MINNESOTA GO

Planning Minnesota's
Transportation Future

AGING INFRASTRUCTURE TREND ANALYSIS

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SUMMARY

Note: Updated investment and system needs numbers will likely be available in 2022. This trend paper will be updated when new information is available.

Minnesota's public infrastructure is aging. Government entities – from small towns to state agencies – have long lists of needed fixes and not enough resources to make them. Waiting longer to do maintenance makes it cost more. To avoid these costs, Minnesota needs to fix its aging infrastructure and consider the life-cycle costs of new assets.

Minnesota's story is like the rest of the country. Transportation is like other industries. Aging infrastructure, a lack of preventative maintenance and not replacing of assets in poor condition has resulted in leaky pipes, pothole-ridden streets and the inefficient delivery of services. There are many investment needs competing for limited funds. In Minnesota, the average driver spends an estimated $542 per year in extra vehicle repairs and operating costs from driving on roads in poor condition.[1]

This report focuses mostly on the transportation infrastructure MnDOT is responsible for. However, it is important to consider infrastructure owned by private interests (such as the freight railroads and pipelines) in addition to other government agencies for transportation and non-transportation purposes. Even underground utility systems like water and sewer infrastructure can affect the transportation system if not properly maintained. For local agencies, the needs of other infrastructure often compete with transportation for limited resources.

