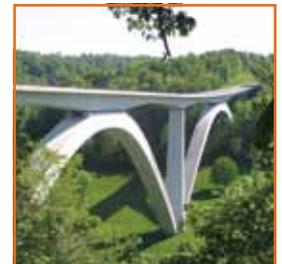
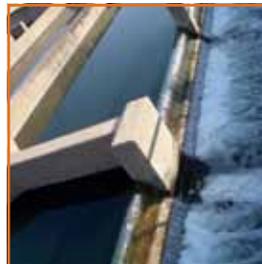
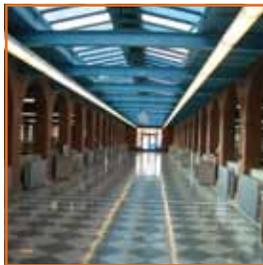


MUSIC CITY Infrastructure

REPORT 2013



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Infrastructure needs can be a hidden problem. Leaking underground pipelines go unnoticed until a pipe bursts or large potholes surface. Roads and bridges wear down with everyone's daily commute but rarely make headlines unless a catastrophic event occurs, like the Minneapolis bridge collapse. Infrastructure, by its nature, is a long-term proposition that is meant to be constantly available for citizens, but it's easy to forget that it also needs maintenance to keep up with citizens' constant use. Consider the problem at the state level shown by the *2009 Report Card for America's Infrastructure*:

- 21% of Tennessee's bridges are structurally deficient or functionally obsolete.
- Tennessee has 148 high hazard dams — defined as a dam whose failure would cause a loss of life and significant property damage.
- 6 of Tennessee's 658 dams are in need of rehabilitation to meet state dam safety standards.
- Tennessee's drinking water infrastructure needs an investment of \$2.77 billion over the next 20 years.
- Tennessee's ports handled 48 million tons of waterborne traffic in 2005, ranking it 19th in the nation.
- Tennessee reported an unmet need of \$1.1 billion for its state public outdoor recreation facilities and parkland acquisition.
- 43% of the major urban highways are congested, and the miles vehicles travel on Tennessee's highways increased by 52% from 1990 to 2007.
- Tennessee has a little over \$1 billion in wastewater infrastructure needs.

The scope of the problem can be mind-boggling, but the old adage applies: the longest journey begins with the first step. The need to build awareness and educate the public to the benefits and necessity of excellent infrastructure is urgent. Without public interest it is difficult to muster the political will to seek funding to solve the problem. Hopefully this report, the 2012 Music City Infrastructure Report (MCIR), will improve the dialogue and assist stakeholders in their decisions by giving the public an easy to understand format to show how their infrastructure is doing.

In January 2011, representatives from Urban Land Institute's Nashville District Council (ULI Nashville) and the American Society of Civil Engineers, Tennessee Section, Nashville Branch (ASCE) decided to team up to explore infrastructure issues in Metropolitan Nashville. The impetus for such a collaborative project stemmed from ULI's focus on infrastructure issues facing the nation coupled with ASCE's leadership in promoting the infrastructure challenges facing communities through their National and State Infrastructure Report Cards. Both of these efforts paint a picture of grave concern over the state of infrastructure at national and a state levels. An examination at the local level would add a valuable perspective to smart growth, the real cost of development, effective public expenditure, and best practices in the use of land across the region.

The intent of this report is to develop a sense of priority and guide the discussion on how to best fund Nashville's infrastructure needs. To do this, the Committee elected to utilize a "stoplight" color scale to indicate the status of each of Nashville's infrastructure categories:



It is imperative to stress that the evaluation given in this report is not a reflection of the hard work, talent and devotion of the numerous employees all the agencies involved in building and maintaining the infrastructure for our city. Public officials in Tennessee do an outstanding job working within their budgets and the limited resources they are provided. To that point, one of the uses of this study is intended to highlight for elected officials how their decisions impact those planning, building, and maintaining our infrastructure.

This is a starting point, a first step. By its nature, the status of data collected for the MCIR changes over time. Its accuracy is guaranteed at the point of its collection and would need to be verified for any necessary updates. We look forward to improving the quality and quantity of information available, and we welcome the feedback of the readers of this Report. In the spirit that our great city rallied after the devastating flood of 2010, "We are Nashville," and we can build a great city with world-class infrastructure.

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Based on research and evaluation of data collected, this report surveys the current condition and anticipated needs of Metropolitan Nashville's infrastructure. The Tennessee Advisory Commission on Intergovernmental Relations (TACIR) has stated that the total identified need for Davidson County over the next five years is \$4,308,982,950 or \$6,876 per person in the Metro Area. But how will the spending for such a massive number be prioritized — and will the funding be there? At a state level only \$11.1 billion in funding has been identified for a need of \$29.5 billion or 38%. Applying the same percentage to Metropolitan Nashville's need, only \$1.6 billion of the \$4.3 billion need is funded. Creative solutions will have to be found to address this glaring need.

Scope

A challenge in drafting this initial report was defining the scope of work — what is “infrastructure?” Clearly, infrastructure is the bones of the metropolis: it is the roads, the rails and airports. It is the bridges and tunnels. It is also everything under the ground — our fresh water systems extending miles from the banks of the Cumberland and our storm and waste-water systems bringing it all back. However infrastructure is more too — it is what makes a city viable. Cities are corporate entities where the citizens are the shareholders. The quality of a city's infrastructure represents the value that the shareholders place on the enterprise. To that end, it is the parks, greenways and bikeways. It is the schools and the power plants. In our sustainable consciousness infrastructure is how we recycle and reuse land, buildings and materials. It is what accommodates smart growth of the city and its population. It is the preservation of our biodiversity, through development of sustainable infrastructure, for future generations and perhaps most importantly, for the quality of life.

Excellent work in studying our current infrastructure and evaluating future needs has already been done — and continues apace — by our Metropolitan Planning Organization and civic interest groups like Cumberland Region Tomorrow, TACIR, Transit NOW and the Transit Alliance. For purposes of this inaugural report the focus is in the readily quantifiable information without spending a lot of effort on topics already covered. Thus, the Committee zeroed in on water systems — potable, waste and storm; roads, bridges and bikeways. In these subject areas extensive research and data collection was conducted. In addition to these highly researched and peer reviewed sections, “survey” sections on our energy grid, parks and recreation and mass transit have been included. These sections were compiled with more readily available data to give the reader an overview, but lack the extensive research and evaluation the other sections received.

Evaluation Criteria

Rather than re-invent the proverbial wheel, the joint Urban Land Institute Nashville (ULI Nashville) and American Society of Civil Engineers (ASCE) committee elected to mirror ASCE's methodology set forth in their instructions for the 2009 America's Infrastructure Report Card. The following factors were considered and evaluated:

- **CAPACITY:** Do the in-place systems have the capacity to accommodate the

current load? Based on population growth expectations will they have the capacity in 5, 10 or 20 years?

- **CONDITION:** What is the current condition of the infrastructure and where are the problems?
- **FUNDING:** What is the current level of funding? Is it adequate given the need, the capacity and the condition?
- **FUTURE NEED:** Based on the projections of need, what is the anticipated funding level over the next 5, 10, 20 years? Are the current levels and sources high enough to support future need?
- **OPERATION & MAINTENANCE:** Do the managers of our infrastructure have the personnel, equipment and operational infrastructure to properly operate and maintain the infrastructure?

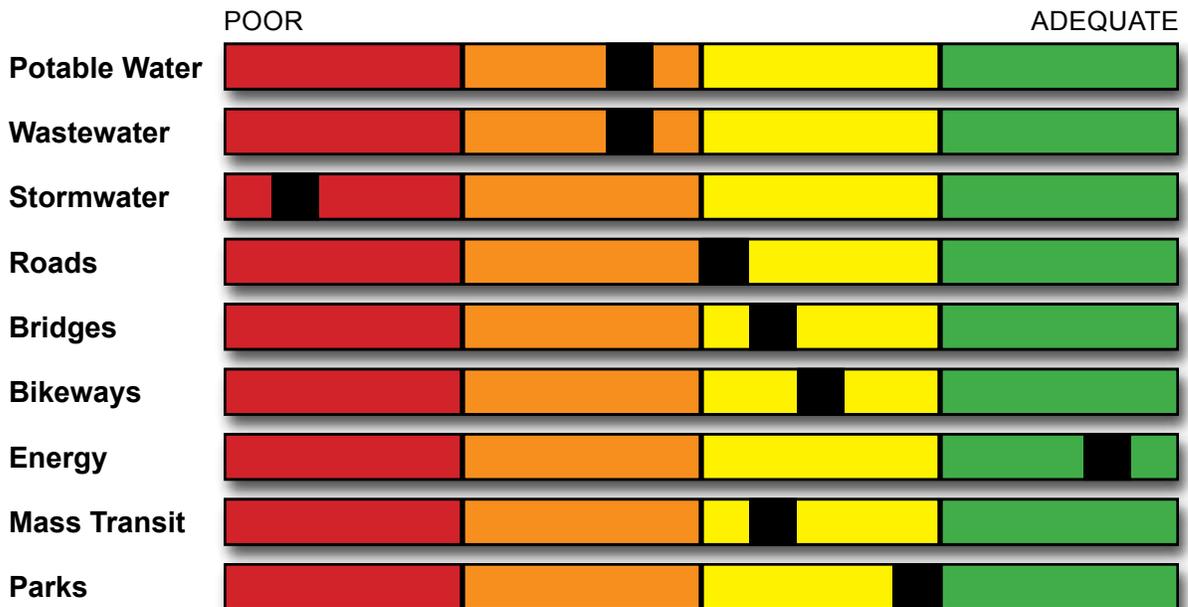
While there is some variation among the platforms, this approach allows for an objective analysis of the current condition and future need.

The Survey Sections were also assigned a stoplight assessment — arguably more subjective than the more thoroughly researched sections, but in a range that with the public awareness of these areas should be acceptable.

Basic Findings

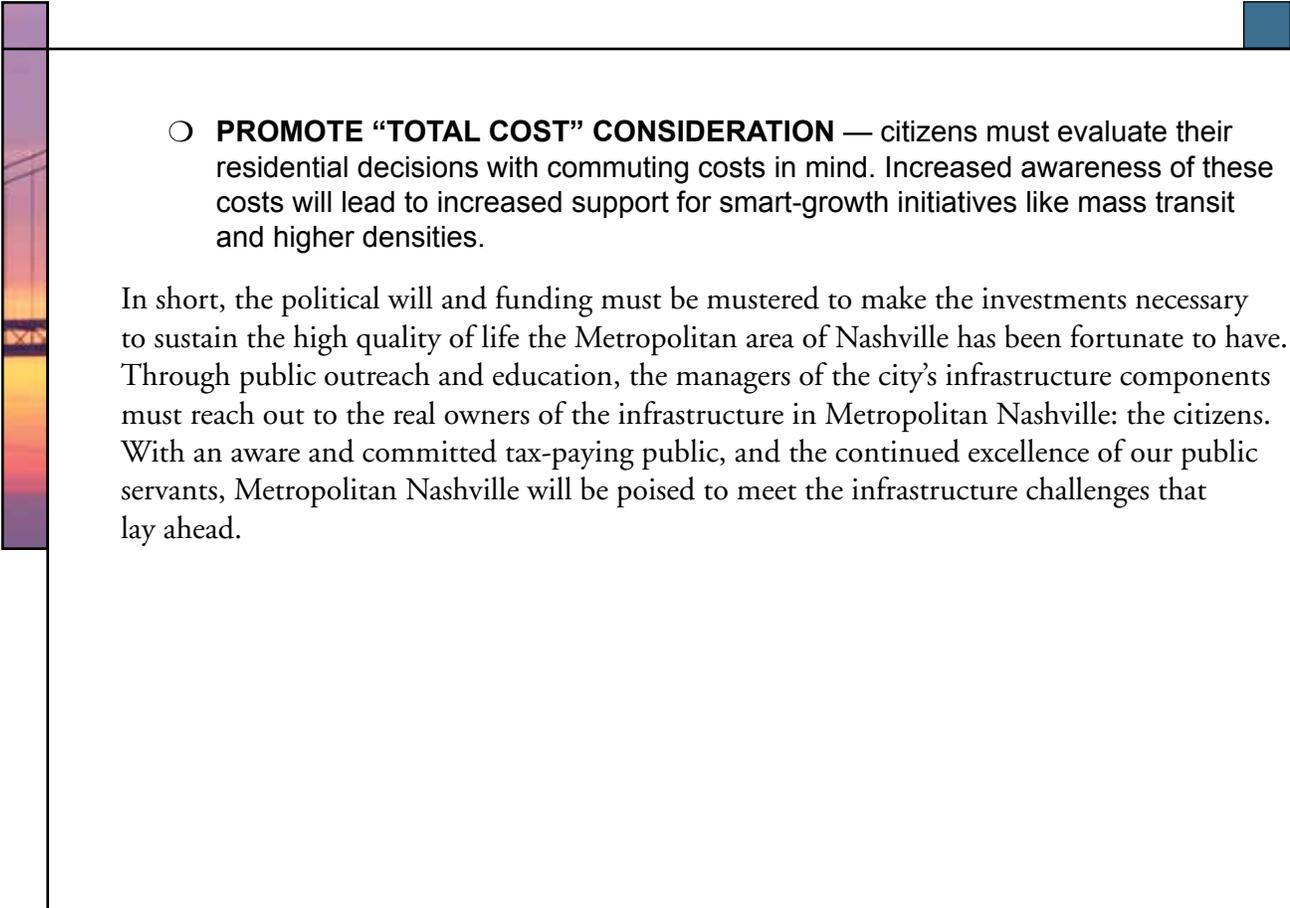
In summary, the analysis shows that some systems are in better shape than others. More often than not, this is a direct result of where funding has been focused in the past. While funding might be inadequate, the services provided by the personnel are superlative. Nashville is fortunate to have a gifted leadership and work force in Infrastructure that is strong and committed.

A summary of the findings of our research is exhibited in the following chart:



The findings of this report tell us that while, for the most part, the city's infrastructure is functioning without significant issues. It is not exceptional nor are all areas well poised to accommodate the anticipated future growth of the Metropolitan Nashville region. The joint committee recommends that government officials and policymakers take action, and consider the following ten-point plan:

- **EDUCATE THE CITIZENS OF NASHVILLE** about the status of the infrastructure, what the risks are of under-investing in it and educate the public on the true costs of making required upgrades or building new systems. Utilize knowledgeable professional organizations such as ULI Nashville and ASCE to help make the case.
- **INCLUDE LIFECYCLE COSTS** that take long-term maintenance and repair into account for future infrastructure repairs and replacement decisions.
- **DEVELOP AN URBAN AND REGIONAL VISION** to provide the framework for implementing future infrastructure construction and maintenance. This vision should help guide the policy and funding initiatives that will be required in the future. The creation of a consolidated "Infrastructure Plan" to account for future growth should be considered, and could be part of the General Plan Update for 2040 process.
- **FOCUS ON MAINTAINING PAST INVESTMENTS** and fund maintenance and repairs of the existing system to bring it up to the high quality the citizens deserve. Repairing and modernizing outmoded systems — reducing leaks in water systems, for example — will make more efficient use of what exists.
- **EXPLORE METHODS OF FOCUSING DEVELOPMENT** to align highway, transit, water and housing in integrated land use solutions that capitalize on existing infrastructure to maximize existing capacity. Extending infrastructure such as roads, sewer lines, and water mains to outlying areas may not be justifiable at the expense of shoring up existing systems.
- **INTEGRATE INFRASTRUCTURE SYSTEMS IN FUTURE GROWTH PLANS** to maximize efficiency and reduce cost. Integrated transit systems that incorporate vehicle, mass transit, bicycling and pedestrian traffic, for example, should be considered.
- **INCORPORATE "GREEN INFRASTRUCTURE" INTO THE SOLUTIONS MIX.** The use of "green infrastructure," can improve Nashville's aesthetic appeal while helping to remove pollution. Large paved areas that become "heat sinks," need to be rethought to include permeable surfaces that allow rainwater to seep into the table below. This achieves better storm drainage while also improving water cleanliness and potentially improving habitat for wildlife and recreational space.
- **EMBRACE DENSITY** to accommodate more intense development along existing corridors of infrastructure. The citizen shareholders need to understand that to preserve our open spaces and high quality of life, a more intense urban fabric will have to emerge over the next 25 years.
- **ENCOURAGE COST-EFFECTIVE MASS TRANSIT ALTERNATIVES** to ease traffic congestion along major corridors and reduce parking needs in the urban core.

