ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

A COMPREHENSIVE ASSESSMENT OF AMERICA'S INFRASTRUCTURE

2021 REPORT CARD FOR AMERICA'S INFRASTRUCTURE

Letter from the President

Founded in 1852, ASCE is the country's oldest civil engineering organization. It represents more than 150,000 civil engineers in private practice, government, industry, and academia who are dedicated to advancing the science and profession of civil engineering, and protecting public health, safety, and welfare. ASCE is comprised of 75 domestic and 17 international Sections, 158 Branches, and 118 Younger Member Groups. The Society advances civil engineering technical specialties through 9 Institutes and leads with its many professional and public-focused programs. ASCE stands at the forefront of a profession that plans, designs, constructs, and operates society's economic and social engine – the built environment – while protecting and restoring the natural environment.

For more than 20 years, the American Society of Civil Engineers (ASCE) has been releasing its quadrennial *Report Card for America's Infrastructure.* In recent years, the Report Card's message has taken hold as public opinion surveys regularly show that Americans recognize the need to repair our nation's aging and deteriorating infrastructure. Yet we are still not investing in infrastructure to the level that is required given these systems serve as the backbone of our economy. Failing to act to rebuild America's infrastructure costs every American family $3,300 a year, with significant costs and consequences to the national economy.

The Report Card not only defines the problems facing our nation's infrastructure; it also offers solutions across all 17 categories. I am pleased to report that many of ASCE's asks have been answered, such as new funding and financing sources for building resilient infrastructure, a permanent fix for the Harbor Maintenance Trust Fund, a modernization of state dam safety programs, and a mainstreaming of asset management approaches across various infrastructure sectors.

However, significant challenges remain. Going forward, bold **leadership and action**, long-term, consistent **investment**, and new approaches to ensure the **resilience** of our infrastructure while satisfying sustainability and climate change criteria will be the solutions to the short-term patches and small-scale improvements that have been implemented thus far. Through such transformative action, our infrastructure will be improved and built for the future.

All Americans share a role in renewing the nation's infrastructure and preparing for the future. We must take collective action and make tough choices. Join ASCE and others in advocating for infrastructure investment and modernization by sharing this *2021 Report Card for America's Infrastructure* and contacting your elected officials. Modern, reliable infrastructure secures our nation's shared prosperity, and helps us achieve our most inspiring vision of the future.

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2021 REPORT CARD FOR AMERICA'S INFRASTRUCTURE

Introduction

Infrastructure supports nearly every aspect of life. Our pipes deliver drinking water to homes and hospitals. Airports, railroads, and inland waterways transport goods from farms and manufacturing plants to store shelves. The roads that crisscross the country allow us to get to work and school safely, and the network of transmission and distribution lines keeps the lights on and our electronics charged. Dams enable consistent water supply in arid climates, and levees hold back floodwaters to protect rain-soaked communities.

Since ASCE began issuing the Report Card in 1998, the grades have struggled to get out of the D's. However, more recently, decision-makers at all levels of government have recognized the critical role our infrastructure plays in supporting our quality of life and economy. Voters and lawmakers alike have championed smart infrastructure policy and increased investment in our multimodal freight system, drinking water networks, and more. This down payment on our infrastructure bill has contributed to modest but meaningful improvements.

Key Findings

The *2021 Report Card for America's Infrastructure* reveals we've made some incremental progress toward restoring our nation's infrastructure. For the first time in 20 years, our infrastructure is out of the D range.

The 2021 grades range from a B in rail to a D- in transit. Five category grades — aviation, drinking water, energy, inland waterways, and ports — went up, while just one category — bridges — went down. And stormwater infrastructure received its first grade: a disappointing D. Overall, eleven category grades were stuck in the D range, a clear signal that our overdue bill on infrastructure is a long way from being paid off.

For the first time in 20 years, our infrastructure GPA is a C-, up from a D+ in 2017. This is good news and an indication we're headed in the right direction, but a lot of work remains.

While we grade 17 categories individually, our infrastructure is a system of systems and more connected than ever before. As we look at the low grades and analyze the data behind them, there are three trends worth noting:

1. **Maintenance backlogs continue to be an issue, but asset management helps prioritize limited funding.** Sectors like transit and wastewater have staggering maintenance deficits, but developing a clear picture of where the available funding is most needed improves overall system performance and public safety. The drinking water sector, for example, has embraced asset management and new technology to pinpoint leaks and target repairs.

2. **State and local governments have made progress. Increased federal investment or reform has also positively impacted certain categories.** Thirty-seven states have raised their gas tax to fund critical transportation investments since 2010. Ninety-eight percent of local infrastructure ballot initiatives passed in November 2020. At least 25 major cities and states now have chief resilience officers. These improvements were made by elected officials from both sides of the aisle and with strong voter support. Meanwhile, categories like ports, drinking water, and inland waterways have been the beneficiaries of increased federal funding.

3. **There are still infrastructure sectors where data is scarce or unreliable.** Sectors like school facilities, levees, and stormwater still suffer from a lack of robust condition information or inventory of assets. To target investments and allocate funding, routine, reliable data should be the standard.

The elected officials and members of the public who have improved infrastructure policy and supported additional funding are applauded. We're seeing the benefits of this action in drinking water, inland waterways, and airports. The private sector has invested in the electric grid, freight rail, and more.

However, significant challenges lie ahead. Importantly, the COVID-19 pandemic's impacts on infrastructure revenue streams threaten to derail the modest progress we've made over the past four years. In addition, many sectors and infrastructure owners are learning what it will take to make our communities climate resilient as we grapple with more severe weather. Meanwhile, many of our legacy transportation and water resource systems are still in the D range. These infrastructure networks suffer from chronic underinvestment and are in poor condition.

We're headed in the right direction, but a lot of work remains.

About The Report Card for America's Infrastructure

Every four years, America's civil engineers provide a comprehensive assessment of the nation's 17 major infrastructure categories in ASCE's Report Card for America's Infrastructure. Using a simple A to F school report card format, the Report Card examines current infrastructure conditions and needs, assigning grades and making recommendations to raise them.

The ASCE Committee on America's Infrastructure, made up of 31 dedicated civil engineers from across the country with decades of expertise in all categories, volunteers their time to work with ASCE Infrastructure Initiatives staff to prepare the Report Card. The Committee assesses all relevant data and reports, consults with technical and industry experts, and assigns grades using the following criteria:

Methodology

CAPACITY
Does the infrastructure's capacity meet current and future demands?

CONDITION
What is the infrastructure's existing and near-future physical condition?

FUNDING
What is the current level of funding from all levels of government for the infrastructure category as compared to the estimated funding need?

FUTURE NEED
What is the cost to improve the infrastructure? Will future funding prospects address the need?

OPERATION AND MAINTENANCE
What is the owners' ability to operate and maintain the infrastructure properly? Is the infrastructure in compliance with government regulations?

PUBLIC SAFETY
To what extent is the public's safety jeopardized by the condition of the infrastructure and what could be the consequences of failure?

RESILIENCE
What is the infrastructure system's capability to prevent or protect against significant multi-hazard threats and incidents? How able is it to quickly recover and reconstitute critical services with minimum consequences for public safety and health, the economy, and national security?

INNOVATION
What new and innovative techniques, materials, technologies, and delivery methods are being implemented to improve the infrastructure?

In addition to this national Report Card, ASCE's sections and branches also prepare state reports on a rolling basis. Visit **InfrastructureReportCard.org** to learn about your state's infrastructure.

2021 Report Card for America's Infrastructure

G.P.A.

C-

AVIATION — D+	PUBLIC PARKS — D+
BRIDGES — C	RAIL — B
DAMS — D	ROADS — D
DRINKING WATER — C-	SCHOOLS — D+
ENERGY — C-	SOLID WASTE — C+
HAZARDOUS WASTE — D+	STORMWATER — D
INLAND WATERWAYS — D+	TRANSIT — D-
LEVEES — D	WASTEWATER — D+
PORTS — B-	

$10 trillion
in GDP

More than 3 million jobs
in 2039

$2.4 trillion in exports
over the next 20 years

Recommendations to Raise the Grade

To improve our quality of life and strengthen our international competitiveness, we need a strategic and holistic plan to renew, modernize, and invest in our infrastructure. This plan should make basic maintenance a centerpiece as we improve our legacy systems. Importantly, policymakers must understand we are only as strong as our weakest link — if our roadways become too rough to travel, if our bridges close to heavier traffic like ambulances, or if our levees protect a community at the expense of the one next door, the economy grinds to a halt. We all pay the price.

ASCE urges bold leadership and action, sustained investment, and a focus on resilience to raise the national infrastructure grade over the next four years, so that every American family, community, and business can thrive.

1) Leadership and action

Smart investment will only be possible **with strong leadership, decisive action, and a clear vision for our nation's infrastructure.** Leaders from all levels of government, business, labor, and nonprofit organizations must come together to:

a. Incentivize asset management and encourage the creation and utilization of infrastructure data sets across classes.

b. Streamline the project permitting process across infrastructure sectors, while ensuring appropriate safeguards and protections are in place.

c. Ensure all investments are spent wisely, prioritizing projects with critical benefits to the economy, public safety, environment, and quality of life (e.g., sustainability).

d. Leverage proven and emerging tech to make use of limited available resources.

e. Consider life cycle costs when making project decisions. Life cycle cost analysis determines the cost of building, operating, and maintaining the infrastructure for its entire life span.

f. Support research and development of innovative materials, technologies, and processes to modernize and extend the life of infrastructure, expedite repairs or replacements, and promote cost savings. Innovation should include a component of integration and utilization of big data, as well as the "internet of things."

g. Promote sustainability, or the "triple bottom line" in infrastructure decisions, by considering the long-term economic, social, and environmental benefits of a project.

2) Investment

If the United States is serious about achieving an infrastructure system fit for the future, some specific steps must be taken, beginning with **increased, long-term, consistent investment.** To close the nearly $2.6 trillion 10-year investment gap, meet future need, and restore our global competitive advantage, we must **increase investment from all levels of government and the private sector from 2.5% to 3.5% of U.S. Gross Domestic Product (GDP) by 2025.** This investment must be consistently and wisely allocated, and must begin with the following steps:

a. Congress should fully fund authorized infrastructure programs.

b. Infrastructure owners and operators must charge, and Americans must be willing to pay, rates reflecting the true cost of using, maintaining, and improving infrastructure.

c. The surface transportation investment gap is the largest deficit in the categories of infrastructure that ASCE evaluates. Continuing to defer maintenance and modernization is impacting our ability to compete in a global marketplace and maintain a high quality of living domestically. Congress must fix the Highway Trust Fund.

d. All parties should strive to close the rural/urban and underserved community resource divide by ensuring adequate investment in these areas through programmatic set-asides.

e. All parties should make use of public-private partnerships, where appropriate.

3) Resilience

We must **utilize new approaches, materials, and technologies to ensure our infrastructure** can withstand or quickly recover from natural or man-made hazards. Advancements in resilience across all infrastructure sectors can be made by:

a. Enabling communities, regardless of size, to develop and institute their own resilience pathway for all their infrastructure portfolios by streamlining asset management, implementing life cycle cost analysis into routine planning processes, and integrating climate change projections into long-term goal-setting and capital improvement plans.

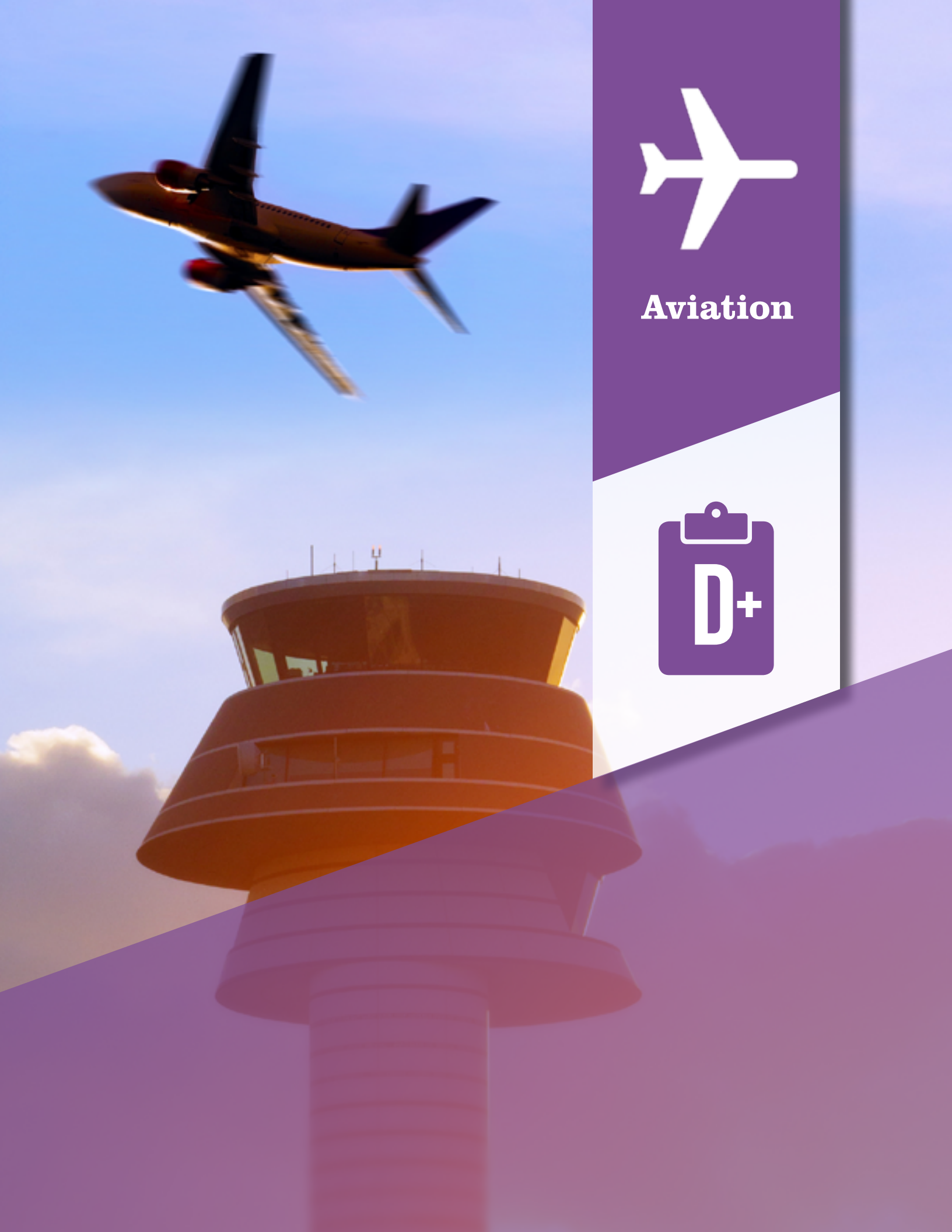
b. Incentivizing and enforcing the use of codes and standards, which can mitigate risks of major climate or manmade events such as hurricanes, fires, sea level rise, and more.

c. Understanding that our infrastructure is a system of systems and encourage a dynamic, “big picture” perspective that weighs tradeoffs across infrastructure sectors while keeping resilience as the chief goal.

d. Prioritizing projects that improve the safety and security of systems and communities, to ensure continued reliability and enhanced resilience.

e. Improving land use planning across all levels of decision-making to strike a balance between the built and natural environments while meeting community needs, now and into the future.

f. Enhancing the resilience of various infrastructure sectors by including or enhancing natural or “green” infrastructure.



Aviation

D+

EXECUTIVE SUMMARY

Prior to the onset of the COVID-19 pandemic, the nation's airports were facing growing capacity challenges. Over a two-year period, passenger travel steadily increased from 964.7 million to 1.2 billion per year, yet flight service only increased from 9.7 to 10.2 million flights per year — contributing in part to a total of nearly 96 million delay minutes for airline passengers in 2019. Terminal, gate, and ramp availability was not meeting the needs of a growing passenger base. Under pre-COVID-19 projections, our aviation system was set to have a 10-year, $111 billion funding shortfall, and that gap has likely grown significantly as passenger volumes dropped in March 2020 and have yet to recover. However, funding from Congress has risen from $11 billion annually to approximately $15 billion from 2017 to 2020.[1] These additional investments are driving some early results as measured by improved economic performance.

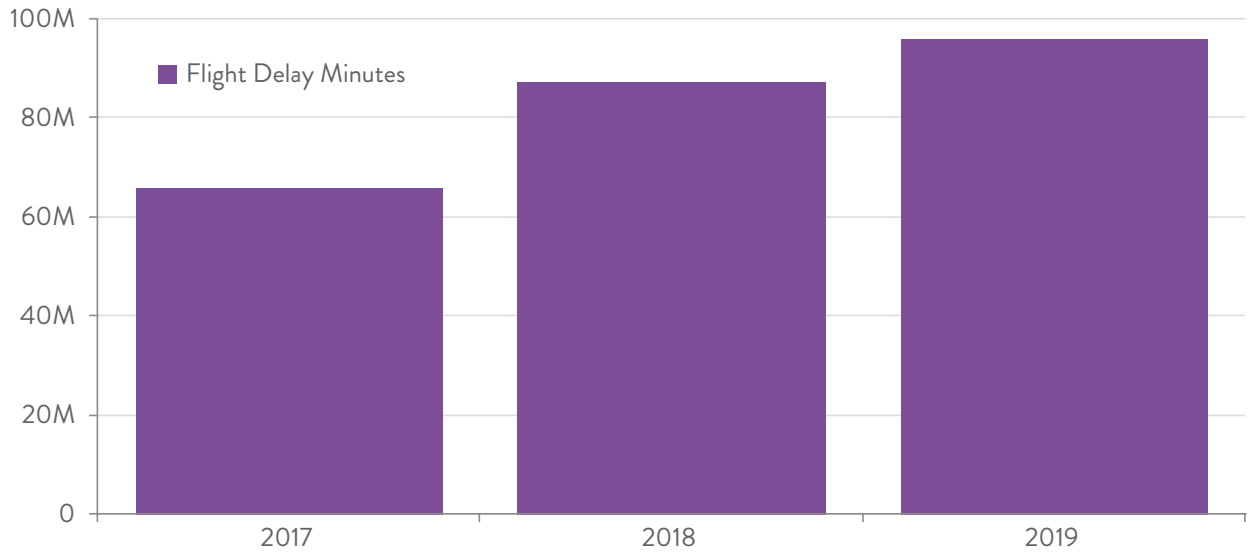
CONDITION & CAPACITY

The National Plan of Integrated Airport Systems (NPIAS) identifies 3,304 public-use airports in the U.S., which includes approximately 520 commercial service airports. More than 2,500 of these NPIAS airports are categorized as general aviation supporting flight training and emergency services.[2]

From 2017 to 2019, passenger travel steadily rose from 964.7 million to 1.2 billion passengers per year, while commercial service flights increased from 9.7 million to 10.2 million flights per year.[3] [4] However, since the onset of the COVID-19 pandemic in early 2020, the aviation sector has been dramatically impacted. In April 2020, passenger travel was 5% of the level seen in April 2019, and by October 2020, passenger volumes had only rebounded to 32% of October 2019. While passenger volumes have endured significant and potentially sustained impacts during the pandemic, cargo volumes have increased with the expansion of "e-commerce."[5]

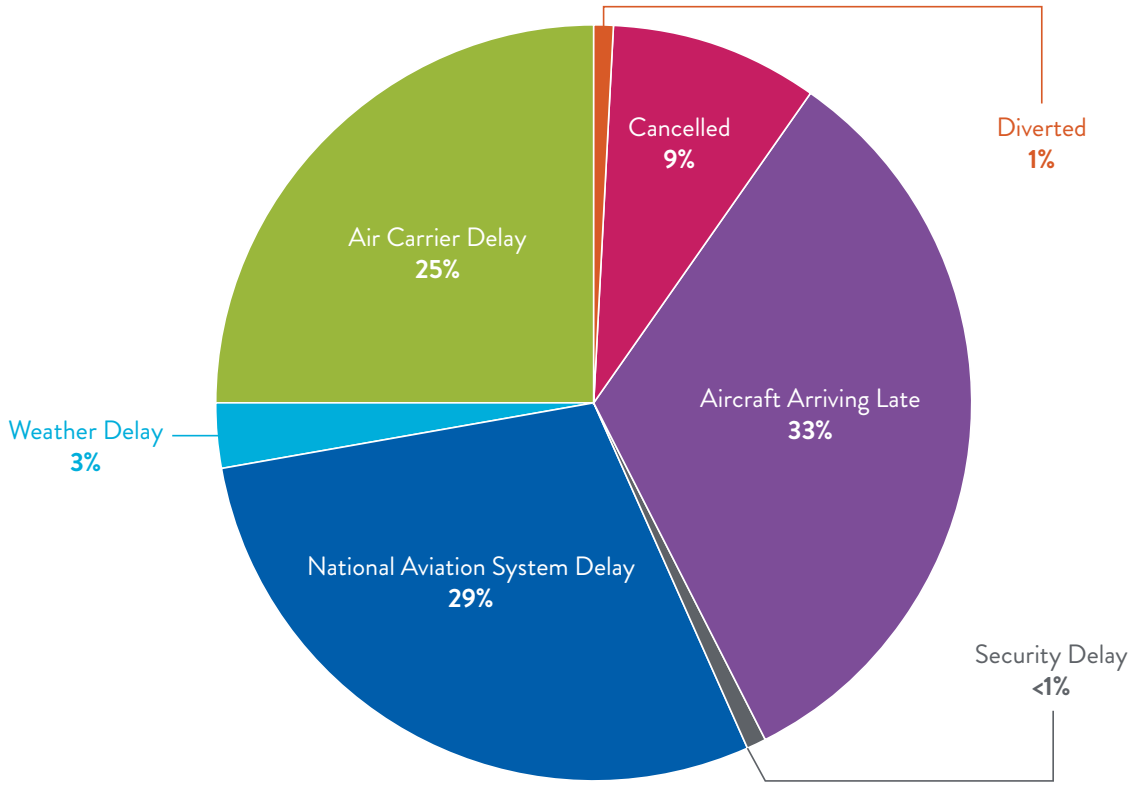
From 2017 to 2019, as passenger travel outpaced available flights, delays in the aviation sector grew, and the percentage of flights with "on-time" performance decreased slightly from 80.1% to 79.2%.[6] The total time passengers were delayed increased from 65.8 million minutes in 2017 to 95.8 million minutes in 2019. Delays in 2019 were caused by a variety of reasons, including aircraft arriving late, national aviation system delays, air carrier delays, weather-related issues, and more.[7]

Flight Delays Over Time



Source: Bureau of Transportation Statistics[8]

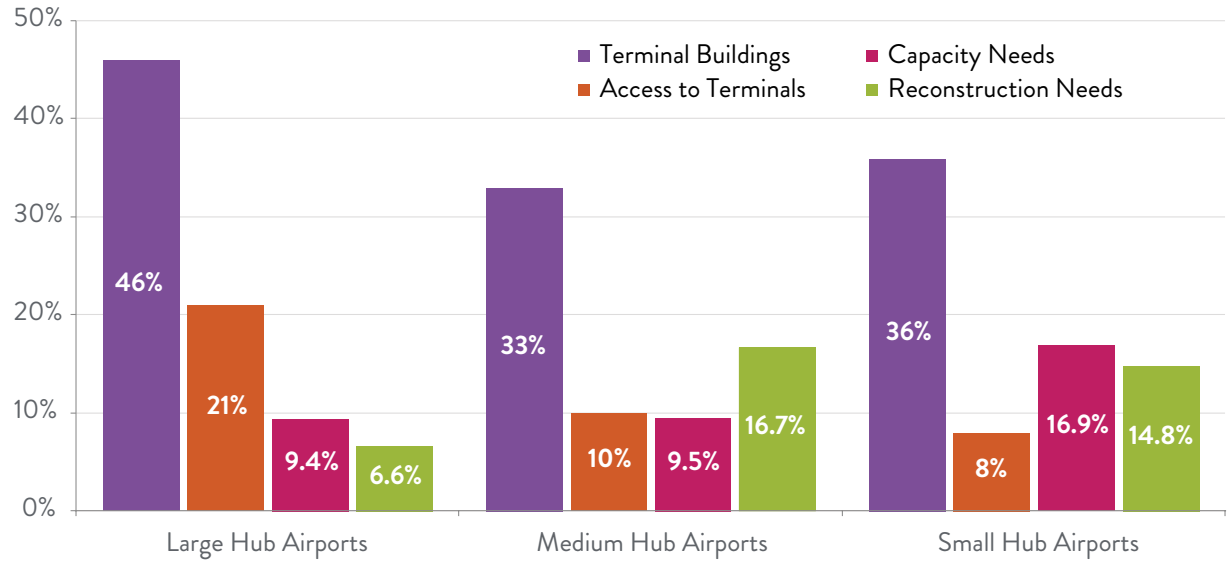
Causes of Flight Delays in 2019



Source: Bureau of Transportation Statistics[9]

While several factors influence air travel delays, airport infrastructure continues to grapple with capacity needs to serve the growing passenger base. The Airports Council International–North America (ACI-NA) shows that over the next few years, all categories of airports will require investments in terminal buildings, access to terminals, airfield capacity, and airfield reconstruction.[10]

Top Four Investment Needs as a Portion of Total Needs for Large, Medium and Small Airports



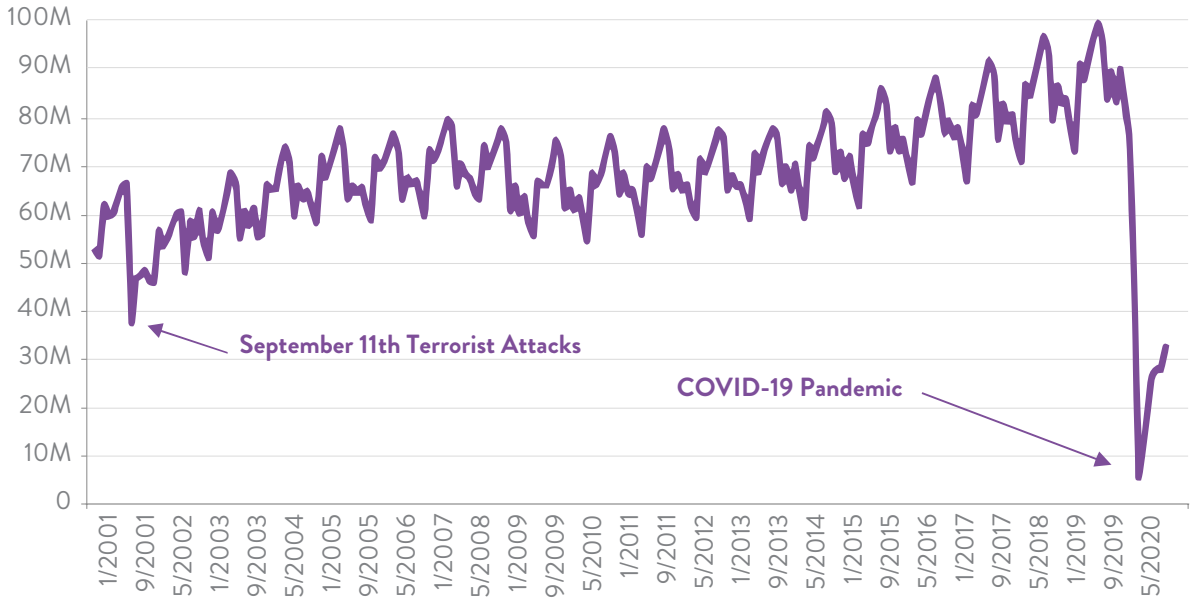
Source: Airports Council International–North America[11]

The largest portion of the investment need at large, medium, and small airports is for terminal buildings and ranges from 30% to nearly 50% of total needs. Similarly, the FAA routinely publishes National Plan of Integrated Airport Systems (NPIAS) reports of anticipated development activities determined by surveying nationwide capital improvement plans. The NPIAS reports show that the needs for various types of airport development projects continue to increase. Since 2019, forecasts for airport needs to expand or rehabilitate terminal buildings ballooned by 62%, pavement reconstruction needs increased by 28%, and capacity-related development needs rose by 31%. Specifically, capital needs for terminal buildings grew from nearly $4.1 billion to more than $6.6 billion, capacity projects rose from $3.1 billion to around $4.1 billion, and reconstruction projects increased from around $13.1 billion to nearly $16.9 billion.[12]

Fortunately, the condition of runways continues to be consistent. The FAA sets system performance goals to ensure that a minimum of 93% of paved runways at NPIAS airports are maintained in excellent, good, or fair condition. In fiscal year (FY) 2019, data indicates that 97.9% of runways at NPIAS airports are rated as excellent, good, or fair, including 97.8% of commercial service airport runways. While the portion of NPIAS airports rated as excellent, good, or fair saw a slight increase from 97.8% in FY 2017, commercial service airport runways decreased from 98.2% during the same timeframe. However, both categories remained unchanged from FY 2015 to FY 2017.[13] [14] [15]

The COVID-19 pandemic has caused a severe decline in flights and passenger boardings, reducing the current capacity demand. Air carriers expect that it will take years to recover from this reduction in operations. The long-term impacts of COVID-19 on air travel remain unclear. It is important to note that there have been similar boarding declines in the past due to traumatic events such as September 11th, but passenger travel has always ultimately rebounded and continued an upward trajectory.

Passenger Boarding Totals After Historic Events



Sources: Bureau of Transportation Statistics[16 17]

FUNDING & FUTURE NEED

Our nation's airports have diverse revenue and funding streams, but total financial resources fall short of the sector's estimated needs. These resources include federal, state, and local grants; revenue from general obligation bonds; airport cash flow through concession fees and other revenue mechanisms; and public–private partnerships (P3s). The two primary federal sources of airport revenue come from the Airport Improvement Program (AIP), which is funded generally through aviation fuel and airline ticket taxes, and the Passenger Facility Charge (PFC), which is funded through a federally mandated $4.50 capped user fee.

In 2018, a five-year FAA reauthorization was signed into law; however, the legislation failed to increase the AIP or the PFC. The AIP has had the same annual authorization level of $3.35 billion for over 10 years, and the PFC cap has remained unchanged since 2000. Despite an unchanged authorization level, Congress has provided recent supplemental funding for the AIP program, including $1 billion in FY 2018, $500 million in FY 2019, and $400 million in FY 2020. The PFC has continued to collect revenue to help make capital improvements to our nation's airports, with the most recent figures indicating that $3.6 billion in fees was collected in 2019. While the PFC is not the sole source of airport capital project funding, it can help alleviate the pre-COVID-19 pandemic, 10-year total investment need of $237 billion.[18 19 20]

LAGUARDIA AIRPORT TERMINAL B ARRIVALS HALL

The long-term impacts of COVID-19 are still unfolding for airport revenue collection. However, in the last two COVID-19 relief packages (the CARES Act and the Consolidated Appropriations Act of 2021), Congress provided a total of $12 billion in direct aid to airports, including $100 million for general aviation. As the pandemic continues, the complex revenue streams that airports depend on for infrastructure improvements are likely to remain in flux.

OPERATIONS, MAINTENANCE, & INNOVATION

Airport operations and maintenance activities are influenced by many factors, including the age of the facilities, aircraft use patterns, and weather exposure, to name a few. Preventive maintenance such as seal coat surface treatment, patching, and crack-sealing must be regularly performed to protect and preserve airfield pavement, while also serving to keep long-term rehabilitation costs down. Airfield pavement maintenance occurs on a four- to seven-year cycle, while more significant repairs take place on a 15- to 25-year cycle.[21]

Technological advancements are playing a critical role in improving airport service flexibility and efficiency. Halfway through its multi-year investment and implementation plan, the FAA has been rolling out its Next Generation Air Transportation System (NextGen) that improves air travel safety, efficiency, and predictability. While transitioning from a radar-based to satellite-based system, NextGen replaces radio communications with data exchange and automation. This ultimately reduces the amount of information needed to be processed by an air crew and will increase routing efficiency (shorten routes), save time and fuel, minimize traffic delays, increase capacity, and permit controllers to monitor and manage aircraft, leading to greater safety.[22] During NextGen implementation, the FAA has reported more than 15,000 hours of delay avoided through improved reroutes, more than 25,000 hours of communication time saved, and average delays less than 17 minutes per flight, despite increased reports of severe weather and traffic. Currently, NextGen capabilities are being implemented at 30 of the largest airports in the nation. Despite some positive momentum, NextGen investments are taking about 4 years longer than expected to translate into foundational infrastructure that supports the new technology.[23] [24]

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SAN FRANCISCO INTERNATIONAL AIRPORT HARVEY MILK TERMINAL 1

PUBLIC SAFETY & RESILIENCE

The people and commerce using the nation's air transportation system are protected by the Transportation Security Administration (TSA).[25] While TSA's primary focus is placed on screening areas and eliminating airplane hijackings, safety goes beyond screening points. For instance, the COVID-19 pandemic has played a major role in airport safety protocols. In February 2021, TSA implemented an executive order requiring individuals to wear a mask at TSA screening checkpoints and throughout the commercial and public transportation systems until at least May 2021.[26] To support airport security, $4.9 million of federal funds were spent on airport security in FY 2020 — consistent with federal spending since FY 2017. However, the NPIAS has identified that from 2021 to 2025, anticipated needs for safety and security projects account for $1.6 billion, or nearly 4% of overall airport funding needs.