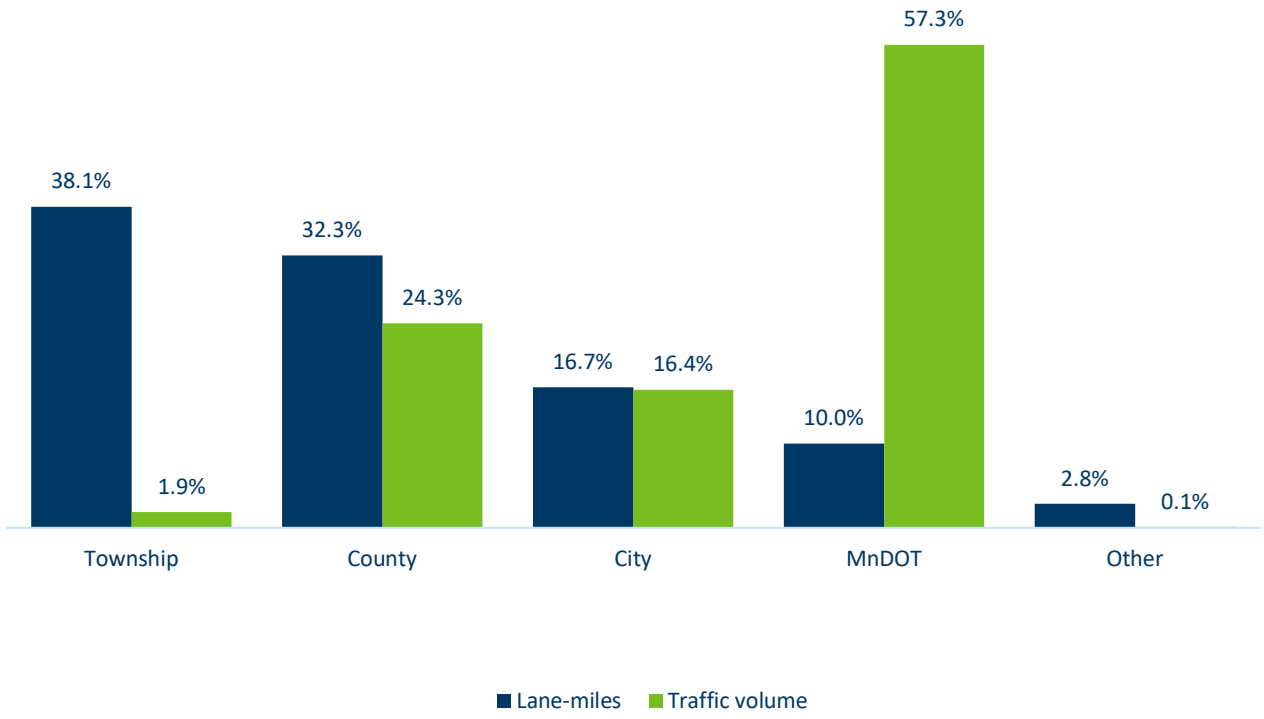
MINNESOTA'S HIGHWAY SYSTEM

Ownership of transportation infrastructure in Minnesota is divided between different government jurisdictions. This can lead to confusion regarding who is responsible for maintenance and what funding sources are available. Figure 1 shows the breakdown of roadway lane-miles in Minnesota by level of government. A lane-mile is one mile of one lane of a roadway. MnDOT is responsible for maintaining a small but highly used portion of the state's highways. Counties own more than three times as many lane-miles of highways as MnDOT, but those highways carry less than half the amount of traffic. The township system is almost four times the length of MnDOT's, but MnDOT roads carry 30 times as many vehicles.

When appropriate, MnDOT negotiates with cities and counties to transfer ownership so that Minnesota's roads are owned and operated by the appropriate level of government based on their use and role in the overall transportation system. Jurisdictional transfers between government agencies often involve costly improvements to make sure that roads are in good condition at the time of the transfer but can lead to cost savings and efficiencies in the long run.

[1] Key Facts about Minnesota's Surface Transportation System and Federal Funding," TRIP, 2019, https://tripnet.org/wp-content/uploads/2019/07/Fact_Sheet_MN.pdf.

Figure 1. Ownership of the roadway system by lane-mile and traffic volume (2019)[2]

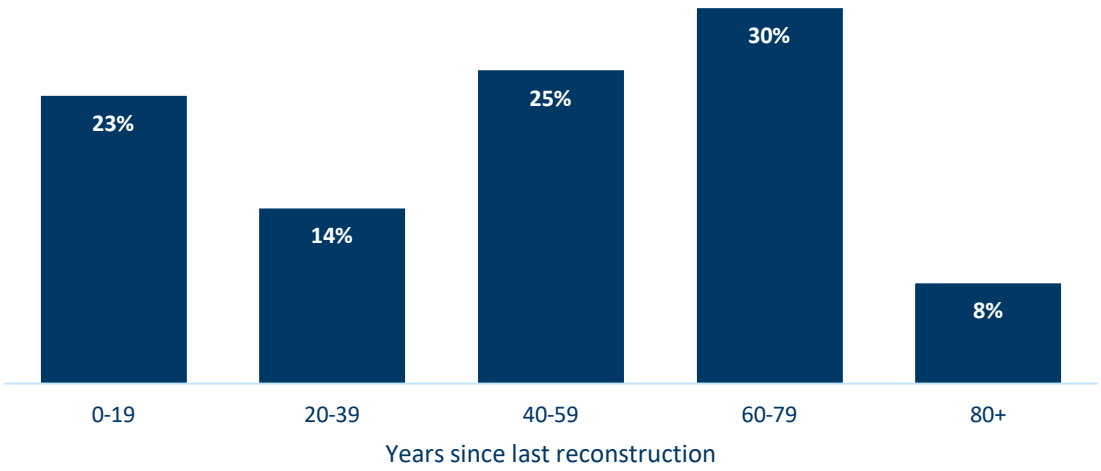


STATE HIGHWAYS

The majority of Minnesota's highways were originally constructed between 60 and 70 years ago and their age is one of the main challenges facing MnDOT today. The Federal Aid Highway Act of 1956 provided funding for freeways and expressways to be built throughout the country, which is the primary reason for the substantial spike in the number of lane-miles between 40-70 years old. Given the number of highways that were built and rapid system expansion that occurred in the years following, many roadways in the United States are now in need of significant maintenance or reconstruction. Generally, roads are fully reconstructed about every 50 years. The age at which a reconstruction is needed varies greatly from roadway to roadway and is due to environmental factors, type of use, traffic levels, use by heavy commercial freight traffic, type of pavement, amount of maintenance received and more. Figure 2 shows the age of pavements on the state highway system based on the date of their original construction or when they were last fully reconstructed. This does not include when they were most recently resurfaced or overlaid.