- 
- **PROMOTE “TOTAL COST” CONSIDERATION** — citizens must evaluate their residential decisions with commuting costs in mind. Increased awareness of these costs will lead to increased support for smart-growth initiatives like mass transit and higher densities.

In short, the political will and funding must be mustered to make the investments necessary to sustain the high quality of life the Metropolitan area of Nashville has been fortunate to have. Through public outreach and education, the managers of the city’s infrastructure components must reach out to the real owners of the infrastructure in Metropolitan Nashville: the citizens. With an aware and committed tax-paying public, and the continued excellence of our public servants, Metropolitan Nashville will be poised to meet the infrastructure challenges that lay ahead.

Overview

In the U.S., we are fortunate to have excellent treatment processes in place to provide safe drinking water to nearly every citizen. Guidelines set by the Environmental Protection Agency (EPA) require treatment to remove dangerous organisms and chemicals from our water to make it safe [1]. However, the infrastructure that delivers the water to our homes and businesses is aging resulting in both loss of treated water through leaks and inefficiencies in transport due to corroded pipes [2]. The infrastructure (i.e., water treatment plants, storage tanks, and distribution lines) is being used well beyond its designed intentions. Leakages account for approximately 13 percent of system losses in the U.S. each year of treated municipal waters [3].



Figure 1: Water System Leakages from Select Cities across the US

| City | Water system leakages [% of water lost between 2000 and 2010] |
|----------------|--|
| City Average | 12.8 |
| Atlanta | 31.4 |
| Boston | 9.0 |
| Charlotte | 11.0 |
| Chicago | 2.0 |
| Cleveland | 28.7 |
| Dallas | 9.1 |
| Denver | 5.0 |
| Detroit | 15.9 |
| Houston | 11.8 |
| Los Angeles | 5.3 |
| Miami | 8.3 |
| Minneapolis | 6.0 |
| New York City | 14.2 |
| Orlando | 10.0 |
| Philadelphia | 26.5 |
| Phoenix | 6.6 |
| Pittsburgh | 26.0 |
| Sacramento | 10.0 |
| San Francisco | 8.8 |
| Seattle | 8.0 |
| St. Louis | 3.0 |
| Washington, DC | 14.4 |

Source: <http://growingblue.com/wp-content/uploads/2012/07/Leakage-Rate-US-Cities.png>

Leakages account for approximately 13 percent of system losses in the U.S. each year of treated municipal waters [3].

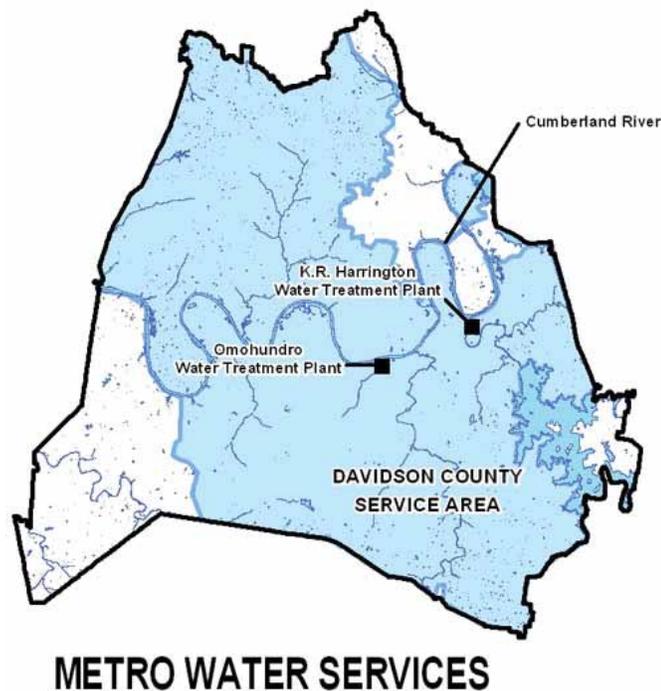
In many areas, especially water rich regions like Tennessee, water is derived from nearby rivers and streams for treatment. In Davidson County, water is obtained from the Cumberland River and must be filtered and treated to remove debris, bacteria and pollutants for safe human consumption. After treatment, the water is pumped to holding tanks or sometimes directly to our homes and businesses for use [4].

Davidson County has several utilities providing treated drinking water to customers including Metro Nashville Water Services (MWS), Madison Suburban Utility District (MSUD), and Harpeth Valley Utility District (HVUD). Some of these systems provide water for individuals outside Davidson County also. MWS serves 176,033 customers each year including some in Williamson and Rutherford Counties [4]. The extent

of Metro Water Services within Davidson County is shown in Figure 2. MSUD serves an approximate 18,000 customers in the northeastern area of the County [5]. The westernmost portion of Davidson County receives water service by the Harpeth Valley Utilities District (HVUD) with approximately 16,000 customers. In addition to Davidson County residents and businesses, HVUD is a regional provider of water to six other water utilities in Cheatham County and Williamson County [6-7].

Because multiple utilities serve Davidson County residents, each utility was examined individually (where data was available) and weighted composite scores were developed based upon individual system attributes and the apportionment of the county area/customer base served for use in identifying the overall grade.

Figure 2: Metro Water Services' Davidson County Service Area



Stoplight Evaluation

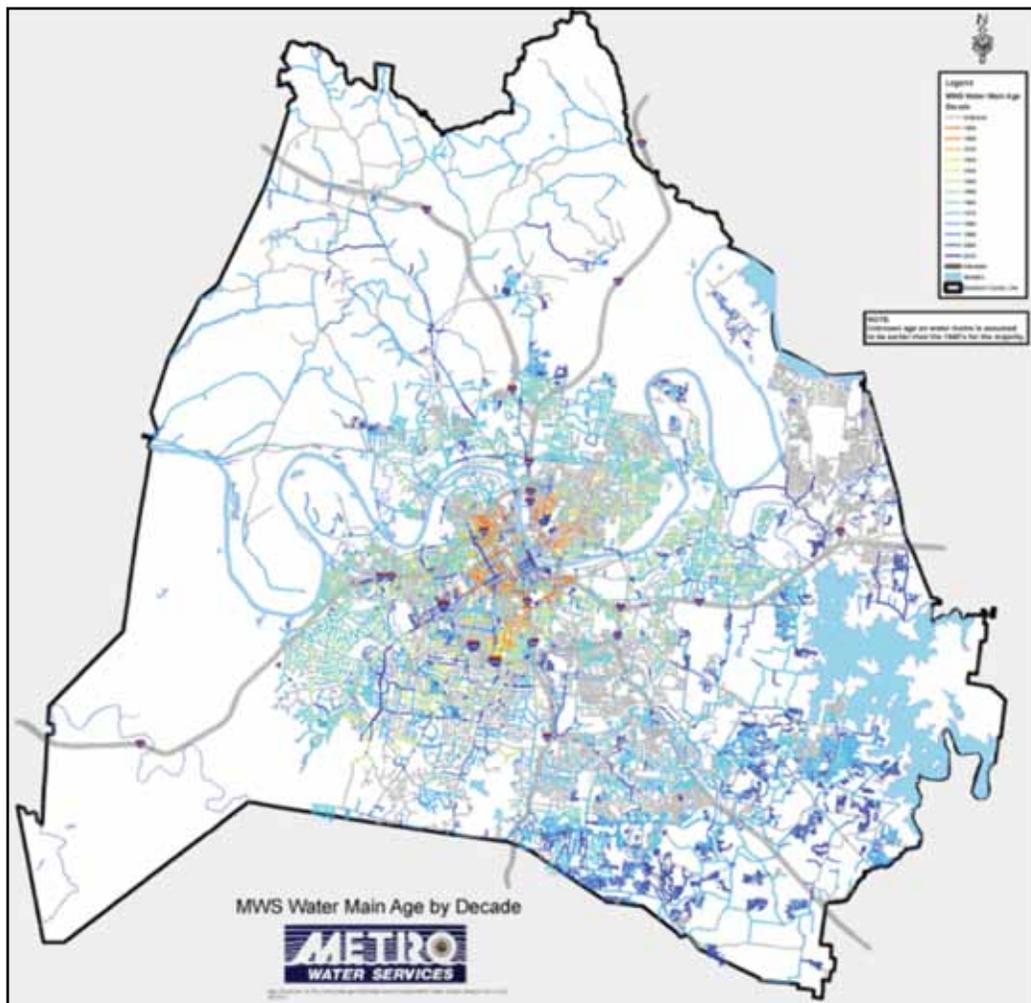


Condition

As previously mentioned, the infrastructure associated with getting safe drinking water to customers (i.e., treatment plants, storage tanks, and distribution lines) is being used well beyond its intended design life and is showing signs of wear. According to the EPA, the useful life of water infrastructure components (e.g., treatment plants, pipes, valves, etc.) ranges from 20 to 50 years [8]. In the U.S., an average water treatment system loses approximately 13% of that treated water en route to customers causing increased treatment costs and difficulties in meeting demands in areas with limited water sources [3].

MWS operates and maintains two water treatment plants: R. L. Lawrence “Omohundro” Water Treatment Plant and K. R. Harrington Water Treatment Plant. The Omohundro Plant is on the National Historic Register with a pumping station constructed in 1889 and a filtration plant constructed in 1928. The Harrington Plant was constructed in 1976. The Madison Suburban Utility District (MSUD) water treatment plant was built in 1925, but has had several additions since [5]. HVUD’s water treatment plant was built around 1964 and has also had several expansions and improvements since original construction [9].

Figure 3: Age of Water Main Distribution Lines for MWS (source: MWS)



MWS has 1827 miles (64%) of water distribution lines that are greater than 40 years old. An additional 746 miles (26%) of these lines are at least 20 years old and only about 10% (~298 miles) of water lines owned and operated by MWS are less than 20 years old [10]. In the figure below, the lines represent the age of pipelines within the MWS system. Red to yellow lines indicate pipelines installed prior to 1940 and blue colors representing the newest (Figure 3). Much of the older pipelines are concentrated in the downtown area where a large percent of the population works and plays on a daily basis.

MSUD has approximately 260 miles of water lines, many of which have been replaced in recent years due to a capital improvement program that began in 1989. This improvement plan included the following rehabilitation efforts or upgrades, which have been made to date [3]:

- Replacement of most 2" and 4" lines along with those identified as deteriorating with corrosion resistant piping,
- Extension of trunk transmission lines to provide adequate water pressure at all areas within the District,
- Construction of additional water storage tanks and booster stations, and
- Expansion of the water treatment plant to 16.5 MG per day.

Given this proactive approach, MSUD appears to be in good condition to meet current and future demands [3].

MWS with the extensive number of pipelines that are over 40 years old has a fairly large loss rate of approximately 27% [11]. This is below the state acceptable maximum of 35%, but a definite concern for such a large system. At present, thanks to implementation of a leak detection system, MSUD system water loss is 6% or less, which is well below the state requirement [3]. HVUD has over 385 miles of water lines that have been installed since 1959, but it is unknown what percentage of these lines is greater than 20 years old. The system water loss is somewhere between 7 and 9%, again below the state requirement [4, 5].

Capacity

The average person consumes or uses approximately 80-100 gallons of water a day [12]. This volume includes water used for drinking, cooking, bathing, washing flushing toilets, industrial manufacturing processes. With a population of about 630,000, using this average rate, it can be assumed that the residents of Davidson





County require 56.7 million gallons of water per day, excluding any manufacturing processes, water used by non-residents working within the County, etc.

Both the Omohundro and Harrington Plants have capacity to treat 90 million gallons per day (MGD) with average daily treatment of 40 MGD for Omohundro and 59 MGD for Harrington from July 2011 to June 2012 [11]. As part of the capital improvement plan that started in 1989, MSUD has already expanded the capacity of the water treatment plant to meet current and anticipated demand. The HVUD water treatment plant has undergone several major expansions and additions since it opened. These expansions have kept pace with the system capacity needs. In recent years, the system demand has come within 10% of the total treatment capacity. The current capacity situation is being addressed with an expansion project slated to begin construction in January 2013 that will increase capacity to 60 MGD [4, 5, 13].

With regards to the water distribution system, MWS has 2,994 miles of 1” to 60” water mains, 57 water-pumping stations, 44 water storage tanks, and 19,914 fire hydrants that require oversight and maintenance [10]. MSUD has 260 miles of 2” to 24” water mains, 2 water-pumping stations, 6 water storage tanks, and 1,900 fire hydrants [3]. HVUD has 385 miles of water lines that have been installed since 1959, but the age and number of fire hydrants are served were unknown at the time of this report.

Operations and Maintenance

Metro Water Services has been hard hit by several natural disasters in the past few years, as have many of the other utilities in the area. In January of 2010, several water mains that were approximately 100+ years old broke as a result of record low temperatures requiring replacement. Again, in May of that year, the entire Davidson County area fell victim to a record storm event with flooding that crippled some of the main utilities and threatened survival of the Omohundro Water Treatment Plant. MWS and the other utilities handled both situations very well with service restored to customers as quickly as possible. Some recovery efforts are still underway.

As a result of some of the damages from the extreme cold event in 2010 and the ongoing attempt to meet increasing demand, several large projects are currently underway by MWS as listed below [14]:

- Downtown Water Main Project (January 2010 – Spring 2010)
- West End — 17th Ave. North and 18th Ave. North Phase 2 Water Infrastructure Rehabilitation (April 2011 – December 2011)
- Caldwell Lane — 24” Water Main Project (June 2011 – December 2011)
- Lakeside 16” Connector Transmission Water Main (February 2012 – Fall 2012)
- Omohundro — 60” Transmission Water Main (Spring 2012)

When considering system operations and maintenance beyond the large water line

replacements, the number of services calls can be used as an indication of the number of system “failures” in the past year as identified below [14]:

- MWS Water System Service Requests requiring investigation and evaluation for action — 8,878
- MWS System Work Orders requiring physical work – 44,650
 - Scheduled — 43,663 (98%)
 - Unscheduled — 691 (2%)

Additionally, the number of line breaks in a system can also serve as an indicator of the viability of the infrastructure. In the period of 2010-2011, MWS had a total of 973 line breaks [11]. MSUD had approximately 36 line breaks during the same period [3]. This low number for MSUD may be attributed to the recent replacement of the majority of lines within MSUD’s operating region. It is unknown how many line breaks occurred in the HVUD system for 2010–2011.

Similar to MWS, following the May 2010 Flood, many HVUD system infrastructure components have been replaced or upgraded. The flood exposed distribution system vulnerabilities in which the utility district has improved upon. The flood also impacted many treatment plant processes. A new administrative operations facility is under construction that will provide an improved level of customer service and improve the workflow process for all levels of distribution and treatment.