In 2018, the FAA reported 395 deaths caused by U.S. airplanes — an increase from 347 the previous year. The death total includes incidents on U.S. air carriers, commuter carriers, on-demand air taxis, and general aviation operations.[27] Maintaining safe conditions through establishing runway safety areas, practicing runway incursion mitigation, and implementing wildlife hazard mitigation improves public safety by minimizing the risk of serious accidents.[28] [29]

The nation's aviation system continues to be tested by natural and man-made disasters. Specifically, cybersecurity issues have the potential to cause harm to all aspects of air travel. Aviation communication and passenger services, like ticketing, are highly dependent on a strong cybersecurity network, so ensuring safeguards to this system ensures traveler safety and system resilience. Furthermore, during and after natural disasters and other emergencies, airports play a major role as a gateway for urgent relief and access to critical supplies. Therefore, it is important that airports develop and exercise rapid facilities assessments and recovery strategies that can be efficiently and effectively implemented after these types of events.

Aviation

RECOMMENDATIONS TO RAISE THE GRADE

- Airport authorities should develop plans to improve resilience to potential catastrophic events, whether it be seismic incidents, weather-related disasters, cybersecurity threats, or global pandemics. Strong revenue mechanisms must be developed that can withstand changes in passenger travel and provide long-term revenue certainty.
- Airports should continue to invest in capacity enhancements that will accommodate projected capacity needs based on pre-COVID-19 pandemic trends.
- Raise or eliminate the cap on the Passenger Facility Charge (PFC) to allow airports the needed revenue to invest in their infrastructure.
- Support efforts to increase federal funding for the Airport Improvement Program (AIP) and continue to support user fee mechanisms that fund the Airport and Airway Trust Fund and maintain budgetary firewalls.
- Explore the use of public-private partnerships (P3s) to support existing funding efforts.
- Support innovative technology, like NextGen, that offers the ability to reduce congestion and improve capacity.
- Continue to recognize that there needs to be a strategic balance between infrastructure investment, enhanced safety measures, and technology improvements, both in investment and long-term planning.

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Bridges

EXECUTIVE SUMMARY

There are more than 617,000 bridges across the United States. Currently, 42% of all bridges are at least 50 years old, and 46,154, or 7.5% of the nation's bridges, are considered structurally deficient, meaning they are in "poor" condition. Unfortunately, 178 million[1] trips are taken across these structurally deficient bridges every day. In recent years, though, as the average age of America's bridges increases to 44 years, the number of structurally deficient bridges has continued to decline; however, the rate of improvements has slowed. A recent estimate for the nation's backlog of bridge repair needs is $125 billion. Estimates show that we need to increase spending on bridge rehabilitation from $14.4 billion annually to $22.7 billion annually, or by 58%, if we are to improve the condition. At the current rate of investment, it will take until 2071 to make all of the repairs that are currently necessary, and the additional deterioration over the next 50 years will become overwhelming. The nation needs a systematic program for bridge preservation like that embraced by many states, whereby existing deterioration is prioritized and the focus is on preventive maintenance.

CONDITIONS & CAPACITY

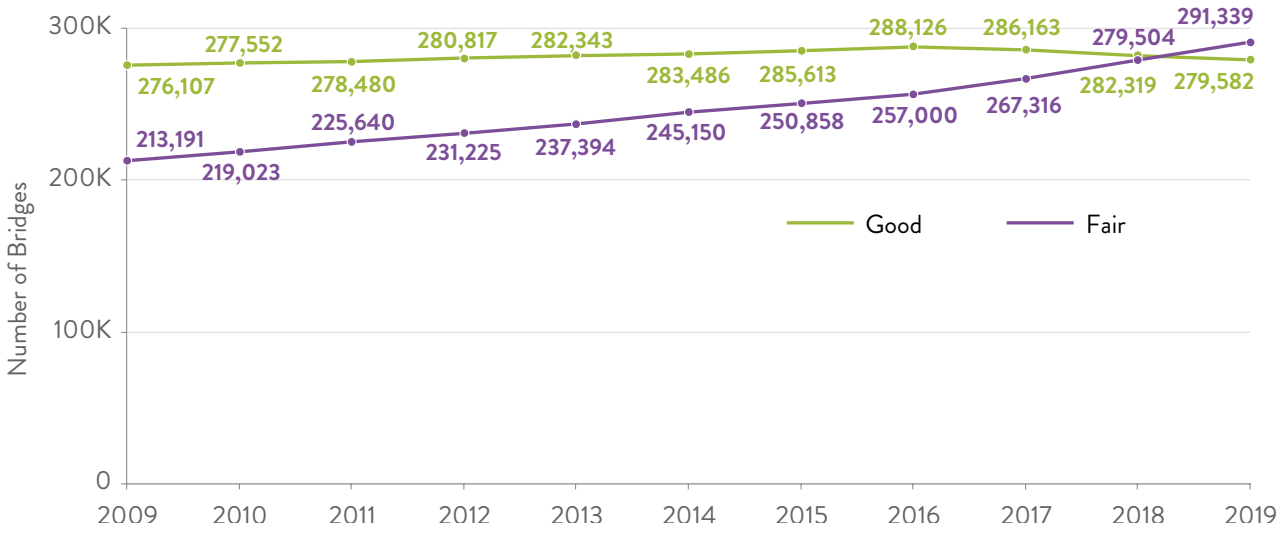
Over the past decade, a concerted effort has been made involving all levels of government to reduce the number of structurally deficient bridges across the nation. While structurally deficient bridges are not inherently unsafe, they require substantial investment in the form of replacement or significant rehabilitation, and they present higher risk for future closure or weight restrictions.

Encouragingly, as of 2019, just one in 13, or 7.5%[2] of highway bridges were designated structurally deficient, or poor, representing a significant improvement from 12.1% recorded a decade ago. Also encouraging is that the total percentage of bridge deck area that is classified as structurally deficient, or poor, has decreased over the past several years, totaling just 5.5% in 2019, compared to 6.3% in 2016.

Even with this renewed focus, nearly 231,000 bridges, in all 50 states, still need repair and preservation work. Unfortunately, the annual rate of reduction of structurally deficient bridges for the past two years has slowed considerably to just 0.1% annually, while the number of bridges that are slipping from good to fair condition is increasing annually. Though higher traffic volume bridges tend to receive more attention and are therefore less likely to be structurally deficient, on average 178 million trips occur over structurally deficient bridges every day. At the current rate of improvement, it is estimated to take more than 50 years, stretching to the year 2071, to repair all of these bridges. This is not a sustainable model. The rate of deterioration is exceeding the rate of repair, rehabilitation, and replacement, all while the number of bridges sliding into the "fair" category is growing. However,

bridges categorized as fair are a concern and an opportunity, as they are potentially one inspection away from being downgraded in classification, but they can also be preserved at a fraction of the cost required to address a structurally deficient bridge.

Bridge Condition By Year



Source: U.S. Department of Transportation, Federal Highway Administration, InfoBridge: Data: https://infobridge.fhwa.dot.gov/Data/Dashboard

While recent improvements show a positive trend in addressing our poorest bridges, progress is not universal because states face different challenges when maintaining, repairing, and replacing bridges. For example, in 2019, the percentage of structurally deficient bridges ranged from 1% in Nevada to 22% in Rhode Island.[3]

Less encouraging is that 42% of the nation's 617,084 highway bridges are over 50 years old, an increase from 39% in 2016. Notably, 12% of highway bridges are aged 80 years or older. Structurally deficient bridges specifically are nearly 69 years old on average. Most of the country's bridges were designed for a service life of approximately 50 years, so as time passes, an ever-increasing number of bridges will need major rehabilitation or replacement.

While recent improvements show a positive trend in addressing our poorest bridges, progress is not universal because states face different challenges when maintaining, repairing, and replacing bridges. For example, in 2019, the percentage of structurally deficient bridges ranged from 1% in Nevada to 22% in Rhode Island[3].

To protect the public's safety, the federal government mandates national bridge inspections for all bridges on a periodic basis. The amount of time between inspections can range from 12 to 48 months and is based on the bridge condition, type of bridge, traffic, location, and age of the structure. If the bridge inspector finds any deficiency in the structural capacity or with an element of the bridge, that bridge could be posted for load, weight, or speed restrictions; temporarily repaired; and/or closed to the traveling public to ensure their safety. In 2019, just over 10% of bridges had such restrictions, a number that has remained stagnant over the past several years. Outside of direct safety concerns, posted bridges can dramatically increase driving time for larger vehicles such as school buses, ambulances, fire trucks, and delivery trucks, in

addition to interstate trucking. In rural areas, posted bridges can prohibit the passage of emergency service vehicles, which can slow response time and impede rescue efforts.

Finally, while the National Bridge Inventory no longer tracks functionally obsolete bridges, there are still over 94,000[4] bridges nationwide with inadequate vertical or horizontal clearances or inadequate approach roadway geometry. Such bridges do not serve current traffic demand or meet current standards, and many of these bridges act as bottlenecks, increasing congestion and crash vulnerability due to inadequate widths, lanes, or shoulders, substandard vertical clearance, or insufficient lanes for traffic demand.

Photo Courtesy of WSP USA

FUNDING & FUTURE NEED

In recent years, all levels of government have prioritized bridge repairs through investments. To make many of these investments, 37 states have either increased or reformed their gas tax since 2010. However, despite states' increased investments, overall spending in the country's bridges remains insufficient. The most recent Conditions and Performance Report from the Federal Highway Administration estimates the bridge backlog for repairs for existing bridges at $125 billion and also estimates that we need to increase spending on bridge rehabilitation by 58 percent from $14.4 billion annually to $22.7 billion annually if we are to improve the condition.[5]

While state and local governments have demonstrated initiative, federal investment in bridges remains stagnant. As a result, the Highway Trust Fund, which historically funds many of the nation's road and bridge projects, has been teetering on the brink of insolvency for over a decade. The trust fund's primary funding source is the federal motor fuels tax, which has remained at 18.3 cents per gallon since 1993. *(See the Roads chapter for more information regarding public spending.)*

INNOVATION

As the nation's bridges continue to age, America's emphasis has slowly evolved from building new bridges to maintaining existing ones. New technologies, materials, evaluation techniques, and construction methods have advanced in recent years to meet this challenge. Additionally, the industry manual provided by the American Association of State Highway and Transportation Officials now requires new bridges to be designed with a 75-year service life, compared to the customary 50 years, meaning bridges are now being built to last longer.

Bridge engineers are now using materials such as ultra-high-performance concrete, corrosion-resistant reinforcement, high performance steel, composites, and improved coatings to increase resilience and add durability, higher strengths, and longer life to bridges. Additionally, minimal-impact, non-destructive evaluation methods are being used more widely, while new technologies such as infrared thermography, ground-penetrating radar, and remotely operated surveillance devices like flying and submersible drones are being deployed to assess bridge conditions and to facilitate safer, more efficient engineering decisions. Additionally, engineers are designing "living bridges" where sensors are being embedded into new and existing structures to provide continuous feedback on structural conditions. Finally, prefabricated bridge elements and Accelerated Bridge Construction are being used with more frequency to reduce the amount of time traffic needs to be disrupted while a bridge is repaired or replaced. All of these innovations, technologies, and evaluation methods are effectively allowing engineers to identify problems earlier, increase the lifespan of the nation's bridges, stretch limited resources, and prioritize public safety.

As the nation's bridges continue to age, America's emphasis has slowly evolved from building new bridges to maintaining existing ones. New technologies, materials, evaluation techniques, and construction methods have advanced in recent years to meet this challenge.

CONCRETE COLUMNS AND RUSTY METAL OF THE OLD BRIDGE.

OPERATIONS & MAINTENANCE

Our nation's bridges comprise a vast, complex system of unique structures, each of which is deteriorating at its own pace and in need of specific treatments at specific times. In order to manage this large array of assets, states are now required to develop and use Transportation Asset Management Plans (TAMPs). The federally required TAMPs outline a systematic, data-based approach for states to manage their inventories. Each TAMP is required to predict and set targets for the bridges that will be in good or poor condition over the next 10 years. Strategic asset management is one of the most cost-effective ways that the nation is addressing its aging and deteriorating bridge inventory.

One critical component of asset management is life-cycle cost analysis (LCCA). When the cost of a bridge replacement, rehabilitation, or repair project is estimated for budgeting purposes without considering the long-term costs of maintenance, operation, replacement, and retirement, decision-makers end up with an underestimated value for their planning purposes. Because bridges are costly and complex assets that provide decades of service, the use of life-cycle cost analysis can minimize long-term costs with a broad, upfront picture of the costs over the infrastructure's lifetime.

RESILIENCE & PUBLIC SAFETY

As investments are made in the nation's bridges, a systematic approach should be taken to make them more resilient. Many of the country's older bridges are susceptible to extreme weather events and more prevalent flooding, which can result in overtopping, washout, and other storm-related damage. In fact, nearly 21,000 bridges were found to be susceptible to overtopping or having their foundations undermined during extreme storm events. In seismic regions, earthquakes are a significant threat, and a bridge's ability to withstand these extreme events is a significant safety issue.[6]

Additionally, bridges are being subjected to trucks that are heavier than those they were originally designed to sustain. These heavier trucks, which can surpass 40 ton loads, threaten to overstress bridge elements, cause metal fatigue and cracking, and decrease the service lives of bridges. The U.S. Department of Transportation found that the introduction of double 33-foot trailer trucks results in a projected 2,478 bridges requiring strengthening or replacement at an estimated one-time cost of $1.1 billion.[7] As future opportunities to platoon connected or autonomous trucks become more commonplace, bridges could see further stress. Engineers are using new design requirements, materials, and technologies to enhance the security and resilience of bridges as they are being built. The great challenge moving forward is to address the hundreds of thousands of existing bridges so they can provide decades of continued, safe service despite a greater frequency in extreme weather events or an increase in design loads.

Bridges

RECOMMENDATIONS TO RAISE THE GRADE

- Increase funding from all levels of government to continue significant bridge repair, rehabilitation, and replacement.
- Prioritize rehabilitating and preserving bridges in fair condition, as these bridges can often be preserved at a fraction of the cost of replacement if the work is performed in a timely manner. This approach can reduce the number of structurally deficient bridges to below 5%, decrease the maintenance backlog, and address the large number of bridges that have passed or are approaching the end of their design life.
- Develop a balanced approach for our current aging bridge inventory that emphasizes preservation, rehabilitation, and replacement where necessary, while also setting aside funding for critical operation and maintenance. Bridge owners should consider the costs across a bridge's entire lifecycle (LCCA) to make smart design decisions and prioritize maintenance and rehabilitation.
- Fix the Highway Trust Fund by raising the federal motor fuels tax by five cents a year over five years. In addition, to ensure long-term sustainable funding for the federal surface transportation program, the current user fee of 18.4 cents per gallon on gasoline and 24.4 cents on diesel should be tied to inflation to restore its purchasing power, fill the funding deficit, and ensure reliable funding for the future.
- Urge states to prioritize investments on bridges that are most critical, for example those that experience the highest daily traffic volume, are on critical freight corridors, evacuation routes, and develop multi-variable prioritization formulas for the bridges in their state.
- Advise states and the federal government to consider long-term funding solutions for transportation infrastructure and potential alternatives to motor fuels taxes, including mileage-based user fees.
- Continue to fund research into the use of innovative technologies, materials, and construction techniques to extend the life of bridges and ensure they are climate resilient.

DEFINITIONS

STRUCTURALLY DEFICIENT – Effective January 1, 2018, the Federal Highway Administration (FHWA) changed the definition of "structurally deficient" as part of the final rule on highway and bridge performance measures published on May 20, 2017, pursuant to the 2021 federal aid highway bill Moving Ahead for Progress in the 21st Century Act (MAP-21). Two measures that were previously used to classify bridges as structurally deficient are no longer used. This includes bridges where the overall structural evaluation was rated poor or worse condition, or with insufficient waterway openings. The new definition limits the classification to bridges where one of the key structural elements – the deck, superstructure, substructure, or culverts – are rated in "poor" or worse condition. Based on the new definition of structurally deficient, there are 6,533 bridges that would have been classified as structurally deficient in 2017 but did not meet the new criteria in 2018.

Bridges

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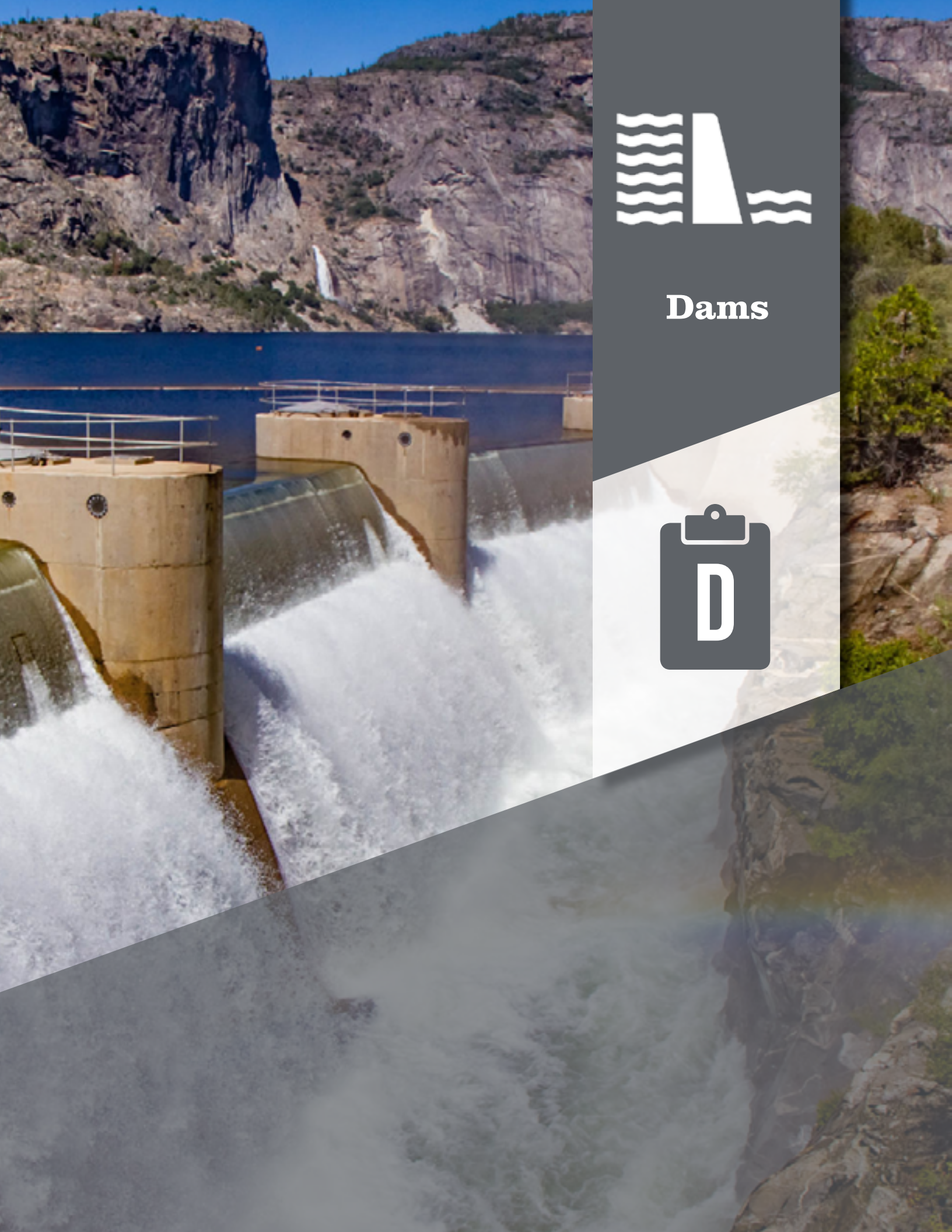

Dams

D

EXECUTIVE SUMMARY

There are over 91,000 dams[1] in the country that serve many purposes. Dams are classified by hazard potential. A high-potential hazard-potential rating does not imply that a dam has an increased risk for failure; it simply means that if failure were to occur, the resulting consequences would likely be a direct loss of human life and extensive property damage. Over the last 20 years, the number of high-hazard-potential dams has more than doubled as development steadily encroaches on once rural dams and reservoirs.[2] Although the number of high-hazard-potential dams has increased, the overall percentage of these dams protected by an Emergency Action Plan has increased as well. As of 2018, 81% of such dams had a plan on file, up 5% from 2015. Unfortunately, due to the lack of investment, the Association of State Dam Safety Officials estimates the number of deficient high-hazard-potential dams now exceeds 2,300.[3] Meanwhile, approximately 3% of dams supply households and businesses with hydroelectric power, and many of these dams are privately owned by utilities and follow a rigorous operations and maintenance schedule.[4]

CONDITION & CAPACITY

Dams are present in all 50 states, serving a wide range of daily needs, such as water storage, irrigation, hydropower, mining, flood control, and recreation. The public most commonly thinks of engineering marvels like the Hoover Dam in Nevada, which provides water supply and hydroelectric power to Arizona, Nevada, and California. However, only 3% of dams are currently a source of hydroelectric energy.

Dams are classified by regulatory agencies based on their hazard potential or anticipated downstream consequences in the event of failure. The failure of a dam that is classified as **high-hazard-potential** is anticipated to cause a loss of life. As of 2019, there are approximately 15,600 dams[5] in the United States that are classified as high-hazard structures. Over the last 20 years, the number of high-hazard-potential dams has more than doubled as development steadily encroaches on once rural dams and reservoirs.[6] Meanwhile the number of dams classified as **significant hazard-potential**, meaning a failure would likely cause significant economic damage, but not necessarily loss of life, reduced during this period from 11,882 in 2017 to 11,343 dams[7] in 2019.

Another contributing factor to the shift in classification of dams is increases in state funding for dam safety programs. With state dam safety programs better able to assess these structures, the opportunity for owners to become aware of rehabilitation, repair, or removal needs increases, as does the likelihood of dams being classified as high hazard potential. Signs of improved funding began as early as 2015 as state economies began to recover from the 2008 recession.[8] Approximately 69% of dams in the National Inventory of Dams (NID) maintained by the U.S. Army Corps of Engineers are state-regulated dams.[9]

Recent crises following heavy seasonal rains, like the failure of the Oroville Dam spillway in 2017 or the failure of the

Edenville and Sanford dams in Michigan, have made major headlines, highlighting the poor condition of many of the nation's dams. Thankfully, incidents of large-scale flooding such as these are rare. Proper maintenance, routine inspection, necessary upgrades, and implementation of an Emergency Action Plan can ensure optimal conditions, which in turn protect the public health, safety, and welfare.

The average age of our nation's dams is 57 years. By 2030, seven out of 10 dams in the United States will be over 50 years old. While this is not a reflection on hazard potential, the high average age means that the majority of dams will not have been built to current standards, let alone incorporate newer standards that improve their resilience and reduce the risk to downstream areas. Furthermore, at the time of their construction, they may have been considered low hazard potential, so they may not be able to withstand the increasingly frequent and severe weather events or other natural hazards like earthquakes.

A secondary classification applied to any dam refers to its condition rating based on structural safety. In the National Inventory of Dams (NID), dams can range from "not rated," which refers to either the lack of inspection or lack of rating, to "satisfactory," indicating no existing or potential dam safety deficiencies. States and federal agencies may have additional definitions and rating applications that are used to classify dams. Definitions may vary slightly from state to state as well as among federal agencies.

FUNDING & FUTURE NEED

Without specific funding programs, many dam owners cite lack of funding as the reason maintenance and upgrades are deferred. As of 2019, over half (56.4%) of U.S. dams were privately owned.[10] The remaining dams are divided among a variety of owners; among them, 20% are local, 4.7% are federal, while an almost equal figure, 4.8%, are owned by states. It should be noted that 42% of federal dams[11] fall under the purview of the U.S. Army Corps of Engineers (USACE) or the Bureau of Reclamation. The smallest share of dams (2.4%) are held by public utilities. Identifying dam owners is critical as funding rehabilitation and repair falls to them.

In fact, the most recent Association of State Dam Safety Officials' (ASDSO) cost estimate indicates the combined total to rehabilitate the nation's non-federal dams exceeds $66 billion.[12] To rehabilitate just those high-hazard-potential dams would cost nearly $20 billion.[13] Additional estimates show the need to rehabilitate federal dams is approximately $27.6 billion.[14]

The High Hazard Potential Dam Rehabilitation (HHPDR) Program authorized in 2016's Water Infrastructure Improvements for the Nation (WIIN) Act is one new program that can help address existing

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funding needs. The goal of this program is to help fund the repair, removal, or rehabilitation of the nation's non-federal, high-hazard-potential dams. In federal fiscal year (FY) 2020 this program was funded at $10 million, less than **0.1%** of the ASDSO need estimate and a **quarter** of its FY20 $40 million authorization.[15]

Dam owners must meet eligibility requirements to receive an HHPDR grant. Eligibility is subject to classification (a high-hazard-potential classification by the State Dam Safety Program) and requires applicants to fail to meet minimum dam safety standards, pose an unacceptable risk to the public, and have an approved Emergency Action Plan (EAP). As of June 2020, there are approximately 60 projects across 25 states that could be construction-ready within the year based on pandemic-related stimulus funds that would require approximately $538 million in total investment.[16] Additionally, there are 1,300 state-regulated high-hazard-potential dams in the NID rated poor or unsatisfactory with an EAP.

When fully appropriated, the HHPDR program has the potential to help repair some of the highest priority dam safety rehabilitation projects in the country. Otherwise, states must navigate a series of smaller state and federal programs. Federal programs include those within the Bureau of Reclamation and National Rural Conservation Services, receiving more than $100 million in FY2019 for grants with funding authority of more than $85 million. For the first time in FY2021, Congress appropriated $12 million to the Corps Water Infrastructure Financing Program (CWIFP), which enables local investment in infrastructure projects like dams that enhance community resilience to flooding, promote economic prosperity, and improve environmental quality. While at the local level, nearly half of states have a grant or low-interest revolving loan program to assist dam owners with repairs. This local commitment of funds can help stretch the potential federal grants even further.

EDENVILLE DAM POWERHOUSE & SPILLWAY

PUBLIC SAFETY

Dam failures not only put the public at risk, they can also cost our economy billions of dollars in damages. Failure includes more than the dam's damage, but can negatively impact many other infrastructure systems, such as roads, bridges, and water systems. When a dam fails, resources must be devoted to the prevention and treatment of public health risks as well as the resulting structural consequences.

EAPs identify potential emergency conditions at a dam, specify preplanned actions to be followed to minimize property damage and loss of life should those conditions occur, and are initiated in the event of an impending dam failure or other uncontrolled releases of water. The number of high-hazard-potential dams with EAPs continues to steadily climb toward a recommended goal of 100%; as of 2018, 81% of dams have EAPs — up from 77% in 2017.[17] Additionally, 34 states reported 90% or more of their high-hazard-potential dams had EAPs on file,[18] while this same number of states saw 100% of their high-hazard-potential dams inspected in 2018.[19]

Every state except Alabama has established a regulatory program for dam safety that bears a large responsibility for public safety, including the certification of EAPs. These programs have regulatory authority for 69% of the NID dams.[20] Further improving public safety is the increase in staffing within state dam safety programs over the past several years. In 2018, state programs spent nearly $60 million[21] on dam safety regulation, a 22% increase over the previous four years. One result from this spending is an increase in dam safety program staff — nearly 450 full-time equivalents[22] — across the 50 states.

Adequate staffing is important to state dam safety program performance. The range of state-regulated high-hazard-potential dams per staff ranges from 5.8 to 120.7, with a national average of 28.6 high-hazard-potential dams per Full-Time Equivalent (FTE) staff. Nineteen states have a staffing ratio more than 10 percent above the national average. State numbers significantly above the high-hazard-potential dams per FTE national average can be an indicator of the need for additional staff resources. Adequate staffing can enable dam safety programs to improve inspection rates and asset monitoring, while also reducing dam owners' challenges in completing needed repairs and upgrades. At the federal level, the National Dam Safety Program (NDSP), which was reauthorized in 2018 through FY 2023, helps facilitate collaboration among stakeholders within federal agencies, states, and owners to streamline dam safety roles and responsibilities.

Finally, low head dams can pose a hazard to unassuming public. A low-head dam is a relatively small, man-made structure spanning a river or stream where water flows over the entire length of the dam. Moderate-to-high flows over these dams create turbulent and recirculating currents that can pull and trap individuals underwater. Because low head dams are inconspicuous, people are often unaware of the dangers these structures pose.

RESILIENCE & INNOVATION

In some areas, engineers, dam owners, regulators, and emergency management professionals are making efforts to engage communities near dams to raise awareness of the potential damage from failure. By expanding community collaboration, stakeholders can support land use decisions, emergency action planning, and maintenance and rehabilitation funding, that all help reduce community risk and improve resilience in the long term.

Further increasing resilience of dams throughout the country is the shift toward a risk-based decision-making process for the design, rehabilitation, and operation of dams. This risk-based approach is innovatively coupled with web-based tools developed by federal agencies, like RiskMAP, DamWatch, and ShakeCast, that aid dam owners in identifying, mitigating, and reacting to potential structural and downstream risks.[23]

RiskMAP, or Risk Mapping, Assessment, and Planning, is a FEMA program that provides communities with flood information and tools they can use to enhance their mitigation plans to protect public safety.[24] The program looks at the lifetime of the asset and identifies other risks within the watershed, which could include dam failures. Dam Watch, a web-based application, provides real-time monitoring of rainfall, snowmelt, stream flow, and seismic events that could pose potential threats to dam safety. With its ability to alert essential staff of critical events, Dam Watch can help ensure Emergency Action Plans and related procedures are executed in a timely fashion. Finally, the ShakeCast system was developed by the U.S. Geological Survey (USGS) as a means of assisting in post-earthquake disaster management, which among other things can include notifying dam owners of potential seismic risks.[25] An extension of the USGS tool, ShakeCast can provide real-time information that enables decisionmakers to take quick action to secure the asset and protect public health and safety.

Dams

D

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the national dam rehabilitation and repair funding program at its full appropriation of $40 million to cost-share repairs for publicly owned, non-federal, high-hazard-potential dams.
- Develop emergency action plans for every high-hazard-potential dam by 2025.
- Implement a national public awareness campaign to educate individuals about high-hazard-potential dams, specifically ensuring the public has a better understanding of the dam rating system and how we determine condition as well as the location and condition of dams in their area.
- Increase state funding for their respective dam safety programs, including adequate staffing of state dam safety offices. Ensure all 50 states have dam safety programs.
- Encourage state and federal agencies to meet reporting deadlines to ensure that adequate data on dams are available for policymakers to facilitate decision-making on funding and to the general public to promote public awareness.
- Require federal agencies that own, operate, or regulate dams to meet the standards of Federal Guidelines for Dam Safety.
- Encourage improved land use planning at the local level so that communication about how dams affect local areas is more accurately known and considered in future planning.

Dams

DEFINITIONS

EMERGENCY ACTION PLAN — A formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life should those conditions occur. The EAP contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities. It also should include inundation maps to show the emergency management authorities the critical areas for action in case of an emergency.

DAM OWNER — Party or parties responsible for the safety and liability of the dam and for financing its upkeep, upgrade, and repair.