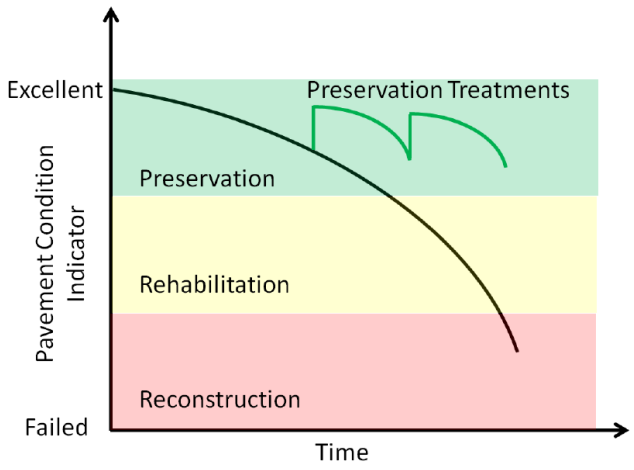
[2] MnDOT, Highway Performance Monitoring System, 2019

Figure 2. Percent of total lane miles by age of pavement on the State Highway System (2019)[3]



Preventive maintenance treatments, which can only be applied when the pavement is in good condition, are significantly cheaper than major rehabilitation at poor condition. If best management practices for maintenance are not implemented in a timely manner, future fixes become more expensive as pavement quality decreases and more substantial repairs are needed (Figure 3). MnDOT tries to invest periodically over time before eventually reconstructing the road, as available funding allows. It is not only cheaper to maintain pavements through the application of preventive maintenance actions, but that the quality of the pavements, and thus service to users, remains higher over time.[4] More information about MnDOT's life cycle cost analysis is available at: www.minnesotago.org/cost-effectiveness.

Figure 3. Typical treatments for pavement repair over time[5]



[3] "MnDOT Transportation Asset Management Plan," Asset Management (MnDOT, June 2019), https://www.dot.state.mn.us/assetmanagement/tamp.html.
[4] Ibid.
[5] Ibid.

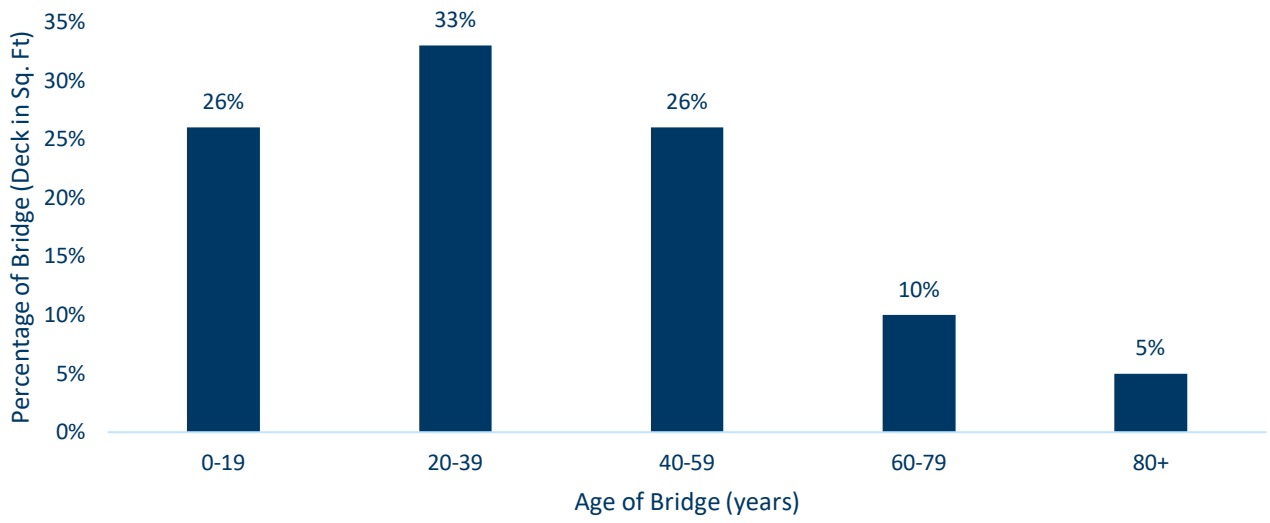
STATE HIGHWAY BRIDGES

Bridges have historically been constructed with a theoretical design life of 50 years, though newly constructed bridges are expected to remain functional for 75 to 100 years or more due to recent materials and engineering improvements.[6] Timely and proper bridge maintenance during their lifespan is an important step in achieving the full useful life of a structure.