Funding

User rates support the majority of the operations and capital improvements debt service costs for most local utilities. Periodic rate increases are necessary to maintain an adequate revenue source. A recent “USA TODAY” survey of 100 municipalities found residential water bills have doubled in the past 12 years in approximately 25% of the areas surveyed [15]. Fortunately, rates in Davidson County have only increased minimally.

There was a 5% water/sewer rate increase in the 2009, 2010 and 2011 fiscal years for MWS customers. These user fees account for 99.39% of funding for the utility (both water and sewer). The other revenue comes from fees (0.34%) and additional sources (0.27%). This increased income goes toward water and sewer capital projects and improvements to the plants and distribution systems including the recent electrical, mechanical, and process improvements at both plants [11].



Metered water sales account for 89% of the MSUD revenues with 11% coming from service, transfer, sign-up, project review fees, backflow annual fees, and annual municipal fire hydrant maintenance fees [3]. MSUD has been proactive in much of their infrastructure management, which is largely attributed in their MSUD Brochure to good leadership and wise use of funds. It could be assumed that this situation will continue because the utility continued to make improvements even during the recent recession.

User rates support 100% of the operations and capital improvements for HVUD.

Future Need

Metro Nashville Davidson County had a population of 613,856 people in 2006 and it is expected to rise to 654,879 by 2015, to 702,871 by 2025, and to 752,326 by 2035 [17]. With this anticipated increase in population, it can only be expected that additional strains on the systems serving the residents will take place. Current rehabilitation projects will help this, but may not fully meet the demands. Given the recent system improvements for MWS, MSUD, and HVUD, it appears that the system will be somewhat prepared to handle an increase in demand as gradual population increases occur.

MWS plans to continue making improvements to the overall system in the next 5 years similar to what has been done in the recent past [11]. MSUD has several improvements planned for the next five years including an upgrade of the intake to the water treatment plant, the electrical system, and reworking of the sludge removal system from the plant are currently in the plans. Within the distribution system, there are plans to a new inter-connection between MSUD and White House Utility District for emergency services between the systems, replacing the existing one, an expansion in the Skyline Hospital Area to allow looping of two different pressure zones for greater backup capacity to customers. The utility is also implementing a program beginning in July 2012 to install all new Neptune Automated Meters for drive-by reading, which helps MSUD meet the No Lead Rule for 2014 [3]. HVUD has performed studies to evaluate the primary needs for the utility which include: (1) a capacity increase for the water treatment plant which includes the latest in treatment technology for the protection of public health, (2) distribution system improvements that will improve water quality characteristics, and (3) cyber security enhancements to reduce the threat of non-utility personnel accessing treatment and distribution processes [6, 7]. No information on investment to make these improvements was provided at the time of the report.

Overview

Combined sewer systems (CSS) combine sanitary sewage from homes, businesses and industries with storm water from rainfall and surface water into one pipe that flows to a treatment facility. These waters are then treated and released to our nation's surface waters (rivers, lakes, etc.). The US Environmental Protection Agency (EPA) has specific guidelines on treatment of this wastewater to ensure safe disposal.

Much like our municipal water treatment systems, the treatment process is highly involved and results in safe waters leaving the plants; however, the infrastructure involved in transporting wastewater to the plants and often the plants themselves are quite old and in need of upgrades or repairs. A serious problem associated with sewer lines is corrosion that leads to leaks that may pollute groundwater or other water sources. During dry weather, the sewer system and treatment facilities are usually able to handle the capacity of wastewater generated and treat it appropriately. Often, during wet weather conditions, the sewer and treatment facilities may reach capacity causing a combined sewer overflow (CSO) into surface water bodies such as lakes, rivers, and streams. Recently, CSOs have become a focus of regulation and necessary improvements to systems to prevent raw sewage from entering these water bodies.

Davidson County's wastewater systems are primarily managed by Metro Nashville Water Services (MWS). Some smaller utilities in the Davidson County boundaries that either treat their own wastewater or contract with MWS for treatment include the cities of Goodlettsville, Old Hickory, and Belle Meade. MWS also provides treatment for utilities outside the Davidson County boundary for Millersville, White House, Hendersonville, Mount Juliet, LaVergne, and Brentwood. Within Davidson County, there are four wastewater treatment plants: Dry Creek, Central, Whites Creek, and the Central BioSolids Facility. Figure 1 shows the extent of the MWS wastewater system. The westernmost portion of Davidson County is provided wastewater service by the Harpeth Valley Utilities District (HVUD) and Belle Meade provides service to a small area of the County.

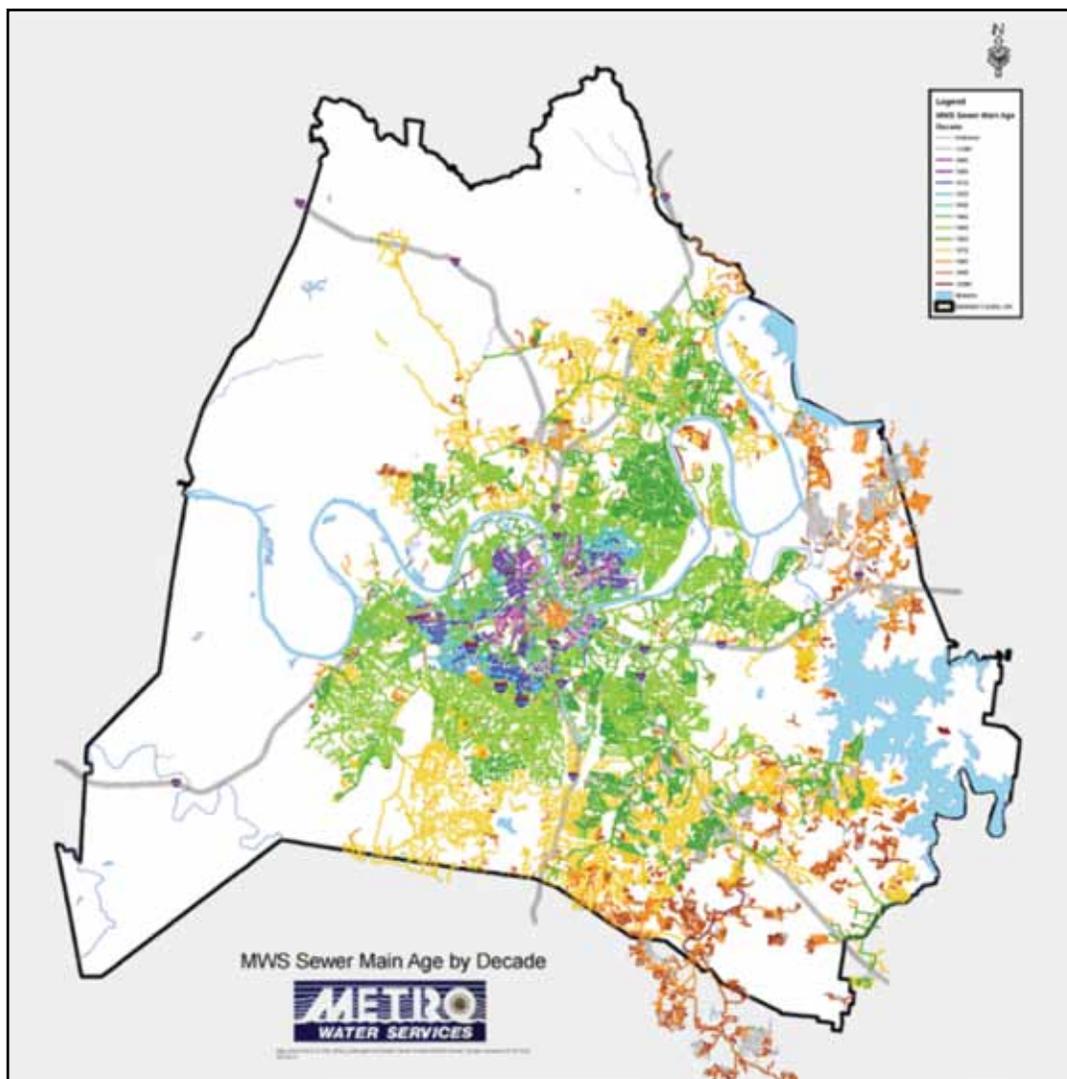


Because different utilities manage various portions of the entire county, each utility was examined individually and composite scores were developed for use in the overall grade. The following discussion includes an overview of each system (where data was available) as well as the grading discussion for the entire county.

Wastewater Treatment plant now works in conjunction with the other plants to serve much of the Davidson County area [1, 2].

Within the past 10 years, the Dry Creek Plant (built in 1961) and Whites Creek Plant (built in 1975) each underwent an optimization study with improvements made based upon the studies. Biosolids processes have been implemented at many of the plants reducing the amount of waste going to landfills. While available data for this report was limited and the resources have not been recently updated, it should be noted that all facilities received WEA Operational Excellence Awards in 2006 and the Dry Creek and Whites Creek plants received NACWA awards as well [3]. In Figure 2, the lines that are reddish to brown are the only areas that have pipelines less than 40 years old. As one can see, the majority of the urban area has sewer lines that are much older.

Figure 5: Age of Wastewater Main Lines for MWS
(source: MWS)



Belle Meade does not have a wastewater treatment facility and sends their wastewater to MWS for treatment [4, 5]. It is unknown when the lines for Bell Meade were installed or their current condition at this time.

At the time of this report, the age of the HVUD wastewater treatment plant was not found, but it is known that the first sewer pipelines were installed in 1965. Treated effluent is discharged to the Cumberland River [6].

Capacity

Metro Water Services treats approximately 47.3 billion gallons of wastewater each year. The design capacity, average daily treatment capacity, and max capacity (in MGD) of each plant is shown in Table 1. Each plant is operating within its design capacity, and not near its maximum [1].

Table 1: MWS Plant Capacities (in MGD).
Source: MWS

| WASTEWATER TREATMENT PLANT | DESIGN | MAXIMUM | AVERAGE |
|----------------------------|-------------|------------|-------------|
| <i>Central</i> | <i>125</i> | <i>250</i> | <i>99.1</i> |
| <i>Dry Creek</i> | <i>24</i> | <i>60</i> | <i>17.8</i> |
| <i>Whites Creek</i> | <i>37.5</i> | <i>75</i> | <i>31.1</i> |

As much as 20 MGD of wastewater is received and treated from other municipalities [1]. There are close to 48,000+ analyses performed annually and the plants maintain very high (greater than 90%) compliance records under the Clean Water Act [2].

HVUD has over 220 miles of gravity mains that collect sewage from 13,000 customers. The wastewater treatment facility located in Bells Bend treats over 2 billion gallons of wastewater per year. The age of the gravity mains was unknown at the time of this report. Aging infrastructure issues have caused these sewers to allow rainfall-derived infiltration and inflow to enter the system causing periodic overflows. An active sewer rehabilitation program that methodically takes cares of these issues is currently in place [6].

Operations and Maintenance

As with the water infrastructure evaluation, services calls can be used as an indication of the number of system “failures” in the past year for MWS as identified below [2, 3]:

- Sewer Service Requests requiring investigation and evaluation for action — 2,428
- Work Orders requiring physical work

- Sewer — 14,770
 - Scheduled — 13,778 (93%)
 - Unscheduled — 992 (7%)

According to an online list of water and sewer project updates, MWS has been working on a Mill Creek Sewer Replacement project since April 2011 [7]. At the time of this report, it was unknown if the project was complete or not. Dry Creek, and likely all other facilities, has a risk management plan in place and they work closely with their industrial users and satellite systems (Belle Meade, Hendersonville Utility District, and Brentwood) to prevent discharges that could adversely affect the system. In 2010, MWS issued 29 notices of violation, no other penalties to significant industrial users [8].

MWS has recently begun work on an overflow abatement program to remediate the combined sewer overflow into our waterways. MWS has submitted their plans and engineering report for review and already begun work to contract program management and construction management services for this program. Current efforts are underway to begin implementation of early, low-risk projects for CSO control [1].

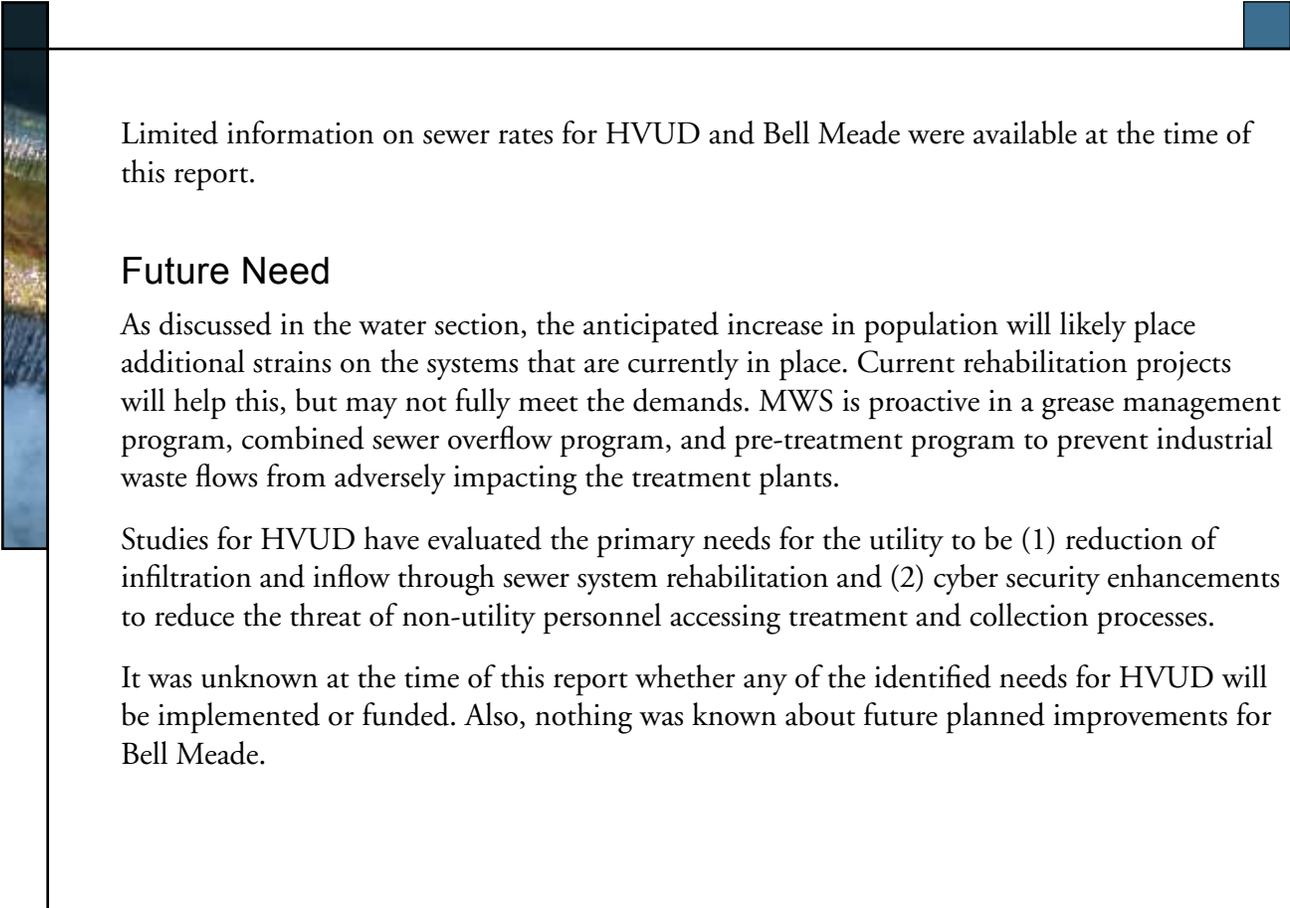
As noted in the 2010 State Compliance Inspection, the Belle Meade system had no chronic problems observed and the City has a sewer rehabilitation program in place that includes inspection of lines every five years using TV. Belle Meade manages 76 manholes and is working to epoxy coat and seal thirty of them that currently have sulfide damage within the 2013 budget. The main problems according to the service records appear to be grease and individuals disposing of things that are not intended to be flushed. The system appears to have few bypasses in 2012, with releases of less than 50 gallons for the four reported to Water Pollution Control at TDEC due to a faulty discharge hub in March. At present, the utility is in the process of changing the 20 air relief valves to a more ECO-friendly valve at a rate of five per year [4, 5].