DAM REGULATOR — Party or parties responsible for dam safety enforcement including the safety evaluations of existing dams, review of plans and specifications for dam construction and major repair work, periodic inspections of construction work on new and existing dams, and review and approval of emergency action plans.

HIGH-HAZARD POTENTIAL DAM — A dam in which failure or mis-operation is expected to result in loss of life and may also cause significant economic losses, including damages to downstream property or critical infrastructure, environmental damage, or disruption of lifeline facilities.

SIGNIFICANT-HAZARD POTENTIAL DAM — A dam in which the failure or mis-operation is not expected to cause loss of life, but results in significant economic losses, including damages to downstream property, critical infrastructure, environmental damage, or disruption of lifeline facilities.

LOW-HAZARD POTENTIAL DAM — A dam located in a rural or agricultural area where failure would not only cause the loss of the dam itself but may cause minor damage to nonresidential and normally unoccupied buildings, or rural or agricultural land.

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Dams

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Drinking Water

C-

EXECUTIVE SUMMARY

Our nation's drinking water infrastructure system is made up of 2.2 million miles of underground pipes that deliver safe, reliable water to millions of people.[1] Unfortunately, the system is aging and underfunded. There is a water main break every two minutes[2] and an estimated 6 billion gallons of treated water lost each day in the U.S.,[3] enough to fill over 9,000 swimming pools. However, there are signs of progress as federal financing programs expand and water utilities raise rates to reinvest in their networks.[4] It is estimated that more than 12,000 miles of water pipes were planned to be replaced by drinking water utilities across the country in the year 2020 alone.[5] In 2019, about a third of all utilities had a robust asset management program in place to help prioritize their capital and operations/maintenance investments with limited dollars,[6] which is an increase from 20% in 2016,[7][8] Finally, water utilities are improving their resilience by developing and updating risk assessments and emergency response plans, as well as deploying innovative smart water technologies like sensors and smart water quality monitoring.

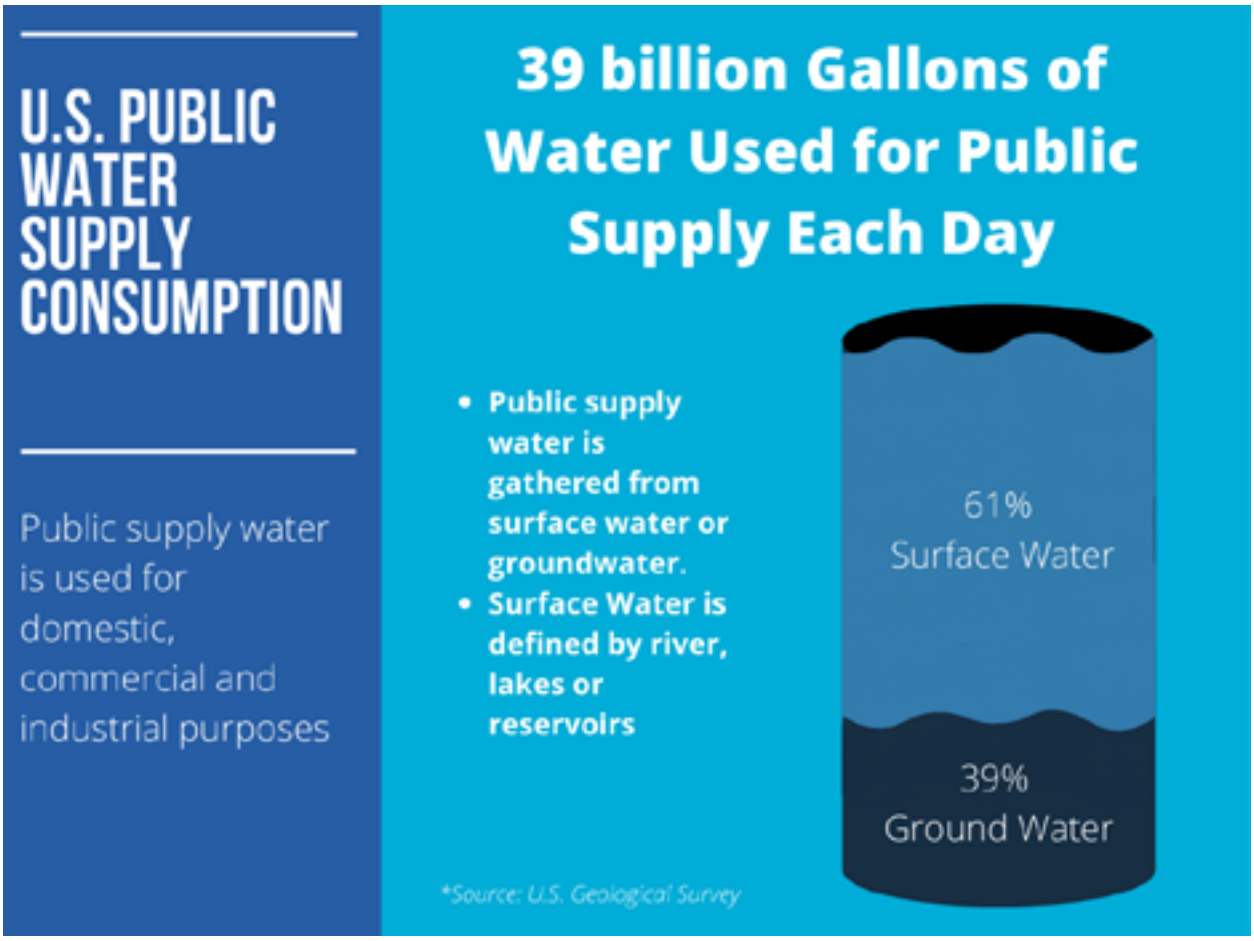
CAPACITY & CONDITION

Access to clean and safe drinking water is critical to public health and economic prosperity and, on average, people use around 82 gallons of water per person, per day in the United States. Nearly half of water utilities report declining or flat total water sales in the past 10 years, largely due to efficiency improvements.[9] Water usage dropped 3% from 2010 to 2015, despite a 4% increase in the nation's total population.[10] Due to declining water usage, there is currently adequate drinking water capacity in the U.S. About 39 billion gallons of water a day are withdrawn from surface water or groundwater sources for public supply. Public supply use represents about 12% of total freshwater withdrawals.

There are more than 148,000 active drinking water systems in the nation. Just 9% of all community water systems serve over 257 million people, while the bulk of community water systems — 91%, or nearly 46,000 in total — serve communities with populations under 10,000 people.[11] About 13 million households in the nation rely on water from private wells.[12]

Our nation's drinking water infrastructure is composed of 2.2 million miles of pipe, most of which is underground and unseen by the millions of consumers who rely on it every day; unfortunately, this often means that water infrastructure is out of sight and thus out of mind.[13] Some of the nation's oldest pipes were laid in the 19th century, and pipes that were laid post-World War II have an average life span of 75 to 100 years, meaning that many of them are reaching the end of their design life.[14]

Between 2004 and 2017, various sources estimate there were between 10 to 37 leaks and breaks per 100 miles of pipe.[15] One report found a 27% increase in water main break rates between 2012 and 2018, reaching an estimated 250,000 to 300,000 breaks per year; this is equivalent to a water main break every two minutes.[16] Smaller utilities can have up to twice as many pipe breaks



than larger utilities, in part because smaller utilities often have more miles of pipe per customer and have a smaller customer base from which to collect revenue, resulting in less funds for repair and asset management.[17]

Water utilities are increasing the rate of pipe replacement and repair. In 2015, utilities were replacing, on average, 0.5% of their pipes per year,[18] meaning it would take an estimated 200 years to replace the entire system. By 2019, utilities were replacing between 1% and 4.8% of their pipelines per year on average,[19] a replacement rate that matches the lifecycle of the pipes. It is estimated that more than 12,000 miles of water pipes were planned to be replaced by drinking water utilities across the country in 2020.[20]

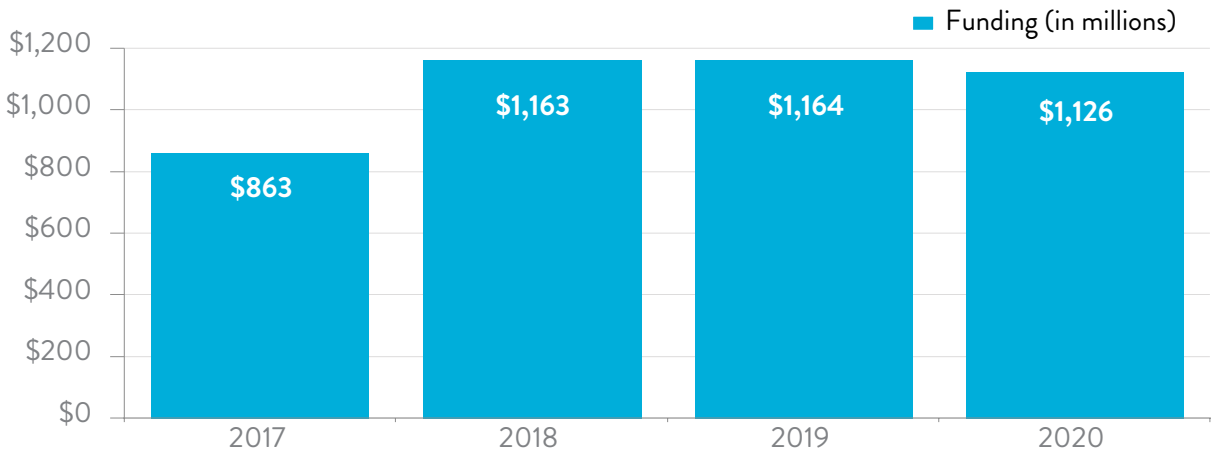
Drinking water systems currently lose at least 6 billion gallons of water, or 9,091 Olympic-size swimming pools, every day. This equates to 2.1 trillion gallons of non-revenue water loss per year.[21] The U.S. lost an estimated $7.6 billion of treated water in 2019 due to leaks.

FUNDING

Funding for drinking water infrastructure has not kept pace with the growing need to address aging infrastructure systems, and current funding sources do not meet the total needs. In general, however, state and local governments have invested more than their federal counterparts. Despite the growing need for drinking water infrastructure, 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.[22] On average, about two-thirds of public spending for capital investment in water infrastructure since the 1980s has been made by state and local governments.[23]

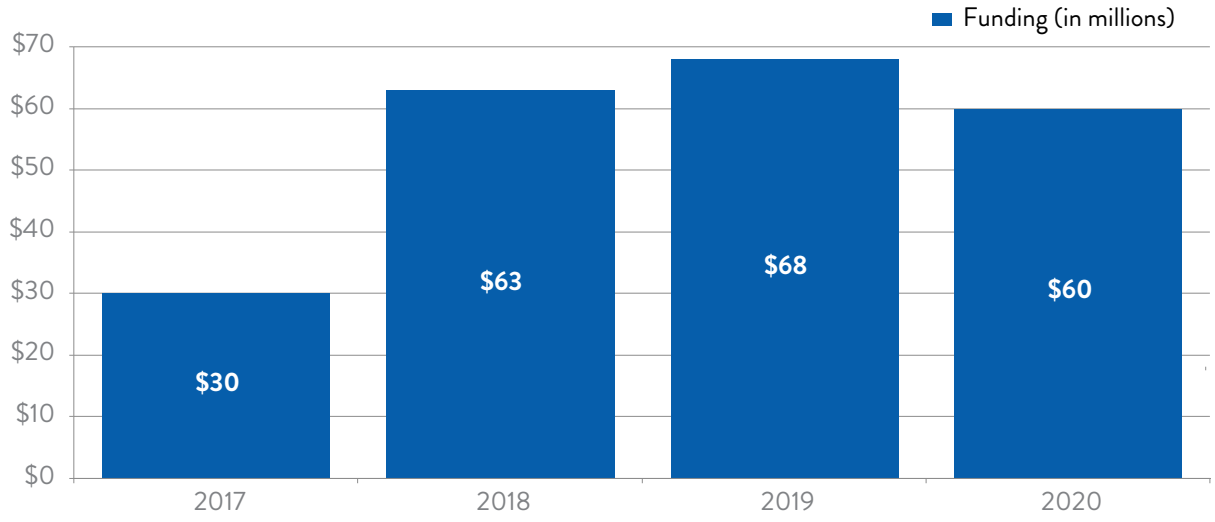
EPA Drinking Water State Revolving Fund Appropriations

The DWSRF provides low-interest loans to state and local drinking water infrastructure projects. It has continued to receive increased federal appropriations since Fiscal Year (FY) 2017.



However, there is some limited federal support. The U.S Environmental Protection Agency's (EPA) Drinking Water State Revolving Fund (DWSRF) provides low-interest loans to state and local drinking water infrastructure projects. The EPA provides an allotment for each state based on its Drinking Water Needs Survey that is conducted every four years, and states in turn provide a 20% funding match. From 2013 to 2018, the DWSRF program grew from just over $2 billion in 2013 to nearly $3 billion in 2018, providing loans of increasing sizes to states. Federal appropriations for the DWSRF helped boost the size of the program from FY17 to FY20.[24] In 2018, the median size of a loan was about $1 million, and one quarter of the projects were co-funded with another source, including funding from the U.S. Department of Agriculture's (USDA) Rural Development program.[25]

The EPA's Water Infrastructure Finance & Innovation Act (WIFIA) program offers the sponsors of large projects (generally over $20 million) a new financing tool to leverage limited federal resources, stimulate additional investment in our nation's drinking water, wastewater, and stormwater infrastructure, and encourage greater private sector participation. As of 2019, prospective borrowers have submitted letters of interest for 156 projects, requesting over $21 billion in WIFIA loans, including $3.9 billion in requests for drinking water projects. Recognizing the program's success, Congress doubled the program's funding in FY20 compared to FY17.[26]The additional support increased the program's lending capacity from $2.5 billion in 2017 to $6 billion in 2019.[27]



WIFIA Program Funding

The U.S. Department of Agriculture's (USDA) Rural Development has over 40 programs in place to support drinking water needs in rural communities across the nation. For example, its Water & Environmental Programs (WEP) provides direct and guaranteed loans, grants, technical assistance, and training to build critical infrastructure for populations of 10,000 or less. From 2015 to 2019, USDA provided over $4.5 billion for 2,016 drinking water projects.[28]

Federal funding and financing is critical, but the primary drinking water infrastructure funding mechanism is user fees. The average nationwide monthly drinking water rate increased 31% from 2012 to 2018. Although water rates have increased, utilities are still facing funding gaps; only 21% of all U.S. utilities report being able to fully cover the cost of providing drinking water services, and only 20% of very large utilities and 10% of small utilities felt they will be able to provide full cost service in five years.[29] Renewal and replacement of aging water and wastewater infrastructure, as well as the financing for capital improvements, are the top two issues facing the water industry.[30]

Although 88% of Americans pay drinking water rates that are lower than the EPA's standard of affordability, it is estimated that up to 36% of households will not be able to afford the cost of drinking water by 2024.[31] The EPA standard for affordability is that households spend no more than 2% on drinking water and 4.5% of median household income on both drinking water and wastewater services.[32] [33]

OPERATIONS & MAINTENANCE

Decades old drinking water infrastructure systems, declining water use, costs of regulatory compliance, and stagnant federal funding has resulted in many water utilities struggling to fund the cost of operations and maintenance of these systems.

Maintenance costs reached an all-time high of $50.2 billion above capital in 2017, in part due to deferred capital projects.[34] A recent survey found that 47% of the maintenance work undertaken by utilities is reactive and done as systems fail.[35]

One of the measures that utilities are taking to improve operations and maintenance and shore up resilience and affordability is the development of asset management programs, which shifts decision-making from reactive to proactive. Some states have asset management requirements for drinking water systems, but there is no federal requirement. Other states give priority for DWSRF loans to water projects that have an asset management plan or provide funding for asset management plan development, training, and technical assistance. Overall, nearly a third of drinking water

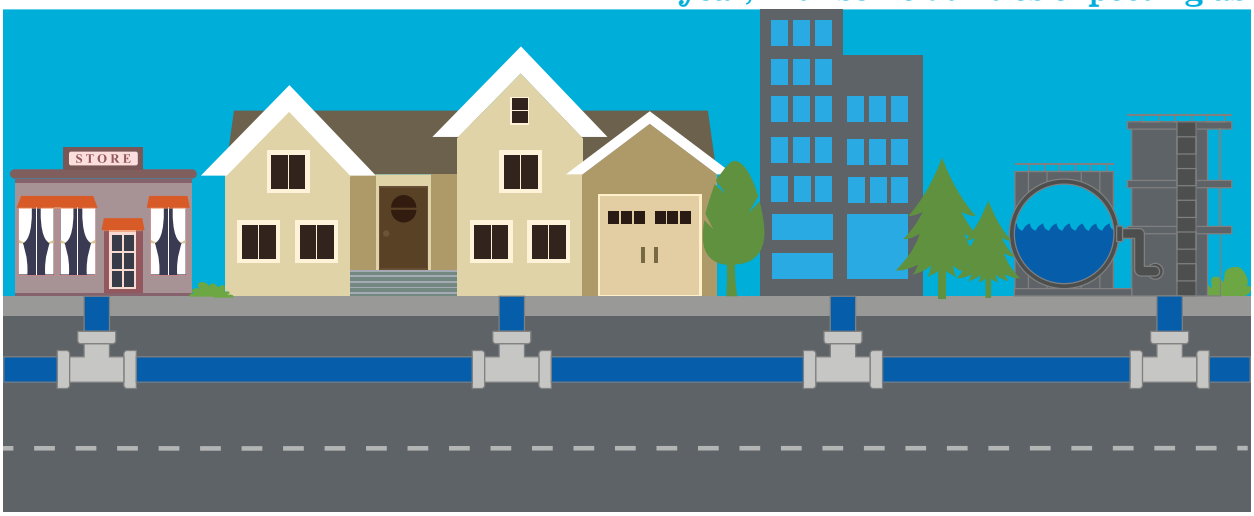
SUSTAINABLE WATER INITIATIVE FOR TOMORROW (SWIFT) IN EASTERN VIRGINIA

utilities have a robust asset management plan in place,[36] which is an increase from 20% in 2016,[37] while another 55% of utilities are in the process of implementation.[38]

FUTURE NEED

Our nation's drinking water systems face staggering public investment needs over the next several decades. ASCE's 2020 economic study, *"The Economic Benefits of Investing in Water Infrastructure: How a Failure to Act Would Affect the U.S. Economic Recovery"* found that the annual drinking water and wastewater investment gap will grow to $434 billion by 2029.[39] Additionally, the cost to comply with the EPA's 2019 Lead and Copper Rule is estimated at between $130 million and $286 million.[40] [41]

Drinking water utilities also face increasing workforce challenges. Much of the current drinking water workforce is expected to retire in the coming decade, taking their institutional knowledge along with them. Between 2016 and 2026, an estimated 10.6% of water sector workers will retire or transfer each year, with some utilities expecting as much as half of their staff to retire in the next five to 10 years.[42]



PUBLIC SAFETY

Since 1974, the EPA has regulated the nation's public drinking water supply through the Safe Drinking Water Act (SDWA). The EPA sets national health-based standards and determines the enforceable maximum levels for contaminants in drinking water. All water suppliers are required to notify consumers upon learning of a serious water quality problem, and states and the EPA are required to prepare annual summary reports of water system compliance that must be made available to the public. In 2019, the number of public water systems with health-based violations was 15% lower than in 2017, and public water systems that were returned to SDWA compliance increased nearly 7% compared to 2017.[43]

Utilities face the increasing challenge of keeping pace with emerging contaminants such as per- and polyfluoroalkyl substances (PFAS), lead and copper in drinking water, and the regulatory requirements needed to remain in compliance with the SDWA. The EPA found that about 12% of water utilities' needs are directly attributable to SDWA compliance.[44] Utilities in more rural communities have a smaller rate-payer base, which results in less revenue and

limited financial capacity to address aging infrastructure and compliance costs. Some struggling community water systems have found success in voluntarily partnering with a larger water utility to access the capital and expertise needed to meet SDWA compliance.

RESILIENCE & INNOVATION

As the nation faces more frequent extreme weather events, water utilities are taking action to increase the resilience of their systems to ensure safety and reliability. In fact, a 2019 survey found that emergency preparedness is one of the top 10 issues facing the water industry.[45] The America's Water Infrastructure Act of 2018 required community water systems serving more than 3,300 people to develop or update risk assessments and EPA. The law also specifies the components that the risk assessments and ERPs must address.

Utilities are also developing innovative smart water technologies such as leak detection, seismic resilient pipes, smart water quality monitoring, and real time data sensors, just to name a few. These technologies improve resilience by allowing utilities to respond to changing climate conditions, improve efficiency of operations by

WATER TRAP ROCK WATER TREATMENT FACILITY IN LOUDOUN COUNTY, VIRGINIA

Drinking Water

RECOMMENDATIONS TO RAISE THE GRADE

- Triple the amount of annual appropriations to the Drinking Water State Revolving Fund program and fully fund the Water Infrastructure Finance and Innovation Act program and the U.S. Department of Agriculture Rural Development programs.
- Utilities should implement asset management programs, tools, and techniques to evaluate asset condition and risk, and to prioritize capital and O&M decisions; states should provide funding, training, and technical assistance for asset management programs.
- Increase utilities' resilience by integrating smart water technologies such as machine learning software and real time data sensors into drinking water infrastructure systems.
- Eliminate the state cap on private activity bonds for water infrastructure projects to bring an estimated $6 billion to $7 billion annually in new private financing.
- Increase federal and local support to find, train, and retain the next generation of the drinking water sector workforce to help offset the large number of expected retirements.
- Utilities need to conduct revenue forecasting models to determine the necessary rate revenues that reflect the true cost of water that is needed to provide safe, reliable drinking water and more resilient infrastructure.
- Develop and fund affordability programs to ensure that low-income and vulnerable communities do not bear a disproportionate burden of rate increases.
- Support voluntary partnerships for small community water systems in need.

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Energy

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EXECUTIVE SUMMARY

In a digital, connected world, Americans increasingly rely on readily available and uninterrupted electricity. Over the last four years, transmission and distribution and reliability-focused pipeline investments have increased, and outages have declined slightly. Annual spending on high voltage transmission lines grew from $15.6 billion in 2012 to $21.9 billion in 2017, while annual spending on distribution systems — the "last mile" of the electricity network — grew 54% over the past two decades.[1] Utilities are taking proactive steps to strengthen the electric grid through resilience measures. However, weather remains an increasing threat. Among 638 transmission outage events reported from 2014 to 2018, severe weather was cited as the predominant cause.[2] Additionally, distribution infrastructure struggles with reliability, with 92% of all outages occurring along these segments.[3] In the coming years, additional transmission and distribution infrastructure, smart planning, and improved reliability are needed to accommodate the changing energy landscape, as delivery becomes distributed and renewables grow.

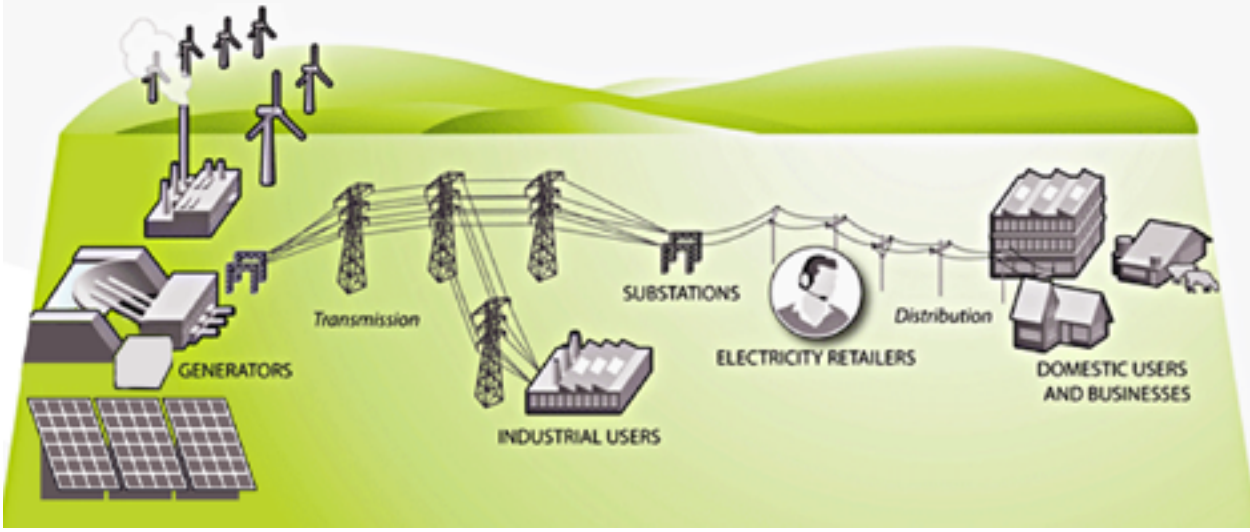
CONDITION, CAPACITY, OPERATIONS & MAINTENANCE
Electricity

Energy infrastructure in the U.S. is used to generate, transmit, and distribute electricity. The electric industry has invested significantly to meet customers' demands, but transmission and distribution (T&D) systems still struggle with reliability. This problem is likely to accelerate as the impacts of climate change persist and the public's expectation of more reliable, "always-on" electricity increases.

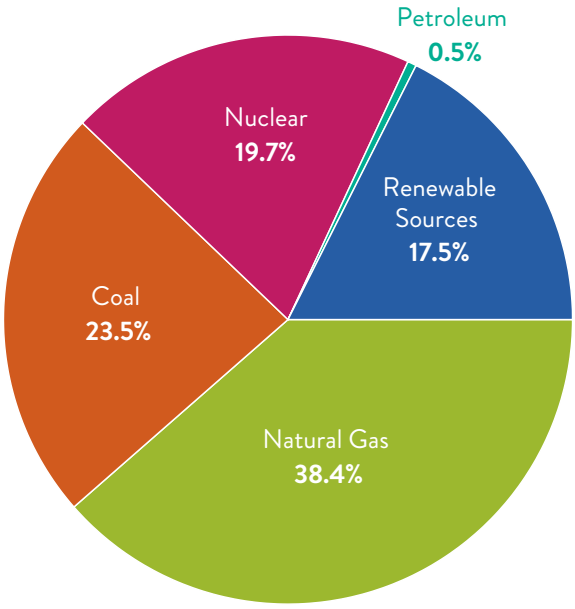
Electricity delivery in the U.S. depends on an aging and complex patchwork of power generation facilities, 600,000 miles of backbone transmission lines (240,000 miles of which are considered high-voltage lines or ≥ 230 Kilovolts), and around 5.5 million miles of local distribution lines that operate within federal, state, tribal, and local regulatory jurisdictions.[4] This system is responsible for providing safe, reliable, and cost-effective electricity to customers. Each type of infrastructure may be owned by an investor or public utility, independent power producer, or governmental agency. While investor-owned utilities (IOUs) make up only 6% of the number of electricity providers, they serve 72% of U.S. electricity customers.[5]

The majority of the nation's grid is aging, with some components over a century old — far past their 50-year life expectancy — and others, including 70% of T&D lines, are well into the second half of their lifespans. The transmission system, which can be thought of as the "interstate highway" of electricity delivery, is regulated by the Federal Energy Regulatory Commission (FERC), and mostly consists of high voltage transmission lines that carry electricity across the country. The distribution system, the "last mile" of the electric delivery system, is regulated by the states and consists of lower voltage lines that act as the local roadways, carrying electric power to neighborhoods and communities. The distribution system also includes substations, individual customer services and meters, as well as other components.[6]

These costly transmission and distribution problems, such as those from weather-related events and other causes, result in power outages that are estimated to cost U.S. households $28 to $169 annually.



U.S. Electricity Generation by Energy Source



U.S. Energy Information Administration 2019

Distribution is a key failure point in the electric grid in terms of system reliability. The distribution system accounts for 92% of all electric service interruptions, a result of aging infrastructure, severe weather events, and vandalism.[7]

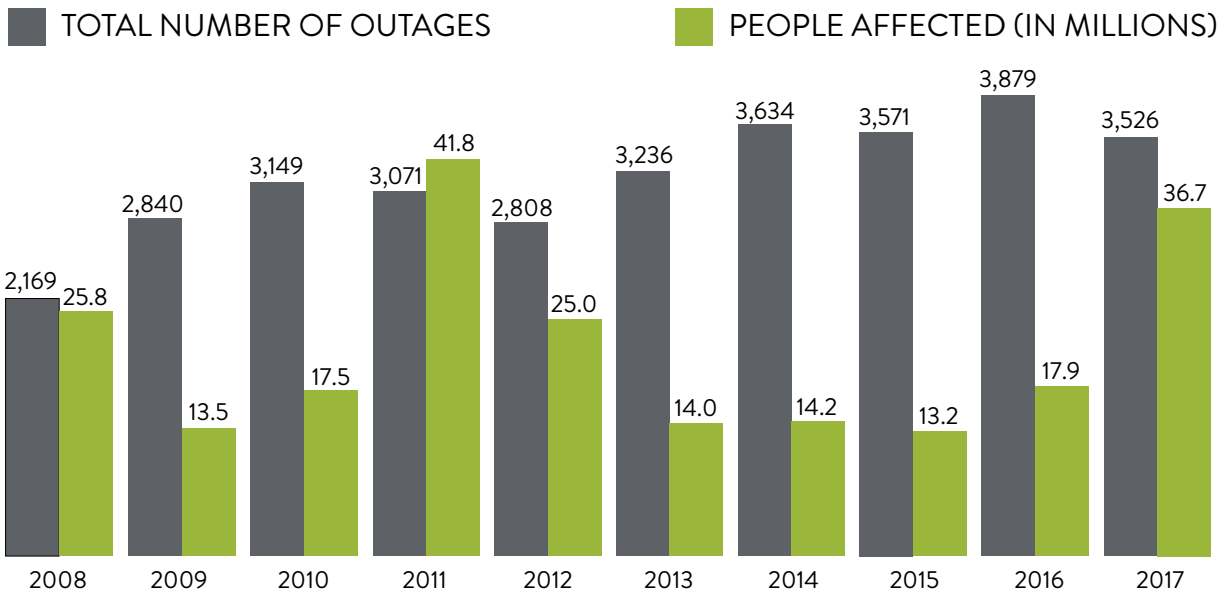
These costly transmission and distribution problems, such as those from weather-related events and other causes, result in power outages that are estimated to cost U.S. households $28 to $169 annually. For an increasingly critical sector, U.S. data centers, on which many industries rely, the cost of outages grew from $505,000 in 2010 to $740,000 in 2016, which equates to $8,851 per minute that the electricity grid is malfunctioning.[8]

For the first time, renewables (solar, wind, biomass, geothermal, and hydropower) accounted for the largest portion of new generating capacity in 2020.[9] Renewables' share of the generating capacity is on track to increase significantly between now and 2023.[10]

Electricity generation from renewable energy sources rose from 18% in 2019 to 20% in 2020 and is expected to rise to 22% in 2021, continuing to expand their lead

over coal (20.1%).[11] Additionally, U.S. energy production exceeded annual U.S. energy consumption in 2019 for the first time since 1957.[12] Near-term, U.S. energy systems are projected to deliver sufficient energy to meet national demands, although increasing electrification — particularly of the transportation sector — could have a significant impact. Electric vehicles (EV) are continuing to penetrate the market. EV charging stations within the United States has grown from 6,900 chargers in 2012 to approximately 61,000 by the end of 2017 for all vehicles. While demand-related impacts due to electrification is uncertain, it is expected that utilities will implement rates that will drive charging to non-peak hours, affecting most passenger vehicles and light duty trucks.[13]

Number of Outages Over Time



2017 Eaton Blackout Tracker

Oil and Gas

Although traditional fossil-fuel-using sectors such as transportation and space heating are transitioning to electrification, there is still dependence on existing oil and gas supply and recovery, processing, and pipeline delivery. Much like the electric grid, the nation's pipelines are also aging, as witnessed by increasing failures and leakage events, thus driving a need to employ improved inspection techniques, preservation technologies, and sound decision-making for upgrades and replacements.[14] America's more than 190,000 miles of oil pipelines and 2.4 million miles or gas pipelines connect sources such wells and port terminals to refineries/processing facilities and consumers.[15] Together, oil and natural gas supply 65% of the energy we use.[16] Similar to electricity, much of the oil and gas infrastructure is privately owned, operated at near full-time capacity, and publicly regulated.[17] Over half of the natural gas transmission and distribution network was installed before 1960, with urban systems being among the oldest.[18] System improvements are principally funded by regulated owner rates and limited recovery; as such, modernization and upgrade investments are typically driven by urgency and necessity rather than through asset management and life-cycle cost-based planning. The risks of aging infrastructure have been witnessed even as recently as 2020 through damaging pipeline events in Baltimore, New York City, and Philadelphia, and failed transmission and distribution lines from Hurricanes Laura and Sally.[19]

New technology improvements have contributed to design, construction, and maintenance methods of oil and natural gas pipelines and improved asset integrity, cost-efficiency, and extended service life expectations.