In 2021, 5.2% of MnDOT's highway bridge structures on the national highway system, MnDOT's priority road network, were in poor condition. 3.8% of other state highway bridges were also in poor condition. Bridges rated "poor" are safe to drive on, but they are at the point where significant investment in repair or replacement is necessary.

Accounting for the pressing needs of bridges in poor condition often takes up resources that could otherwise be used to maintain bridges that need minor, preventive maintenance. This can result in the establishment of a "worst-first" maintenance strategy that is more expensive to carry out in the long term. Figure 4 shows the age of bridges and large culverts on the state highway system based on their year of construction.

Figure 4. Age of bridges and large culverts in Minnesota (2019)[7]



MNDOT ASSET MANAGEMENT

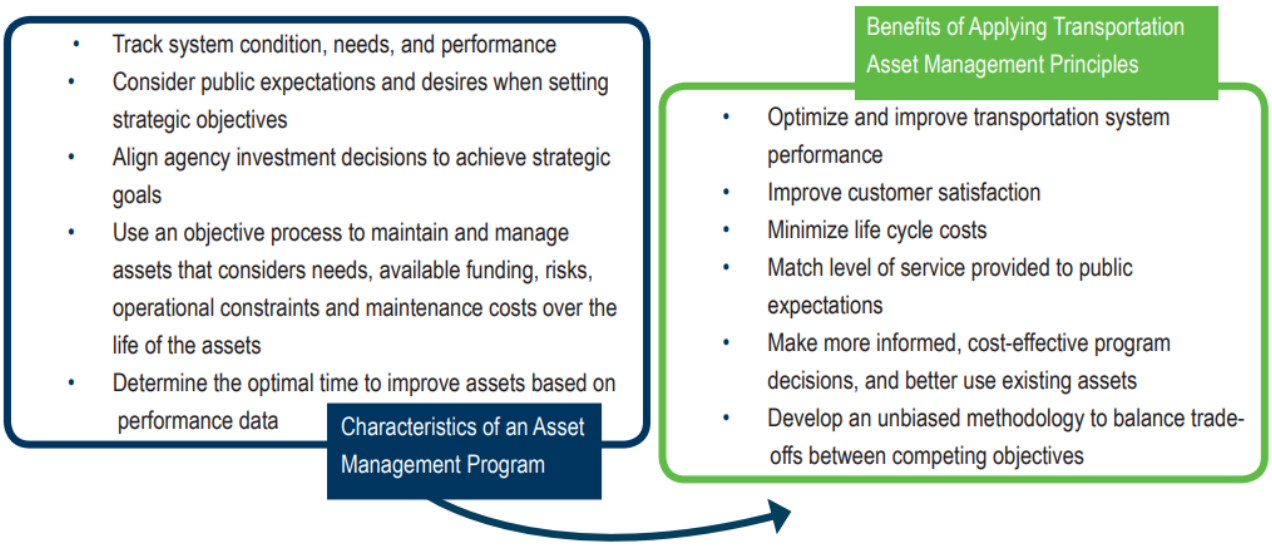
MnDOT's asset management department has developed a Transportation Asset Management Plan that informs capital and operations planning efforts. Asset management includes ongoing conditions assessments for pavement, bridges and other infrastructure. Pavement condition data is collected and reported annually.[8] Results are measured against federal pavement performance targets to identify the level of investment needed to

[6] FHWA, Bridge Preservation Guide, 2018, accessed May 24, 2021 https://www.fhwa.dot.gov/bridge/preservation/guide/guide.pdf.
[7] "MnDOT Transportation Asset Management Plan," Asset Management (MnDOT, June 2019), https://www.dot.state.mn.us/assetmanagement/tamp.html.
[8] Ibid.

achieve these targets. Bridges are inspected every other year with MnDOT's Central Bridge Office supervising fracture critical inspections. Culverts are inspected on a variable timeframe between one to six years.

MnDOT's Transportation Asset Management Program serves as a communication and accountability tool to meet federal standards for keeping infrastructure in good condition. As shown in Figure 5, there are many facets to asset management beyond data collection and conditions assessments. Data collection is an input to making decisions about prioritizing investments, balancing trade-offs and ultimately improving transportation system performance.