The May 2010 Flood adversely impacted many sewage lift stations for HVUD; the utility district has recently completed the replacement and upgrade of those facilities. A new administrative operations facility is under construction that will provide a higher level of customer service and improve the workflow process for all levels of collection and treatment staff to receive instruction.

Funding

User rates support the majority of the operations and capital improvements for the utilities serving Davidson County. Periodic rate increases are necessary to maintain an adequate revenue source.

The 5% water/sewer rate increase in 2009, 2010 and 2011 fiscal years for MWS provided for electrical, mechanical and process improvements to all three wastewater treatment plants [1]. Continued improvements are planned for the plants and as mentioned earlier, MWS is funding a very large CSO improvement program currently.



Limited information on sewer rates for HVUD and Bell Meade were available at the time of this report.

Future Need

As discussed in the water section, the anticipated increase in population will likely place additional strains on the systems that are currently in place. Current rehabilitation projects will help this, but may not fully meet the demands. MWS is proactive in a grease management program, combined sewer overflow program, and pre-treatment program to prevent industrial waste flows from adversely impacting the treatment plants.

Studies for HVUD have evaluated the primary needs for the utility to be (1) reduction of infiltration and inflow through sewer system rehabilitation and (2) cyber security enhancements to reduce the threat of non-utility personnel accessing treatment and collection processes.

It was unknown at the time of this report whether any of the identified needs for HVUD will be implemented or funded. Also, nothing was known about future planned improvements for Bell Meade.

Overview

Stormwater infrastructure has become a significant and complex utility system for Metropolitan Government of Nashville and Davidson County (Metro) to evaluate, manage, repair, and design. The stormwater utility has for the most part been neglected and severely underfunded throughout the United States and Nashville. Only when catastrophic events occur as in the case of the May 2010 flood, do the public and media realize the importance of a well designed and functioning stormwater management system.

Polluted stormwater runoff has been identified as the largest cause of water pollution and at times rival wastewater treatment plants and large factories as a pollutant point source. Stormwater pollution damages drinking water sources, fouls recreational waters, fills waterways, destroys aquatic wildlife, and damages residences, business, and valuable infrastructure during flooding events.

After the implementation of the Environmental Protection Agency’s (EPA) Clean Water Act in 1972, the State of Tennessee administered the Water Quality Act of 1977. However, an established stormwater management system was largely ignored until mandated by the EPA with the Municipal Separate Storm Sewer System (MS4) in 1990 for large municipalities. The City of Nashville has been playing catch-up ever since.



In 2007, Metro signed a consent decree with the EPA and the state of Tennessee to address combined sewer and stormwater sewers. The consent decree revealed a nine-year plan to alleviate the estimated 765 million gallons of annual overflows to the Cumberland River. Metro finally established a Stormwater Master Planning District in 2008 to establish a stormwater infrastructure

plan. The rapid urban growth of Nashville and surrounding areas coupled with the area’s topography and vast amount of streams and rivers makes the implementation of a good stormwater system daunting.

Stoplight Evaluation



Condition

The Metropolitan Government of Nashville and Davidson County is responsible for maintaining more than 4,000 miles of stormwater system including channels, culverts, ditches, lakes, pipes, retention areas, rivers, and streams. The condition of the stormwater system can have a major impact on an individual community and down gradient areas. Problems with the systems can include:

- Aged, damaged, or deteriorated stormwater pipes, culverts, or ditches;
- Areas where drainage infrastructure was never planned and does not exist; and
- Areas where the capacity of the system needs to be increased to account for upstream development.

Although a study of the current condition of the system was not found, a review of stormwater flooding complaints within the study area and construction permits help paint a picture of the condition of the system. Complaints have been on the rise over the past 10 years while construction permits have decreased. This is an indication that the condition of the system in place continues to deteriorate and without improvements will become increasingly inadequate as construction projects begin to rebound. The flooding complaints when compared to rainfall data also illustrate that smaller storm events are triggering the issuance of a complaint.

Capacity

The capacity of the stormwater system is obviously the most critical aspect for successful management of stormwater. Capacity within a stormwater system is its ability to adequately accept and convey stormwater efficiently to the discharge point with limited adverse impacts. The system's infrastructure is very complex in which it must handle flows from up gradient areas. When a particular portion of the infrastructure, i.e. pipe, fails then the potential for flooding occurs. A failure has a "snowball" effect in which a small failure results in more and/or larger failures.



The flood of May, 2010 illustrated that in extreme events there is a capacity problem in the system. Although flooding is not a wide spread problem, there are certain areas within Metro Nashville that continue to have flooding problems thus indicating the capacity of the system is inadequate.



Operations and Maintenance

With more than 4,000 miles of stormwater drainage structures within the study area, operation and maintenance of these systems becomes overwhelming. Maintenance has always been recognized as vital to the proper and prolonged performance of a stormwater system. Failure to perform adequate maintenance not only leads to reductions in expected or desired performance levels, but may cause conditions that are worse than if the structure had not been constructed at all.

Although Metro Water Service does provide personnel and funds for the maintenance of the system, the number of complaints and backlog projects to be addressed continues to increase. The complaints and backlog reflect an insufficient staff force to handle the operations and maintenance of the stormwater system.

Funding

The lack of dedicated funding for the stormwater program has been a problem since the early 2000's. Metro implemented a stormwater user fee in 2009 to fund the system. The gap between estimated costs to maintain the system properly plus provide upgrades to meet increased capacity needs and tax revenues collected from system users are continually increasing. Based on a 2008 study, the stormwater program was operating on a \$12 million dollar annual budget. However, based on a detailed analysis \$25.8 million dollars was needed annually to operate the system to meet public needs, water quality demands and begins to address unresolved issues. It was also estimated that approximately \$85 million dollars were needed to resolve the backlog of projects and services requested at that time. Since the issuance of this study, the problem has only worsened. The May 2010 flood dramatically increased the need for improvements and required funds. Even with the acquisition of federal aid for the flood event, Metro falls short of funding the stormwater program adequately. The stormwater user fee draws sharp criticism from Nashville's citizens making the local government's funding job more difficult. The implementation of the stormwater fee is a step in the right direction and illustrates that Nashville is proactively addressing the problems that were brought to light in 2010.

Future Need

As discussed in greater detail above, the funding to maintain the current stormwater system falls short of that required and the gap continues to grow. Metro Nashville has implemented a tax-rate increase to help offset some of these cost short falls, but these additional funds will still not bring the system up to the needed level.

Conclusion

As the previous sections have illustrated, the Metropolitan Government of Nashville and Davidson County has a large task ahead of them to develop an adequate and functional stormwater system. On the Stoplight Assessment scale, stormwater showed the most need for improvement.



Metro has been backed into a corner from decades of limited activity and lack of funding for the system. A focused effort is needed for improving, repairing and funding the system. Failure to continue improvement of the system will result in greater flooding conditions, an increase of degradation, and greater financial obligations.

Overview

There are over 2,600 lane miles of roadway within Davidson County with multiple organizations having responsibilities for planning, funding, maintenance, and operations of these roadways. The Music City Infrastructure Report for roads is based on three categories for which pertinent data are collected and made available: Roadway Condition & Maintenance, Traffic Capacity, and Roadway Needs and Funding.

Stoplight Evaluation



Roadway Condition and Maintenance

Metro Public Works (MPW) maintains pavement condition data on non-Interstate and State Route roadways within Davidson County. MPW has established a pavement management system to systematically assess pavement condition, identify maintenance and rehabilitation (M&R) needs, and schedule M&R activities. Roads are routinely monitored, tested, and assigned an Overall Condition Index (OCI) in the categories of “Excellent”, “Good”, “Fair”, and “Poor”. The OCI is a number representing the condition of the pavement. An OCI is assigned to the roadways managed by MPW. Roadways funded and managed by the Federal and State systems are not graded or included in MPW’s pavement management system. The following figures are from Metro’s OCI system and represent a conservative pavement condition grading system:

Table 2: Percentage of Lane Miles in Good or Better Condition

| YEAR | PERCENTAGE |
|------|------------|
| 2008 | 78.6% |
| 2009 | 77.5% |
| 2010 | 70.0% |
| 2011 | 52.7%* |

* Note that the significant decrease here was due in part to effects of the May 2010 flood, and the unseasonal harsh winter with heavy snowfall and salt usage that followed.

What this chart illustrates is an adequate system at present, but one that appears to be experiencing steady degradation.

Capacity

To evaluate the capacity score of the existing roadway network in Davidson County, a volume-to-capacity ratio was used. The volume-to-capacity ratio (v/c) is a measure of the volume of

traffic on a given roadway in relation to the volume of traffic that the roadway can theoretically accommodate (capacity). The value of v/c starts at zero (no traffic) and can exceed 1.0 when traffic demands exceed the ability of the road to carry the demand volume.

The Nashville Area Metropolitan Planning Organization (MPO)

maintains a travel demand model that can provide v/c ratios for roadways throughout the county for different demographic conditions and analysis years. The results of the model for the base year (2008) showed that approximately 30% of the lane miles within Davidson County have a v/c ratio greater than 0.75 and were therefore approaching capacity.

The results of the model for the 2025 horizon year, which include proposed roadway improvements expected to be made by then, show that approximately 32% of the lane miles within Davidson County will be approaching capacity.



Future Need / Funding

The MPO forecasts nearly one million more people will live in the 10-county Middle Tennessee region area by the year 2035. With this type of growth in the region, the region's traffic volumes, as expressed in vehicles miles traveled, are expected to increase by 45 percent according to the MPO. Increases in travel demand will increase the need for improvements in all transportation modes, including roadway infrastructure.

In June 2011, The Tennessee Advisory Commission on Intergovernmental Relations (TACIR) published Building Tennessee's Tomorrow: Anticipating the State's Infrastructure Needs to assess the transportation improvement needs for the entire state. This assessment determined that approximately 78.2% of all transportation needs are related to the roadway system. As applied to the Davidson County transportation infrastructure needs estimated by TACIR for the period 2009 – 2014. The estimate is that approximately \$82.4 million is needed annually to adequately fund roadway expansion, maintenance, and operations.

By comparison, historic bond funding levels for roadways in Metro's capital improvements budget have averaged \$57.2 million per year over the past six years. The past two years have seen slightly lower funding allocations. With only 69% of current and estimated future needs funded, this situation, though not critical, will need to be addressed.

Overview

The Metropolitan Area of Nashville (Davidson County) has a total of 1119 bridges on its public roads. They fall into two categories: On-System and Off-System bridges. On-System bridges are owned, maintained, and operated by the state, specifically the Tennessee Department of Transportation (TDOT); and Off-System bridges are owned, maintained, and operated by The Metropolitan Government of Nashville and Davidson County (Metro). Metro owns 326 Off-System bridges, 325 of which are inspected by TDOT and one special structure (Shelby Street Pedestrian Bridge) that is inspected by Metro. Metro owns and maintains all 326 structures. This total includes all bridges with a span of 20 feet or greater. Bridges and culverts with a span less than 20 feet are not included in Metro's inventory and details of their condition and other features are generally unknown. This report card will focus on several factors that include: condition, capacity, operation and maintenance, funding, future need, and public safety of Off-System bridges under the control of Metro Public Works. The condition of On-System Metro bridges will be reported, but for additional information regarding these bridges please see the 2009 Tennessee Infrastructure Report Card.

Stoplight Evaluation



Condition

The data in Table 1 is from the most currently available 2009 TDOT Bridge Inspection Report. TDOT inspects all Metro bridges bi-annually (and in response to service requests) with reports rolled out on a two-year cycle. Of the 325 Metro owned bridges (Off-System); 81.5% are in a State of Good Repair, 1.5% are Structurally Deficient, and 17.0% are Functionally Obsolete. Metro Off-System bridge conditions compare favorably to the condition of Metro, Tennessee, and National On-System bridges (see table below).

Table 3: Data from 2009 TDOT Bridge Inspection Report

Percentage of State of Good Repair (SGR), Structurally Deficient (SD), and Functionally Obsolete (FO)

| | METRO (Off-System) ^{1,2} | METRO (On-System) ³ | TENNESSEE (On-System) ³ | NATIONAL ³ |
|----------------------|--------------------------------------|-----------------------------------|---------------------------------------|-----------------------|
| SGR | 81.5% | 81.2% | 80.3% | 75.2% |
| SD | 1.5% | 4.3% | 6.2% | 11.8% |
| FO | 17.0% | 14.5% | 13.5% | 13.0% |
| Total SD + FO | 18.5% | 18.8% | 19.7% | 24.8% |



A Structurally Deficient bridge is closed or restricted to light vehicles because of its deteriorated structural components. These bridges are not necessarily unsafe, but must have posted limits of both speed and weight. A Functionally Obsolete bridge does not meet current design criteria. While not unsafe for all vehicles, such a bridge cannot safely accommodate current traffic volumes, vehicle sizes, and vehicle weights.

Metro's bridge network has steadily improved through the Bridge Maintenance and Management Program. All bridges in poor condition are currently scheduled for replacement. TDOT uses a scale of 1–9 (1-4: Poor, 5-6: Fair, 7-9: Good) to rate each element of the bridge (i.e., superstructure, substructure, safety features, approaches, waterway, etc.). The condition is assigned to the overall structure based on a composite rating from the individual elements of the bridge. However, if all elements of the bridge are rated good except for the bridge deck which is rated poor, the entire structure would be rated poor.

Capacity

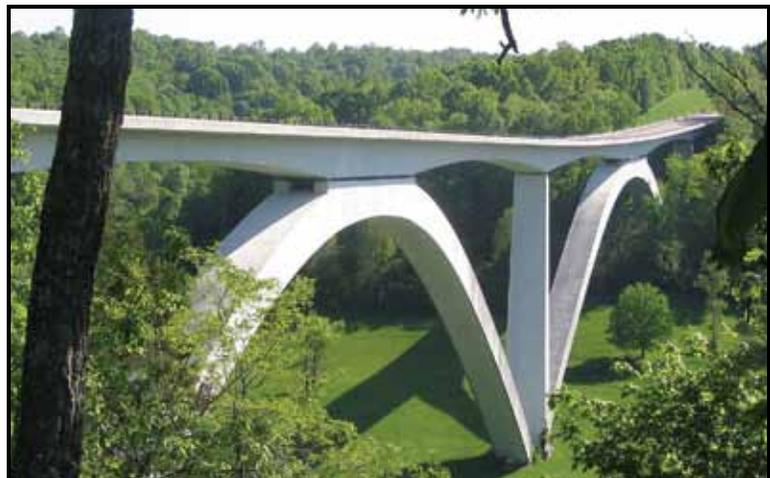
Based on local and regional planning agency reports, Metro Off-System bridges are adequate to handle current demand. The capacity of the bridges is continually evaluated as regional development patterns change. The capacity of bridges is closely tied to the capacity of the roadways, as bridges are an integral part of the entire roadway system. See the Roads section of this report card for additional information regarding capacity of both On and Off-System bridges.