These new technologies have also greatly eliminated incidents in newer systems.[20]

Critical infrastructure bottlenecks also exist, including the gas delivery constraints to New England and New York and challenges with urban infrastructure upgrades. According to the U.S. Energy Information Administration, the nation's 135 oil refineries are operating at or near capacity with 2019's production rate approaching a record 19 million barrels per day and only one new refinery coming online. While production has kept up with demand, outage-driven commodity price spikes are often experienced due to the capacity limitations and lack of geographic diversity of the oil and gas sector, as many systems are along the Gulf of Mexico, frequently exposed to extreme storms.

FUNDING & FUTURE NEED

All three major components of the electric grid (generation, transmission, and distribution) have an investment gap. To meet the latest state-driven Renewable Portfolio Standards in generation infrastructure, the gap is projected to grow to a cumulative $197 billion by 2029.[21]

Despite the large gap, transmission infrastructure has benefited from increased investment. Transmission spending in the U.S. increased from $15.6 billion in 2012 to $21.9 billion in 2017, driven by a desire to provide access to clean energy and to increase the grid's reliability, security, and resilience.[22] Spending also reduced congestion, lowered resource pricing, and renewed the focus on meeting customer needs.[23] Across all regions of the country, factors such as upgrades and replacements of aging transmission infrastructure, system hardening, and resilience measures that minimize impacts from catastrophic events, improvements to comply with evolving transmission reliability and security compliance standards, and expansion of the transmission system to integrate renewables and natural gas have contributed to the increase in transmission spending.[24] As wind and solar generation grow, new T&D lines are required to link these renewable resources to customers. Doing so allows owners to make investments that "harden" the grid and reduce outage frequency and duration.

Spending on electricity distribution systems by major U.S. electric utilities — representing about 70% of the

total U.S. electric load — has risen 54% over the past two decades, from $31 billion to $51 billion annually.[25] This increase has been anchored by capital investment from utilities that are working to upgrade aging equipment. Poles, wires, and substation transformers are being upgraded with advanced materials and new technology to better withstand extreme weather events, to allow easier frequency and voltage control during system emergencies, and to accommodate greater use of variable renewable generation.[26]

In the past decade, investment in overhead poles, wires, devices, and fixtures such as sensors, relays, and circuits has risen by 69%, while spending on substation transformers and other station equipment increased by 35%.[27] Investment in customer meters has more than doubled over the past decade as utilities have upgraded traditional meters to smart meters that can be accessed remotely, communicate directly to utilities, and support smart consumption and pricing applications using real-time or near real-time electricity data. However, there will be additional required investment to maintain these wires and poles, transformers, meters, and similar equipment, which are usually the responsibility of the local utility.[28]

The National Environmental Protection Act (NEPA), which directs agencies to consider environmental impacts in decision-making, was updated by Executive Order in 2020.[29] Changes are expected to expedite the permitting process to no more than two years for most transmission and distribution projects. Reducing delays in the permitting process would facilitate the expansion of the nation's energy infrastructure to increase its capacity. However, these efforts must be made with safeguards in place to protect the natural environment.

Investment in oil and gas infrastructure is driven by changing sources, increasing demand, and pricing fluctuations, in addition to physical condition, failure events, and regulation. Where demand approaches or exceeds existing supply in geographic regions, commodity pricing is elevated, and funding is justified. When commodity pricing is low, infrastructure investment declines. Through 2035, investment in oil and gas infrastructure is expected to contribute $1.50 to $1.89 trillion to U.S. GDP, or between $79 billion and $100 billion annually.[30] This investment produces positive impacts on the economy, from employing individuals to fostering delivery of lower cost energy to households and businesses.

The recent Keystone XL Pipeline permit rescindment will have a future impact on America's pipeline infrastructure. In addition to the significant number of jobs lost, the precedent of rescinding already granted permits is concerning and could harm future investment in all energy infrastructure.

ASCE 48: Design of Steel Transmission Pole Structures	Provides a uniform basis for the design, detailing, assembly, fabrication, testing, and erection of steel tubular structures for electrical transmission poles[31]
ASCE 10: Design of Latticed Steel Transmission Structures	Provides requirements for the design of guyed and self-supporting latticed steel electrical transmission structures[32]
ASCE Manual of Practice 74: Guidelines for Electrical Transmission Line Structural Loading	Provides most relevant and updated information related to transmission line structural loads and has been updated to address impacts of climate change[33]
ASCE Manual of Practice 104: Recommended Practice for Fiber-Reinforced Polymer Products for Overhead Utility Line Structures	Details best practices for the use of fiber-reinforced polymer (FRP) composite poles and crossarms in resilient conductor support applications[34]
ASCE Manual of Practice 123: Prestressed Concrete Transmission Pole Structures	A complete engineering reference on static-cast and spun-cast prestressed concrete poles for electric distribution and transmission power lines[35]
ASCE Manual of Practice 141: Wood Pole Structures for Electrical Transmission Lines: Recommended Practice for Design and Use	Provides comprehensive knowledge of the principles and methods for the design and use of wood poles for overhead utility line structures[36]

Preserving the nation's energy infrastructure requires balancing the affordability and access to delivered energy products (e.g., electricity and natural gas) with maintaining reliable and resilient service as well as reducing the carbon footprint. This is readily addressed through life-cycle cost analysis, wherein technology improvements and best and sustainable practices to replace aging infrastructure can be confirmed.

RESILIENCE & INNOVATION

While weather has always been the number one threat to the energy sector's reliability, climate change has only exacerbated the frequency and intensity of these events and associated costs.[37] The Department of Energy (DOE) found that power outages are costing the U.S. economy $28 billion to $169 billion annually.[38]

Rather than focusing on repairing the grid after a major disaster, more utilities are taking proactive steps to adapt to climate change, by strengthening the grid through resilience measures and incorporating consensus-based standards during long- and short-term planning.

Incorporating these consensus-based standards in the design and construction of T&D infrastructure, which should be used for all overhead infrastructure (transmission, distribution, and communication) will improve the physical strength of the systems and allow them to better withstand natural disasters. The cost to properly design a typical distribution line by following the applicable standards increases by only $681 per mile.[39] This is not only considered cost-effective, but also could prevent the loss of life.[40]

Many of the nation's 8,625 power plants were deliberately sited near shorelines to have access to water. As a result, when hurricanes strike, power plants face significant flooding damage. During Hurricane Harvey in Houston, Texas, in 2017, wind and catastrophic flooding knocked down or damaged more than 6,200 distribution poles, and 21.4 gigawatts of generation were affected by wind damage, flooding damage, fuel supply issues, or evacuations and shutdowns.[41] As sea levels rise, storm surges would hit further inland, causing more coastal flooding to transmission, distribution, and generation infrastructure.[42]

Electric companies have invested more than $285 billion in T&D since Superstorm Sandy, partially to harden the energy grid and make it more resilient to future storms, including investing in new and upgraded T&D infrastructure, improving efficiency and reliability, and enhancing protection to enable a more secure, flexible, and resilient electric system.[43]

Other ways utilities have incorporated resilience are through increased utilization of microgrids and battery storage.[44] Innovations support decarbonization, electrified transportation, remote pipeline inspections, and also include smart technologies such as T&D line sensors.

PUBLIC SAFETY

Pipeline incidents impacting people or the environment have declined by 20% in the past five years, while national pipeline capacity has grown by 12%. Pipeline and Hazardous Materials Safety Administration (PHMSA) statistics indicate that the frequency of significant pipeline incidents has fluctuated between 291 to 308 incidents in 2017 to 2019.[45] Each incident typically results in some injury or death as well as property damage in excess of $50,000 per event. Since 2017, significant pipeline incidents have caused over $3 billion in property damage. Clearly, continued upgrades and improvements are needed but must be balanced against the advancement of electrification and demand shift, among other factors.

Beyond just the inconvenience of having no lights or internet, prolonged power outages have significant consequences for everyone. Nearly every other part of our infrastructure relies on electricity.

Communications are the first to be impacted; public and private transportation is immediately affected; water and wastewater cease to operate; gas stations and grocery stores cannot sell the goods that they have due to our digital economy; and commercial activity immediately terminates as even cash transactions require electric registers. The public's health is in danger as medical devices could be shut off, water contaminated, and food spoilage will begin.[46]

With new technologies deployed by the transmission system, power outages also bring increasing risks in cyber and physical security. Consumers depend on electricity constantly, and the grid's reliability can be impaired by cyberattacks on information technology systems that support its operations, with the potential to cause power outages. The electric grid is becoming more vulnerable to cyberattacks via industrial control systems, consumer Internet of Things devices connected to the grid's distribution network, and the global positioning system (GPS). From 2014 through 2018, grid owners and operators reported 17 events to DOE that were initially believed to be caused by cyber-related activity. Further analysis of the 17 events shows only four were determined to be related to cybersecurity, and none disrupted the reliability or availability of the grid or resulted in a power outage.[47] But cyberattacks will only increase and the possibility of a major breach on part of the U.S. grid is always a risk.

Select energy systems, such as the transmission grid, are also exposed to low-probability severe threats, such as geomagnetic pulse, which could have a significant impact on public safety and the economy. The DOE released a Cybersecurity Strategy to strengthen the resilience and cybersecurity of the nation's energy infrastructure.[48] Additional actions by both FERC and the North American Electric Reliability Corporation (NERC) have focused on increasing physical resilience, enhancing cybersecurity, and bolstering the interdependence of the nation's energy and telecommunications infrastructure. [49]

CONSTRUCTION UNDERWAY ON FIRSTENERGY TRANSMISSION LINE UPGRADE IN NORTHEAST OHIO

Energy

RECOMMENDATIONS TO RAISE THE GRADE

- Adopt a federal energy policy that provides clear direction for meeting current and future demands factoring in technology change, carbon reduction, renewables and distributed generation, state and market-based factors, and rate affordability.
- Require the adoption of consensus-based standards for all overhead T&D lines, structures, and substations to ensure safety and increase reliability.
- Improve grid and pipeline reliability by increasing frequency and effectiveness of critical asset inspections and focusing on robust risk mitigation; consider life cycle costs and technology impacts during system upgrades and replacements.
- Develop a national hardening plan that considers investment in production/generation and delivery (T&D, pipelines) to enable rapid restoration of energy systems after natural and/or manmade disasters.
- Consolidate federal, state, and local environmental reviews and permitting processes so new T&D and pipelines can be funded, create jobs earlier, and modernize energy infrastructure faster — while ensuring environmental and community impacts are fully vetted and considered.
- Design energy infrastructure including life-cycle cost analysis and construction of additional transmission grid infrastructure to efficiently deliver power from generation sources to regions with greatest demand requirements.

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Hazardous Waste

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Photo courtesy of the Bureau of Land Management of Oregon & Washington

EXECUTIVE SUMMARY

There are an estimated 35 million tons of hazardous materials managed annually in the United States.[1] In general, there is adequate capacity for the treatment and disposal of these materials through the year 2044. However, progress toward mitigating legacy sites where hazardous waste was produced and improperly disposed of has stalled. There are approximately 1,300 Superfund sites where cleanup activities are either incomplete or not yet begun, roughly the same number as four years ago. Meanwhile, the Superfund budget has remained essentially flat at around $1.1 billion over the last 10 years.[2] The two other hazardous waste programs — one for brownfields and one for hazardous waste regulated under the Resource Conservation and Recovery Act — are also in a steady state. In general, grant funding for the Brownfields Program has increased, but the program is still oversubscribed, with just 30% of applicants receiving funding. Meanwhile, resilience is a growing concern at many hazardous waste sites. Around 60% of all nonfederal Superfund sites are located in areas that may be impacted by flooding, storm surge, wildfires, or sea level rise related to climate change effects.[3]

CAPACITY & CONDITION

Recognizing that hazardous waste disposal without planning and management endangers the public health and environment, Congress passed the Resource Conservation and Recovery Act (RCRA) in 1976 to manage hazardous waste from generation to disposal. The RCRA Corrective Action (CA) program drives the cleanup of legacy sites, while the RCRA permitting program governs the generation and proper transport, treatment, and disposal of hazardous waste for ongoing operations that result in hazardous waste. To clean up hazardous waste produced and improperly disposed of prior to the enactment of RCRA, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. CERCLA created the hazardous waste cleanup program commonly referred to as "Superfund."

The Environmental Protection Agency's (EPA) 2019 National Capacity Assessment Report indicates that there is adequate capacity nationwide for the treatment and disposal of hazardous waste through the year 2044. The 25-year capacity is noteworthy given that there has been significant consolidation of commercial hazardous waste management facilities. In contrast, the number of hazardous waste generators has increased, primarily reflecting increased compliance within the retail sector on RCRA reporting requirements.[4]

The amount of hazardous materials requiring long-term management has decreased by 22% between 2001 and 2019, from 45 million tons to 35 million tons per year. Another 1.5 million tons of hazardous wastes — such as metals, solvent, or other recovery — were managed by recycling. The number of facilities where hazardous wastes are managed has decreased from over 2,100 to 964 over that period.[5]

Assuming per- and polyfluoroalkyl substances (PFAS) are determined to be hazardous substances under CERCLA, it is likely to result in more sites being added to the Superfund program. Unfortunately, due to the fact that PFAS compounds are difficult and costly to treat, they will present a significant challenge to our current hazardous waste infrastructure.

Superfund

Superfund is a mature program, and technologies for cleanup are advancing; however, the capacity of the program to take on very large and complex sites, including contaminated sediment sites and area-wide impacts from legacy mining sites, is not sufficient to address the scope of the problem. While the impact of cleanup activities is clearly significant, increased enforcement, liability provisions and technical requirements have led to a significant reduction in careless disposal of hazardous materials.

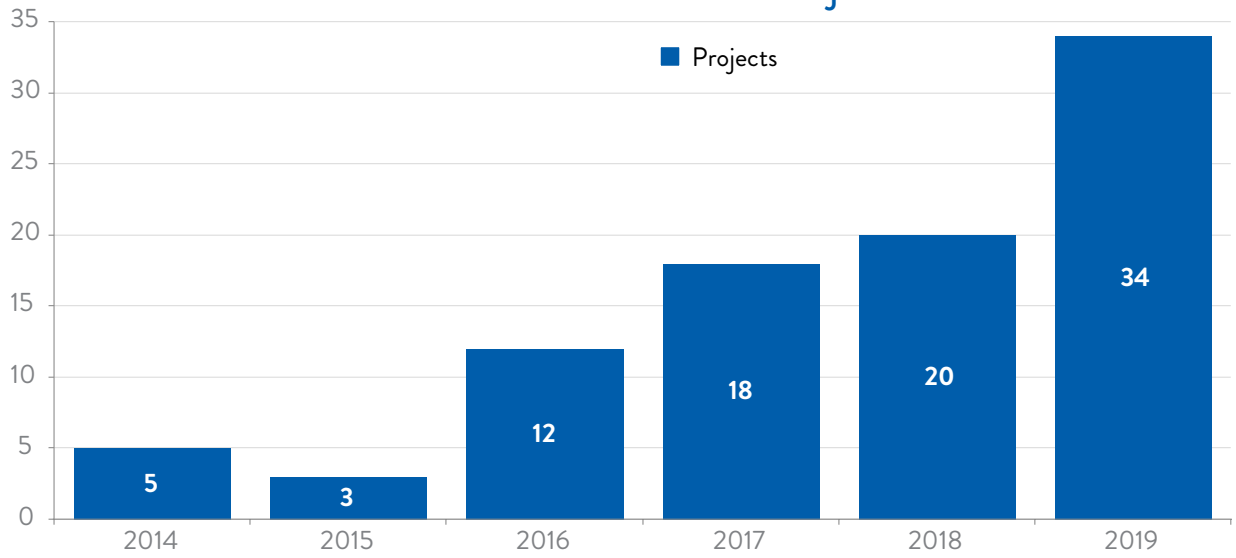
The National Priorities List (NPL), maintained by EPA, contains the list of sites covered by Superfund. The NPL is routinely updated as sites are cleaned and removed from the list, and other sites are discovered, evaluated, and added. As of April 2020, there were 1,178 non-Federal Superfund sites, 157 Federal Sites (i.e., Superfund sites where another federal department or agency is responsible for the cleanup), and 51 sites proposed for the NPL. There are 424 former Superfund sites, sites that have been cleaned up and deleted from the NPL.[6]

The Superfund program has been essentially "steady state"— the rate of deletions from the NPL plus remedial construction completions has been very close to the rate at which new sites have been added to the NPL.

Additionally, it is estimated that there are as many as 500,000 abandoned mines in our nation.[7] Abandoned mine lands (AMLs) pose health risks like radiation exposure, poisoned fish, and contaminated soil, water, and air. Surface runoff carries AML-originated silt and debris down-stream, which is often contaminated by metals and acid. Acid mine drainage (AMD) from abandoned mines poses significant risks to surface water and groundwater. Abandoned uranium mines pose the added threat of radiation exposure to the list of health concerns.

The Superfund program has been essentially "steady state"— the rate of deletions from the NPL plus remedial construction completions has been very close to the rate at which new sites have been added to the NPL. In 2017, EPA revised the Hazard Ranking System (HRS), the evaluation system used to determine if sites should be considered for inclusion on the NPL based on the threat to human health and the environment. In that revision, EPA added the potential for exposure to hazardous substances via vapor intrusion, where vapor-forming chemicals migrate from the subsurface into overlying buildings.

Unfunded New Construction Projects



There has been a yearly increase in the number of sites ready to be cleaned up; however, funding is lacking. In essence, these are "shovel-ready" cleanup projects to protect human health and the environment that are not moving forward because of insufficient funding. These unfunded projects tend to stay unfunded; of the 34 unfunded remedial construction projects in FY 2019, 16 had been unfunded for two or more years, and six had been unfunded for four or more years. This has led to the growth of the backlog of deferred projects. That growth in backlog has occurred despite a decrease in the number of NPL additions over the last several years. For example, only seven sites were added in FY 2019.

When funding is available, Superfund cleanups are successful in converting contaminated sites into commercially viable properties to the economic benefit of communities. In 2017, EPA established a Superfund Task Force and has undertaken a sustained effort to examine the Superfund program and develop recommendations to expedite the remediation of sites and return them to communities. At the end of FY 2018, 529 current and former Superfund sites were in reuse or continued use, supporting 8,690 businesses that provided 195,465 jobs, resulting in $13.3 billion in estimated annual employment income and $52.4 billion in annual sales — many times EPA's expenditures at these sites. Fifty-nine of those sites are home to renewable energy projects, with an installed capacity of 360 megawatts.[8]

At the end of FY 2018, 529 current and former Superfund sites were in reuse or continued use, supporting 8,690 businesses that provided 195,465 jobs, resulting in $13.3 billion in estimated annual employment income and $52.4 billion in annual sales

Resource Conservation and Recovery Act (RCRA)

Whereas the Superfund program manages legacy hazardous waste sites, RCRA provides instructions for current hazardous waste generation. Under RCRA, hazardous waste is managed from the moment it is generated to its final disposal. More than 80% of all generated hazardous waste is produced by the chemical manufacturing industry and the petroleum and coal products manufacturing industry. Over half the nation's hazardous waste is generated in the state of Texas.[9]

The "RCRA universe" includes over 45,000 facilities that generate large quantities of hazardous waste, about 1,200 hazardous waste management facilities, and approximately 8,000 hazardous waste recycling facilities. In addition, 3,779 contaminated sites, covering over 18 million acres (approximately the size of South Carolina) are being cleaned up under the RCRA Corrective Action (CA) program.[10]

The effectiveness of RCRA can be measured by how well it is protecting populations and preventing exposure to hazardous chemicals. Program data from FY 2018 shows that 95% of RCRA CA facilities have controls in place that prevent human exposure to toxic chemicals, and 89% of RCRA facilities are effectively preventing the migration of contaminated groundwater. Complete construction of remediation systems has been achieved at 70% of RCRA CA sites, and 36% have achieved environmental performance goals.[11]

Brownfields

There are an estimated 450,000 brownfield sites in the U.S. Brownfields differ from Superfund sites in the degree and nature of the contamination, and often in the site's commercial potential. Cleaning up and reinvesting in brownfield sites increases local tax bases, facilitates job growth, utilizes existing infrastructure, reduces development pressures from open land, and both improves and protects the environment. There are multiple federal grant programs that provide funding and incentives that support brownfields cleanup and revitalization.

Brownfields redevelopment has resulted in significant economic and environmental benefits, with an economic benefit ratio of 20:1 for every federal dollar spent, increasing home values near former brownfield sites, business expansion, and job growth related to infrastructure improvements and improved business performance. Since 2006, approximately 150,000 sites have been cleaned up, facilitating the creation of more than 144,000 jobs, with 2 million acres made ready for reuse.[12]

FUNDING & FUTURE NEED

The Superfund budget has remained essentially flat at around $1.1 billion since 2009. In FY 2019, funding limitations resulted in deferring cleanup on 34 sites that were ready for remedial construction. Funding limitations have resulted in a growing backlog of deferred cleanups. In constant dollars, funding for the Superfund program has decreased by 43% since FY 2000.[13] [14]

In FY 2018, the Superfund Enforcement Program obtained commitments from private parties of approximately $453 million for site cleanup and $80 million to reimburse the EPA. Historically, approximately 70% of Superfund cleanup activities has been paid for by the parties found responsible (PRPs) for cleanup.[15]

The 2017 Tax Cut and Jobs Act allows investors to defer or reduce taxes on capital gains for projects built within census tracts of low-income and distressed communities designated as "Opportunity Zones (OZ)." Investments in cleaning up and redeveloping brownfields sites in an OZ affords investors significant tax benefits, making more projects financially attractive. The 2018 Brownfields Utilization, Investment, and Local Development Act ("BUILD Act") increased the funding limit for brownfields remediation grants from $200,000 per site to $500,000.

Since 2017, the number of EPA employees has declined by 8%.[16] Declines can significantly compromise EPA's ability to effectively implement its responsibilities. With loss of EPA Superfund project managers, scientists, engineers, and procurement professionals, EPA's ability to keep pace with program needs is questionable.

HAZARDOUS WASTE IS STORED IN NEW YORK.

State waste management agencies do much of the work under RCRA, relying on federal grants to fund much of their programs. It is critical that states and EPA maintain sufficient expertise and resources to process permits in a timely manner, enhance compliance reporting, expand technical assistance to manufacturing and other waste generators, and improve and streamline permitting processes.[17]

For FY 2020, EPA issued 155 grants for communities and tribes totaling over $65.6 million in EPA brownfields funding through multiple grant programs[18]. Brownfields competitive grant programs remain substantially over-subscribed, with approximately 30% of grant proposals receiving funds.

PUBLIC SAFETY & RESILIENCE

The core purpose of the nation's hazardous waste infrastructure is public safety — preventing the release of, and exposure to, hazardous and toxic substances. Therefore, the infrastructure is generally fit for that core purpose. However, its resilience is less certain. A 2019 Government Accountability Office (GAO) report found that about 60% (945 of 1,571) of all nonfederal National Priorities List (NPL) sites are located in areas that may be impacted by flooding, storm surge, wildfires, or sea level rise related to climate change effects.[19] A clear demonstration of this risk occurred in 2017, when Hurricane Harvey dumped nearly 50 inches of rain over the greater Houston area, damaging several Superfund sites that contain hazardous substances. At the San Jacinto River Waste Pits site near Houston, floodwaters eroded the containment structure, releasing highly toxic wastes including dioxins into the river. In 2018, the Carr Fire in California burned through the Iron Mountain Mine site near Redding, California, nearly destroying the water treatment system. According to the GAO report, some high-density propylene lines that caught fire nearly resulted in an explosion in the mine.[21]

Hazardous waste infrastructure also has an impact on climate. As reported under EPA's Greenhouse Gas Reporting Program, the waste sector contributed 134 million metric tons of CO2-equivalents in 2018, representing about 2.0% of direct, reported U.S. emissions.[21] New technologies and waste reduction strategies have the potential to reduce the hazardous waste management sector's contribution to climate change and strengthen the resiliency of our hazardous waste infrastructure.

INNOVATION

Remediation technologies continue to improve, and more effective site characterization and cleanup strategies are being employed by EPA, other federal entities, and the private sector, emphasizing adaptive management and optimization of treatment systems.

Hazardous Waste

RECOMMENDATIONS TO RAISE THE GRADE

- Increase funding for Superfund at a level sufficient to eliminate the backlog of unfunded remedial actions within a three-year period, while also accelerating the implementation of positive program reforms identified by EPA's Superfund Task Force.
- Address staff shortages, training gaps, and contracting delays in the Superfund program.
- Focus on Superfund and RCRA Corrective Action sites located near historically disadvantaged, low income communities, as these communities have been disproportionally harmed by exposure to contamination from these sites.
- Accelerate and increase investment in PFAS research aimed at characterization, treatment, and analysis of these compounds, as well as understanding health impacts. Drive that research to establish a protective and scientifically sound regulatory framework for managing PFAS in the environment.
- Emphasize a robust technical focus and establish a stable, designated funding source for mining site cleanup, which already consumes a large percentage of the Superfund budget.
- Expand brownfields grant programs to support investment in pre-development site characterization activities, increasing leverage and stimulating greater investment from state, regional, local, and private funding sources.
- Conduct further research on more sustainable, cost-effective remedial approaches for mining sites.
- Invest in technology to optimize and improve efficiency of groundwater treatment systems.

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Inland Waterways

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EXECUTIVE SUMMARY

The Mississippi River and its tributaries, as well as the Columbia, Sacramento, and San Joaquin Rivers on the West Coast make up nearly 12,000 miles of navigable waterways — the U.S. freight network's "water highway." Inland waterway infrastructure includes locks and dams as well as navigation channels. Investing in this infrastructure helps move agricultural exports and relieves strain on other transportation modes. One barge can move as many tons as 70 tractor trailers.[1] Recent boosts in federal investment and an increase in user fees have begun to reverse decades of declining lock and dam conditions, with unscheduled lock closures reaching a 20-year low in 2017.[2] While this is encouraging, the system still reports a $6.8 billion backlog[3] in construction projects and ongoing lock closures — totaling 5,000 hours between 2015 and 2019 — harming the industries that rely on the waterways to get their goods to market. The U.S. Department of Agriculture estimates delays cost up to $739 per hour for an average tow, or $44 million per year.[4]

CONDITION & CAPACITY

The waterway network is comprised of approximately 12,000 miles of inland navigation channels as well as an additional 11,000 of intracoastal waterways owned and operated by the U.S. Army Corps of Engineers (USACE).[5] Most of the mileage of USACE's inland network is comprised of the Mississippi River and connecting waterways. Additional navigable waterways include the Columbia River that makes up the border between Washington and Oregon and the Sacramento and San Joaquin Rivers in California.

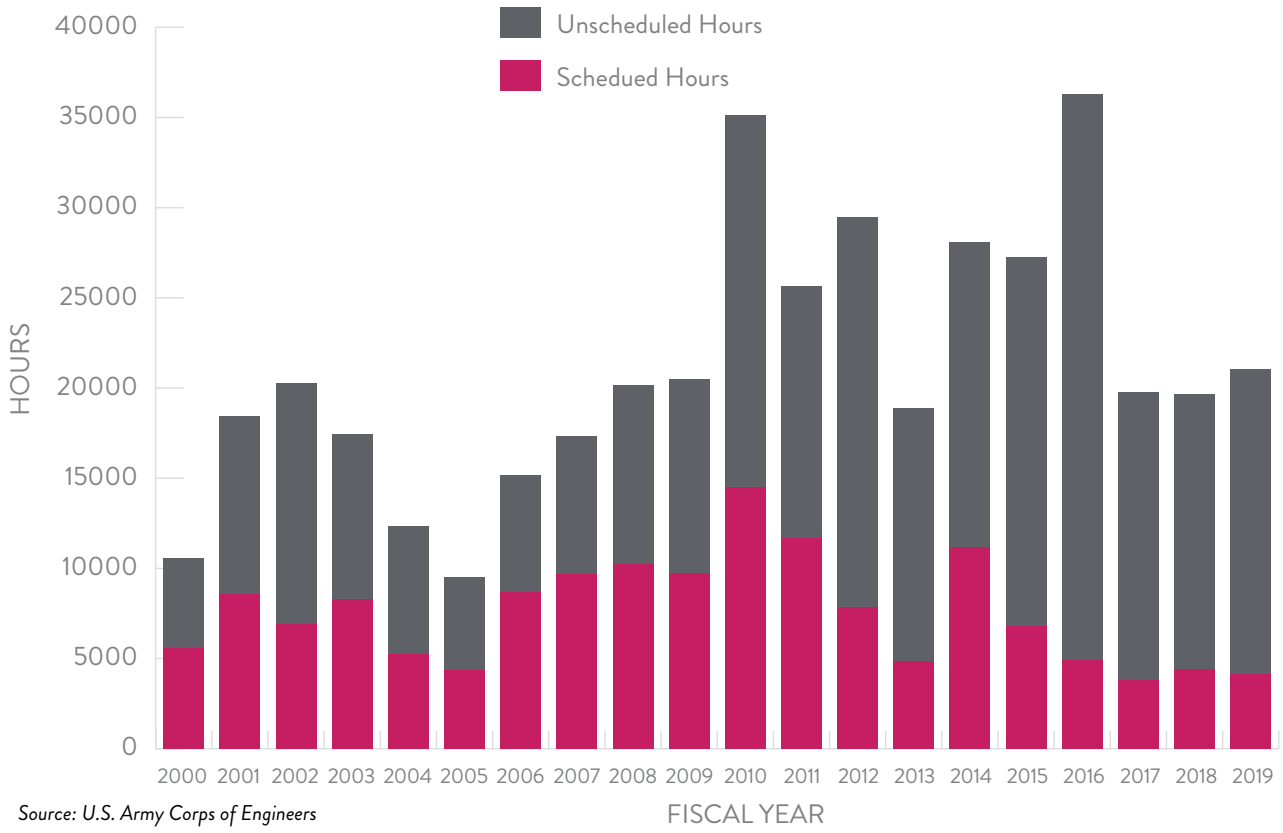
Inland waterways are an important part of the multimodal freight network, and nearly 830 million tons of cargo are moved on the inland waterways system annually.[6] The network is especially crucial for our agricultural industry, which relies on waterways to cost-effectively[7] [8] move and export wheat, soybeans, and other goods to domestic and international markets. One barge on the inland waterways can move as many tons as 70 tractor trailers or 16 train cars.[9] The U.S. Department of Agriculture (USDA) estimates that farm products moved via barge save farmers between $7 and $9 billion annually as compared to other modes of transportation.[10] In addition to food products, the inland waterways move raw materials, manufactured goods, chemicals, coal, petroleum products, and more.

Infrastructure on inland waterways is comprised of locks and dams as well as navigation channels. Attempts are made to dredge channels to ensure a minimum depth and width needed to support commercial barge traffic. However, the current USACE budget does not provide adequate funding to keep all channels consistently opened to the authorized levels. As a result, some rivers are deemed low use and are a lower dredging priority for USACE, forcing system users to alter their shipping methods, which in turn perpetuates the "low use" river designation. Additionally, the growing severity and frequency of flooding is pushing more sediment into the navigation channels, meaning more frequent dredging is necessary to keep the Mississippi River and its tributaries navigable.