Figure 5. Characteristics and Benefits of a Transportation Asset Management Program[9]



Beyond roads and bridges, MnDOT also maintains other types of transportation-related infrastructure including:

- Overhead sign structures
- High-mast light towers
- Noise walls
- Traffic signals
- Lighting
- Pedestrian infrastructure (curb ramps and sidewalks)
- Buildings (rest areas, weigh stations/scales, truck stations, salt sheds, storage sheds, office buildings, miscellaneous buildings)
- Intelligent transportation systems (dynamic message signs, traffic signal timing)

[9] "MnDOT Transportation Asset Management Plan," Asset Management (MnDOT, June 2019), https://www.dot.state.mn.us/assetmanagement/tamp.html.

LOCAL INFRASTRUCTURE

Local units of government are often responsible for maintaining their public infrastructure systems, including streets, bridges, water systems and more. Over half of local governments in Minnesota practice some form of asset management to operate, maintain and extend the life of their infrastructure.[10] Most larger cities and counties engage in formal asset management practices or planning.[11] In a recent study, each level of government viewed their effectiveness differently. Large cities and counties saw their current efforts as being the most effective, while small cities viewed it as less effective.[12] Asset management is especially important for local units of government because funding for infrastructure often comes from property taxes. Infrastructure maintenance can be a significant issue for towns with struggling tax bases.

There are a variety of ways to facilitate asset management activities, including mapping and establishing a database of an agency's assets. Airports, roads and water supply and distribution pipes are the assets most commonly documented through mapping applications.[13] This is perhaps unsurprising given the important role that asset mapping plays in society for wayfinding purposes. Buildings, ports, traffic fixtures and agency fleet vehicles were consistently the least frequently mapped assets across local units of government.[14] Tracking asset location and quality allows local governments to develop estimates of the total value of assets, though few local municipalities have completed value assessments.

A 2016 study found that the majority of local entities do not know the value of their assets.[13] Five hundred and twenty nine out of 2,744 relevant jurisdictions across Minnesota responded to the MN2050 State of Infrastructure survey. Of those, 22% of large cities reported the value of road assets, which was the highest response rate for all asset types. Much more research is needed to fully understand the total value of local, publicly owned assets in the state.

ST. CLOUD CASE STUDY

The St. Cloud Area Planning Organization (APO) included a focus on asset management strategies in their update of their Mapping 2045 Metropolitan Transportation Plan. Based on data collected from roadway owners in the region, the APO found that 42% of pavements were in good condition, while 42% were in fair and 16% were in poor.[15] Most poor condition pavements are on the local and county roadways.[16] In contrast to pavement condition, 99% of bridges were in either good or fair condition. In 2019, 72.9% of non-interstate national highway system roadways were considered in good condition and 96.3% of the interstate system was considered in good condition.[17] Pavement condition, bridge condition and transit state of good repair are all monitored periodically as a part of the MPO's ongoing performance scorecard for the system.

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[10] Anna Bartholomay and Nicole MartinRogers, "MN2050 State of the Infrastructure" (St. Paul, MN: Wilder Research, 2016).
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] "Current Metropolitan Transportation Plan," Saint Cloud Area Planning Organization, accessed June 9, 2021, https://stcloudapo.org/current-plans/current-mtp/.
[16] Ibid.
[17] "Saint Cloud Area Planning Organization Transportation Performance Monitoring Report," 2019, https://stcloudapo.org/wp-content/uploads/2021/05/2019-TPMR.pdf.

AIRPORTS

MnDOT's State Aviation System Plan includes an overview of estimated maintenance costs at Minnesota's airports, broken into common funding categories. Infrastructure needs at airports include building maintenance, taxiways and property management challenges. According to the American Society of Civil Engineers, "From 2018-2022, Minneapolis-St. Paul airport and its reliever airports forecast needs of $170 million per year, while airports in Greater Minnesota forecast needs of approximately $96 million per year."[18] The Metropolitan Airports Commission anticipates a need of $2.54 billion from 2018 to 2035 at MSP, which averages out to $127 million per year over 20 years, indicating no funding gap issues.[19] MSP recently underwent major upgrades including adding additional parking, Concourse G improvements, an airport hotel and remodeled retail and bathrooms.[20] Pavement condition on runways, taxiways and aprons at airports throughout the state from 2018-2021 were generally fair, meaning they have several remaining years of useful life with regular maintenance activities.[21] Eight terminals have also been updated in the past decade in Greater Minnesota, with improvements ranging from full terminal replacement to ADA improvements.[22]

RAILROADS

Minnesota's railroads, while not owned by the State, also contribute to the growing body of aging infrastructure that requires maintenance. The State of Minnesota does own the safety equipment at highway/rail grade crossings, and MnDOT oversees crossings on all public roadways. Only four percent of crossings are on state highways.