Operations and Maintenance

Metro employs a systematic preventive maintenance approach to maintaining their Off-System bridges. Information from the TDOT bi-annual inspection reports is entered into Metro's Bridge Maintenance Management System (BMMS) which ranks the bridges based on the overall bridge system repair/maintenance needs along with cost estimates. Metro uses this information to prioritize bridge repairs and preventive maintenance and determine the annual funding needs for the program. Program goals are adjusted based on the funding received and maintenance is performed by Metro's annual bridge contractor based on available funding. (See Funding section that follows.)

Funding

The majority of funds for Metro Off-System bridges are locally generated through bond funds. In addition to local funding, Metro participates in the State-Aid





Program (approximately \$64,600 annually based on 5-year average) and the Federal Bridge Replacement for Off-System bridges (BRZ) Programs. Metro attempts to meet their funding needs by leveraging all available funding opportunities. Metro currently has four bridge locations in design or construction through the BRZ program.

Table 2 below illustrates estimates of the total funding needs to fund all bridge program costs including maintenance, operation, repair, replacement, new construction, and demolition; as if all issues could be completed in the funding year. The first year that an estimate was attempted and contained many unknowns was between 2008-2009, but more recent years' data are more realistic approximations of current funding needs. Projections for 2013-2016 reflect estimates of maintenance costs only and assume that other issues have been completed in the previous periods, although realistically they will not be. Maintenance costs have roughly run in the \$6–8 million range and available funding has been approximately half of that. The highest ranked bridges (for maintenance) are repaired first as funds become available, and maintenance on other bridges is deferred to future years. Maintenance deferred costs will continue to result in higher funding needs in future years until adequate funds are made available to meet current needs.

Table 4: Bridge Funding Needs
Historic, Current, and Proposed Funding vs. Needs²

| FUNDING YEAR | 2008–09 | 2009–10 | 2010–11 | 2011–12 | 2012–13 | 2013–14 | 2014–15 | 2015–16 |
|---------------------------|-------------|-------------|-------------|-------------|-------------|------------|------------|------------|
| Local Funds (\$M) | 1.2 | 5.4 | 3.0 | 0 | – | – | – | – |
| Funds Needed (\$M) | 13.9 | 17.9 | 12.6 | 16.9 | 16.1 | 6.6 | 8.3 | 8.6 |

Future Need

Current funding levels are well below what is needed to maintain the current bridge system much less keep up with future demand for new bridges. Though functioning well now, as the On System bridges age, and approach their design life, additional work and assessment will be required. Economic analysis will be needed to determine if replacement or partial repair is best warranted. With funding levels currently well below what is needed and no increase expected, Metro will likely be faced with an additional percentage of structurally deficient and functionally obsolete bridges in their inventory over the next several years.

Overview

Bikeways are a comparatively recent addition to Metro Nashville's infrastructure picture. A commitment to improved health on the part of Nashville's political leadership has provided additional support for the rapid expansion of a complete bikeways system. Major studies by the Nashville Area Metropolitan Planning Organization and Nashville Public Works have been published fairly recently. Unlike the other infrastructure sections, bikeway systems have been evaluated using a letter scale (A-F). The composite score is translated into the Stoplight Evaluation below.

Stoplight Evaluation



Condition

Bikeways in Nashville have been evaluated by the Nashville Area MPO, most recently in the 2009 Regional Bike and Pedestrian Study (Tech Memo 2). The methodology utilized a "Level of Service" or "LOS" model based on the National Cooperative Highway Research Program (Report 616). Factors used for the evaluation included average daily traffic volume, number of lanes on the roadway segment, percentage of trucks, width of outside travel lane, shoulder or bike lane existence and condition of pavement. Cyclists participating in the Nashville Area MPO study represented a wide range of riding experience and all age levels and reported on approximately 880 miles of bikeway in Davidson County. The Nashville Davidson County Strategic plan for sidewalks and bikeways (amended 2008) made a similar assessment evaluating some 338 miles of roadway using a Bicycle Compatibility Index or BCI. Roadways were placed in one of five categories ranging from most suitable to least suitable. Compiling these two reports, which both used a letter grading scale; an overall "C" is achieved for the condition of the bikeways in Metro Nashville.

Capacity

For the purpose of grading, capacity was divided into three evenly weighted components: existing parking, existing bikeways, and planned projects. The composite grade achieved in this category was a "B."

Parking: According to the 2009 Nashville Parking Study by the Metro Nashville Public Works Department there is a significant shortfall in adequate end of trip facilities for popular destinations in Nashville and bicycle parking facilities within Metro as a whole is very limited. This sub-section received a "D."

Existing Bikeways: According to the Nashville Area MPO Bike Pedestrian Study (Tech Memo #1) and recent updates from the Dept of Public Works (DPW), Nashville has approximately



45 miles of bike lane (DPW), 81 miles of signed/shared bike routes (DPW) and 55 miles of greenways were identified in the MPO Bike/Pedestrian Study for a total of 181 miles. Grade: A

Planning: The Nashville Area MPO Bike Pedestrian Study recommendations call for 412 network miles in Davidson County. Eighty-three percent (83%) of these miles are included in local planning (Table 3 of Tech Memo #5).

Planned improvements by the Department of Public Works include:

- **Music City Bikeway:** The Music City Bikeway is a new 26 mile continuous route that connects Percy Priest Dam in eastern Davidson County and Percy Warner Park in west Nashville with downtown Nashville and winds through 5 scenic greenways and along the Cumberland River as well as some of Nashville's great attractions.
- **28th/31st Avenue Connector:** Complete Street with Multi-Use Bicycle and Pedestrian Path: Measuring approximately 1/3 mile, this new roadway will be a green and complete street with sustainable features including rain garden medians, solar markers, and a pedestrian corridor and bike lanes separated from the road by a landscaped barrier.
- **Additional Planned Bikeway Projects:** There are 20 bikeway projects in various stages of development planned.
- **Additional Planned Sidewalk Projects:** The current capital budget will allow for approximately 8 miles of new sidewalks and 4 miles of repaired sidewalks. The Harding Place Sidewalk/Pedestrian Improvements Project is one example of a major planned improvement underway. Made possible with a grant from TDOT, this project includes construction of almost 1 mile of new sidewalk, curb and gutter, pedestrian crosswalks and signals and a pedestrian bridge over Seven Mile Creek.
- **Green Bike Symbols:** Nashville has successfully implemented FHWA-approved experimental green bike symbols on Davidson St, Charlotte Ave, and Rosa L Parks Blvd. These bike symbols increase motorist awareness and visibility of bicyclists.
- **Expansion of Nashville GreenBikes Bike-share Program:** This program allows riders to enjoy Nashville's downtown, as well as the city's extensive system of greenways, bike lanes and parks, on comfortable cruiser-style bikes. The program will be expanding this spring with the addition of 300 new bicycles and a fee-based kiosk system in downtown Nashville.
- **Traffic Signal Enhancements:** Project seeks to improve pedestrian infrastructure, transit ridership, bicycle safety, and to ensure the safety of the traveling public. Improved infrastructure (signal indications, push buttons, and ADA ramps) has recently been completed at 35 intersections on Gallatin Pike and Murfreesboro Pike.
- **Wayfinding:** Phase 1 of this design and sign management project almost completed with 128 sign installations completed, and 27 additional to be installed by the end of 2011.
- **Bike Racks:** Bike racks, each parking 2 bikes, have recently been installed at key locations in the downtown Nashville area.

- **Bike Corrals:** Additional bike parking will be facilitated in heavily visited areas of the community through a bike corral project currently being implemented.

Operations and Maintenance

Operations: The Nashville Area MPO Bike Pedestrian Study (Tech memo #1) identified six peer communities to determine best practices for bicycle and pedestrian accommodation. The comparable cities were Charlotte, NC; Chattanooga, TN; Chicago, IL; Denver, CO; Louisville, KY; and Phoenix, AZ. Six primary categories for best practices were identified: Policies, Programs, Design, Funding, Practices and Planning. The Six Categories were broken down into (26) subcategories and of those Nashville can answer yes or “in-progress” to 17 of the 26 for a grade of “D.”

Maintenance: When bike route maintenance issues are discovered or reported, they are addressed with dedicated maintenance funding. Greenway paved trails are swept and inspected (and repaired if required) on a regular basis. The Public Works study gave this area a grade of “A.”

A composite grade of “C+” was achieved in this area of bikeway evaluation.

Funding

According to a 2010 benchmarking report from the Alliance for Biking and Walking, Nashville spends 3.3% of its Federal Transportation dollars towards Bike/Pedestrian funding. Out of the 51 “largest cities” ranked, Nashville is only exceeded by three cities: Albuquerque (6.4%), Kansas City Mo (3.8%) and Portland OR, (8.2%). Relatively speaking Nashville gets an “A” for Funding.

Local funding for bikeways is \$3M, FY11. This is the highest level of funding for bikeways to date. Additionally, the Sidewalks program received \$12.5M and \$3.25M has been dedicated to Greenways FY11. Federal Grants and other funding sources supplement local funding. Grant opportunities are pursued when available (i.e., Music City Bikeway). Funding is linked to Strategic Sidewalks and Bikeways Plan as well as the Complete Streets Policy. (Chapters 1.1 and 3.5 of the Public Works Subdivision Street Design Standards and Specifications.) [7]

Future Need

Local Policy: Bike facilities are pursued on every roadway according to Metro’s Complete Streets Executive Order and Policy. As roadways are paved they are assessed/evaluated for bike (pedestrian and transit) facilities. Major Bikeway connections/widening are funded through the dedicated Bikeways local funding and also through grants when applicable. Greenways, a vital component of the bikeways network, are expanded according to the Parks and Greenways Master Plan. (DPW)

Anticipated Funding Shortfall: In order to achieve sidewalk and bikeway recommendations outlined in the Regional Bike Pedestrian Study, the current level of Funding will need to be increased by a factor of 2.19 (Tech Memo #5) over a 25-year horizon. This translates into a



future funding need of \$31.72M based on the current funding level of \$14.5M. A detailed list of Federal, State and Private Funding sources available for bike and pedestrian improvements can be found in Tech Memo #7. Without an identified funding mechanism for this anticipated growth, the future need grade is a “D.”

History and National Outlook

Demand for electricity is derived from the need for power required to operate and provide sufficient energy for both domestic and commercial uses. Although energy services did not undergo the same assessment of quality and needs performed in the other areas of the report, continuous investment in its infrastructure is critical to meet future energy demands. Experts project national electricity consumption will increase substantially in the coming decades, accompanying economic growth and social progress. The United States' system of energy generation, transmission and distribution facilities were built over the course of the late 19th and 20th centuries. Centralized electric generating plants with local distribution networks were started in the 1880s and the grid of interconnected transmission lines was started in the 1920s. Today, there is a collective system of regional and local power plants, power lines and transformers that have widely varying ages, conditions, and capacities. This incongruity explains some of the equipment failures that have led to temporary disruptions in power quality and availability. These concerns make it critical to understand what investments are needed to repair and consistently maintain electric energy infrastructure, and what negative implications any shortfall could have on the national or local economies.

While historically fossil fuels have been the source for energy, significant investment for new types of energy infrastructure investment is important. Adoption of new technologies are required to further mitigate the incidence of service failures to households and businesses and to meet the demands of a growing population and evolving economy over the next 30 years. Innovative research investigates the performance, cost, sustainability and availability of new clean energy technologies. Hydropower, electricity generated using the energy of



moving water, is one of America's leading renewable energy resource due to its reliability, efficiency and low cost. The developments of smart grid technologies are also evolving in efforts to promote reduced emissions, lower energy costs and provide greater flexibility to accommodate new renewable distributed energy sources. Smart grid, a dynamic two-way communication system,

allows for the delivery of optimal amounts of information and load control for customers, distributors and grid operations to change behavior in a way that reduces system demand and costs, and increases energy efficiency. As the world's most abundant energy resource, solar deployment has increased at a record pace in the United States due to its readily domestic availability and cost-competitiveness. Electric utilities are expanding to take advantage of the benefits and create new business models for building solar power capacity. Finally, nuclear energy has raised in eminence on national policy agendas as an impetus to supply more non-



fossil energy sources. The U.S. nuclear power industry is composed of 103 reactors in 31 states that together generate about 20% of the nation's power. Electricity production from nuclear power plants exceeds that from oil, natural gas, and hydropower sources. Additionally, compared to major fossil fuel sources used to generate base load electricity, nuclear power plants emit far lower levels of greenhouse gases even when mining, enrichment, and fuel fabrication are taken into consideration. Above all, there is a growing consensus that these clean energy sources can be effective alternatives in efforts to reduce emissions from the electricity sector while simultaneously increasing supply. Utility industries are recognizing the importance of partnerships with the engineering and scientific communities in efforts to grow these renewable energy technologies.

The Region's Power Generation and Distribution Utilities

The purpose of the utilities industry in Middle Tennessee is to produce and delivery sufficient quantities of power in efforts to maintain the current quality of life and support progress critical to the region's prosperity and large economy. Davidson County has a diverse economy, with companies in insurance, finance, publishing, banking, health care, music, tourism, manufacturing and distribution. Therefore, affordable and dependable power generation; transmission and distribution systems are crucial. Projected electric utility investment needs will continue to increase to create projects involving infrastructure that are responsive to the community needs. The region's utility companies need to continually evolve and provide products and capabilities and investments in varied programs and service that meet the increasing demands.

Tennessee Valley Authority (TVA) owns and operates one of the largest and most reliable power generation systems in North America, serving some 9 million residents in an 80,000-square-mile area. Spanning portions of seven states, TVA's 15,900 miles of line moves electric power from the generating plants where it is produced to distributors of TVA power and to industrial and federal customers across the region. The system requires 260,000 acres of transmission right of way and 487 power stations and switchyards. TVA has 48 active fossil-plant operating units in the Tennessee Valley and 98 generators powered by combustion turbines units located at 12 sites across the region. While these combustion turbines cost more to operate than TVA's other power sources, they are necessary for peak operating periods when the demand for power is high. TVA's 11 coal-fired generating facilities, including 59 generating units (only 48 active), became the backbone of the power system in the 1950s. TVA also has combined cycle units at five locations. The combined cycle units, using hot combusting gases to produce steam to drive a steam turbine, produce an additional 50 percent output. In fiscal year 2011, TVA's coal-fired and combustion-turbine units produced about 81.4 billion kilowatt-hours of electricity, accounting for about 57 percent of TVA's power supply from the operated facilities.

The electric distribution system of the Nashville Electric Service (NES) delivers electric energy to homes, businesses and industries in the utility's service area. NES has no generating capacity and purchases its power from the Tennessee Valley Authority (TVA). According to "Public Power," a periodic publication of the American Public Power Association, NES is the 11th



largest public electric utility in America based on customers served, the 13th largest based on electric revenues, and the 15th largest based on megawatt-hour sales. Its service area, which includes all of Davidson County and portions of six surrounding Middle Tennessee counties, is approximately 700 square miles. Of the more than 360,000 customers, residential customers account for approximately 40 percent of kilowatt-hour sales and total operating revenues, and commercial and industrial customers account for approximately 55 percent of kilowatt-hour sales and total operating revenues. As it exists today, the electric energy delivery system is a complex system of transmission lines, transformers, switches, distribution lines, controls, protective devices, meters and other components that function together to provide power to customers. NES maintains 90,995 distribution transformers, 233 distribution substations, 5,721 distribution pole line miles, 66,609 streetlights in service and 41,195 private security lights, and twenty-three 161,000-volt feed points. Current reliability-related activities include ensuring that the electric system is planned, designed and constructed to meet the growing needs of the community. NES uses the standard reliability indices System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI) and Momentary Average Interruption Index (MAIFI) to monitor and track system reliability.