Locks and dams act as a stairway for cargo ships, enabling easier navigation during uneven and inconsistent water levels. When a ship reaches a lock, a gate opens, and the ship enters the lock chamber. Once the ship is inside the chamber, the gate closes, and water either fills or empties from the lock chamber. Once the ship is level with the water on the other side of the opposite gate, the opposite gate opens for the ship to proceed.

In total, there are 218 lock chambers at 176 sites on the USACE waterways.[11] Most of the locks and dams are well past their 50-year design life. Locks constructed on the Upper Mississippi, Illinois, and Tennessee Rivers were built in the 1930s, while those on the Ohio River were generally constructed in the 1950s.[12] However, it is very important to note that age does not necessarily correlate with the condition of a lock. Regular maintenance, rehabilitation, and appropriate applications of technological advancements by USACE can considerably extend the lifespan of a lock.

National Lock Portfolio Service Trends
Main Chamber Mechanical Unavailable Hours
(Events Longer Than One Day)



Source: U.S. Army Corps of Engineers

LA GRANGE LOCK AND DAM ON THE ILLINOIS WATERWAY

Inadequate funding for maintenance and rehabilitation activities can cause lock deterioration, which leads to unplanned system outages. Shippers using the inland waterway system experience extraordinary losses from unplanned outages when they can't plan for these in advance and reroute or reschedule their shipments accordingly. For example, when the LaGrange Lock and Dam in Beardstown, Illinois, experiences an unplanned closure, manufacturers, farmers, and other system users in 135 counties in 18 states are immediately impacted. Each unplanned closure at the LaGrange Lock and Dam contributes to nearly $1.7 billion annually in additional transport charges and a $2.1 billion loss in farm-dependent incomes.[13] Another study shows that failure of Lock and Dam 25 in Winfield, Missouri, could result in 12 million tons of agricultural products diverted to over 500,000 truckloads between St. Louis and the Twin Cities over nine months (the average shipping season).[14] Such a closure would ultimately require shippers to spend $283 million in trucking costs and add nearly 22,000 tons of CO_2 to the atmosphere. On average across the country, the USDA estimates that delays cost up to $739 per hour for an average tow, or $44 million per year.

On average across the country, the USDA estimates that delays cost up to $739 per hour for an average tow, or $44 million per year.

Congress has increased appropriations for inland waterways, resulting in improved system performance, as measured by unscheduled lock closures. After peaking in 2010, unscheduled lock closures reached a 20-year low in 2017.[15] From 2010 to 2014, the system experienced nearly 18,000 hours of unscheduled closures, while the years 2015 to 2019 only saw 5,000 hours of unscheduled maintenance closures.[16] While this is an improvement from previous years, 5,000 hours of unscheduled delay is still indicative of an aging system that has, for too many years, lacked adequate and consistent maintenance and capital investments.

Scheduled delays, while not necessarily desired, are set to conduct much needed capital construction and major rehabilitation projects. This type of delay lets shippers plan for outages, minimizing the impact to their operations. Thanks to increased funding from Congress, today USACE is scheduling closures and reducing system inefficiencies. The planning and foresight that is being introduced to the system is resulting in higher reliability for shippers.

FUNDING & FUTURE NEED

Traditionally, 50% of a major rehabilitation or new construction project is paid for with support from the U.S. General Fund, and 50% is supported with revenue from the Inland Waterways Trust Fund (IWTF) account.

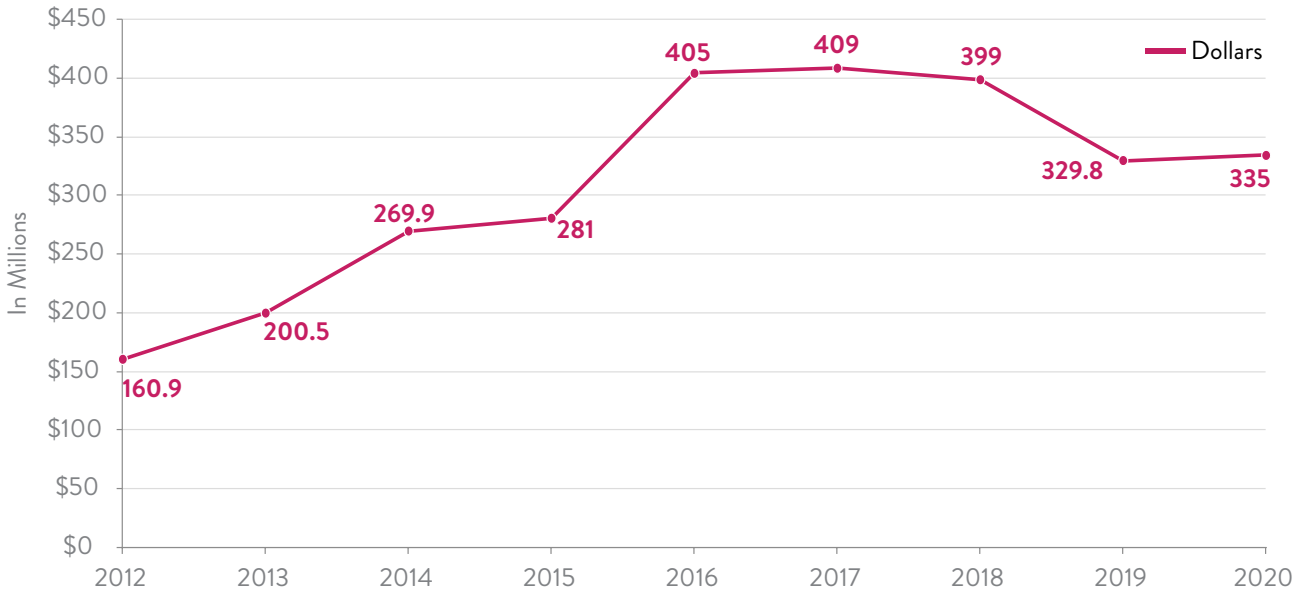
The IWTF collects money from a 29-cents-per-gallon tax on barge fuel paid by shippers using the navigation channels. In 2015, a much sought-after increase to the barge fuel tax was signed into law, which now raises approximately $25 million in additional annual funds and has helped cut down on the backlog of maintenance projects.

Supplemental appropriations made by Congress for the Olmsted Locks and Dam, a megaproject on the Ohio River in Illinois, helped accelerate the long-delayed project, and construction was completed in August 2018. Olmsted was a new construction, but the $3 billion megaproject proved to be too expensive for the typical 50/50 cost share agreement between the General Fund and the IWTF. Congress ultimately ended up paying for 85% of the project, which resulted in Olmsted coming online four years earlier and freeing up IWTF revenue for other projects. Congress has since agreed to pay more than 50% for the Chickamauga Lock project in Nashville.

For every $1 invested in infrastructure, between $2 and $3 is generated in economic activity around the U.S. over time.

These additional appropriations by Congress help expedite the modernization of the nation's locks and dams, improve efficiency along the system, and realize economic benefits earlier. For example, Olmsted began contributing $640 million annually in economic benefits as soon as it was finished.[18] In general, projects along the inland waterways system yield a substantial return on investment. For every $1 of investment in infrastructure, between $2 and $3 is generated in economic activity around the U.S. over time.[19]

Annual Construction Funding from the Inland Waterways Trust Fund



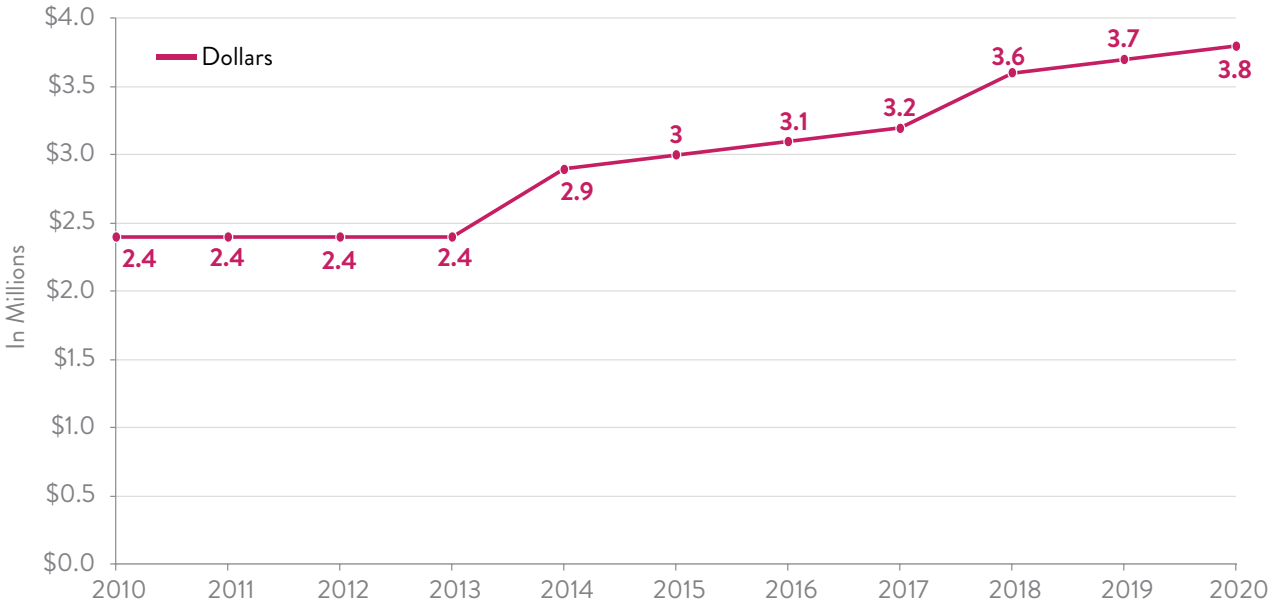
Source: USACE Inland Waterways Annual Reports, Nos. 24-32[17]

OPERATIONS & MAINTENANCE

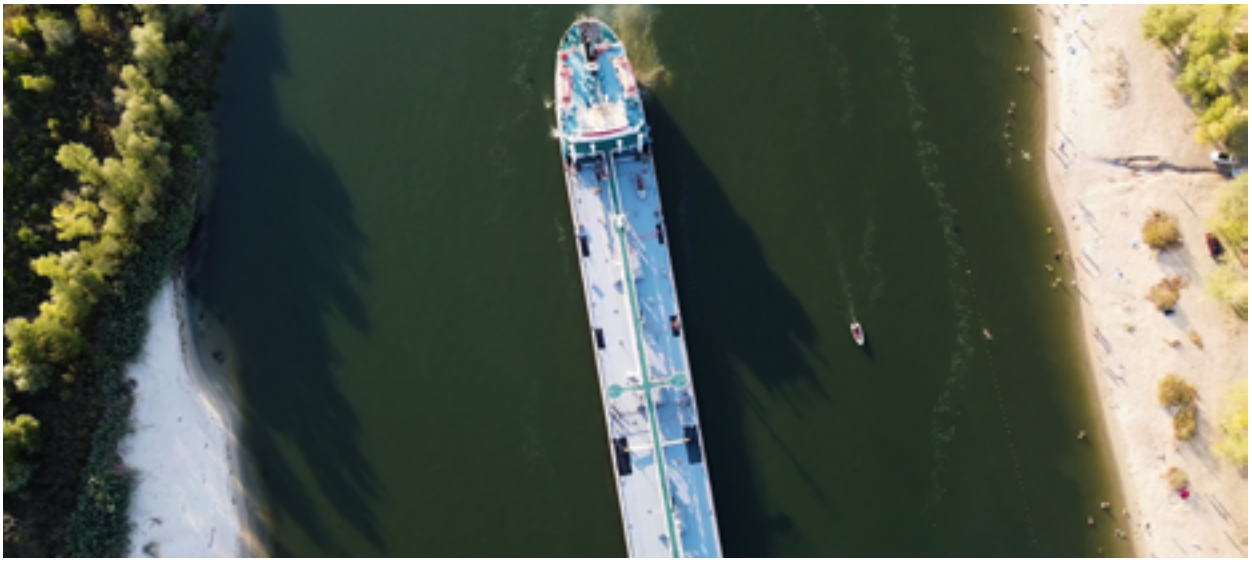
Regular operations and maintenance needs, such as minor lock repairs and dredging, are paid for with appropriations from the General Fund. Project costs are authorized through the Water Resources Reform and Development Act (WRDA) and appropriated by the Energy and Water Appropriations Act. In recent years, Congress has not only regularly passed WRDA legislation, but inland waterways have been the beneficiary of robust appropriations, which have spurred investment along the system and increased reliability for its users.

USACE allocates appropriated operations and maintenance funding to inland waterway projects based on risk and economic benefits to help prioritize limited dollars. However, the agency lacks a definition of deferred maintenance, and as a result there are different estimates of how much deferred maintenance exists on the system.[20] The USACE backlog of authorized projects that are waiting for appropriations funding is $6.8 billion. The agency reports a navigation backlog of $2.7 billion annually in unmet maintenance work activities.

Annual Funding for Operations and Maintenance



Source: Waterways Council



PUBLIC SAFETY & RESILIENCE

The inland waterway network is very safe to operate. According to USDA, on a million-ton-mile basis, there are 21.9 rail fatalities and 79.3 truck fatalities for every one fatality on the waterways system.[21]

A changing climate is contributing to less predictable water levels and impacting the efficiency of the waterway system. When water levels are too high or too low, a river shuts down for barge traffic, and shippers are forced to utilize other modes of transport to get goods to market. Traditionally, flood and drought periods were more predictable, but today's extreme weather incidents are more frequent and more severe. For example, the Mississippi River in Baton Rouge was flooded for 67 days during 2018, which in turn forced hundreds of barges to offload and shippers had to put their goods on trucks.[22]

The inland waterways are also susceptible to natural disasters. For example, a major seismic event in California could cause a breach or failure of one of the levees that channel the state's rivers. The results would be incredibly costly and difficult to recover from, both from a budgetary and environmental perspective, particularly for the neighboring farming communities.

Some waterways, like the Sacramento Deep Water Shipping Channel, need funding for modernization so vessels can safely maneuver in inclement weather. Modernization projects on the Sacramento and San Joaquin Rivers include navigation improvements and additional structural assessments.[23]

A GRAIN BARGE TRAVELS UNDERNEATH A BRIDGE ON THE MISSISSIPPI RIVER.

INNOVATION

Federal funding for new and existing federal navigation projects; designations of high- , medium- , and low-use waterways; and private investment decisions all hinge on tonnage reporting. Traditionally, shippers reported tonnage based on national inland port boundaries rather than geopolitical boundaries. For example, the municipality of Helena, Arkansas, denotes their port by one set of boundaries, while legislation designates different boundaries, and shippers have operated under a third geographic area. This contributes to incorrect tonnage reporting as goods move through these inland ports. To obtain more accurate tonnage reporting, USACE is creating a Geographic Information System (GIS) to prepare enterprise-wide statistical port boundaries. Utilization of geospatial data will improve public reporting and, in turn, create a more accurate data map for policymakers to use when making funding decisions.[24]

Inland Waterways

RECOMMENDATIONS TO RAISE THE GRADE

- Give USACE the authority to manage a project from start to finish and ensure sufficient and timely appropriations from Congress to avoid costly stop-and-start of construction that has traditionally taken place.
- Develop and implement a standardized measurement for delays on the system.
- Fund waterways projects at the authorized levels and do so consistently, passing a Water Resources Development Act on a two-year cycle.
- Ensure that full use of the Inland Waterways Trust Fund continues to be appropriated.
- Increase the amount spent on operations and maintenance of the inland waterways each year by providing more robust appropriations and consider a prioritization method that can more strategically direct limited funds to needy projects.
- Modify the cost sharing for future spending on construction and major rehabilitation projects to require 25% of the project cost to be paid for by the IWTF and the remaining 75% to be derived from the General Fund.

DEFINITIONS

DREDGE — To excavate or deepen the bed of a harbor, river, or other area of water by scooping out sediment and moving it to a different location. This technique is often used to keep waterways navigable.

LOCK CHAMBERS — An enclosure consisting of a section of canal that can be closed to control the water level. It is used to raise or lower vessels that pass through it.

TOW — Barges can be lashed together to form a "tow." A tow may consist of anything from four to six barges on smaller waterways to over 40 barges lashed together on deeper and larger portions of the waterway system.

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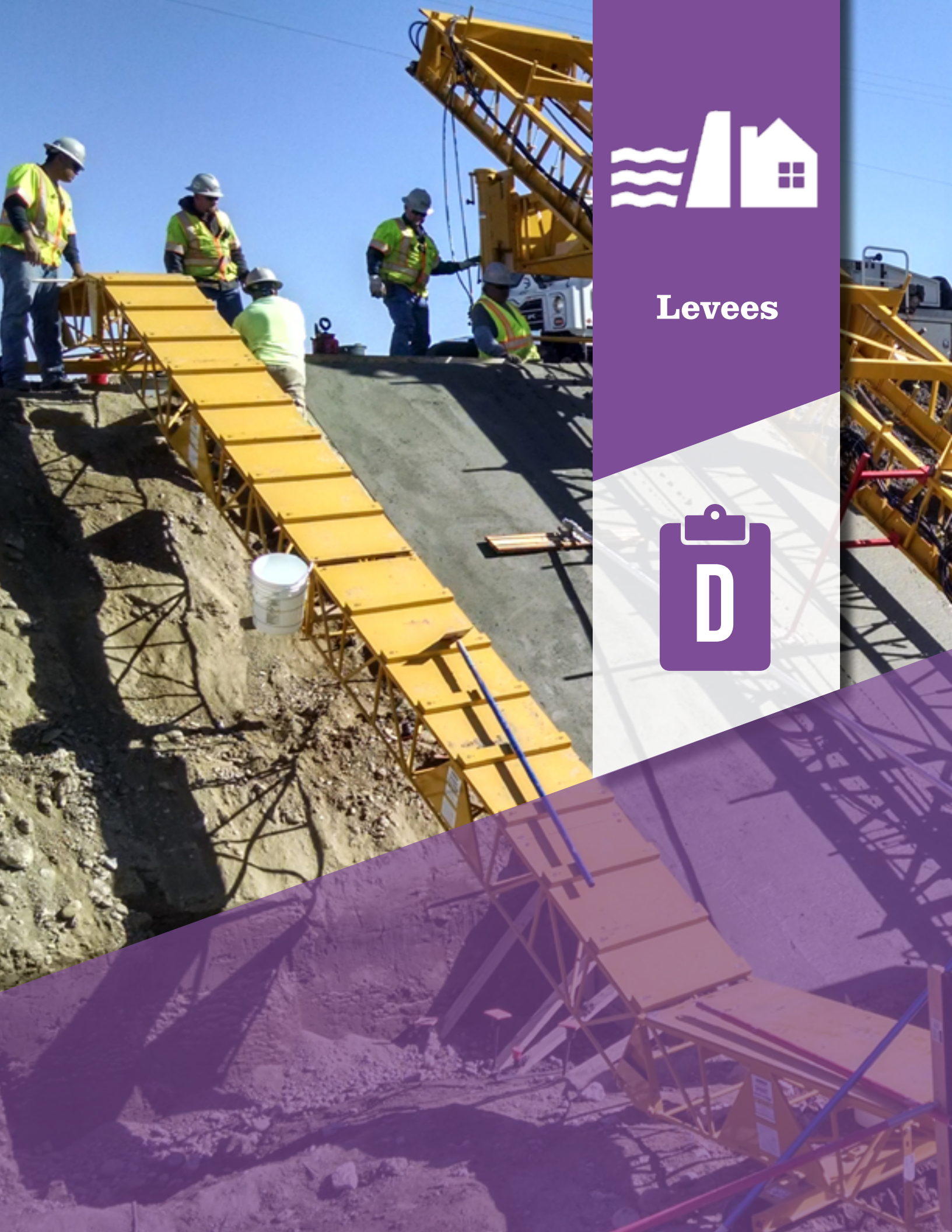


Levees

D

EXECUTIVE SUMMARY

Seventeen million people across the nation live or work behind a levee. Levees protect critical infrastructure systems, $2.3 trillion of property, 4,500 schools that collectively enroll over 2 million students, and a range of industries. The National Levee Database contains nearly 30,000 miles of levees across the U.S., and current estimates identify up to 10,000 additional miles of levees outside of the U.S. Army Corps of Engineers (USACE) portfolio whose location and condition are unknown due to complex and varying local ownership.[1] The USACE estimates that $21 billion is needed to improve and maintain the moderate to high-risk levees in its portfolio, which represents only about 15% of the known levees in the U.S.[2] As more extreme weather events result in increased flooding, such as the $20 billion in damages caused by flooding in the Midwest during the spring of 2019, it is now more important than ever to have a complete inventory of the nation's levees and to equip communities with resources to mitigate flood risk and make necessary repairs.

CONDITION & CAPACITY

Communities in all 50 states, the District of Columbia, Puerto Rico, and Guam depend on levees to mitigate flood risk. Earthen embankments make up 97% of all levees, while the remaining 3% are concrete, rock, and steel floodwalls. The nation's levees are, on average, 50 years old, and many were built using engineering standards less rigorous than our current best practices.

Congress authorized the National Levee Safety Act in the Water Resources Development Act of 2007. This legislation created the National Levee Database (NLD) and authorized the inventory, inspection, and risk assessment of all levees within the USACE's portfolio. Since that time, the USACE has inventoried nearly 30,000 miles of levees across the U.S., including approximately 15,000 miles of levees not within their portfolio and whose condition is unknown.

However, this portfolio represents a small portion of all the nation's levees; it is estimated there are up to an additional 10,000 miles of levees in the U.S., but they are difficult to inventory due to the diverse public and private entities that own, operate, and maintain them. Since 2017, the USACE has incorporated a variety of different inventory sources into the NLD; corrected levee alignments (shortening or increasing lengths); recategorized or removed structures that were not levees; and added new levees, all of which brings the database closer to being a complete inventory of levees in the U.S. Most levees yet to be inventoried are anticipated to have a zero to relatively low population (<100 population) behind them.[3]

As of March 2019, the USACE has completed levee risk assessments for three-quarters of the levees within the portfolio. For the remaining quarter, the USACE expects to complete levee risk characterizations in the next few years. Risk relates a levee's condition to the potential consequences for the size of the population living or working behind the levee. The most recent risk assessment shows that less than 4% of levees within the USACE portfolio are characterized as high or very high risk down

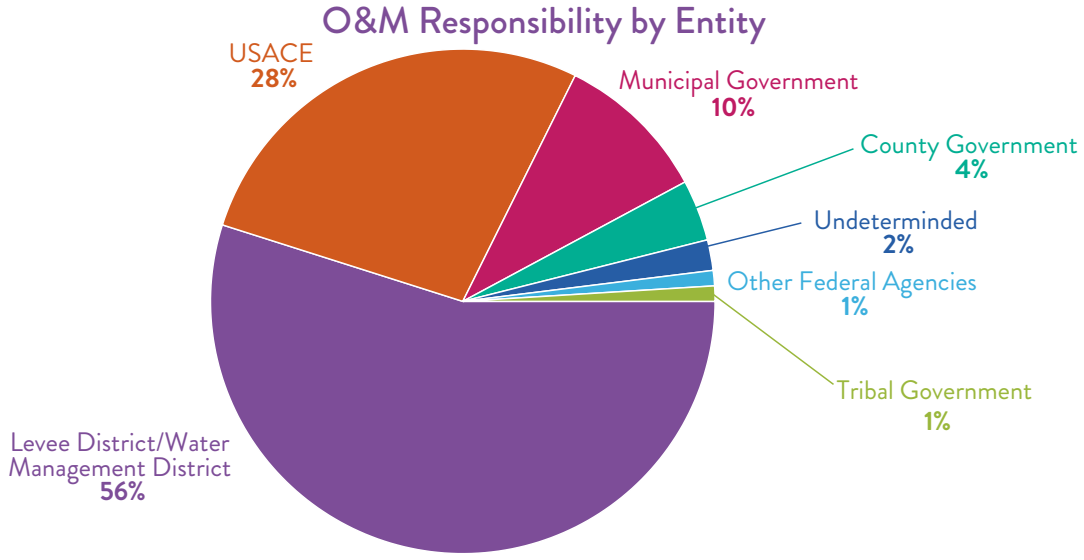
from 5% in 2017. Furthermore, 9% of USACE levees are moderate risk, 60% are low risk, and the rest have not been assessed. By comparison, 5% of levees within the USACE portfolio were high or very high risk in 2017. While most levees within the portfolio are characterized as low risk, a larger portion of the population — about 45% — lives or works behind a high- or very high-risk levee. Unfortunately, 80% of high- or very high-risk levees were found to have one or more levee performance concerns that would likely result in a breach prior to overtopping.[4]

Unfortunately, 80% of high- or very high-risk levees were found to have one or more levee performance concerns that would likely result in a breach prior to overtopping.

About 500 levee systems nationwide are accredited as part of the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP), and roughly 270 of these levee systems are within the USACE's portfolio. A FEMA-accredited levee is one that is certified by a registered professional engineer; meets the National Flood Insurance Program minimum design, operation, and maintenance requirements; and is expected to provide 1% annual chance flood risk reduction. Approximately 30% of these accredited levees within the USACE's portfolio are characterized as moderate, high, or very high risk. These levee systems have about 3.6 million people living or working behind them and protect $400 billion of property.[5]

OPERATIONS & MAINTENANCE

Roughly 70% of the levees, or nearly 10,000 miles of levees, within the USACE's portfolio are operated and maintained by a non-federal levee sponsor — i.e., a municipality or special district. The remaining levees in the portfolio — about 4,200 miles — are operated and maintained by the USACE. Of the levees operated by an entity other than the USACE, 55% are operated and maintained by a levee district or water management district, while 15% are operated and maintained by municipal or county governments. About 15% of all levee systems within the USACE's levee portfolio have multiple levee sponsors responsible for operation and maintenance.[6]



U.S. ACE Portfolio broken down by entity responsible for O&M and percentage of miles of the total portfolio
Source: USACE 2018 Levee Portfolio Report

Local governments rarely have the resources necessary to properly maintain a levee system; it may not be until a flood event occurs that the levee owner recognizes maintenance must be a priority. Many levees that local governments are charged with managing were built many years ago, and the knowledge of the construction materials may be limited without costly and potentially invasive investigations. Basic problems arise with subsurface conditions such as seepage, undersizing of the structure due to increased floods, and structural issues due to erosion or destruction by tree roots, ground-burrowing animals, or encroaching development. Dedicated funding sources often do not exist for non-federal levee sponsors to operate and maintain their levee systems.

There is currently no national standard or requirement for levee design, construction, or operation and maintenance.[7] However, some states have regulatory authority for the construction and safety of levees.

There is currently no national standard or requirement for levee design, construction, or operation and maintenance.[7]

FUNDING & FUTURE NEED

In 2018, it was estimated that $21 billion is needed to improve and maintain the moderate- , high- , and very high-risk levees in the USACE's levee portfolio.[8] This estimate does not include any of the levees outside of the USACE portfolio, so the actual cost to improve and maintain levees is likely much higher. Federal funding for non-federally operated and maintained levees is limited, and most levee operation, maintenance, and repair is the responsibility of the levee owner.

Nonetheless, several federal funding programs exist, including the USACE Rehabilitation Program and the National Levee Safety Program. The Rehabilitation Program provides federal repair funds to levees operated and maintained by a non-federal levee sponsor that are damaged by floods or coastal storms.[9]

The Water Resources Reform & Development Act (WRRDA) of 2014 authorized the creation of the National Levee Safety Program, which is modeled after the successful National Dam Safety Program. This program creates levee safety guidelines and a levee rehabilitation program, makes progress toward completing the National Levee Database, provides assistance to states for establishing safety programs, and promotes community education and awareness about levees. In Fiscal Year

Local governments rarely have the resources necessary to properly maintain a levee system; it may not be until a flood event occurs that the levee owner recognizes maintenance must be a priority.

LEVEE CONSTRUCTION IN PUEBLO, COLORADO

2021, appropriators provided just $5 million, even though the National Levee Safety Program is authorized at $79 million per year. Overall, federal funding for levees falls far short of the estimated $21 billion investment need. Fully funding the National Levee Safety Program is critical to identifying the location and condition of all the nation's levees and in protecting people, communities, critical infrastructure systems, and trillions of dollars of property.

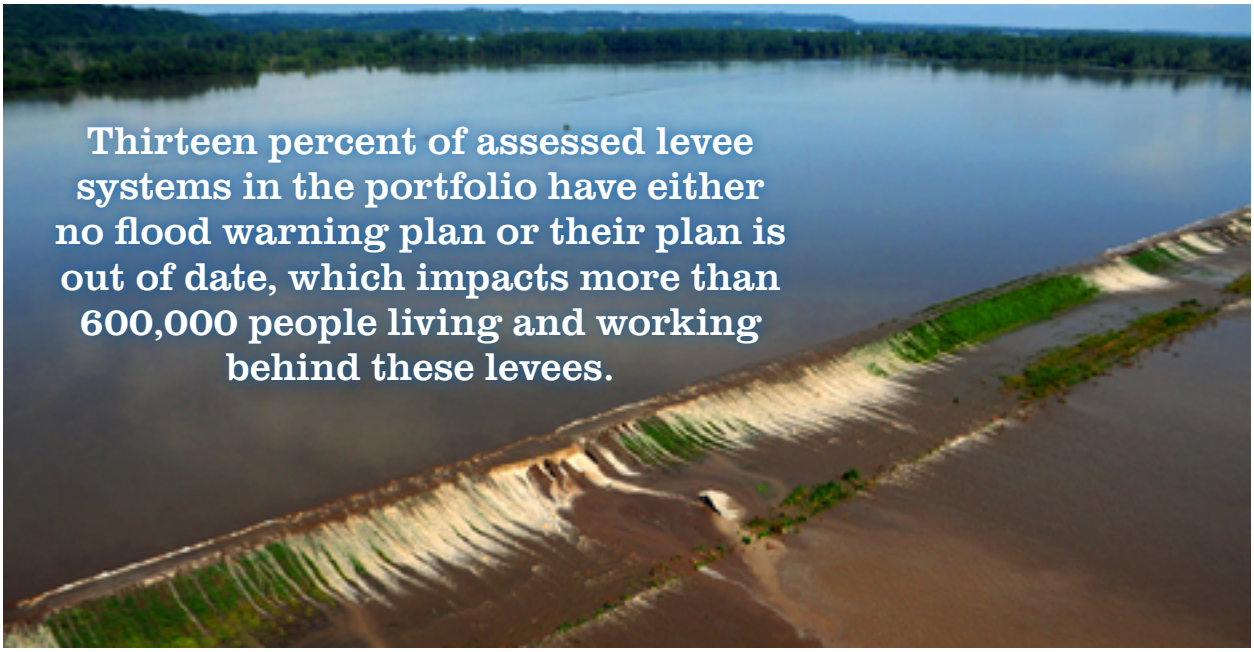
PUBLIC SAFETY & RESILIENCE

Levees are vital components of public safety and help safeguard millions of people, other critical infrastructure systems, and trillions of dollars of property. Over 9 million people — or 86% of the population living behind USACE levees — are concentrated behind about 150 levees, or just 7% of the total USACE levee portfolio.