Approximately 1,400 grade crossings have active warning systems in place. Older signal systems tend to experience more problems with malfunctioning equipment than newer systems. Signal modernization needs to be an integral component of MnDOT's efforts to maintain safety at highway/rail grade crossings. The normal life cycle for highway/rail crossing signals is 20 years. Based on inventory data, there are over 750 signal systems that should be replaced as of 2021. MnDOT has developed a statewide life cycle planning process to manage system replacement. This life cycle planning process addresses the need to replace approximately 75 signal systems per year; however current funding levels allow for replacement of only 20 signals annually. Recent legislative actions by both the State and federal governments are expected to provide significant enhancements to funding for freight rail safety and development programs in the future.

The safety of people who use the roads at Minnesota's 4,000-plus railroad grade crossings has improved in recent decades. In the early 1990s, over 100 automotive crashes and 10 fatalities per year occurred at rail crossings in Minnesota. Currently, the state records about 36 crashes per year, of which, five involve fatalities. 2020 was the first year in over a decade during which there was only one fatality. According to Minnesota Regional Railroads

18 Gene Clark et al., "Report Card for Minnesota's Infrastructure" (Minnesota Section of the American Society of Civil Engineers, 2018).
19 Ibid.
20 "Current Construction," Airport Improvements (Minneapolis-St. Paul International Airport), accessed June 9, 2021, https://www.mspairport.com/about-msp/airport-improvements.
21 Minnesota Department of Transportation Office of Aeronautics AIRview Application (At least 81% of pavements with >55 PCI).
22 "Current Construction," Airport Improvements (Minneapolis-St. Paul International Airport), accessed June 9, 2021, https://www.mspairport.com/about-msp/airport-improvements.

Association, railroad operations in Minnesota are the safest on record.[23] From 2012 to 2020, total train accidents annually have declined from 44% to 28%. Track-related accidents are down 73.3%. During the same period, only five freight cars involved in accidents released hazardous material.[24]

Public awareness about the importance of crossing infrastructure has increased due to high-profile incidents involving trains that carry hazardous materials, such as crude oil. Canadian Pacific's ongoing pursuit of the merger with Kansas City Southern would afford the combined company a "single line," over which they can ship significantly more oil by rail from Canada and North Dakota through Minnesota toward the gulf refineries. In 2021, Canadian Pacific ran 15 to 20 additional oil trains through Minnesota each month. With an increase in trains comes an increase in safety concerns for Minnesota residents. In late 2021, Canadian Pacific Railway and the oil terminal's developer say they are using a new technology that makes shipping oil safe enough that it need not be categorized as a flammable hazardous cargo.[25]

In addition to upgrading signal systems and utilizing new shipping technology, the state needs to install new active warning devices at passive highway/rail grade crossings based on a risk ranking system. The risk ranking system considers approaching and clearing sight distances as well as geometric factors such as skew and vertical alignments. This risk ranking system was developed in the 2016 Rail Grade Crossing Project Section Report. A new effort is underway to develop the Minnesota Rail Crossing Safety Action Plan as required by the Federal Railroad Administration. This plan will identify rail grade crossing issues, evaluate effectiveness of current prioritization processes and evaluate and recommend crossing improvement strategies. This plan will be completed in February 2022.