Energy Infrastructure and Economic Growth

TVA has marked its 12th consecutive year of serving customers with 99.999 percent reliability. For a sixth straight year, TVA was named among Site Selection magazine's top 10 North American utilities for achievement in economic development. Likewise, NES's distribution system has provided adequate growth and reliability to the region, and NES' increased use of automated metering, computer-based routing has resulted in an average meter reading cost well below the national average. NES has automated operational aspects of the electric distribution system not included in the Supervisory Control and Data Acquisition system (SCADA). The system is composed of a geographical information system (GIS) based on ARC/INFO, an operational system called CADOPS, and a computer-aided planning and design system called CADPAD. Additionally, NES has employed an extensive fiber-optic network to offset operational costs and increase its revenue by leasing spare fiber-optic capacity. To continue their mission of providing constant and energy at affordable prices, the electric industries of the region must evolve to be prepared to respond to the constantly changing environment and economic climate. Continued investment in their generation and transmission systems is critical to meet the daily challenge of moving power to where it is needed, regardless of weather, time of day or competing demand and to avoid failure or disruption of its operations.

There have been efforts to quantify the total economic costs of any power failure on regional economies. Estimates are often derived from post-blackout surveys of affected major industries and businesses and analyses of the direct and indirect economic consequences of power outages. Based on the much-studied 2003 Northeast blackout affecting eight states and the Canadian province of Ontario, the U.S. Department of Energy and ICF Consulting estimated the total economic cost of the blackout to be between \$7 and \$10 billion. These figures are based on estimates of direct costs per kWh of the power outage (e.g., losses due to food spoilage, lost production and overtime wages) and indirect costs due to the secondary

effects of the direct costs. There are a remainder of reported impacts on specific facilities such as the motor vehicle and automotive parts manufacturers, petroleum refineries, steel producers, chemical facilities, and commercial and public sector organizations. In a separate study completed shortly after the August 2003 blackout, the Ohio Manufacturers' Association (OMA) estimated the direct costs of the blackout to Ohio manufacturers to be \$1.08 billion. Some 12,300 manufacturing companies in the state (representing approximately 55% of the manufacturers in Ohio) were impacted with an average estimated direct cost of nearly \$88,000 each. All companies reporting indicated that the blackout caused a "complete shutdown in operations." The OMA study noted that other indirect costs also resulted from the blackout, including: the diversion of significant amounts of capital investment from new job producing investments to blackout protection systems and lower bottom lines resulting from lost production reducing the value of those companies' securities. Above all, these surveys confirm that the event's cost, measured in the "billions" of dollars, can deeply affect a region's economic stability.

Careful planning of the generation and distribution systems that serve Davidson County can result in a high degree of reliability for all areas of the generation and distribution system. Portions of the systems that are outdated, suggestive to be candidates for failure or replacement need crucial investment in maintenance. In support of its vision of being one of the nation's leading providers of low-cost and reliable energy by 2020, TVA will idle or retire 2,700 megawatts of older, less-economical coal-fired capacity by the end of 2017. NES and TVA must continue to meet the region's economic goals through updated processes and revised systems. Improvement in reliability regarding product and services may be gained through the use of new technology such as development for rapid implementation of mobile data. Fast-track process for repairs such as an Automated Metering Infrastructure (AMI) could be critical to the service expansion and communication process for infrastructure problems. Expanding urban underground footprint or the development of a process for hard-to-access facilities are also potential opportunities for the utilities to continue to improve its operations.

Renewable Energy Resource Policy and Programs

Substantial investments in cleaner generation, transmission and distribution are expected over the coming decades. Likewise, the utilities serving Davidson County must support a larger vision that includes greater environmental responsibility, cleaner air and energy efficiency. TVA has long been committed to taking actions at its facilities to protect the environment and the area's natural resources. TVA also provides natural resource protection and improvement, flood control, navigation and land management. TVA manages public lands for multiple benefits, striving to keep them in good environmental health while balancing the need for sustainable development. TVA manages an integrated river system for multiple uses while striving to provide clean and sufficient water for the region's needs.

The power industry is employing strategies to minimize the effects of its operations on the environment and increase cost-effectiveness for its customers. TVA surpassed its annual energy efficiency goal, achieving 559 gigawatt-hours of energy savings for its commercial customers, equivalent to the energy used by 35,000 homes, and its home energy review program marked



its 25,000th in-home audit saving money for residents. Additionally, TVA has begun a transition to time-of-use rates, which will provide greater incentives for customers to save money by shifting their energy use away from expensive, peak power periods. TVA is also working towards their vision of a cleaner, more diversified energy portfolio. This includes renewable sources of energy such as hydropower, wind, solar and biomass; large-scale energy storage; advanced clean fossil power; waste heat and combined heat and power. TVA maintains 29 conventional hydroelectric dams throughout the Tennessee River system and one pumped-storage facility for the production of electricity. In addition, four Alcoa dams on the Little Tennessee River and eight U.S. Army Corps of Engineers dams on the Cumberland River contribute to the TVA power system. TVA's nuclear plants contribute about 6,600 megawatts of electricity to the power grid, making the Nuclear Power Group an integral part of the seven-state power system. As nuclear performance improves across the industry, TVA's nuclear challenge is to continue its mission to ensure safe plant operations and achieve its vision of being the best multi-site nuclear power operator in the world.

Another aspect of the growing energy sector is electric transportation. As electric transportation moves from the drawing boards to production of operating electric vehicles, battery technology must continue to advance, charging stations and infrastructure must be built, and the entire system must be integrated into the power grid. TVA and regional power distributors are conducting research to make sure this transition is a success. Research will focus on developing technologies to make the cars and the charging stations that fuel them work together efficiently while minimizing demands on the power grid. TVA is working with the Electric Power Research Institute, Oak Ridge National Laboratory, local power distributors and regional stakeholders to develop fast, efficient stations where drivers can recharge their cars. Other strategies include developing solar-assisted charging and distributed energy storage, refining existing processes of the power system to take full advantage of the environmental benefits of electric transportation, and researching the recycling of car batteries to help meet demand placed on the power grid by the charging stations.

TVA published a comprehensive Integrated Resource Plan that will provide an energy roadmap for the next two decades. The Integrated Resource Plan proposes to actively reduce its carbon emissions through cleaner energy options and energy efficiency initiatives. The policy also addresses TVA's response to the uncertain future of legislation on greenhouse gases (GHGs), including carbon, and the scarcity of available mitigating technologies in a carbon-constrained future. Under environmental agreements with federal and state regulators, TVA will reduce air emissions by retiring 18 older coal-fired units by 2017 and will convert, idle or retire 16 more by 2019. Seven units were idled in 2011. TVA improves regional air quality by installing emission control equipment on existing generation and planning for cleaner future energy options. From 1977 to 2011, TVA invested about \$5.4 billion to reduce emissions from its power plants. To maintain compliance with future Clean Air Act requirements, TVA may need to invest an additional \$3.4 billion through 2018. TVA also has installed a variety of other emission control technologies on selected units. To reduce sulfur-dioxide emissions, TVA has installed scrubbers on 17 of its coal-fired units and switched to lower-sulfur coals at 41 units. These measures have helped reduce TVA's sulfur dioxide emissions by at least 90 percent below their peak in 1977. The TVA board of directors has approved adding scrubbers to three

units at Allen Fossil Plant and four units at Gallatin Fossil Plant. To reduce nitrogen oxide emissions, TVA has installed selective catalytic reduction systems on 21 coal-fired units. These measures have helped reduce TVA's nitrogen oxide emissions by at least 86 percent below peak 1995 levels. To reduce particulate emissions, TVA has equipped all its coal-fired units with mechanical collectors or electrostatic precipitators. Other emission control technologies include selective non-catalytic reduction systems, High Energy Reagent Technology, low-NOx burners and combustion systems, and combustion optimization measures.

NES and TVA have also developed long-term, sustainable renewable energy programs that are offered to consumers, businesses and industries across the region. TVA, local distributors and members of the environmental community launched Green Power Switch in 2000 as the first-of-its-kind program in the Southeast. It allows consumers to help ensure that renewable energy from wind, solar and landfill gas is added to the available power supply. Consumers and businesses can purchase Green Power Switch blocks of 150 kilowatts (about 12 percent of a typical Davidson County home's monthly electricity use) from their local power distributor such as NES. Each block costs an additional \$4 on the consumer's monthly power bill and consumers can buy as many blocks as they like. The Green Power Providers program offers the option to build renewable generation with a maximum project size of less than 50 kilowatts (kW) in size. Green Power Providers will benefit Tennessee Valley power consumers because it aligns renewable generation payments with those who voluntarily support renewable energy through TVA's Green Power Switch program. Green Power Providers implements industry best practices to continue helping add sustainable solar and renewable energy in the region. One of the most important advantages of the program is longer-term contracts of 20 years. In addition, participants receive a \$1,000 initial rebate to help offset the cost of the system and a 12-cent incentive on top of retail rates for solar through the end of December 2012. Going forward on an annual basis, the incentive will be aligned with the renewable energy costs as they continue to decline. The new program will also make participation easier for the consumer. By matching the renewable system size to the energy used by the residence or business, interconnection with the local power company will be easier and quicker. In addition, the program includes a "fast track" process for small systems, 10 kW and less in size. Up to 10 megawatts (MW) of renewable generation will be available for purchase through Green Power Providers through December 2013. To facilitate the transition from Generation Partners, 2.5 MW of this capacity is reserved through December 2012.

These two optional programs complement TVA's existing renewable programs, including the Solar Solutions Initiative for installations between 50 kW and 1 MW and the Renewable Standard Offer program for renewable energy generation up to 20 MW. The purchase of renewable electric energy is similar to feed-in tariffs used in Europe and in at least five states in the U.S., as well as a number of cities and other utilities. The Renewable Standard Offer is designed for developers of renewable energy projects greater than 50 kW, and less than or equal to 20 MW. Developers of projects less than or equal to 50 kW should investigate TVA's Generation Partners; and developers of projects larger than 20 MW should investigate the Unsolicited Proposal Process or the Dispersed Power Production (DPP) Program. The Renewable Standard Offer has been designed using guidance from TVA's Board concerning the terms by which TVA may purchase renewable energy. Where flexibility exists under the

authorization, the Renewable Standard Offer provides choices to developers, such as different contract lengths. Major renewable power generating technologies, including solar, wind, biomass gasification, and mature renewable technologies, such as biomass direct combustion, methane recovery, and co-firing of 50% or more biomass, are each covered under the program. The Renewable Standard Offer will accept up to 100 MW, but no single technology can exceed 50% of total Renewable Standard Offer MW. Ultimately, the energy industries are in the process of aligning all of the renewable energy programs to provide sustainability in pricing and capacity levels. This strategic alignment benefits the local power companies, renewable energy developers and consumers. Through continued investment in existing and new infrastructure and innovative renewable power programs, the energy industry can put the vision of low-cost and dependable energy into action.

Overall Assessment



The Metropolitan Nashville region is fortunate to be nestled into the TVA system. With proactive initiatives and forward thinking, the energy needs of the area seem well positioned to accommodate future growth.

Developing Mass Transit

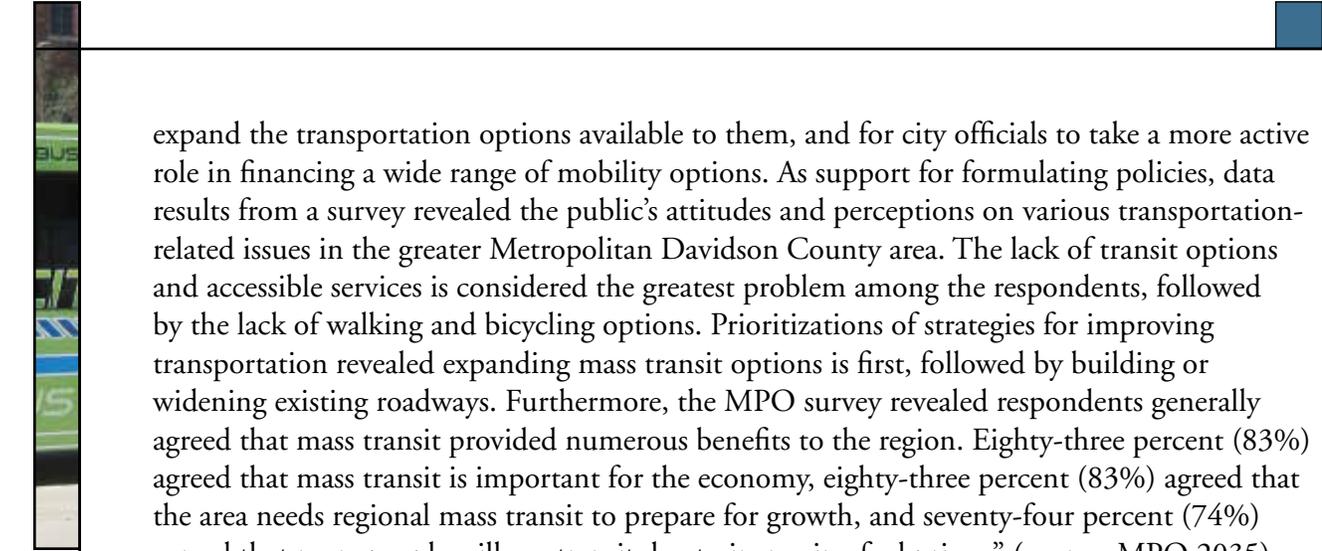
While mass transit was not included in the analysis and grading methodology as the other areas in this document, it remains a critical part of the overall vision for infrastructure improvements. Several national growth indicators related to energy and transportation (e.g., vehicle miles traveled per capita) show that land development patterns have created an unsustainable urbanized footprint that needs to be addressed in the short-term in order to ensure future, long-term prosperity. Over the last decade, Davidson County has experienced significant expansion of sprawling development pattern which has threatened the region's natural resources as well as placed an increased pressure on the fiscal resources to keep up with growing demands for new infrastructure and community services.

The healthy growth of any area is closely interconnected with, and dependent on, a well-conceived transit system that includes a balanced mix of transportation modes. Many sectors of the Middle Tennessee region's economy depend heavily on the safe and efficient movement of people and goods and services by car, truck, rail, air and water. Additionally, the economic health of the region is dependent on attracting high-quality jobs and maintaining a desirable quality of life with a low cost of living and doing business. Individually, transportation expenditures are the second highest household expense after housing, with lower-income households spending a higher percentage of their income on transportation costs than on housing. Collectively, higher prices for all petroleum products—not just fuel—are shared. For example, according to the Nashville Area Metropolitan Planning Organization (MPO), the price of asphalt more than doubled in Tennessee from January 2008–December 2008. This increase has contributed to a doubling of project costs in some places. Finally, global instability potentially affecting energy supplies could continue to drive up transportation costs, in turn affecting the fiscal capacity of businesses and households. While transportation is crucial to our economy, it is also a significant factor in the environmental quality of the region. Previous research has shown the transportation sector to be a significant source of greenhouse gas (GHG) emissions accounting for roughly 28 percent of the total GHG emissions across the nation. Indeed, conclusions derived from more recent studies strongly point to the relationship between transportation options and improved environmental health.

The Middle Tennessee region's top economic competitors (e.g., Charlotte, Austin, Denver, etc.) have recently invested billions of dollars in modernizing their public transportation system to position their areas for competing in an ever-changing world. Likewise, Davidson County officials are recognizing that the transportation system plays a crucial role in sustaining the economic vitality and environmental health of their region.