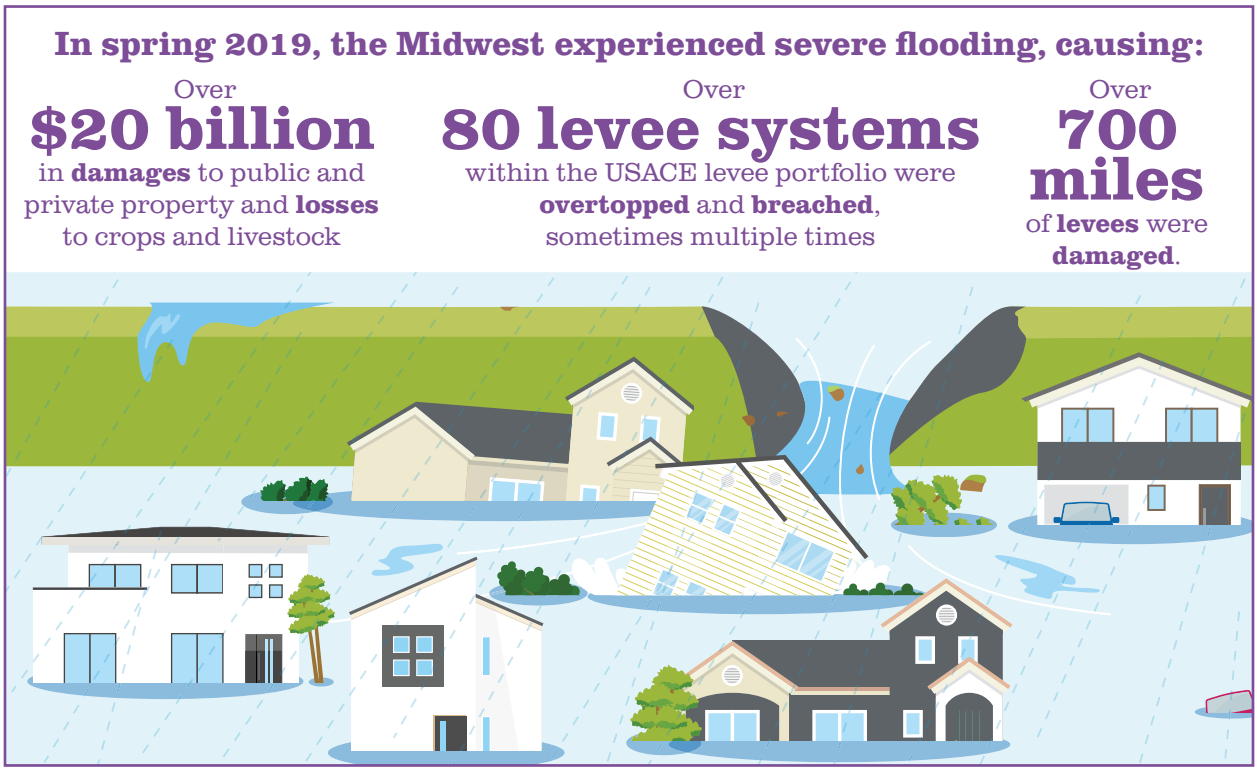
Even well-maintained levees can breach, and water can seep through and underneath them; these effects are hard to detect but can weaken the levee's stability. Frequent extreme weather events put many communities at an increased risk of flooding and levee breaches, including those communities that were previously not in high flood risk areas. In spring 2019, the Midwest experienced severe flooding, causing over $20 billion in damages to public and private property and losses to crops and livestock. Over 80 levee systems within the USACE levee portfolio were overtopped and breached, sometimes multiple times, and over 700 miles of levees were damaged. Preliminary estimates indicate that levee repairs from these floods alone could reach $1 billion.[10] However, it is estimated that USACE levee and shore protection projects prevented almost $350 billion in flood damages from October 2018 to September 2019.[11]

Nearly 40% of the levees in the USACE's portfolio have either a comprehensive emergency plan or recent evacuation success. Thirteen percent of assessed levee systems in the portfolio have either no flood warning plan or their plan is out of date, which impacts more than 600,000 people living and working behind these levees. About 10 million people live and work behind a levee in the USACE portfolio that has some type of flood warning plan; however, nearly 7 million people live in areas that do not have a detailed flood warning plan. Flood warning systems, which include flood inundation maps, contact information for emergency responders, and other key information, are strongly recommended to be included in the development of an Emergency Action Plan for all levee systems. Additionally, more than 3 million people live and work behind levees in communities that are unaware of flood risk.

FEMA and the USACE work collaboratively to incorporate information for levees collected by FEMA



into the NLD in order to increase public awareness about flood risk, and to leverage criteria between existing and new programs to provide incentives for sound flood risk management. While FEMA does not build, own, operate, maintain, or certify levees, they identify flood hazards and work with federal, state, tribal, and local partners to communicate flood risks in areas with levees. The agency is also responsible for determining and establishing flood insurance risk rates.[12] FEMA manages a suite of programs that provide funding to states for mitigation activities that reduce losses and protect life and property from future disaster damages, including the new Building Resilient Infrastructure and Communities (BRIC) Grant Program and the Hazard Mitigation Grant Program (HMGP), among others. Eligible projects include construction of or modification of levees, elevating flood-prone homes or businesses, retrofitting buildings to minimize damage from flooding, and acquiring, demolishing, and/or relocating NFIP-insured property owners.[13]



INNOVATION

Several innovations have emerged in recent years to help maintain and modernize the nation's levees. LIDAR (Light Detection and Ranging) technology is being tested and utilized to help identify levee maintenance issues, assess levee vulnerabilities, and efficiently and cost-effectively target improvements. This technology evaluates risk of catastrophic levee failure and provides continuous and accurate assessments to mitigate risk.[14] In other cases, drones are being used to fly over levees to collect pertinent data; this approach saves time and costs. Additionally, adding field-based sensing in new or existing levees to detect ground motion or seepage of water under levees is being considered to detect potential areas of concern before significant damage occurs.

Further, systems of "fuses" are being evaluated within levee systems that would operate and divert flood water away from areas where there are high concentrations of people, property, and infrastructure. Much like fuses designed to protect electronic devices, levee fuses would be placed to "break" and redirect flood water into lower risk areas. While broken levee "fuses" would require post-flooding repair, the costs to repair the fuses are likely to be dramatically lower than the cost of restoring flood-damaged properties and infrastructure in areas of higher population.

Levees

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the National Levee Safety Program at $79 million a year to identify and inventory the location and condition of all the nation's levees — federal and non-federal alike — and complete the National Levee Database.
- Communities can work to reduce the number of new developments behind levees through zoning restrictions and land development regulations.
- Increase resources, education, and outreach efforts to those communities that live and work behind levees in order to communicate to the public the risk to people, property, and critical infrastructure systems behind levees, as well as the risk and consequences of levee failure.
- More broadly deploy and utilize innovative, efficient technologies, such as LIDAR, to quickly assess levees and identify problems.
- When appropriate, encourage property owners behind levees to purchase flood insurance, even if behind an NFIP-accredited levee.
- Increase the number of levees with an emergency action plan and flood warning plan.
- Encourage states to regulate levee safety.
- Consider using risk-based design approach when designing new levees and evaluating existing levees.

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Levees

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Ports

B-

EXECUTIVE SUMMARY

The nation's more than 300 coastal and inland ports are significant drivers of the U.S. economy, supporting 30.8 million jobs in 2018 and 26% of the total GDP. Ports and port tenants plan to spend $163 billion between 2021 and 2025, up by over $8 billion over the last four years. Investments are focused on capacity and efficiency enhancements as maximum vessel size has doubled over the last 15 years, and tonnage at the top 25 ports grew by 4.4% from 2015 to 2019. Federal funding has increased through multimodal competitive grant programs. However, there is a funding gap of $15.5 billion for waterside infrastructure such as dredging over the next 10 years, with additional billions needed for landside infrastructure. Smaller and inland ports are especially challenged to maintain their infrastructure and have difficulty competing for federal grants. Meanwhile, a port's success is reliant on the infrastructure outside of its gates, which is often congested or in poor condition. For example, just 9% of intermodal connector pavement — the portions of roadway that connect a port to other modes — are in good or very good condition.

INTRODUCTION

The United States' more than 300 ports[1] serve as major economic drivers and places of employment. According to the American Association of Port Authorities (AAPA), seaports contributed $5.4 trillion to the economy, or nearly 26% of the total GDP in 2018. The economic impact of ports is only growing. AAPA estimates that 30.8 million jobs were supported by ports in 2018, up from 23.1 million in 2014.[2]

Seaports in the U.S. are often located in or adjacent to large coastal metropolitan areas. By comparison, inland ports are located on the Great Lakes or the inland waterway network and are frequently in more rural areas. Ports thrive on their flexibility to handle a variety of products, from bulk aggregates and agriculture to liquids and manufactured goods and equipment.

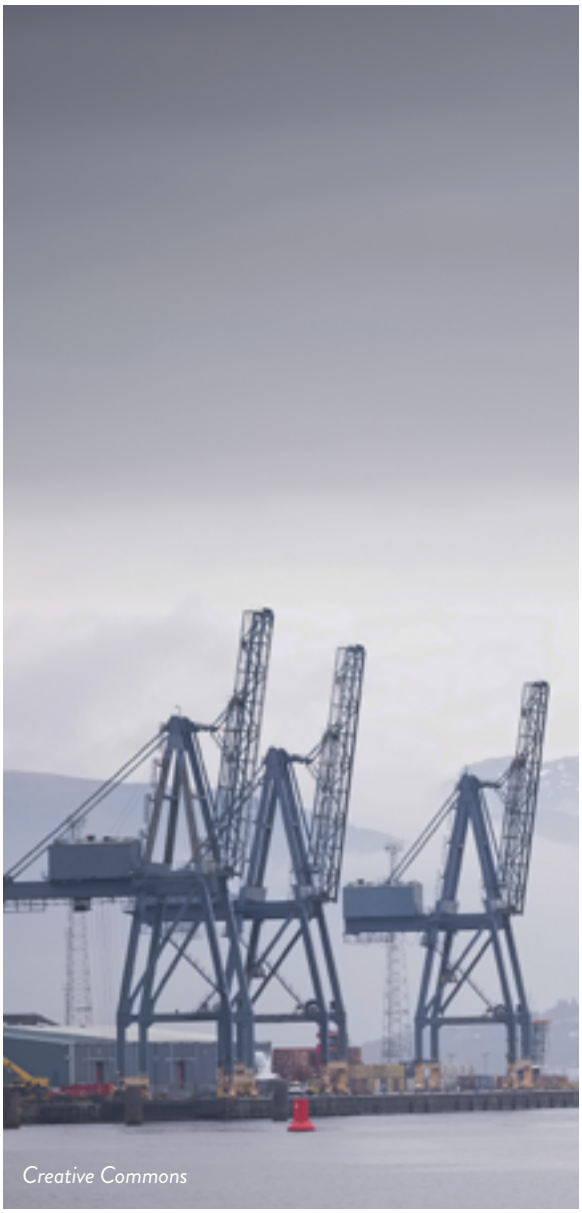
Port facilities vary widely in terms of productivity, footprint, customers, and governance.[3] Some ports are privately owned and operated, while others are managed by a government or quasi-government authority representing a city or state.[4] The owner of a port may lease space or infrastructure to a tenant, most commonly a terminal operator. Terminal operators are responsible for maintaining equipment and buildings, but typically partner with a public agency for major capital projects.[5] The varied ownership structures contribute to the uniqueness of each port — the industry saying goes, "once you've seen one port, you've seen one port."

CAPACITY & CONDITION

Port infrastructure includes docks, piers, channel harbors, and more. In general, the conditions from terminal to terminal within a port vary. However, all ports are challenged to maintain their infrastructure in harsh marine environments. Corrosion from saltwater and de-icing salts, constant wet and dry cycles, temperature variations, and more accelerate the rate of decline of everything from cranes to wharfs.[6] Port owners are tasked with monitoring the structural integrity of their infrastructure in these harsh environments.

Many ports can trace their origins back a century or more, and all owners are pressed to continue to modernize their infrastructure. Seaports, for example, are consistently expanded to accommodate larger container ships. Vessel capacity at container ports is measured in TEUs, or "twenty-foot equivalents," which equals one 20-foot container. Maximum vessel capacity has doubled in size over the last 15 years, from 10,000 TEUs in 2005 to almost 20,000 TEUs today.[7] As vessels have increased in size, port infrastructure — including berths, cranes, and channel depths — have required investment to keep pace. Today, a growing number of shallow water ports are dredged to a channel depth of 45 feet or more, which is necessary for accommodating post-Panamax ships that are now able to traverse an expanded Panama Canal.[8]

Other retrofits and modernizations are needed to accommodate larger ships, including larger cranes. According to the U.S. Department of Transportation's (DOT) Bureau of Transportation Statistics (BTS), in 2019 the top 25 container ports operated a total of 504



CRANES AT PORT OF GALVESTON IN TEXAS

Many ports can trace their origins back a century or more, and all owners are pressed to continue to modernize their infrastructure.

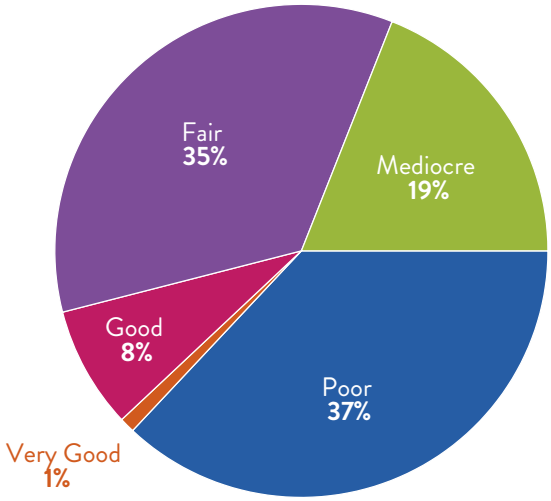
ship-to-shore gantry cranes, and nearly 50%, or 235, were classified as super post-Panamax, or cranes large enough to load and unload super post-Panamax ships.[9]

In general, ports are expanding and adding capacity across the country. BTS reports the total tonnage handled at the top 25 ports in the country grew by 4.4% from 2015 to 2019.[10] This growth is reflective of an industry that is investing in its capacity and growing its ability to accommodate larger volumes.

While most ports are adding capacity to address growing freight volumes, their success is contingent on the capacity of, and ease of access to, other modes of transportation such as roads and rail. On-dock rail allows for containers to be loaded directly onto rail lines that are adjacent to port terminals. According to BTS, a total of 44 out of the 88 active container terminals at major U.S. ports had on-dock rail access in 2019. All major ports either have on-dock rail or are located nearby to rail facilities.[11]

Intermodal connectors are the portions of roadways that link our National Highway System to ports and other modes. These segments are traditionally underfunded, as historically they have not fit neatly into existing funding programs. A 2017 Federal Highway Administration (FHWA) report collected pavement condition readings from the 798 designated freight intermodal connectors and found that 37% of pavement condition was rated as poor. These segments also contend with congestion; FHWA specifically identifies port connectors as having some of the worst congestion, with a 14% speed drop between free-flow conditions and slowest daytime conditions.[12]

Figure 1. Intermodal Connector Pavement Condition



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FUNDING & FUTURE NEED

Funding for port infrastructure is derived from a variety of sources, including federal, state, and local funding, as well as private sector revenue streams. Waterside infrastructure needs, namely for dredging, are paid for through the federal Harbor Maintenance Trust Fund (HMTF). The HMTF collects its revenue through a 0.125% user fee on the value of the cargo in imported containers, which equates to approximately $15 per container box. Ports, particularly on the East and Gulf coasts, have significant dredging needs, but the fund's balance has traditionally been used to pay for things other than port needs, its designated purpose.

For the first time, in Fiscal Year (FY) 2019, total Harbor Maintenance Trust Fund appropriations met the level of new receipts and interest. The subsequent CARES Act codified the requirement that the money coming in must be spent on dredging, as intended by the original creation of the Harbor Maintenance Trust Fund. The 2020 Water Resources Development Act took this a step further, allowing for the use of the unspent balance of $9.3 billion dollars in the HMTF by 2030.[13]

Landside federal funding is typically provided through grants. The U.S. DOT's Better Utilizing Investments to Leverage Development (BUILD) Transportation

Discretionary Grant program allows for federal multimodal investment opportunities. The BUILD program and its predecessor (Transportation Investment Generating Economic Recovery, or TIGER) provide an average of 12% of available funding each round to port projects, or roughly $1 billion over the past 11 cycles.[14]

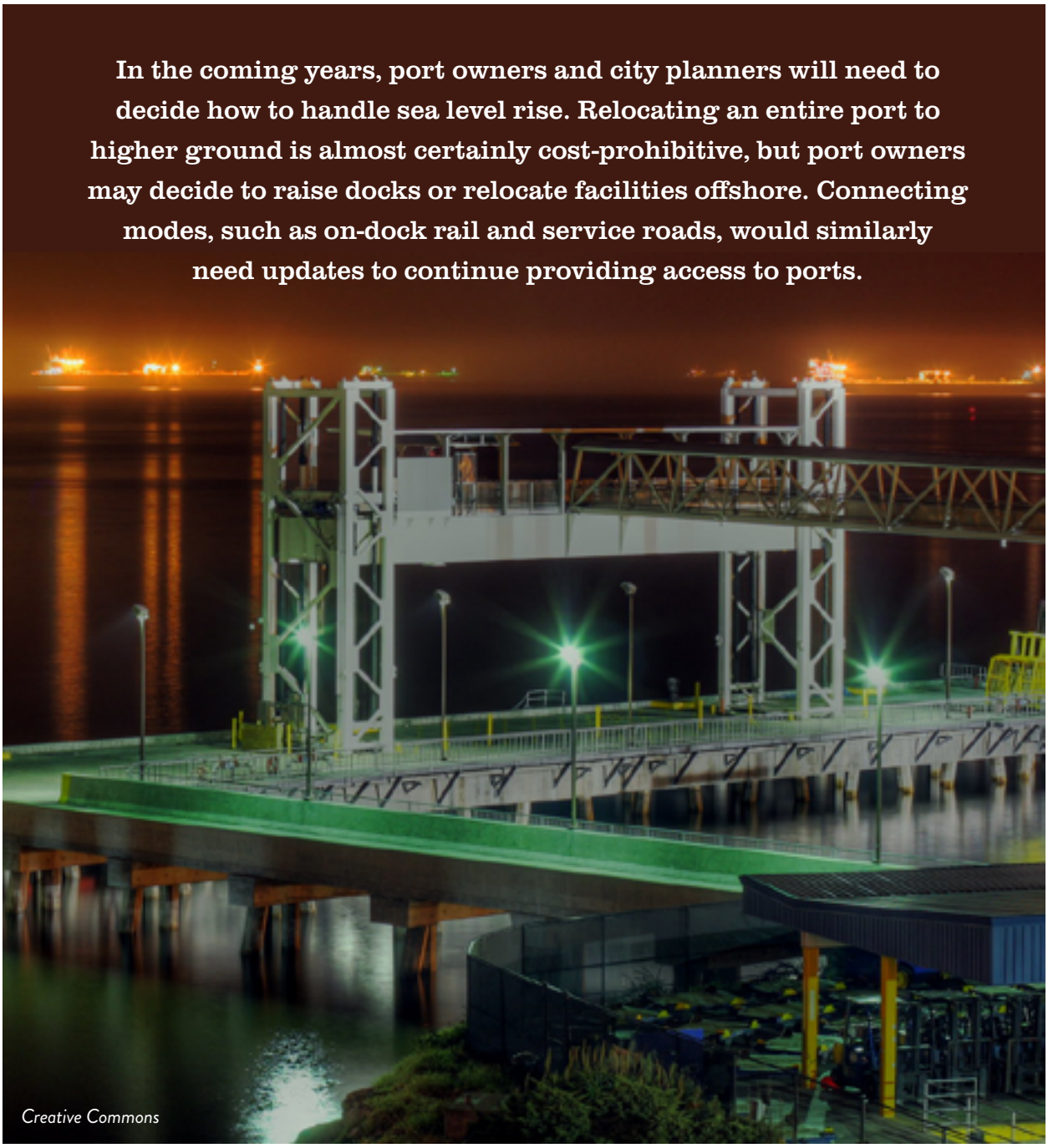
A newer program is the FAST Act's Nationally Significant Freight and Highway Projects program, renamed INFRA in 2017. INFRA is designed for large highway freight projects, but up to $500 million can be spent on multimodal projects, including those located inside a port gate. So far, 16% of available INFRA dollars have been awarded to port projects, or roughly $358 million.[15] Both INFRA and the BUILD program are oversubscribed, with approximately $10 or more of requests for every $1 available for award.[16]

Additionally, federal funding is now available through the U.S. DOT Maritime Administration's Port Infrastructure Development Program (PIDP). PIDP was authorized in the FY2010 National Defense Authorization Act but was not appropriated money until FY2019. Congress' FY2019 appropriations bill provided $287 for PIDP, and $221 million was available the following year.[17] [18] It should be noted that most PIDP funding is reserved for coastal seaports or Great Lake ports, meaning inland ports receive a much smaller amount of funding.

Some states have dedicated funding for ports, including Florida, Minnesota, Missouri, Virginia, and others.[19] [20] [21] [22] Additionally, ports — especially those located inland — have a diversified revenue stream that can include housing, urban development, and more.

In general, ports continue to invest in their own infrastructure. A survey conducted by the American Association of Port Authorities (AAPA) reports that ports and port tenants plan to spend $163 billion between 2021 and 2025, up from the forecasted $154.8 billion in the 2016-2020 AAPA study. Many ports have successfully leveraged the modest increases in available public funding to make more efficient and innovative investments in capacity and condition projects.[23] It should be noted that forecasted capital spending over the next four years is contingent on an economic recovery and the continued availability of federal and state funding.

ASCE's 2021 Failure to Act economic study looks at available funding compared to needs for navigational-related improvements, including dredging and lock and dam repair. The report shows that unmet waterside infrastructure needs at coastal ports will be $12.3 billion over the next 10 years.[24] Importantly, ASCE's infrastructure gap estimate does not consider landside investments. In 2018, AAPA's U.S. member ports identified $32.03 billion for landside needs.[25] Inland river ports and terminals also have significant needs that are not reflected in the AAPA estimate.



In the coming years, port owners and city planners will need to decide how to handle sea level rise. Relocating an entire port to higher ground is almost certainly cost-prohibitive, but port owners may decide to raise docks or relocate facilities offshore. Connecting modes, such as on-dock rail and service roads, would similarly need updates to continue providing access to ports.

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OPERATIONS & MAINTENANCE

The USDOT Strategic Plan identifies lifecycle and preventive maintenance as a strategic objective to keep the nation's infrastructure in a state of good repair. To implement this strategic objective, the Maritime Administration initiated an internal review in 2017 and found that ongoing planning frequently fails to target state-of-good-repair projects and could be better at considering resiliency to threats like weather and earthquakes. The Maritime Administration subsequently instituted a risk-based asset management program and is encouraging port owners and operators to utilize the risk rating and scoring systems created by the agency.[26]

PUBLIC SAFETY & RESILIENCE

Ports have a key role to play in helping a community recover from a natural or manmade disaster. Goods can be transported via oceans and inland waterways to communities in need when other trade routes are blocked. Similarly, berths can accommodate emergency vessels and personnel, as was observed in 2020 when the 1,000-bed hospital ship *USNS Comfort* docked at Port 90 in Manhattan to serve patients during the COVID-19 crisis.[27] Ports are also able to support force deployment in the instance homeland protection is needed. Nine federal agencies, including the U.S. Army, U.S. Army Corps of Engineers, and the Maritime Administration work together to ensure preparedness for national defense emergencies.[28]

In the coming years, port owners and city planners will need to decide how to handle sea level rise. Relocating an entire port to higher ground is almost certainly cost-prohibitive, but port owners may decide to raise docks or relocate facilities offshore. Connecting modes, such as on-dock rail and service roads, would similarly need updates to continue providing access to ports. Some limited investments are being made today to head off potential complications of sea level rise. The Port of Virginia, for example, is spending $375 million to raise their power stations several feet off the ground and position their data servers as far inland as possible.[29]

Photo courtesy of Illinois Ports Association

SENECA REGIONAL PORT ON THE ILLINOIS RIVER

INNOVATION

In the U.S., the Ports of Long Beach and Los Angeles each have one fully automated terminal. Three semi-automated terminals can be found in Virginia and New Jersey.[30] Automation stands to add throughput capacity and provide safety benefits.[31]

Advanced analytics, such as blockchain, use existing and historic data collected with devices and sensors, through open-sourced platforms can improve efficiencies at ports. Such benefits are already being realized abroad.[32] Advanced analytics also aid ports in becoming more resilient as predictive approaches driven by machine learning ensure flexible, responsive, and adaptive management amid highly complex and dynamic scenarios.

Ports

RECOMMENDATIONS TO RAISE THE GRADE

- Remove the multimodal cap on INFRA funds and increase overall investment in the INFRA and BUILD programs to ensure ports can effectively distribute and receive goods as ships continue to grow in size.
- Appropriate funds to the Congressionally authorized projects to ensure that projects crucial to freight movement are completed in a timely manner.
- Adopt new technologies to reduce wait times at docks, boost efficiency, improve resilience, and increase security.
- Improve freight and landside connections to strengthen the entire freight system and reduce congestion that is costly to the economy when moving goods.
- Ensure that ports are a part of comprehensive disaster planning. Ports play a critical role in the aftermath of a disaster, facilitating the movement of people and the delivery of supplies. Integrating ports into a holistic disaster recovery plan — one that is developed with all stakeholders and is based on the data and data sharing — is vital to ensuring a community can quickly recover.
- Port owners and operators should utilize asset management to prioritize limited funding and pinpoint needed repairs.
- Ensure smaller ports can compete in existing and new competitive grant programs.
- Spend down the balance of the Harbor Maintenance Trust Fund on port projects.

Ports

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Public Parks

D+

Photo courtesy of the National Parks Service

EXECUTIVE SUMMARY

Americans spend a lot of time in their parks, visiting local parks and recreational facilities more than twice a month on average.[1] In 2017, people spent $887 billion on outdoor recreation, directly supporting 7.6 million jobs. There are about 10 acres of public park land per 1,000 residents.[2] Despite their increased popularity, investment in parks is lagging, resulting in deteriorating bridges, trails, parking areas, drinking water systems, and more. State parks and local parks face a $5.6 billion[3] and $60 billion deferred maintenance backlog, respectively. While the National Park Service's deferred maintenance backlog grew over 9% in the last decade with more than half of their assets in need of repair, federal funding for parks is set to increase with passage of the Great American Outdoors Act of 2020. Meanwhile, limited space in urban areas is causing local governments, utilities, and nonprofits to be more creative by building parks projects that provide mutually beneficial functions, such as public access spaces that also serve as flood control.

INTRODUCTION

Parks support economic prosperity and build thriving, healthy, resilient communities. Besides providing recreational opportunities and green space for all ages, parks provide a suite of ancillary benefits such as higher property values, protection and improvements to drinking water sources, fewer urban heat islands, and stormwater management.[4]

Our nation's public parks are owned and operated by a variety of government entities, including federal agencies, such as the National Park Service (NPS) and the U.S. Army Corps of Engineers (USACE), as well as states, regional authorities, counties, and local entities.

CONDITION & CAPACITY

The National Park Service (NPS), which manages 419 parks, covering over 85 million acres nationwide, hosted over 327 million visitors in 2019. The popularity of parks is growing, with national parks visits 13% higher now than a decade ago. There are more than 8,500 state parks nationwide that hosted 807 million visitors in 2017– nearly twice as many visits as to federal parks and forests combined.[5] There are about 10 acres of public park land per 1,000 residents, and the typical park and recreation agency has about eight full time employees for each 10,000 residents.[6]

The NPS manages more than 75,000 constructed assets, and more than half of them need repair. The agency currently reports $11.92 billion of deferred maintenance, including $6.15 billion in bridges, tunnels, and paved parking areas and roadways, and $5.77 billion in wastewater and drinking water systems, dams, utility systems, and other non-surface transportation projects.[7] Over the past decade, deteriorating facilities, an increased number of assets, and resource constraints resulted in a 9% growth in the deferred maintenance backlog.[8] State parks, meanwhile, have well over $5.6 billion in deferred maintenance backlogs, with the average state park facing $143.7 million of deferred maintenance. On average, state parks rated both the condition of their roads and their water infrastructure a "5" (with 1 being the lowest

and 10 being the highest).[9] Local parks nationwide have an estimated $60 billion deferred maintenance backlog.

Parks generate economic value in addition to providing recreational benefits. In 2019, 327 million visitors to national parks resulted in $41.7 billion in benefits to the nation's economy and supported 340,500 jobs nationwide. Visitors spent $21 billion in 2019, which contributed to more than 278,000 jobs in park gateway communities, or those within 60 miles of an NPS unit.[10] This is an increase from 2018, when 318.2 million visitors contributed $40.1 billion in national economic output and spent an estimated $20.2 billion in local gateway regions. In the last five years, NPS visitor spending has increased by $4.1 billion, and the effect on the U.S. economy grew by $9.7 billion.

The U.S. Army Corps of Engineers (USACE) manages many outdoor recreation areas but trails the NPS in total number of visitors, hosting almost 270 million visits per year among their more than 402 lake and river properties in 43 states. Over 90% of USACE recreation areas are located within 50 miles of a major metropolitan center. Visitors to USACE recreation areas in 2016 spent $10.6 billion, supporting about 189,000 jobs nationwide.[11]

Americans, on average, visit their local park and recreation facilities more than twice a month. In 2017, America's local park and recreation agencies generated $166.4 billion in economic activity and supported more than 1.1 million jobs,[12] compared to $154 billion in economic activity in 2015.[13]

Photo courtesy of the National Park Service

THE GRAND CANYON

Local jurisdictions and Americans alike are increasingly rethinking what makes a park. Many local park and recreation agencies are consolidating or partnering with other governmental agencies, private companies, and/or nonprofit organizations to provide a range of services, including intergenerational programs, playgrounds, walking loops, dog parks, music or movie events, and child and afterschool care, many of which can be incorporated into existing parks facilities.[14]

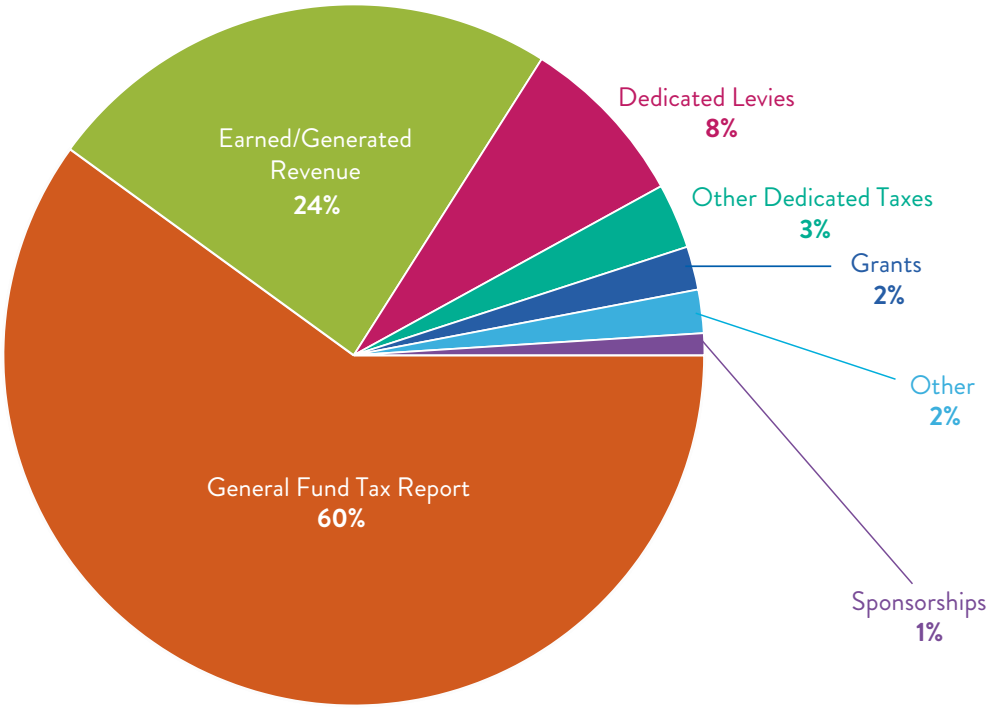
OPERATIONS & MAINTENANCE, FUNDING, AND FUTURE NEED

Despite the increasing popularity of parks, investment is lagging, resulting in deferred maintenance backlogs and deteriorated parks facilities nationwide. However, 4 in 5 Americans believe their local parks are well worth the average $70 per person paid annually in local taxes for their upkeep, with more than 30% of Americans believing parks are worth more. An overwhelming 91% of Americans agree that parks and recreation is an important service provided by local governments.[15]

Within the NPS, road and bridge improvements are partly funded by mandatory allocations from the U.S. Department of Transportation and fee collections. Additionally, the NPS also collaborates with states to submit joint applications for U.S. Department of Transportation grants. The remainder of repair, rehabilitation, and operations and maintenance funding comes from discretionary annual appropriations. In FY2020, the NPS received $572 million in discretionary funding and $510 million in mandatory funding for its deferred maintenance backlog, which is about 26% of the agency's full budget.[16] Discretionary funding for NPS deferred maintenance has increased by 52% over the last decade, but these accounts also cover other maintenance activities outside of deferred maintenance.[17] Even with the increased funding, assets are rapidly deteriorating, and there remains a large gap between what the NPS needs and what they receive in annual funding.