PORTS & WATERWAYS

Minnesota's ports and commercial waterways face a similar plight as other components of the transportation system – a large list of sorely needed maintenance work and limited funding. Commercial waterways in Minnesota are used extensively to ship bulk goods to and from the state. The ports account for more than 50 percent of Minnesota's agricultural exports.[26]

MnDOT offers funding support to public ports through the Port Development Assistance Program (PDAP). The four ports (out of nine) in Minnesota who most recently sought funds from the PDAP had project needs in excess of $34 million compared to only $5 million in available state funds in 2018.[27]

Dredging needed to maintain predictable shipping passageways for barges and ships are one of the key expenses on Minnesota's waterways. Every year the Corps is on the river dredging to maintain a nine-foot river depth to meet a federal mandate. The U.S. Army Corps of Engineers spent $9.3 million for dredging on the Saint Paul

23 Minnesota Regional Railroads Association, "Information about Minnesota's Railroads 2021-2022," date accessed November 22,2021, https://www.mnrailroads.com/assets/MRRA%202021-22.pdf.
24 Federal Railroad Administration, "Train Accident Reports," U.S. Department of Transportation, date accessed November 22, 2021, https://railroads.dot.gov/accident-and-incident-reporting/train-accident-reports/train-accident-reports.
25 Mike Hughlett, "Railroad venture boosts number of oil trains in Minnesota," Star Tribune, October 17, 2021, https://www.startribune.com/railroad-venture-significantly-increasing-number-of-oil-trains-running-through-minnesota/600107523/.
26 MnDOT Newsline, "Departure marks end of Mississippi River shipping season," December 8, 2021, https://www.newsline.dot.state.mn.us/articles.html#Z1
27"Minnesota GO Statewide Ports & Waterways Plan," (MnDOT, 2014).

District's section of the Mississippi River in 2012 and $5 million in Minnesota's Lake Superior ports.[28] In August 2021, they dredged the Mississippi River near Winona to maintain the nine-foot navigational channel. Producers save around one dollar per bushel when shipping corn or soybeans on the river. These savings add up to an estimated $430 million dollars from Minneapolis to Lock and Dam 10 in Guttenberg, Iowa.[29]

Maintaining locks and dams is also critically important. While the Corps spent $9.2 million in 2012 on lock and dam maintenance, there is a total need of more than $110 million on the St. Paul District's lock and dam system (which includes Minneapolis through Guttenberg, IA).[30] Between 2019 and 2022, St. Paul District has scheduled more than $18 million in repairs to the lock system. The work includes concrete repairs, replacing anchorages, inspecting and repairing miter gates and repairs to the tow haul rail system. The new construction will improve safety for lock operators and industry deckhands.[31]

OTHER INFRASTRUCTURE

Other infrastructure systems like water delivery and sewer face similar issues to transportation infrastructure. Given that many local roadway systems rely on general revenue sources like property taxes, these systems often must compete for limited funding. Additionally, they are frequently co-located with transportation infrastructure. Finding ways to coordinate maintenance activities on transportation, water and sewer infrastructure systems is key to minimizing disruptions and maximizing efficiencies.

PUBLIC DRINKING WATER INFRASTRUCTURE

A 2018 assessment estimated investment needs for buried drinking water infrastructure across the country for the next 20 years total more than $472.6 billion.[32] For Minnesota, the U.S. Environmental Protection Agency estimates over $7.5 billion in drinking water infrastructure needs.

The lifespan of water pipes tends to be longer than most transportation assets, but the importance of preventive maintenance at appropriate times remains important. Maintaining consistent preventive maintenance schedules is a challenge, considering that systems across the United States experience 240,000 water main breaks each year.[33] Pipes built in the late 19th and early 20th centuries are reaching the point where they need to be replaced.[34] Funding maintenance activities is difficult as water rates have been held at levels that do not accurately depict the true cost of treating and delivering water to the public.[35] A combined strategy of rate hikes

28 Ibid.
29 "Corps of Engineers set to dredge Mississippi River near Winona," US Army Corps of engineers, St. Paul, District, August 26, 2021, https://www.mvp.usace.army.mil/Media/News-Releases/Article/2748156/corps-of-engineers-set-to-dredge-mississippi-river-near-winona-mn/
30 Ibid.
31 "Corps of Engineers Set to Perform Maintenance at Three Locks This Winter," US Army Corps of Engineers St. Paul District, November 27, 2019, https://www.mvp.usace.army.mil/Media/News-Releases/Article/2028209/corps-of-engineers-set-to-perform-maintenance-at-three-locks-this-winter/.
32 "EPA's 6th Drinking Water Infrastructure Needs Survey and Assessment," EPA (United States Environmental Protection Agency, October 2, 2018), https://www.epa.gov/dwsrf/epas-6th-drinking-water-infrastructure-needs-survey-and-assessment.
33 "Drinking Water," 2021 Report Card for America's Infrastructure (American Society of Civil Engineers, March 25, 2021), https://infrastructurereportcard.org/cat-item/drinking-water/.
34 "Buried No Longer," American Water Works Association, accessed May 24, 2021, http://www.awwa.org/Portals/0/files/legreg/documents/BuriedNoLonger.pdf.
35 "Drinking Water," 2021 Report Card for America's Infrastructure (American Society of Civil Engineers, March 25, 2021), https://infrastructurereportcard.org/cat-item/drinking-water/.

for water service and creative financing solutions will be needed to address public drinking water maintenance needs.