Establishing A Regional Vision

One of the defining strengths of Middle Tennessee lies within its demonstrated capacity to effectively organize key leaders to address issues and challenges of regional significance. There have been substantial efforts in the critical area of mass transit by several of the area's interest groups and organizations. Statistically-valid research released in 2010 by the MPO, a federally-designated transportation planning agency for over 2800 square miles and more than 1.5 million people, revealed that Middle Tennesseans have a strong and broadly shared desire to



expand the transportation options available to them, and for city officials to take a more active role in financing a wide range of mobility options. As support for formulating policies, data results from a survey revealed the public's attitudes and perceptions on various transportation-related issues in the greater Metropolitan Davidson County area. The lack of transit options and accessible services is considered the greatest problem among the respondents, followed by the lack of walking and bicycling options. Prioritizations of strategies for improving transportation revealed expanding mass transit options is first, followed by building or widening existing roadways. Furthermore, the MPO survey revealed respondents generally agreed that mass transit provided numerous benefits to the region. Eighty-three percent (83%) agreed that mass transit is important for the economy, eighty-three percent (83%) agreed that the area needs regional mass transit to prepare for growth, and seventy-four percent (74%) agreed that more people will use transit due to increasing fuel prices.” (source: MPO 2035)

Serving as a regional partnership among the U.S. DOT, Tennessee DOT, local elected and public works directors, the business community, and citizens across the thirteen county planning area, the MPO leads in the development of the region's long-range transportation plan and short-range Transportation Improvement Program (TIP). The regionally envisioned and federally funded projects and transportation services in the MPO planning area include highway and street projects, public transit projects, and bicycle/pedestrian enhancement projects. The Middle Tennessee area is served by seven major regional corridors, each a significant part of the overall vision for mass transit to provide increased connectivity between downtown Nashville and other traditional town centers and emerging activity centers across the area. In partnership with the numerous government, business, and community organizations, the Nashville Area MPO prepared a Regional Transportation Plan (RTP) for the citizens of the Nashville-Davidson-Murfreesboro-Franklin, TN Metropolitan Statistical Area. The general concept of a metropolitan statistical area is that of a core area containing a substantial population nucleus, together with adjacent communities having a high degree of economic and social integration with that core.

Already shaped by thousands of citizens, guided by commonly shared principles and goals, the intent of the RTP is to encourage healthy regional growth through the year 2035. One way the RTP can assist growth in the Region is for engineers, architects and developers to pursue the four guiding principles (livability, sustainability, diversity, prosperity) in design. A significant element of the RTP encourages a bold, new vision that calls for the expansion and modernization of the region's mass transit system. Such a move is a necessary part of the region's preparation for the increasing competitive global economy, and proactively addresses the growing concerns about the health of our environment, worsening congestion, and the sprawling land development pattern that has begun to encroach upon the area's cherished rural countryside. The vision includes a variety of new and expanded services for regional corridors, urban centers, suburban communities, and even the rural countryside as commuting patterns begin to yield sufficient demand for transit. The long range vision for mass transit calls for a strategic mix of transit options for Middle Tennesseans, ranging from high frequency rapid transit service to the continued provision of rural transit services for those who do not live nearby to fixed route options.

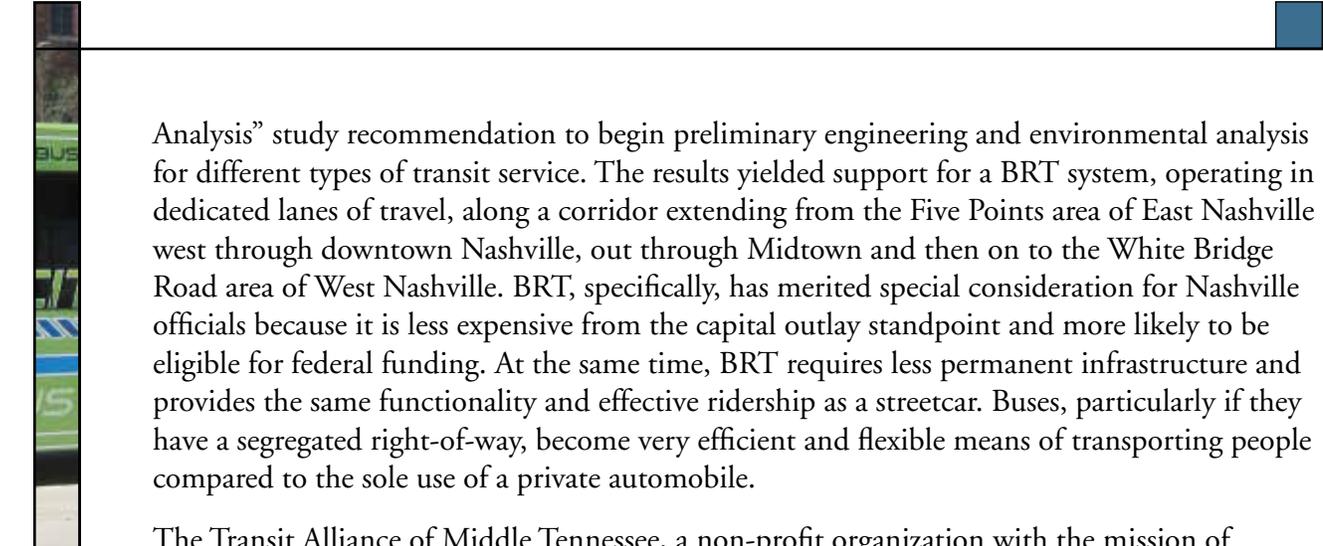


The Nashville Area MPO worked closely with several other organizations on their research and formation of the RTP. Cumberland Region Tomorrow (CRT) was formed in 2000 as a non-profit regional organization dedicated to working with the public sector to support and encourage quality growth planning. Through its work, CRT brings people together to address the challenges and opportunities that come with growth and development in Middle Tennessee. In its mission to foster communication, collaboration, and action as the region plans for the long-term livability, economic vitality and sustainability, CRT produced a document in 2005 called “The Cost of Community Services Study (COCS)”. Modeled from a national study conducted to improve understanding the cost of community services on a county level scale, the COCS study was completed by the American Farmland Trust in Blount, Robertson, and Tipton Counties in Tennessee. Revenues and expenditures of public services (e.g. transportation, public safety, government administration, schools, courts, etc.) were examined to show the cost of providing these services to residential, commercial/industrial and farmland uses. This study can provide local officials a baseline description of the economic demands of land use and offer assistance for making informed decisions which sustain the local economy, contribute to economic diversity and help shape the overall quality of life in a region. Above all, the CRT study suggests that development of certain strategies would be a good long-term investment.

The MPO also worked closely with The Middle Tennessee Mayors Caucus and The Greater Nashville Regional Council (GNRC). Both organizations provided leadership on important issues facing a rapidly changing regional landscape. Transportation served as the early catalyst in the formation of these partnerships, but both organizations have served as an effective forum to build personal relationship among the civic leaders, improve relationships among jurisdictions, and helped local governments support each other on a range of issues both on municipal and regional levels. The Nashville Area Chamber of Commerce, through its regional economic development initiative Partnership 2020, pursues opportunities to grow the Nashville region through corporate relocation, expansion of existing business and entrepreneurship. It offers diverse programming in workforce development, public policy and also addresses issues related to quality of life enhancement, broaden the regional perspective of diverse and proven community leaders and support their conversation about essential public infrastructure and services required to accommodate regional growth and development including new job opportunities for our growing population.

Implementing Local Bus Rapid Transit (BRT)

Urban services are the backbone of any regional transit system and must be optimized in order to ensure the success of investments in regional mass transit. Based on traffic density, a system must be selected that will have adequate capacity. There are many examples of transportation systems that are revitalizing communities and stimulating great economic activity. They can be a dynamic force enhancing the physical and social structure of the city. Public transit can afford directness of route, accessibility, comfort, and convenience comparable to what private cars can provide. In Nashville, recent studies reveal the projected amount of traffic density at high enough levels to make automobiles alone impractical. Investment in either modern streetcar or Bus Rapid Transit (BRT) solutions could provide potential positive benefits. In 2011, The Metropolitan Transit Authority (MTA) in Nashville approved an “Alternative



Analysis” study recommendation to begin preliminary engineering and environmental analysis for different types of transit service. The results yielded support for a BRT system, operating in dedicated lanes of travel, along a corridor extending from the Five Points area of East Nashville west through downtown Nashville, out through Midtown and then on to the White Bridge Road area of West Nashville. BRT, specifically, has merited special consideration for Nashville officials because it is less expensive from the capital outlay standpoint and more likely to be eligible for federal funding. At the same time, BRT requires less permanent infrastructure and provides the same functionality and effective ridership as a streetcar. Buses, particularly if they have a segregated right-of-way, become very efficient and flexible means of transporting people compared to the sole use of a private automobile.

The Transit Alliance of Middle Tennessee, a non-profit organization with the mission of encouraging new investments in mass transit in the 10 county region of Middle Tennessee, along with other groups are working to secure public and private sector support for BRT in Nashville. The Alliance of Middle Tennessee has become a close partner with the MTA, Mayor Karl Dean, the Greater Nashville Chamber of Commerce, Vanderbilt University, the Downtown Partnership and a host of other organizations, businesses and institutions as design and ultimate construction of a new transportation option develops. Through communication and education efforts regarding the social and economic value of mass transit, local organizations are actively pursuing the steps necessary to secure dedicated funding for mass transit in the years ahead. The Transit Alliance often uses the EmX system of Eugene, Oregon as a model case for local BRT. Opened in 2007, the EmX system connects downtown Eugene to downtown Springfield, the University of Oregon, Lane Community College and a library. The system operates in both an exclusive lane and mixed traffic and supports 7,000 trips per day. Regulatory changes have been put in place to support higher-density, walkable areas served by transit. Features such as modern, low-floor, high capacity vehicles accommodate a large number of riders and allow fast boarding and exiting. Exclusive travel lanes allow BRT vehicles to be free of conflicting automobile traffic, parked or stopped vehicles and other obstructions, which maximizes the speed and reliability of the system. Conveniently located throughout the corridor at key areas, BRT stations provide protection from the elements where frequent, continuous service and directness to key destinations assure the system is reliable. A streamlined fare collection process is simplified through self-service kiosks and prepaid “smart cards” allowing efficient boarding. Finally, through the use of hybrid or electric buses, vehicle emissions will be reduced.

Initially described as the “Broadway/West End Corridor”, Nashville’s “East-West Connector” bus system will replicate several components of Eugene’s EmX. The “East-West Connector” proposes to connect the many activities and attractions along a corridor with frequent and rapid transit travel. More than any other corridor in the area, the East-West Connector brings together universities, hospitals, businesses, tourist and cultural attractions, key residential areas and centers of federal, state and local government. Mass transit along the East-West Connector will serve commuters traveling to and from work; hospital patients, staff and visitors; individuals making everyday trips, such as running errands and going to restaurants; residents and visitors traveling to special events; and regional residents making trips to the area’s core. Strategic plans by both the Metropolitan Transit Authority (MTA) and the Nashville Area

Metropolitan Planning Organization (MPO) emphasize the East-West Connector's vital role as part of a larger transportation plan that will connect the region and be the next major step in turning our region's "Bold New Vision for Transit" into reality.

Utilizing Improved Technology

Intelligent Transportation Systems (ITS) refers to the use of technology to manage the transportation system more effectively, improve its efficiency, and make it easier to use. Wide varieties of ITS techniques are under development or are being used in various parts of the country. In the Nashville area, the Tennessee Department of Transportation has recently installed dozens of dynamic message signs along interstates to provide important traffic related messages to motorists. Local jurisdictions are using ITS technology to achieve better signal coordination along important arterial routes, and to establish traffic management centers where data is collected and analyzed. Over the long term, the local and state efforts are coordinated through a plan known as the ITS Regional Architecture. This plan spells out what types of data are being collected by each agency, what will be shared, and the compatibility needs for equipment.

The MTA system, including The East-West Connector, aims to use advanced technologies like traffic-signal preference at intersections and cross streets, as well as GPS to provide real-time bus arrival and departure information. Transit Now, a local non-profit service organization, recognizes the strong need for a mobile transit application in Nashville to help improve the lives of current and future riders. During the 2012 Transit Week, an online poll found 93% of respondents interested in a real-time mobile app, and 82% said they would be more likely to ride public transportation with real-time data in the palm of their hand. Each MTA vehicle is equipped with an AVL unit that is broadcasting its current geographical location. On-time performance has a direct impact on perceptions of public transportation. A public transportation system known to be off-schedule or causing fears of potential mechanical difficulties greatly affects the perception of public transportation as being undependable and severely limits ridership. The support for the development of an "app" by Transit Now seeks to solve some of these problems by providing riders with real-time GPS information about the MTA's bus system to the individual. Their support of this mission to improve the reliability of public transportation in Nashville by providing precise real-time geographical locations of transit vehicles on smartphones and signs could be critical to the success of BRT's implementation.

Overall Assessment

Metropolitan Nashville is behind similar sized cities such as Raleigh and Charlotte, North Carolina in the development of mass transit systems. Nevertheless, there is extensive planning underway and a substantive community discussion occurring on the need for mass transit to accommodate a growing population.



While open space and parks were not included in the in-depth analysis of the other areas in this document, it remains a significant part of the overall vision for infrastructure investments in Davidson County. A network of parks and open spaces that conserves natural ecosystem functions, and sustains open land, clean air and water can provide a wide array of benefits to people and wildlife. It is essential that government officials, civic leaders and the greater public understand the importance of support for a wide range of measures to protect open space. Implementation of local policies and strategies can serve to achieve much toward protecting open space and prioritizing the need for natural areas and parks. For example, the 2002 Metropolitan Parks & Greenway Master Plan created a vision and established specific goals and strategies for neighborhood and community open spaces. Subsequently, the 2008 Master Plan Update listed the completion of over 20 projects set forth in the 2002 Plan as reaching achievement of those goals and strategies. In 2008, total metro parks included 115 park locations, 114 playgrounds, approximately 170 tennis courts, 6 year-round golf courses, multiple athletic fields and swimming pools, over 37 miles of greenway, community centers and several covered structures including concession stands and picnic shelters. Ultimately, it is critical to emphasize the importance of these spaces as part of larger system that are protected and managed for the several benefits they provide.



Most recently, as Nashville recovered from the 2010 flooding, a new approach to open space planning began to take shape. Local leaders formed together to develop the Nashville-Davidson County Open Space Master Plan and Green Infrastructure Master Plan. With guidance from the community, the purpose of both the Nashville-Davidson County Open Space Master Plan

and Green Infrastructure Master Plan was to develop an implementable vision for protecting and enhancing Nashville’s lands and natural resources. Both plans were created to inventory and evaluate open space as well as integrate natural land protection with the adopted land use plans. In other words, both plans sought to prioritize conservation opportunities and plan development in ways that optimize the use of land to meet both the needs of the people and the natural environment. Significantly, both plans encourage a collaborative effort that engages a broad community of both conservation and development leaders.

Nashville-Davidson County Open Space Master Plan

The creation of Nashville-Davidson County Open Space Master Plan was a key recommendation in the 2009 report of the Mayor’s Green Ribbon Committee on Environmental Sustainability. Shortly after the release of the report, Mayor Dean formed a

public/private partnership to carry out the recommendation. Working with the Land Trust for Tennessee, Mayor Dean selected the Conservation Fund to develop a formal open space plan for Nashville. The result is Nashville: Naturally, the first conservation plan that maps every inch of protected open space in Davidson County as well as depicts a clear vision for how to protect and connect to open space. The Conservation Fund viewed all networks of natural areas and open spaces such as woodlands, wetlands, trails and parks as essential parts of the plan. Nashville: Naturally builds upon existing green space and large parks, such as the Bicentennial Mall, Public Square, Ft. Negley. These larger parks serve as nodes connected by green linkages. The linkages promote a stronger connection between people and wildlife to natural area networks, support urban and rural farming, and preserve historic and cultural resources.