Typical local park and recreation agencies receive 60% of their funding from general fund tax support. Because the general fund is not dedicated to funding only parks, the amount of money allocated each year is often inconsistent. Meanwhile, typical local park and recreation agencies dedicate 44% of their operating budget to maintenance.[18] Inconsistent, uncertain funding makes capital planning for parks difficult.

Sources of Operating Expenditures



Source: National Recreation and Parks Association, "2020 NPRA Agency Performance Review"

Over the past decade, state parks' operating expenditures have steadily decreased, falling from more than $3 billion in 2008 to about $2.5 billion in 2019.[19] State parks generate an average of 45% of their own funding through user fees, while the remainder comes from the states' general funds and a mix of dedicated funds and federal funds.

The Land and Water Conservation Fund (LWCF) is a critical source of funding for the protection of natural resources, the preservation of water quantity and quality, the development of outdoor recreation projects, and increased recreation accessibility for all Americans.[20] More than 98% of the nation's counties have a park project that has been funded by the LWCF.[21] The LWCF is funded with revenues generated through offshore oil and gas energy development; for every $1 invested, a yield of $4 in economic value is realized. The LWCF is authorized at $900 million a year; less than half of the $40.9 billion in total revenues that have accrued in the LWCF have been appropriated, leaving a balance of approximately $22 billion.

In 2020, the bipartisan Great American Outdoors Act was enacted into law, which creates a National Parks and Public Land Legacy Restoration Fund and directs up to $9.5 billion over five years in unobligated federal mineral revenues — such as royalties from on and offshore oil & gas and renewable energy development on public lands — to address the deferred maintenance backlog at the NPS and other federal agencies with public lands. The law also permanently and fully funds the LWCF and ensures its funds are used for its intended purpose. It is estimated that fully addressing the NPS deferred maintenance backlog would create or support 108,364 jobs.[22]

RESILIENCE AND PUBLIC SAFETY

As the frequency of extreme weather events increases, so does the need to reduce combined sewer overflows (CSOs). CSOs discharge untreated wastewater and stormwater, often containing agricultural runoff and toxic substances, directly into nearby bodies of water. While the primary way to deal with combined sewers is the separation of storm and sanitary sewers, the use of parks as raingardens is an innovative way to manage stormwater sustainably. These green infrastructure systems use the natural environment to manage stormwater and provide a diverse range of ancillary benefits such as aesthetic value to communities; increasing property values by up to 20%; filtering rain which reduces water pollution and protects drinking water sources; providing up to $3.8 billion in air pollution savings; and keeping cities cooler by reducing the heat island effect.[23] Green infrastructure being implemented in parks across the nation is also becoming more cost competitive with gray forms of infrastructure in certain contexts.

Over the past decade, state parks' operating expenditures have steadily decreased, falling from more than $3 billion in 2008 to about $2.5 billion in 2019. State parks generate an average of 45% of their own funding through user fees, while the remainder comes from the states' general funds and a mix of dedicated funds and federal funds.

Green and open spaces, including floodplains, floodways, and estuaries, are being more fully embraced as part of a total parks programs. Efforts are being made, especially in areas of repeated flooding, to return those areas to their original uninhabited state so that they can not only act as buffers between bodies of water and inhabited areas, but provide wildlife habitat. In this way, our parks can contribute greatly to the sustainability of communities and mitigate the effects of climate change.

BERKELEY ISLAND PARK IN OCEAN COUNTY, NEW JERSEY

People use parks for a wide range of purposes, and they expect that regardless of what activity they may engage in, they are protected from crime and that help will come in the case of natural disaster. For example, the wildfires of 2020 greatly impacted public lands in the western states. During the crisis, federal and state agencies worked collaboratively to rescue campers and preemptively close facilities to protect the public. A dramatic example of this was the National Guard airlift of 150 people from a U.S. National Forest Service campground that was cut off by fire.[24]

INNOVATION

Parks are increasingly being used for multiple functions, from recreation to green stormwater management, to transformation into lifelong learning centers used for arts, culture, education, events, conferences, retreats, and other similar programs. State and local parks are partnering with other agencies, nonprofit organizations, and private entities to find innovative ways to make these green spaces accessible and desirable to every member of the community.

Some state parks are working with innovative Geographic Information System (GIS) mapping technology to efficiently track all projects underway within the park system, including park, facility, and infrastructure needs. These GIS databases assist with asset management and task and revenue tracking, and they provide information for data-driven decision-making on future development and infrastructure repairs based on important metrics like return of investment and infrastructure age.

Many states have implemented innovative funding mechanisms for their parks. For example, some states have dedicated sources of funding for recreation such as a portion of lottery proceeds, redirecting sales taxes on sporting goods, or dipping into real estate tax revenues. These funding tools have had varying levels of success. However, revenues from federal excise taxes on shooting, hunting, fishing, and boating equipment provided more than $1.1 billion to states in 2018.[25]

Meanwhile, the NPS is engaged in partnerships where outside organizations assume some asset maintenance responsibilities or where the NPS leases assets to other parties in exchange for the lessee rehabilitating or maintaining the asset. Many NPS units also engage volunteer groups to perform maintenance duties; it's estimated that if the NPS could increase its number of volunteers to 600,000 by 2028, it would result in 40 million hours of volunteer labor valued at $802.6 million over a 10-year period.[26]

SHIRLEY CHISHOLM STATE PARK IN BROOKLYN, NEW YORK

Public Parks

D+

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the Great American Outdoors Act, which creates a dedicated fund to address the National Park Service's deferred maintenance backlog of nearly $12 billion and permanently and fully funds the Land and Water Conservation Fund.
- Enact legislation to permit agencies, including the U.S. Army Corps of Engineers, to retain user fees in the park system in which they were collected for use at its facilities, for parks and recreation uses.
- Mainstream the utility of GIS and other technologies to assist with asset management and to enhance user experience at parks.
- Promote the benefits of multiple-use parks that increase the community's resilience, such as rain gardens, which reduce stormwater pollution and protect drinking water sources.
- Encourage local, state, and federal public parks to partner with other government agencies and outside entities — private companies, nonprofit organizations, and volunteer groups — to assist with asset maintenance and to develop multiple uses for the park that maximize their use and benefit for the community.
- Strive to make all parks facilities and programs accessible to everyone by making the parks walkable, making public transit accessible, and making the parks accommodating to those of all ages, incomes, abilities, and community-specific needs.
- Ensure that parks facilities and programs are maintained and located across all parts of communities by eliminating "parks deserts."

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Rail

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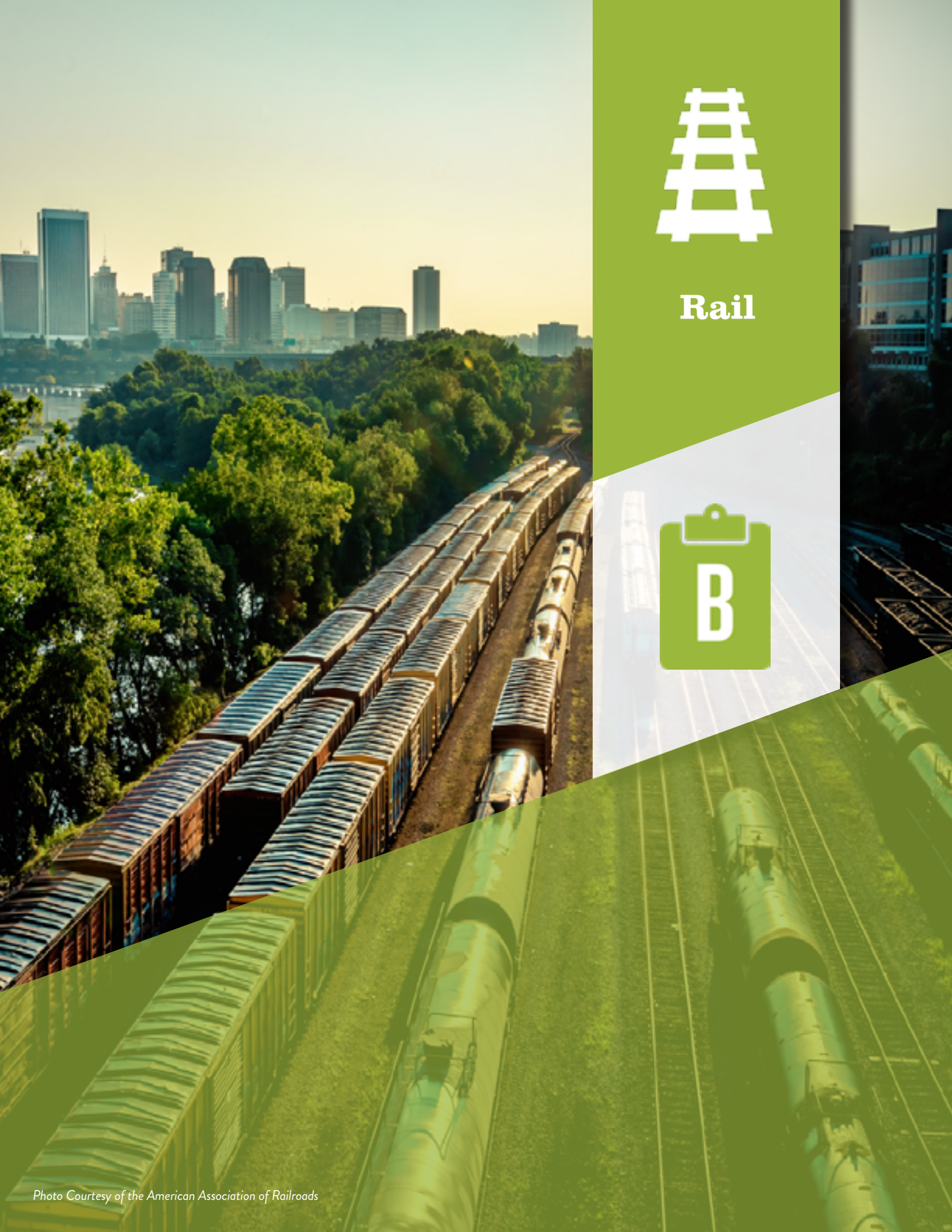


Photo Courtesy of the American Association of Railroads

EXECUTIVE SUMMARY

Our nation's rail network is divided into two categories: freight rail and passenger rail. Approximately 140,000 rail miles are operated by freight's Class I, II, and III railroads. Amtrak operates over a 21,400-mile network, 70% of which is owned by other railroads, also known as host track. Despite freight and passenger rail being part of an integrated system, there remain stark differences in the challenges faced by the two rail categories. While freight maintains a strong network largely through direct shipper fees — investing on average over $260,000 per mile — passenger rail requires government investment and has been plagued by a lack of federal support, leading to a current state of good repair backlog at $45.2 billion. Along our nation's busiest passenger rail corridor, the Northeast Corridor, infrastructure-related issues caused 328,000 train-delay minutes, or the equivalent of roughly 700 Northeast Regional train trips from Boston, Massachusetts, to Washington, D.C.

CONDITION & CAPACITY

Approximately 140,000 rail miles are operated by Class I, II, and III freight railroads.[1] Amtrak, the national intercity passenger carrier, operates over a 21,400-mile network. Approximately 70% of the 21,400 miles traveled by Amtrak trains are over tracks owned by other railroads.[2]

Freight Rail

Freight rail is divided into three classifications based on yearly earnings and service distance.[3]

Freight Rail Classification	Number of Lines	Operating Revenues
Class I	7	At least $490 million[4]
Class II	22	Between $39.1 and $489.9 million
Class III	584	$39.1 million or less

Photo courtesy of Amtrak

According to the American Association of Railroads, from 2017 to 2019, Class I capital expenditures — including track, structures, and equipment — totaled $38.3 billion over 198,554 operating track miles. Included below is the latest operating data from the top four Class I railroads:[5]

Top 4 Class I Railroads	Road Operating Miles	Billions of Revenue Ton-Miles	Operating Revenue
BNSF Railroad	32,445	702	$23.4 Billion
Union Pacific (UP)	32,236	474	$22.8 Billion
CSX Transportation	20,602	209	$11.9 Billion
Norfolk Southern (NS)	19,420	207	$11.4 Billion

Class II and III serve in partnerships with Class I railroads to provide first and last mile service and delivery. Short line and regional railroads (Classes II and III) in 2017 operated in 49 states over 47,500 miles of track, or 29% of the national rail network. The short line industry reports a $10 billion shortfall for state of good repair projects needed to retain strong connection to the Class I network.[6]

According to the U.S. Department of Transportation's (DOT) Bureau of Transportation Statistics (BTS), in 2018 there was a total of 1.7 million ton-miles per day transported on our nation's freight rail network, an increase of over 100,000 ton-miles from the previous year and an increase of nearly 400,000 over the past 20 years.[7] Goods moved on the nation's freight network are projected to grow from 1.40 billion tons in 2018 to 1.58 billion tons in 2045.[8]

Between 2017 and 2019, total U.S. carload traffic decreased from 13.4 million to just under 13.0 million carloads.[9][10] This decline is largely associated with reduced coal and mineral/ore shipments and was expected to continue through 2020, reflecting the downturn in the economy associated with the coronavirus pandemic.

Passenger Rail

In 2019, Amtrak's network carried 32.5 million riders to more than 500 destinations across 46 states and the District of Columbia. This translates to a daily average of nearly 89,100 trips on more than 300 Amtrak trains. Passenger travel operates on both privately and publicly owned railroads. Host railroads include 93% freight railroads, with the remainder owned by commuter railroads, commuter authorities, and municipalities.

Amtrak service is provided along the Northeast Corridor (NEC) between Washington, D.C., and Boston and on the national network incorporating state-supported and long-distance services. State-supported service is provided on 28 routes less than 750 miles in length, and long-distance service is provided on 15 routes. Between 2017 and 2019, Amtrak spent $713 million on state-of-good-repair projects. Infrastructure maintenance and replacement is provided to Amtrak by host railroads, but the Amtrak-owned NEC has unique infrastructure.[11][12]

In 2019, Amtrak's network carried 32.5 million riders to more than 500 destinations across 46 states and the District of Columbia. This translates to a daily average of nearly 89,100 trips on more than 300 Amtrak trains.

The NEC is largely owned by Amtrak and is the busiest railroad segment in the passenger rail system, providing 18.8 million trips to 12.5 million riders in 2019. The NEC is shared with eight commuter railroads (MBTA, CTrail, Long Island Rail Road, Metro-North Railroad, NJ TRANSIT, SEPTA, MARC, and VRE) who financially support operating and capital costs.[13] The NEC is at capacity and has a current state-of-good-repair backlog of $45.2 billion. Infrastructure-related issues continued to be the largest source of delay on the corridor in 2019, causing 328,000 train-delay minutes.[14] [15]

The Northeast Corridor Commission, comprised of eight states (Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland) and the District of Columbia, was established by Congress to determine the funding needs of the NEC that would be shared between the commuter railroads and Amtrak. The current NEC Commission report for investment needs for FY2020-24, has identified a $32.2 billion funding requirement, with $18 billion available, $7.6 billion being requested through existing federal grant programs, and $6.6 billion currently unfunded.[16]

FUNDING, FUTURE NEED, AND OPERATION & MAINTENANCE

Freight Rail

Over the last 40 years, private railroads have spent over $700 billion to develop the current network; this includes $24.9 billion in 2018 at an average of over $260,000 per mile. Freight railroads determine their project priorities under two categories: mission-critical projects and potentially funded/optional projects. Mission-critical projects include scheduled maintenance and unscheduled repairs. Potentially funded or optional projects include those that reduce bottlenecking, line extensions, information technology solutions, and related capital investments. Private railroads reinvest close to 20% of their operating revenue into infrastructure, and in 2017, $11.5 billion was budgeted for capital expenditures by Class I railroads. Freight railroads use their revenues to cover both operating costs and capital investments.[17] [18]

Class II and III railroads reinvest an average of 25% to 33% of annual revenues in capital expenditures and maintenance-of-way costs. Despite this investment, funding for capital projects is very challenging. A federal tax credit provides $0.50 on every dollar spent up to $3,500 per mile on track and bridge improvements. This has resulted in approximately $4 billion in investment since it was enacted in 2005.[19]

Passenger Rail

In addition to passenger revenues and state funding, Amtrak relies on federal grants to operate, maintain, and invest in capital programs for intercity passenger rail. Under the Fixing America's Surface Transportation (FAST) Act, Amtrak is authorized from fiscal year (FY) 2016 through FY2020 a total of $8.1 billion in federal grants, though Congress provided additional funding to support Amtrak over the course of the 5 year bill.

Fiscal Year (FY)	Annual Appropriation	NEC	National Network	Net Financing Cash Flows
2016	$1.4 Billion	$400 Million	$1.0 Billion	$1.8 Billion
2017	$1.5 Billion	$328 Million	$1.2 Billion	$2.3 Billion
2018	$1.9 Billion	$650 Million	$1.3 Billion	$2.2 Billion
2019	$1.9 Billion	$650 Million	$1.3 Billion	$2.5 Billion
2020	$2.0 Billion	$700 Million	$1.3 Billion	TBD

Photo Courtesy of the American Association of Railroads

Amtrak also receives funding from state agencies. In FY2019, 18 states provided financial support, totaling $234.2 million, an increase by $0.4 million from the previous year.[20] Additionally, Amtrak received $1 billion in direct aid through the CARES Act, with $492 million directed toward the NEC and $526 million toward the national network. In a recent round of COVID-19 relief (H.R. 133), Amtrak received an additional $1 billion, with the NEC receiving $655 million and $345 million directed toward the national network. It is important to note that prior to the pandemic, Amtrak was projected to require no federal funding support to cover operating costs in FY2020.

PUBLIC SAFETY

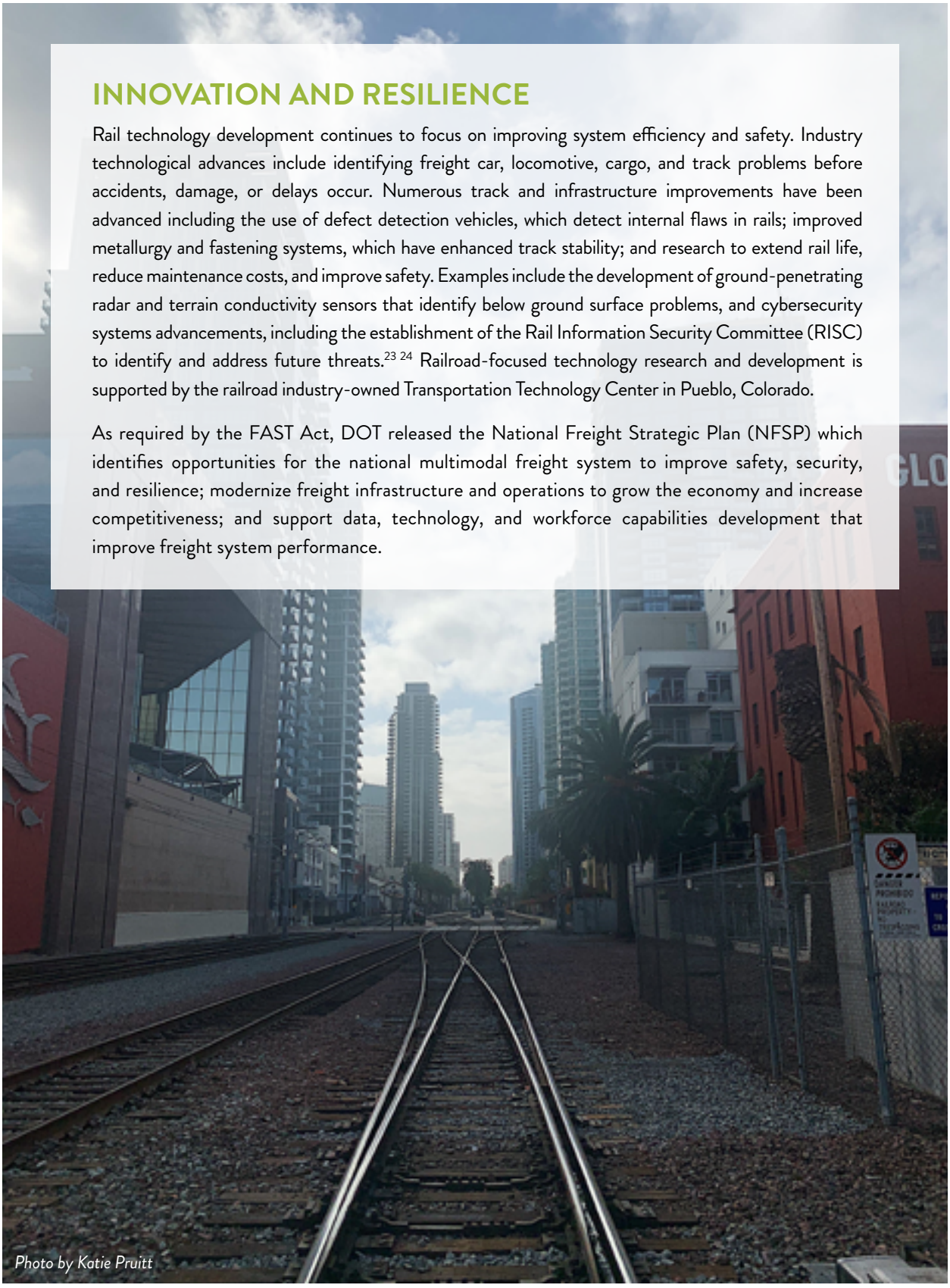
In 2019, DOT's Federal Railroad Administration (FRA) reported a total of 11,667 accidents/incidents, a slight increase from 11,247 incidents 10 years ago. Trespassing on railroad rights-of-ways remains the leading cause of rail-related fatalities, growing from 505 in 2017 to 577 in 2019, or 64% of total U.S. rail-related fatalities that year. Collisions at highway-rail grade crossings are the second leading cause of rail-related fatalities, making up approximately 30% of total fatalities. Grade crossing collisions declined in 2018 and 2019 from 2,230 to 2,216, respectively.[21]

Through the implementation of Positive Train Control (PTC), both freight and passenger rail have used technology designed to automatically stop a train before certain accidents associated with human error can occur.[22] In 2020, Amtrak completed PTC installation on all of its owned or controlled track miles. Amtrak spent $265.7 million and $222.9 million in 2018 and 2019 respectively for PTC-related projects on their owned/controlled rail lines and equipment. In December 2020, FRA announced that PTC technology is in full operation on all required freight and passenger railroad route miles.

INNOVATION AND RESILIENCE

Rail technology development continues to focus on improving system efficiency and safety. Industry technological advances include identifying freight car, locomotive, cargo, and track problems before accidents, damage, or delays occur. Numerous track and infrastructure improvements have been advanced including the use of defect detection vehicles, which detect internal flaws in rails; improved metallurgy and fastening systems, which have enhanced track stability; and research to extend rail life, reduce maintenance costs, and improve safety. Examples include the development of ground-penetrating radar and terrain conductivity sensors that identify below ground surface problems, and cybersecurity systems advancements, including the establishment of the Rail Information Security Committee (RISC) to identify and address future threats.[23] [24] Railroad-focused technology research and development is supported by the railroad industry-owned Transportation Technology Center in Pueblo, Colorado.

As required by the FAST Act, DOT released the National Freight Strategic Plan (NFSP) which identifies opportunities for the national multimodal freight system to improve safety, security, and resilience; modernize freight infrastructure and operations to grow the economy and increase competitiveness; and support data, technology, and workforce capabilities development that improve freight system performance.



AMTRAK'S PACIFIC SURFLINER ROUTE IN SAN DIEGO, CALIFORNIA

Rail

RECOMMENDATIONS TO RAISE THE GRADE

- Support concepts in the National Freight Strategic Plan (NFSP) that would improve the multimodal freight network, enhance safety, provide for capacity improvements, and improve economic competitiveness. As part of implementing the NFSP, a robust National Asset Management system should be created to support the identification, prioritization, and sourcing of funding for capital investment projects.
- Continue a financial and regulatory environment that supports private rail investment and innovative financing options for future investment. This includes maintaining the now permanent federal Railroad Track Maintenance Tax Credit and supporting existing financing programs, such as the Railroad Rehabilitation and Improvement Financing (RRIF) program and Transportation Infrastructure Finance and Innovation Act (TIFIA).
- Encourage passenger rail infrastructure investment in high-population centers, and support continued investment for state-supported routes. Continue to support rail investment in added capacity and expanded service in high-density markets to relieve system stress on other modes.
- Sustain the planning for NEC investments and acquire funding for projects identified in NEC Commission's multi-year capital investment plan.
- Fund regional freight rail investment plans, including the CREATE program, to support efficient operation and reduce delays by eliminating bottlenecks.
- For future surface transportation reauthorizations, include and fund programs that reduce hazards at railway-highway crossings.

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Roads

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Photo courtesy of Matt Hoffman

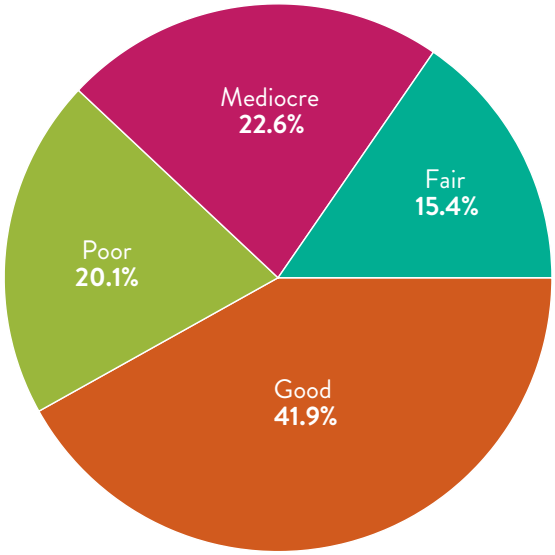
EXECUTIVE SUMMARY

America's roads are critical for moving an ever-increasing number of people and goods. However, these vital lifelines are frequently underfunded, and over 40% of the system is now in poor or mediocre condition. As the backlog of rehabilitation needs grows, motorists are forced to pay over $1,000 every year in wasted time and fuel. Additionally, while traffic fatalities have been on the decline, over 36,000 people are still dying on the nation's roads every year, and the number of pedestrian fatalities is on the rise. Federal, state, and local governments will need to prioritize strategic investments dedicated to improving and preserving roadway conditions that increase public safety on the system we have in place, as well as plan for the roadways of the future, which will need to account for connected and autonomous vehicles.

CONDITION, CAPACITY & PUBLIC SAFETY

There are over 4 million miles of public roadways in the United States carrying people and goods to their destinations every day. However, these roadways are expected to withstand an ever-increasing volume of traffic each year, with vehicle miles traveled reaching more than 3.2 trillion in 2019, an 18% increase from 2000.[1] Unfortunately, the growing wear and tear to our nation's roads has left 43%[2] of our public roadways in poor or mediocre condition, a number that has remained stagnant over the past several years. Of note, the vast majority of roads in poor and mediocre condition tend to be on urban and rural collectors and the non-interstate system, while the interstate system tends to be in good condition. Overall, our deteriorating roads are forcing the nation's motorists to spend nearly $130 billion[3] each year in extra vehicle repairs and operating costs. Even more troubling is that the number of vehicle miles traveled on roads in "poor" condition has risen from 15% to more than 17% over the last decade.[4]

Roadway Condition



Source: Data from TRIP, a National Transportation Research Nonprofit

Congestion and Reliability

In the years following the 2008 economic recession, congestion increased by 1% to 3% annually and continues to outpace population growth. In fact, 47%[5] of the nation's urban interstates are experiencing congestion during peak hours, and 30%[6] of trips taken on the nation's roads are impacted by severe or extreme congestion. Compounding the problem has been the growth of transportation network companies (TNCs) or ride-sharing services, which initial studies have shown can increase congestion in urban areas. For example, studies have shown that TNCs have accounted for 52% of vehicle delays in San Francisco alone.[7] With estimates that ridesharing trips can reach 97 million daily[8] by 2030, congestion concerns will continue to grow.

In 2017, congestion caused urban Americans to travel an extra 8.8 billion hours and purchase and extra 3.3 billion gallons of fuel.[9] This congestion costs the nation $166 billion each year, or approximately $1,080 annually in wasted time and fuel for the average auto commuter. This is additional spending to the money already spent on vehicle repair costs due to the condition of the roadways. However, as every lane-mile of road costs approximately $24,000 annually in operation and maintenance, roadway expansion can be more costly and less efficient than operational changes. In fact, in many cases, roadway expansion can lead to induced demand and further sprawl.

Our nation's highways and roads move 72%, or nearly $17 trillion,[10] of the nation's goods; therefore, consumers, industry, and the traveling public require reliable and consistent travel times.

While everyday congestion remains common in and around many U.S. cities, unexpected congestion is highly troubling for commuters and freight movement. Without consistent, reliable travel times due to irregular and unpredictable backups, it is more difficult for the public and shippers to plan their trips. Even after accounting for unexpected crashes, bad weather, special events, or other irregular congestion, the average American is spending 54 hours each year in traffic congestion, up from 42 hours in 2014.[11] If these trends continue, on average across the U.S., a 60-minute trip is expected to take 106 minutes in 2039.[12] While the Federal Highway Administration is now encouraging agencies to adopt travel time reliability measures to better manage and operate transportation systems, work still needs to be done to create a national database.

10 Most Congested Urban Areas in the U.S.

2019 Congestion Rank	Urban Area	Hours Lost In Congestion	2018-2019 Change	2017-2018 Change	Incident Impact	Cost Per Driver	Total Cost Per City	Bike	Transit	Last Mile Speed (Mph)
1 (1)	Boston, MA	149	-5%	3%		$2,250	$4.1B			12
2 (3)	Chicago, IL	145	4%	0%		$2,146	$7.6B			11
3 (5)	Philadelphia, PA	142	4%	5%		$2,102	$4.5B			10
4 (2)	New York City, NY	140	-4%	-3%		$2,072	$11B			11
5 (3)	Washington, DC	124	-11%	4%		$1,835	$4.1B			10
6 (7)	Los Angeles, CA	103	4%	-8%		$1,524	$8.2B			16
7 (6)	San Francisco, CA	97	-8%	-4%		$1,436	$3B			10
8 (9)	Portland, OR	89	10%	-7%		$1,317	$1.2B			14
9 (11)	Baltimore, MD	84	5%	9%		$1,243	$1.3B			10
10 (12)	Atlanta, GA	82	9%	-3%		$1,214	$3.0B			12

Source: Inrix 2019 Global Traffic Scorecard

TRAFFIC IN LOS ANGELES, CALIFORNIA

While traffic fatalities increased annually in the early part of the last decade, they have been declining since 2017. Unfortunately, 36,096 people died on the nation's roadways in 2019, with an increasing proportion of those fatalities suffered by non-motorists, such as pedestrians. In fact, in 2019 over 6,000 pedestrians[13] were killed, marking a 60% increase of pedestrian fatalities from 10 years prior and the highest number since 1988. Additionally, the overall fatality rate in rural areas continues to be disproportionately higher than the fatality rate on all other roadways, and it is estimated that roadway design features are likely a contributing factor in approximately one-third of traffic fatalities. Investments to widen lane, shoulder, and clearance widths, as well as introducing more center lane rumble strips, lane markings, and sidewalks are infrastructure improvements that could reduce traffic fatalities.

