as systems that have been properly maintaining their collection systems for many years.

No information was available on the resilience of system's capability to prevent or protect against significant multi-hazard threats and incidents and the ability to expeditiously recover and reconstitute critical services. However, it is reasonable to think that the problems which were documented for capacity, condition and O&M will also affect resilience.

Innovation and State Iniatives

The Division has promoted improved nutrient removal and overall plant optimization at existing facilities. There were four plants in 2015 and seven more in 2016 with significant nutrient removal after training, some additional instrumentation and consultant involvement. All eleven plants achieved total nitrogen and most total phosphorus removal without chemical addition and with energy savings. The program was supported by Region IV USEPA and is continuing to expand. Plant optimization is being added to permits of plants with capability to introduce biological removal and new plant designs are being screened for operational flexibility and instrumentation to promote optimization efforts.

Recommendations

ASCE has adopted Policy Statements with general principles pertaining to wastewater collection and treatment systems. Our recommendations follow these general principles but are very specific, incremental improvements that will help public entities to better understand their individual systems and help improve the sustainability of their wastewater infrastructure. The recommendations fall in three general categories: identify problems; assist failing systems; and improve operations and sustainability. Most of these incremental improvements are administrative and have a relatively low cost compared to the $217 million being wasted annually by I/I in Tennessee.

The ASCE Policy Statements are referenced as appropriate after each of the following specific recommendations for Tennessee: Policy Statement 283 - Periodic Inspection of Existing Facilities; Policy Statement 299 - Infrastructure Investment Policy; Policy Statement 418 - The Role of the Civil Engineer

in Sustainable Development; Policy Statement 451 - Life-Cycle Cost Analysis; Policy Statement 500 - Resilient Infrastructure; Policy Statement 543- Performance-Based Ownership of Infrastructure.

- Identify and document the extent and magnitude of the problem of leaking sewers I/I) and overloaded treatment plants in Tennessee

  - TDEC require municipal wastewater system operators to calculate and report the amount of I/I leakage in their systems (using the data they already are required to collect) as part of their regular monitoring and permit reporting (no additional cost involved). (Policy 543)

  - TDEC implement electronic reporting of Wastewater Facility operating data in the state Monthly Operating Reports (MORs). (The Federal NPDES reports filed as DMRs are already being reported electronically.) This will require all public sewerage systems to use a computer for creating and reporting operational data. It will also require that TDEC create a computer database system to receive and store the data for analysis. (Policy 543)

- Identify and assist failing wastewater facilities and systems

  - The Tennessee Water and Wastewater Financing Board should add consideration of levels of excessive I/I in wastewater collection systems as one of the criteria in identifying "distressed systems". (This would be analogous to the present practice of identifying distressed water systems through water loss.) (Policy 299 and Policy 543)

  - Municipal systems should conduct annual rate studies for future 5-year periods and verify that they are fully funding depreciation for their wastewater systems. If a negative net change of asset position is predicted, then the system must revise its rates as needed. (Policy 451)

  - "Corrective Action Plans - Engineering Reports" (CAP-ER) required by TDEC as part of Orders issued to municipal systems (experiencing sewer overflows, overloaded wastewater treatment facilities or other I/I related problems) should require an evaluation of the cost-benefits of reducing I/I as part of any proposed improvements. (Policy 451 and Policy 543)

  - TDEC and funding agencies (e.g. USDA) should include requirements for before-after flow and rainfall monitoring and calculation of I/I reduction to measure and report the effectiveness of sewer rehabilitation projects and be accountable to the public. (Policy 543)

- Assist wastewater systems to improve operations and life cycle sustainability

  - TDEC should move to full implementation of the existing "Design Criteria" for sewerage systems, including those sections intended to reduce the impact of I/I, and should implement new criteria to help improve system sustainability and resilience. (Policy 418, Policy 451, and Policy 500)

  - Public wastewater systems should create or update a Capital Improvement Plan (CIP). The CIP should expand over 3 – 5 years, contain the name of each project, the estimated cost, method of financing and estimated amount of new depreciation. Utilities need to realize that capital expenses and improvements will increase depreciation and rates may need to

be adjusted to stay compliant with state laws. (Policy 418 and 451)

- TDEC should require an inspection and performance-based assessment of each treatment facility and collection system by an Engineer at the end of each applicable permit cycle (typically 5 years or more frequently if needed). The assessment should be certified by the Engineer, the Owner, and the Licensed Operator. Completion of the O&M (or CMOM) checklist published by the US EPA would serve this purpose well. (Policy 283 and Policy 543)

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Committee Chair
Monica M. Sartain, P.E.
Power Consulting Associates, LLC
Nashville, TN

Aviation
Lukas Sayler
Forterra Pipe and Precast
Chattanooga, TN

Bridges
Antonio Montiel, P.E.
Volkert, Inc.
Franklin, TN

Scott Wilson, P.E.
Palmer Engineering
Nashville, TN

Ed Wasserman
Modjeski and Masters
Nashville, TN

Dams
Mario Glorioso, P.E.
AMEC/Foster Wheeler
Nashville, TN

Arpita Nandi, Ph.D.
East Tennessee State University
Johnson City, TN

Roads
Ignatius Fomunung, Ph.D.
University of Tennessee at Chattanooga
Chattanooga, TN

Roger Meier, Ph.D.
University of Memphis
Memphis, TN

Schools
Douglas O. Bell, P.E.
TTL, Inc.
Nashville, TN

Navigable Waterways
Lori Troxel, P.E., Ph.D.
Vanderbilt University
Nashville, TN

Craig Philip
Vanderbilt University
Nashville, TN

Transit
Kevin Comstock
TDOT
Nashville, TN

Parks
Helen S. Hennon, P.E.
QE2
Knoxville, TN

Randall McKinnon, P.E.
TLM Associates
Jackson, TN

Water
Jennifer Osgood, P.E.
CDM Smith
Nashville, TN

Paul A. Bizier, P.E.
Barge Waggoner Sumner & Cannon
Nashville, TN

Wastewater
George Kurz, P.E., DEE
Sewer Capacity Management
Madison, TN

Paul A. Bizier, P.E.
Barge Waggoner Sumner & Cannon
Nashville, TN

George Garden, P.E.
TDEC
Nashville, TN

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