As the planning team began to select sites of conservation for future open space and linkages, preference was given for certain areas based on maximizing the use of existing trails, proximity to downtown, and potential for connectivity between residential neighborhoods, private, commercial and public destinations. Other important factors that were reviewed included existing utilities, floodplains, soils, wetlands, and slopes. Parcel boundaries and an inventory of cultural and historic sites, and tourist attractions were also collected and reviewed. In addition to trails and paths, connectivity elements such as “blueways” or water trails also count toward park and open space inventory and also aid in accessibility to park and recreation facilities. The National Recreation and Park Association (NRPA) established a standard of 6 acre per 1000 population. As part of the development of the plan, the planning team worked with appropriate city agency representatives to identify opportunities to set aside land for greenways and parks to meet or exceed this standard. The plan discusses its goals of adding approximately 3,000 acres of parkland in the next 10 years to keep up with the growing population needs. This will increase the Metro Parks system by approximately 30%. Furthermore, the plan encourages adding 25 miles of new greenways in the next 5 years in efforts to improve key park and greenway linkages and stream corridors.



Envisioned in the Open Space Master Plan are large reserves of protected open space in each of the “four corners” of the county that serve as anchors for the open space network to be set aside and preserved for parks, trails, and wetlands, combining active and passive forms of recreation. Gaps between the larger reserves should be filled to connect all of the four corners to each other. By bicycle or on foot, one should be able to travel from one corner of the county to another and into downtown via greenways or bikeways. A green, thriving urban



core will have more parks and greenways, a substantial increase in tree canopy, and innovations such as green roofs and rain gardens that capture and filter stormwater. The plan identifies future opportunities for a revitalized riverfront with a network of open spaces. For example, in past development, the industrialization of along the edge of the Cumberland resulted in a large build-out of structures in the floodway. Following the floods, the city leaders formed a part of the plan that would push programs to buy and remove a large number of such structures. Once removed these spaces were legally required to be preserved as open space in perpetuity.

Nashville and Davidson County Green Infrastructure Master Plan

Green infrastructure is the interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that naturally manages stormwater, reduces flooding risk and improves water quality. The Nashville and Davidson County Green Infrastructure Master Plan was created in response to the ordinance directing Metro Water Services to develop a plan for the installation of green infrastructure within the Stormwater Master Planning District through cooperation with the Metropolitan Planning Department, the Metropolitan Development and Housing Agency, and the Department of Public Works. The Master Plan document was prepared by AMEC, Hawkins Partners, Urban Blueprint, and the Low Impact Development Center and was finalized and approved by the city in 2009. The plan includes an analysis of the city's combined sewer system along with green infrastructure practices to be integrated. Green infrastructure utilizes an ecosystem-based approach that is used to replicate a site's predevelopment hydrologic function. The goal of the Green Infrastructure Master Plan is to design a built environment that remains a functioning part of an ecosystem rather than existing apart from it.

The Natural Resource Defense Council (NRDC) commented on Nashville's Green Infrastructure Master Plan stating, "In addition to identifying various green infrastructure practices in the stormwater planning district, the plan provides a detailed analysis of the impacts that four types of practices have on the volume of stormwater runoff: rainfall harvesting; green roofs; urban trees; and three infiltration practices (bioinfiltration areas, permeable surfaces, and tree planters)," (NRDC, 2011). The plan's discussion of green infrastructure methods also includes impediments to implementation, land use demands as well as cost and maintenance recommendations. In addition, recommendations are identified for environmental protection through suitable locations for these processes and the identification of key environmentally sensitive sites.

Benefits of Open Space and Parks

Open spaces, parks and greenways are often more than a network of recreational opportunities. These 'green infrastructure' components of communities conserve open space close to where people live and work, soften the patterns of urban growth, mitigate water and air pollution, protect wildlife habitat, provide viable means for alternative transportation, promote economic growth and improve the quality of everyday life. Programs and policies should be designed and implemented to complement these green infrastructure investments, forming a comprehensive



approach to creating healthy communities and healthy ecosystems. The Nashville and Davidson County Open Space Master Plan and Green Infrastructure Master Plan both recognize the environmental, economic, and social benefits of implementing these plans objectives and goals.

Environment:

Green infrastructure planning identifies areas that are environmentally beneficial and ensures those areas are protected. Sustainability practices, resulting from the open space and greenway system, can improve water quality, decrease potable water requirements, and decrease urban heat island effect. Implementation of green infrastructure for the purposes of stormwater management is also becoming increasingly vital for enhancing the environment. On a national level, new U.S. Environmental Protection Agency EPA standards promote the use of green infrastructure to deal with stormwater runoff. Green infrastructure uses infiltration, evapotranspiration and alternative reuse of the stormwater to reduce the amount that runs off of a site. The EPA is also addressing the significance of green infrastructure in the regulation of pollutants. Infiltration, for example, employs trenches and dry wells to enhance water percolation through a media matrix that slows and partially holds stormwater runoff, facilitating pollutant removal that could ultimately lead to eliminating certain water bodies from the EPA impaired list. On a local level, connections among wildlife and water networks have also evolved as an essential component of the plan to restore the endangered Nashville crayfish population.

Green infrastructure practices can be environmentally effective when using sustainable materials and construction methods throughout greenway building and structures. For example, provision of pervious pavements at trailhead and trail access parking areas can increase infiltration and decrease surface runoff. Sustainability features can also be promoted in greenway and trail networks by implementing raingardens, bioswales, or constructed wetland, thus, increasing the amount of land for natural stormwater retention and allowing a community to become potentially more disaster resistant.

Economic:

National studies indicated positive changes in land and property values when located near open space or greenways. For example, land closest to a greenbelt in Salem, Oregon was valued at \$1,200 more an acre than land 1,000 ft away from it (Flink, 2010). The selling price of property near these spaces was attributable to the proximity of that greenspace. In addition, trails and greenways in Apex, NC increased property values within The Shepard's Vineyard housing development that added \$5,000 to the price of 40 homes adjacent to the regional greenway — and those homes were first to be sold. (Greenways Inc., 2010). Thus, conservation of open space and greenways can create economic value for land or property within a community or potentially catalyze quality urban development around it.

Local revenues from open spaces, parks and greenways can also occur through sound public investments. Further opportunities in construction and maintenance, recreation rentals (such as bicycles, kayaks, and canoes), recreation services (such as shuttle buses and guided tours), historic preservation, restaurants and lodging and other tax revenues can be created

through development of open space and trail systems. For example, bicycling in the Outer Banks of North Carolina is estimated to have an annual economic impact of \$60 million with 1,407 jobs supported from the 40,800 cycling visitors. The annual return on bicycle facility development in the Outer Banks is approximately nine times higher than the initial investment. At the Virginia Creeper Trail, a 34-mile trail in southwestern Virginia, locals and non-locals spend approximately \$2.5 million annually related to their recreation visits. Another example includes the San Antonio Riverwalk, created for \$425,000, which is now one of the most popular destinations in the city feeding a \$3.5-billion tourist industry.



In addition, employing green infrastructure strategies can create other economic implications for savings. For example, the National Home Builders Association did a comparative study of subdivisions — one designed using green infrastructure and one designed using conventional drainage — the project utilizing green infrastructure saved approximately \$280,000.

Other research conducted in Philadelphia, PA reveals the difference between building a sewer tunnel versus green infrastructure for stormwater management. In most urban areas, flood protection and stormwater management are accomplished by building a vast network of underground storm sewers and detention ponds or levees-solutions that are not only costly to construct but have substantial ongoing maintenance needs. The green infrastructure constructed in Philadelphia offered a 24 to 1 return. Thus, flood protection presents a major opportunity for the development and installation of green infrastructure and flood protection projects, floodways, floodplains, and adjacent wetlands.

Community Development and Public Health:

Green infrastructure projects also foster community cohesiveness by engaging all residents in the planning, planting and maintenance of the sites. Protecting Nashville's open space through a formalized plan, could serve to preserve cultural sites and historic viewsheds as well as working forests and farms as a way of life. The plan also recognizes the benefits to public health when residents have expanded access to parks and greenway systems. Green infrastructure also can reduce the erosion of precious top soil, which aids local farms and can provide a healthier food source.

In terms of trails, according to a 2002 survey of recent homebuyers by the National Association of Home Realtors and the National Association of Home Builders, trails ranked as the second most important community amenity out of a list of 18 choices. Additionally, the study found that 'trail availability' was ranked above several other options such as ballparks,

golf courses and shopping centers. Other potential community benefits of trails include providing alternate means of travel through walk and bike paths, reduction in household fuel spending and provision of a safe connection between downtown areas, surrounding residential neighborhoods, parks, schools, libraries, cultural and historical destinations, office and retail.

Concluding Thoughts:

In keeping with the goal to become one of the top 25 sustainable cities in the country, the City of Nashville, Tennessee identified the need to expand their plans guiding principles relating to environmental sustainability by recognizing the need to utilize and expand their existing open space and greenways. Both plans offer numerous policy recommendations to promote green infrastructure, connect people and wildlife, protect water networks, support urban and rural farming, as well as preserve several natural and historic resources. Above all, the Greenway and Open Space Master Plan and Green Infrastructure Master Plan provides the City of Nashville and Davidson County with a tool to be used in conjunction with the current zoning ordinance and land use plans for determination of appropriate placement, alignment and design for new trails, bike routes, greenways and open space based on new development requests and funding availability.

Overall Assessment

Nashville is lucky to have forward thinking civic and municipal leaders. The visions being executed to provide ample park and green space for current and future citizens is fueling the city's reputation for progressive city management.



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ACKNOWLEDGEMENTS AND THANKS

The joint committee is grateful for all the hard work of the numerous members of ULI Nashville and ASCI who have helped bring this project to fruition. The authors would particularly like to recognize the following individuals for their extraordinary efforts:

- Katy Brookby
- Janey Camp
- Emily Fronheiser
- Chris Gwaltney
- Tony Montiel
- Dana Neal
- Darryl Peder

The MCIR owes enormous gratitude to the research, drafting and ideas of our committee members: Aras Barzanji (USACE), Brendan Boles (Lose and Associates), Janey Camp (Vanderbilt University), Clint Camp (Parsons Brinckerhoff), David Coode (Kimley Horne Consultants), Irucka Embry (EcoC2S), Jay Everett (Lose and Associates), Emily Fronheiser (Barge Waggoner Sumner Cannon), Matt Gardner (Southern Land Company), Jason Griffith (Jacobs Engineering), Chris Gwaltney (Lipscomb University), Fiona Haulter (CBRE), Marty Heflin, co-leader (Range Light Partners), Richard Jones (Rogers Group Inc), Tony Montiel (CDM Smith), Dana Neal (Carter Group) , Darryl Peden (Barge Waggoner Sumner Cannon), Buddy Petty (Barge Waggoner Sumner Cannon), Jeffrey Ross (USACE), Greg Sanford (Gresham Smith and Partner), Monica Sartain, co-leader (Patriot Engineering Inc.), Garland Stone (Trestles, LLC), and Blake Turner (RPM Transportation Consultants)

In addition, we could never have gotten this far without the tireless efforts of ULI's Nashville District Council Director, Rose Faeges-Easton.

Funding for this project was provided by the ULI 75th Anniversary Urban Innovations Grant.

ULI, the Urban Land Institute, is a 501(c) (3) nonprofit research and education organization supported by its members.

A multidisciplinary real estate forum, ULI facilitates an open exchange of ideas, information, and experience among industry leaders and policy makers dedicated to creating better places.

Members say we provide information they can trust, and that ULI is a place where leaders come to grow professionally and personally through sharing, mentoring, and problem solving. With pride, ULI members commit to the best in land use policy and practice.

ULI Nashville is “ULI at the local level.”



Mission & Priorities

The mission of the Urban Land Institute is to provide leadership in the responsible use of land and in creating and sustaining thriving communities worldwide.

ULI is committed to

- Bringing together leaders from across the fields of real estate and land use policy to exchange best practices and serve community needs;
- Fostering collaboration within and beyond ULI’s membership through mentoring, dialogue, and problem solving;
- Exploring issues of urbanization, conservation, regeneration, land use, capital formation, and sustainable development;
- Advancing land use policies and design practices that respect the uniqueness of both the built and natural environments;
- Sharing knowledge through education, applied research, publishing, and electronic media; and
- Sustaining a diverse global network of local practice and advisory efforts that address current and future challenges.

Established in 1936, the Institute today has nearly 30,000 members worldwide, representing the entire spectrum of the land use and development disciplines. ULI relies heavily on the experience of its members. It is through member involvement and information resources that ULI has been able to set standards of excellence in development practice. The Institute has long been recognized as one of the world’s most respected and widely quoted sources of objective information on urban planning, growth, and development.

ULI's Priorities

Creating Resilient Communities

- What are the best new models in the real estate and land use industry, and how can we support their development?
- How can we best adapt and reuse existing real estate while eliminating obsolete space in order to create thriving communities?
- How can we influence land use leaders locally and around the world as they reshape the process of community building and developing both social and physical infrastructure?

Understanding Demand and Market Forces

- How can we best understand demand (quantity, type, price, and location of the need) for real estate and discover what the market wants short term versus what it needs long term?
- How can we help balance local, regional, national, and global interests, as well as public and private interests, in terms of how they affect land use decisions and development?
- How will changing technology influence building and buildings, and how will people's use of technology influence how they interact with the physical environment?

Connecting Capital and the Built Environment through Value

- How can we best generate value in the built environment that is greater than its cost?
- What are the best ways to ensure the attractiveness of real estate as an investment as institutional capital allocators continue to change and become more global?
- What is the most effective way to demonstrate and explain the relationship between investment in both public projects (including infrastructure) and amenities and the impact on real estate value?

Promoting Intelligent Densification and Urbanization

- What are the most responsible ways to provide cost-effective housing for a rapidly increasing global population that is becoming increasingly urbanized?
- How can we advance the understanding of the relationship between a high quality of life and the built environment in order to promote creation of high-quality, appropriately priced density that is attractive to users?
- What is the relationship between a thriving economy and a thriving city—between a dynamic society and the built environment?





Integrating Energy, Resources, and Uses Sustainably

- How can we best reduce the negative impact of the built environment on our natural resources and climate?
- What are the best ways to use the world's energy resources and protect the built environment from volatile and unpredictable conditions?
- How will trends in energy and resources affect the future best use of land?

Founded in 1852, the American Society of Civil Engineers (ASCE) represents more than 140,000 members of the civil engineering profession worldwide and is America's oldest national engineering society.



ASCE's mission is to provide essential value to our members and partners, advance civil engineering, and serve the public good. In carrying out that mission, ASCE:

- Advances technology
- Encourages lifelong learning
- Promotes professionalism and the profession
- Develops civil engineer leaders
- Advocates infrastructure and environmental stewardship

ASCE Vision

Civil engineers are global leaders building a better quality of life.

ASCE Mission

Provide essential value to our members and partners, advance civil engineering, and serve the public good.

ASCE Goals

- Facilitate the advancement of technology to enhance quality, knowledge, competitiveness, sustainability, and environmental stewardship.
- Encourage and provide the tools for lifelong learning to aid our members' continued growth throughout their careers.
- Promote professionalism and the profession throughout society to enhance the stature of civil engineers and to influence public policy.
- Develop and support civil engineer leaders to broaden our members' perspectives, enhance their career growth, and promote the public interest.
- Advocate infrastructure and environmental stewardship to protect the public health and safety and improve the quality of life.