WASTEWATER SYSTEMS

Minnesota's wastewater infrastructure consists of pipes, pumps, treatment plants, buildings and grounds and land for disposal. Requirements under the Clean Water Act have led to new investment in pipes, plants and equipment to eliminate the occurrence of combined sewer overflow events. As a result, the number of people provided with advanced wastewater treatment at the national level increased dramatically from 7.8 million in 1972 to 127.7 million in 2012. While there was an increase in investment, the federal government's share of capital spending in the water sector fell from 63% in 1977 to 9% of total capital spending in 2017.[36]

In Minnesota, wastewater systems have been improved significantly in the past decade. The Minnesota Pollution Control Agency (MPCA) estimates $5 billion in wastewater infrastructure needs over the next 20 years.[37] Minnesota has identified 983 wastewater infrastructure projects. These projects are necessary to rehabilitate, expand and improve wastewater sewer system needs.[38] The Public Facilities Authority's (PFA) administers statewide funding including "the Clean Water and Drinking Water Revolving Funds." Since inception in 1990, these revolving loan funds have provided $4.5 billion in low interest loans to municipalities throughout the State, with below-market interest rates that are saving communities over $900 million in interest costs."[39] In the seven-county metro area, the Metropolitan Council has budged $449 million for water and wastewater projects for 2021-2026.[40]

STORMWATER SYSTEMS

Early sewers in Minnesota built in the 1800s were combined, carrying both stormwater and sanitary sewage directly to rivers and streams such as the Mississippi River. Today, much of Minnesota's stormwater infrastructure is over 100 years old. A 1987 amendment to the Federal Clean Water Act required implementation of comprehensive national program to address polluted stormwater runoff.

Maintaining stormwater systems is important for making sure that the state's structures and transportation assets are safe. Climate change will likely increase the amount, frequency and intensity of precipitation, potentially exceeding the design capacity of stormwater infrastructure in Minnesota. State agencies and municipalities have a growing obligation to manage their aging infrastructure with limited budget and resources. The estimated cost of replacing stormwater system in the City of Minneapolis alone is $713 million.[41] The City of Minneapolis actively models their storm drainage system to help prioritize capital improvement projects to upgrade the system over time.

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36 Ibid.
37 "Public Facilities Authority: Wastewater Infrastructure Programs," (Minnesota Office of the Legislative Auditor, 2019)..
38 "Future wastewater infrastructure needs and capital costs," Minnesota Pollution Control Agency, January 2020, https://www.pca.state.mn.us/sites/default/files/lrwq-wwtp-1sy20.pdf
39 "2021 Estimated Funding Needs Report," (Minnesota Public Facilities Authority, , February 1, 2021).
40 "MCES Capital Program," Metropolitan Council, accessed May 24. 2021, https://metrocouncil.org/Wastewater-Water/Funding-Finance/Budgets/Budget.aspx.
41 "Case Study: City of Minneapolis Stormwater Asset Management System" (Minneapolis, MN: United States Environmental Protection Agency, n.d.).

RELATED TRENDS

- Climate Change
- Economy & Employment
- Freight Rail
- Transportation Behavior
- Transportation Safety
- Urban & Rural Populations

Minnesota's vision for transportation is known as Minnesota GO. The aim is that the multimodal transportation system maximizes the health of people, the environment and our economy. A transportation vision for generations, Minnesota GO guides a comprehensive planning effort for all people using the transportation system and for all modes of travel. Learn more at MinnesotaGO.org.

REVISION HISTORY

Date	Summary of revisions
January 2016	Original paper.
March 2018	Updated to reflect new data.
December 2021	Updated to reflect new data, added more context.