The National Safety Council attributes the recent decline in traffic fatalities to the implementation of several risk mitigation actions over the last several years. For example, since 2016, 10 cities have embraced Vision Zero models,

In fact, in 2019 over 6,000 pedestrians[13] were killed, marking a 60% increase of pedestrian fatalities from 10 years prior and the highest number since 1988. ... the overall fatality rate in rural areas continues to be disproportionately higher than the fatality rate on all other roadways, and it is estimated that roadway design features are likely a contributing factor in approximately one-third of traffic fatalities.

and more than 30 other cities have joined the Vision Zero Network, which is an alliance of communities committed to making streets safer by taking actions such as redesigning areas that have a history of high crashes and lowering speed limits where possible. Further action from policymakers and communities focused on reducing traffic fatalities through infrastructure, combined with vehicles that are becoming safer through advances in technologies, could reduce the severity of future crashes or prevent them altogether. In fact, some estimates have found that new technologies such as connected vehicles can cut fatal crashes by as much as 86%.[14]

FUNDING & FUTURE NEED

The U.S. has been underfunding its roadway maintenance for years, resulting in a $786 billion backlog of road and bridge capital needs. The bulk of the backlog ($435 billion) is in repairing existing roads, while $125 billion is needed for bridge repair, $120 billion for targeted system expansion, and $105 billion for targeted system enhancement (which includes safety enhancements, operational improvements, and environmental projects).[15] However, in 2017, federal, state, and local governments spent just $177 billion on roads and bridges, with an increasing focus on operations and maintenance needs.[16] As roads age and deteriorate, the most recent data estimates that over 62% of roadway spending was directed toward system preservation, a 3% increase from the Federal Highway Administration's previous reporting period.[17] Therefore over the next 20 years, the projected spending is estimated at $41 billion. However, the funding required to rehabilitate pavement and other operational conditions will average $53 billion annually. We need to increase current spending levels by a 29% to address the current and anticipated backlogs.[18]

Federal investment in roads has historically been paid for from a dedicated, user fee-funded source, the Highway Trust Fund. Unfortunately, the Highway Trust Fund has been teetering on the precipice of insolvency for nearly 15 years due to the limitations of its primary funding source,

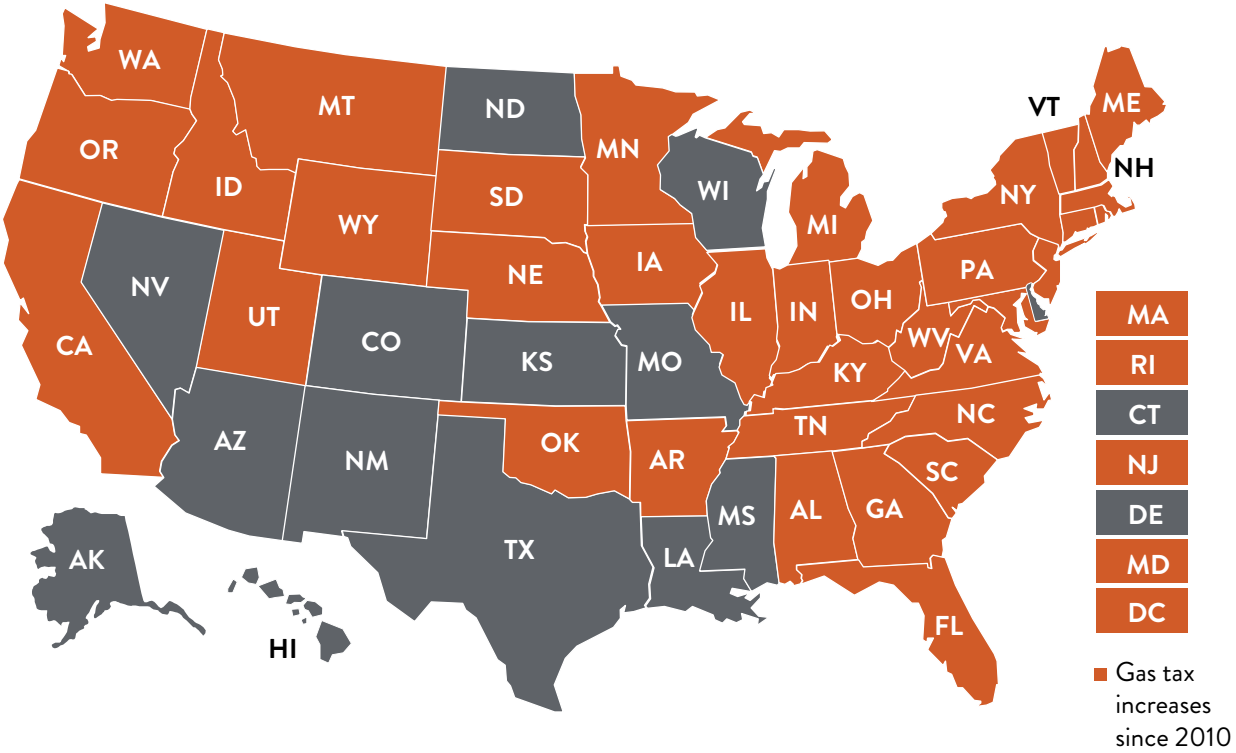
The U.S. has been underfunding its roadway maintenance for years, resulting in a $786 billion backlog of road and bridge capital needs.

the federal motor fuels tax. The tax of 18.4 cents per gallon for gasoline and 24.4 cents for diesel has not been raised since 1993, and inflation has cut its purchasing power by 40%. Additionally, new vehicle fuel economy for passenger vehicles has increased by 11 miles per gallon between 1993 and 2017, further reducing revenue. The Congressional Budget Office estimates that by 2022 the Highway Trust Fund is projected to have a $15 billion deficit as current spending levels exceed revenues from user fees that supply the fund.

Encouragingly, some state lawmakers are helping reverse losses in the federal gas tax purchasing power by making the decision to raise or reform state gas taxes. Since 2010, 37 states have raised or reformed their gas taxes either through legislative action or automatic formulas that regularly adjust the gas tax rate. Furthermore, in 2019 alone, voters in 19 states approved $9.6 billion in one-time and recurring revenue through ballot initiatives. In fact, in 2018 alone, states spent $151.8 billion on state-owned roads, up 9% from the previous year.[19]

States are also exploring other revenue sources for funding road investment, including mileage-based user fees. With continued improvements in vehicle fuel efficiency and the popularity of hybrid and electric vehicles, mileage-based user fees could present an opportunity for a long-term funding alternative to the motor fuels tax. However, while legislative and voter action has allowed some states to maintain or increase local sources of roadway funding, federal funding remains a significant portion of overall road funding. Put another way, federal partnership for roadway infrastructure is still required to maintain and modernize the system. Additionally, the COVID-19 pandemic has led to a sharp decline in vehicle miles travelled and therefore gas tax receipts in 2020, and the full impact of this revenue loss for state transportation budgets, could be as much as $37 billion over 2020 and 2021.[20]

Gas Tax Increases Since 2010



Source: Institute on Taxation and Economic Policy

INNOVATION

Timely, preventive maintenance of our roads with better materials extends the life of pavement and costs less than reconstructing pavements after they reach failure. The increased use of innovative materials to preserve and rebuild pavements that are better suited to today's vehicle loading and more resilient to environmental impacts has led to longer lasting pavements and lower life cycle costs. However, material innovations in pavements have not kept pace with other areas of infrastructure, such as bridge construction.

Advancements in technology have created opportunities for the nation's road networks. Technologies like advanced pavement monitoring, where the use of moisture and temperature sensors are embedded in the pavement, have made it possible to collect information about the condition of road pavements more quickly and with less impact on roadway users. The advent of smart pavement is opening up the possibility for features like radio-connected sensors being embedded in a road to constantly monitor and report the pavement's changing condition or to charge electric cars as they drive along, thus reducing the need for off-road recharging stops. Additionally, the use of next generation materials and decentralized traffic lights to promote traffic flow are innovative solutions for issues like congestion data collection. Meanwhile, the increased focus on how to efficiently integrate bicycle and pedestrian traffic is creating longer term congestion solutions in urban areas.

Furthermore, one of the largest technological shifts is the introduction of connected and autonomous vehicles onto the nation's roadways. While these new technologies can provide an opportunity to increase safety and

Rising temperatures are estimated to add approximately $19 billion to pavement costs each year by 2040.

Photo by Anna Denecke

mobility, reduce congestion, improve land use, and reduce our carbon footprint, if implemented incorrectly this technology could have the opposite effect and lead to extra stress on the system. With 40 states having enacted either legislation or an Executive Order related to autonomous vehicles, policies are already accounting for the deployment of these technologies on our nation's roads.

RESILIENCE AND OPERATIONS & MAINTENANCE

The increase in severe weather events is damaging key roadways that serve as community lifelines, while simultaneously increasing maintenance needs, interrupting the normal operation of the nation's roads, creating delays, and negatively impacting the economy. For example, rising temperatures are estimated to add approximately $19 billion to pavement costs each year by 2040.[21] Therefore, engineers are increasingly incorporating the resilience of the road network during the materials selection and design process and using data-driven analysis to make investments. Furthermore, the Federal Highway Administration now requires state transportation departments and planning organizations (DOTs and MPOs) to consider resilience in the planning process and include resilience considerations in asset management plans.

States are also developing asset management plans to define strategic processes for operating, maintaining, and improving their road networks. Effective plans focus on engineering and economic analysis to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement while promoting actions that will help optimize their networks within the available funding constraints. Every state DOT is now required to have an asset management plan in order to receive federal funding, although many of these plans still do not cover the majority of roadways, as the plans are only required to cover the National Highway System. While asset management plans still have room for improvement, when paired with life-cycle cost analysis, they are helping states set priorities and determine where investments should be made to improve the overall system. Repaving and surface treatments might improve a roadway in the short term, but because underlying roadways continue to age, replacing the road might be a more effective solution for the long-term. Life-cycle cost analysis can help facilitate these decisions.

Roads

RECOMMENDATIONS TO RAISE THE GRADE

- Focus resources on preserving a state of good repair, as the nation will never be able to fully build its way out of congestion. Policies and efforts focused on improving travel time reliability will need to be implemented to maximize the capacity of the existing road network. This should be done in coordination with the acceleration of the development and deployment of new technologies that promote an integrated, multimodal transportation system.
- Increase funding from all levels of government and the private sector to address the condition and operations of the roadway system to maintain a state of good repair and ensure safety for all users.
- Fix the federal Highway Trust Fund by raising the federal motor fuels tax by five cents each year over five years. To ensure long-term, sustainable funding for the federal surface transportation program, the current user fee of 18.4 cents per gallon on gasoline and 24.4 cents per gallon on diesel should be tied to inflation to restore its purchasing power, fill the funding deficit, and ensure reliable funding for the future.
- Develop state and local level comprehensive transportation asset management plans that link asset management efforts to long-term transportation planning and incorporate the use of life-cycle cost analysis.
- Create dedicated federal investments to build resilience into the nation's road and bridge infrastructure and integrate resilience planning into State Transportation Asset Management Plans.

DEFINITIONS

CONDITION – The "ride quality" of highways and roadways is typically evaluated using the International Roughness Index (IRI), and the Federal Highway Administration (FHWA) data are the only national source of pavement condition ratings based on a consistent criterion. Using this information, TRIP categorizes the condition of a region's roads and highways into poor, mediocre, fair, or good condition. The FHWA has found that a road surface with an IRI rating below 95 provides a good ride quality, a road with an IRI from 95 to 170 provides an acceptable ride quality, and a road with an IRI above 170 provides an unacceptable ride quality.

Roads

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Schools

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EXECUTIVE SUMMARY

School facilities represent the second largest sector of public infrastructure spending, after highways, and yet there is no comprehensive national data source on K-12 public school infrastructure. What data is available indicates that 53% of public school districts report the need to update or replace multiple building systems including HVAC systems. More than one-third of public schools have portable buildings due to capacity constraints with 45% of these portable buildings in poor or fair condition. Meanwhile, as a share of the economy, state capital funding for schools was down 31% in fiscal year 2017 compared to 2008. That is the equivalent of a $20 billion cut. The best estimates indicate a minimum of $38 billion annual funding gap for public school facilities across the country. Meanwhile, public schools increasingly serve a secondary function as emergency shelters and community resource facilities during man-made or natural disasters, and facility upgrades are needed to effectively fulfill this important community purpose.

CAPACITY & CONDITION

There are approximately 84,000 public schools with nearly 100,000 buildings[1] in the U.S. with a projected enrollment of 56.8 million by 2026.[2] Every community across the U.S. has public school buildings and facilities. They are used not only for learning, libraries, sports, and feeding children, but also for community meetings and as emergency centers and shelters. To provide a safe and healthy environment that is conducive to learning for children of all ages, school buildings need to be in good condition and provide adequate spaces, natural light, working heating and air conditioning, clean water, and modern technology to fulfill a host of other functions.

A 2015 Congressional Research Service report[3] concluded that national data on the condition of school infrastructure and the investment needs are extremely limited and outdated, and comprehensive findings remain elusive. There is no consistent federal data collection process to aggregate information on the condition of schools. Furthermore, the data that is collected is based on a wide variety of assumptions and definitions regarding both conditions and needs.

School facilities represent the second largest sector of public infrastructure spending, after highways, and yet there is no comprehensive national data source on K-12 public school infrastructure. The most comprehensive data available is a National Center for Education Statistics (NCES) survey for the 2012-2013 school year.[4] The U.S. General Accountability Office (GAO) issued a limited, one-time survey of school districts in 2020, which found that 53% of public school districts needed to update or replace multiple building systems, reinforcing the findings of the NCES report that found that 53% of public schools needed to spend money on repairs, renovations, and modernizations to bring the infrastructure into good overall condition.[5] Nearly 41% reported issues with HVAC systems, a significant concern for facilities where children routinely spend eight hours a day.

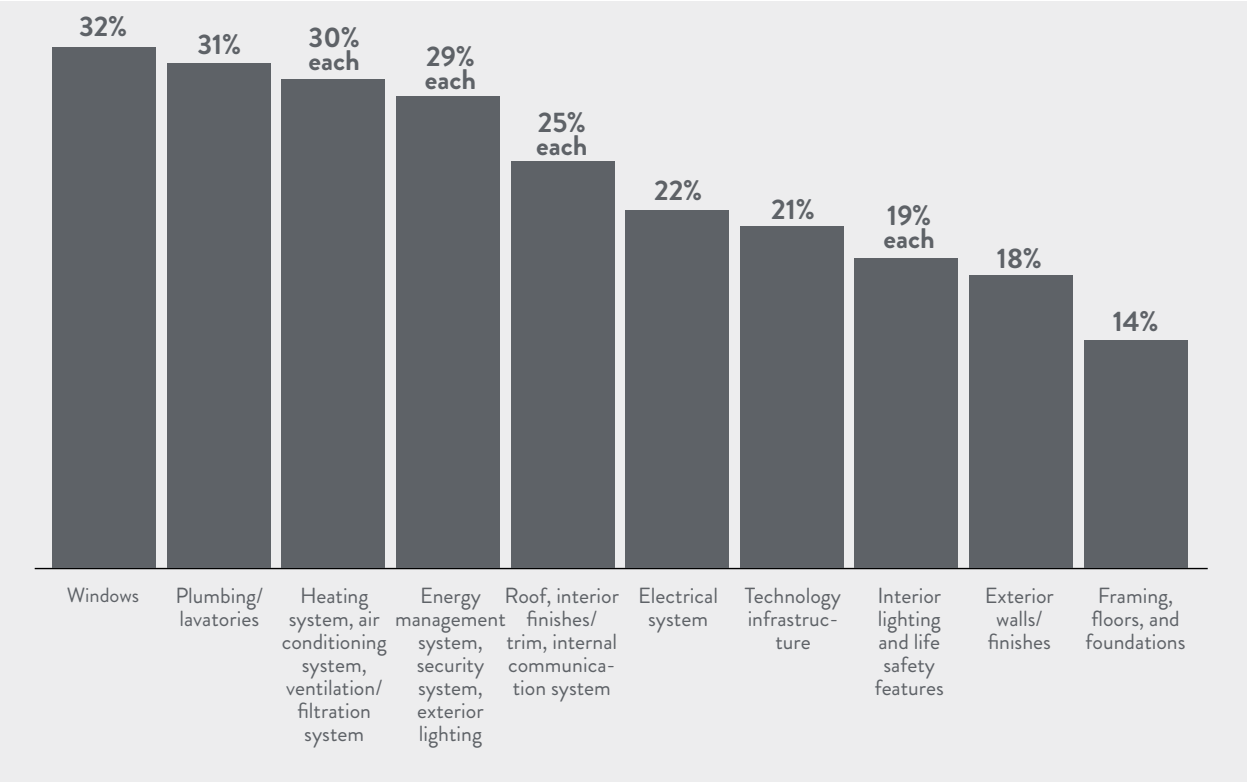
The NCES report, while older, was more comprehensive and found that 24% of overall building conditions were rated as fair or poor, while 14% to 32% of systems and features within these permanent buildings were rated in fair or poor condition. Among the 31% of public school systems with portable (temporary) buildings, 45% of overall building conditions were rated as fair or poor. Additionally, outdoor features were rated as fair or poor, including school parking lots and roadways; fencing; bus lanes and drop-off areas; outdoor athletic facilities; and outdoor play areas/playgrounds.

OPERATION & MAINTENANCE

State and local governments face a constant challenge to keep pace with operations and maintenance and the need for new school construction, in addition to accommodating improved health and safety standards, stronger accessibility requirements, and new technology. Great strides have been made in infusing technology into schools and into the instructional process. Some school districts have invested heavily in the infrastructure required to accommodate technology. As the COVID-19 pandemic illustrated, investments in technology are critical to ensure continued learning, yet despite progress, many school districts have not been able to keep pace. Meanwhile, school districts need to upgrade HVAC systems and add capacity to classrooms with outdoor classrooms, temporary buildings, or leasing new space, all with limited budgets.

The GAO estimates that while 65% of school districts have assessed their facilities within the past 10 years (86% of those do so yearly), 16% of districts have not done so within the past 10 years. Planning is often lacking, as four in 10 public schools do not have a long-term facility plan in place to address operations and maintenance. Better planning through life-cycle cost analysis will lead to a better allocation of resources. Such analysis should review costs associated with planning, funding, design, construction, operation, maintenance, and decommissioning.

Percent of building systems and features in fair and poor condition in public schools with all permanent buildings



U.S. Department of Education, National Center for Education Statistics, Institute of Education Sciences, "Condition of America's Public School Facilities: 2012–13," NCES 2014-022, March 2014.

FUNDING & FUTURE NEED

An estimated 55% of districts use local revenues as their primary source of funding for school facilities, compared to 36% that rely mainly on state funds. The most common source of local funding is property taxes, which are used in 77% of school districts. Other local funding comes from grants, bonding, other taxes, and public-private partnerships.

The Center on Budget and Policy Priorities reports that as a share of the economy, state capital funding for schools was down 31% in fiscal year 2017 compared to 2008.[6] **That's the equivalent of a $20 billion cut.** Thirty-eight states cut school capital spending as a share of the state economy over the 2008-2017 period, in many cases drastically.

Between 1994 and 2013, school systems spent $973 billion for new school construction and capital projects to improve existing infrastructure. This spending totaled $49 billion annually. However, to provide healthy and safe 21st century learning environments, it is estimated that the nation should be spending $87 billion per year on capital needs.[7] This leaves an additional $38 billion per year that is required to regularly upgrade existing facilities' systems, components, fixtures, equipment, and finishes as they reach the end of their anticipated life expectancy; systematically reduce the backlog of deferred maintenance that has accumulated; and alter existing facilities to respond to changing educational requirements.[8]

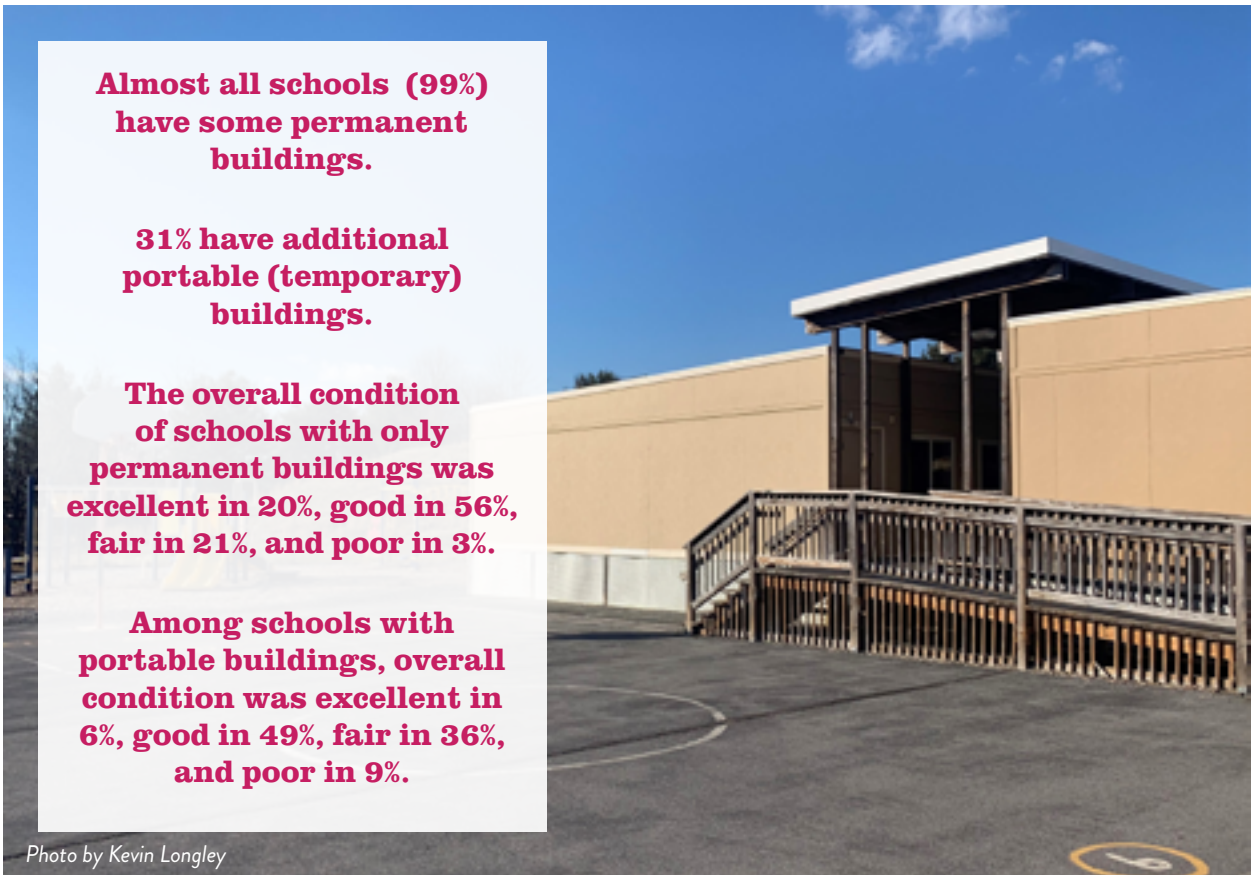
The number of students nationwide enrolled in school was 76.4 million in 2017 (pre-school — college), not statistically different from the level in 2016. (U.S. Census)

Those who are enrolled make up 24.7% of the population age three and older. (U.S. Census)[9]

Every school day, nearly 50 million K-12 students and six million a dults occupy close to 100,000 public school buildings on an estimated 2 million acres of land. (NCES)

The student population increased by nearly 5 million between 1994 and 2013, requiring an additional 13,000 K-12 schools. (NCSF)[10]

Enrollment is projected to increase by 3% between the 2013-2014 and 2025-26 academic years — rising from 50 million to 51.4 million students. (NCES)[11]



A TEMPORARY SCHOOL BUILDING IN MARYLAND.

Though the current school infrastructure funding gap is nearly $40 billion annually, the true cost is undoubtedly higher due to school systems' loss of income during the 2020 pandemic and its impact on tax revenues.[12]

PUBLIC SAFETY AND RESILIENCE

To provide a safe and effective learning environment for the nation's K-12 students, public schools need to be in good condition.

Public schools often serve a secondary function as emergency shelters and community resource facilities during man-made or natural disasters. This critical function has a significant role in public health, safety, and welfare, and requires facilities to be maintained to function in emergencies and help communities recover quickly. Schools require upgrades to effectively fulfill this important community purpose, including windows that can withstand high winds, structures designed to survive earthquakes, and rooms specifically designed as shelters from tornados.

SCHOOL CONSTRUCTION IN NORTH CAROLINA

Schools

RECOMMENDATIONS TO RAISE THE GRADE

- All schools (new and existing) should be designed to withstand seismic, wind, and flood events. State and local governments must support the widespread adoption and enforcement of modern building and infrastructure codes, such as *ASCE 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures.* ASCE 7 describes the means for determining flood, tsunami, snow, rain, atmospheric ice, earthquake, wind, and other loads and their combinations for general structural design. ASCE 7 is continuously updated to reflect our changing world and to make infrastructure more resilient in the face of new challenges.
- The U.S. Department of Education should coordinate with state agencies and local school districts to obtain and publish nationwide statistics on school infrastructure at regular intervals.
- School districts should focus on Life-Cycle Cost Analysis (LCCA) principles in the planning and design processes to evaluate the total cost of projects.
    - Design new campuses for the lowest net present value cost that includes life-cycle O&M in addition to capital construction.
    - Implement building condition assessment of existing school infrastructure.
    - Budget for the total cost of ownership and train facilities staff to implement these policies.
- School districts should develop capital planning frameworks that can be nimble and responsive to changing technologies and demographics, in order to optimize learning environments and consider the holistic needs of the community.
- Continue to encourage school districts to adopt regular, comprehensive major maintenance, renewal, and construction programs, and implement preventive maintenance programs to extend the life of school facilities.
- Explore alternative financing for public school facilities, including lease financing, as well as ownership and use arrangements, to facilitate school construction projects.

Schools

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Solid Waste

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EXECUTIVE SUMMARY

The U.S. produced approximately 268 million tons of municipal solid waste (MSW) in 2017, or 4.51 pounds per person per day. This is a modest increase from the 4.4 pounds of MSW generated per person per day in 2014. Overall, 53% of waste is deposited in landfills, 25% is recycled, 10% is composted, and 13% is combusted for energy. The transport and disposal of MSW remains largely funded and managed by the private sector. However, the U.S. MSW management system faces a growing number of challenges such as plateauing recycling rates, emerging contaminants found in legacy landfills, and significantly changing global markets. Funding mechanisms are needed to invest in a nationwide solid waste infrastructure system that recognizes MSW as a resource to be utilized more so than waste to be disposed.

INTRODUCTION

The Environmental Protection Agency (EPA) defines municipal solid waste (MSW) as, "everyday items such as product packaging, yard trimmings, furniture, clothing, bottles, cans, food, newspapers, appliances, electronics, and batteries" that are discarded from residential, commercial, or institutional sources.[1] However, the EPA's MSW definition does not include industrial, hazardous, or construction and demolition (C&D) waste, which are covered in a separate report card chapter on hazardous waste.

Solid waste management includes infrastructure for landfills, converting waste to energy (WTE), and recycling or composting. MSW processing includes shredding, compaction, incineration, or biological degradation to reduce MSW volume. Thereafter, the garbage may be transported to landfills, discrete areas, or excavations designed to protect the environment from potential contaminants.[2]

Another approach, the waste-to-energy (WTE) process, involves non-recyclables from the waste stream undergoing combustion, gasification, pyrolization, or anaerobic digestion to produce electricity and heat. Finally, recycling and composting efforts include collecting, sorting, processing, and remanufacturing materials and organics, respectively, that are otherwise considered waste.

Figure 1: Solid Waste Management Infrastructure and Processes[3]

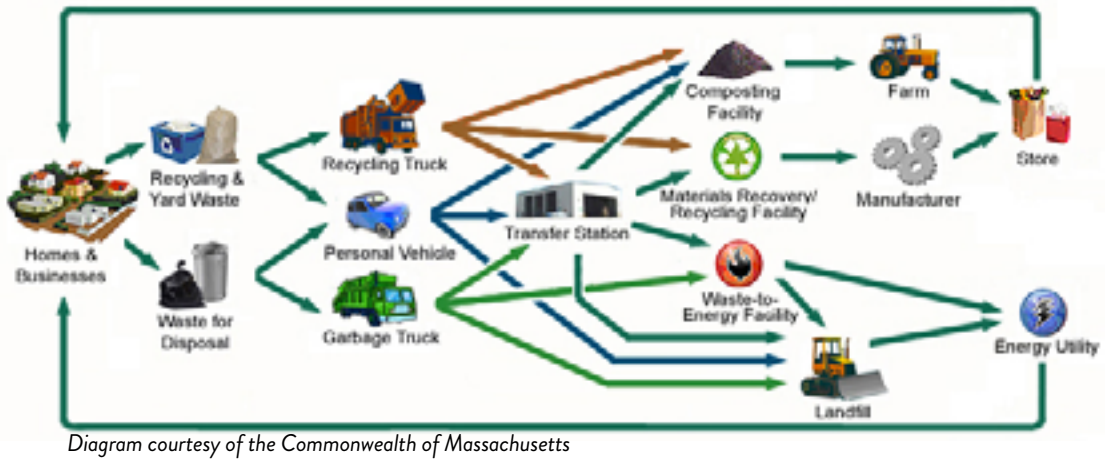

Diagram courtesy of the Commonwealth of Massachusetts

CAPACITY & CONDITION

In 2017, the EPA reported that Americans generated nearly 268 million tons of MSW, up from 262 million tons in 2015 and 251 million tons in 2010. This represents a modest increase in the per capita MSW generation rate from 4.45 to 4.51 pounds per person per day between 2010 to 2017, respectively.[4] In the last few decades, an increasingly larger portion of America's MSW is diverted from landfills. In 2017, 25% of waste was recycled, 10% was composted, and nearly 13% was combusted via WTE processes. However, recent years have shown that the percentage of recycled and composted MSW materials has plateaued.[5]

Because there is no comprehensive database of landfills in the U.S., the exact number and age is difficult to determine.[6] Estimates show that more than 2,600 landfills exist, while over 1,250 are currently open with varying amounts of remaining capacity.[7] The average age of landfills is somewhere between 30 and 50 years old.[8] Also receiving MSW are the 75[9] WTE facilities across 20 states; the majority are in Florida and along the East Coast.[10] The most recent estimates of the nation's WTE facilities come from the U.S. Energy Information Administration, which shows in 2015, nearly 29 million tons, more than 10% of the nation's MSW, was burned, generating 2.3 gigawatts.[11] While no publicly available data exists to characterize the condition of the nation's materials recovery facilities, which sort and process recyclables, from 2009 to 2020 the U.S. Bureau of Labor Statistics reported an increase from 906[12] to 1,331[13] public and private materials recovery facilities.

In 2017, the EPA reported that Americans generated nearly 268 million tons of MSW, up from 262 million tons in 2015 and 251 million tons in 2010.

A LANDFILL TRACTOR IN MINNESOTA.

OPERATION & MAINTENANCE

States play a leading role in ensuring federal regulations are met for operating and maintaining MSW and industrial waste landfills. However, some states may set and follow more stringent requirements. In absence of an approved state program, the federal requirements must be met by waste facilities. Regulations address common problems associated with landfills, including location restrictions, liner requirements, leachate collection and removal systems, groundwater monitoring, and closure and post-closure care expectations.[14]

In 2020, to more sustainably manage the nation's solid waste, the EPA announced its National Recycling Goal, which set a 10-year benchmark to increase the recycling rate for all materials by 50%.[15] To achieve this goal, operational improvements include reducing the percentage of the wrong materials such as food and other contaminants entering into the recycling stream. Clean recyclables improve the efficiency of processing materials into new products or energy. The EPA notes that clear, consistent public education and outreach are critically important to achieving this goal.[16]

PUBLIC SAFETY

An ongoing concern for landfills and other solid waste management systems are emerging contaminants, which are chemicals that are not commonly monitored but have the potential to enter the environment and cause known or suspected adverse ecological and/or human health effects. They consist of per- and polyfluoroalkyl substances (PFAS), pharmaceuticals, pesticides, industrial chemicals, surfactants, personal care products, and more. These substances are consistently being found in groundwater, surface water, wastewater, drinking water, and some food sources.[17] [18]

Over the past several years PFAS have become a major concern to human health and the environment, and the EPA has moved to list PFAS and associated chemicals as hazardous substances. PFAS were traditionally used in many products that are now ending up in landfills. As a result, landfills are having to manage PFAS in groundwater, especially at historic landfills that were not previously constructed to today's specifications. PFAS are also being identified in landfill leachate that is sent to wastewater treatment plants.[19]

FUNDING AND FUTURE NEED

Funding for operation and maintenance (O&M) of landfills and recycling facilities is generated through trash collection fees. The national average annual trash collection or tipping fee increased from about $48 per ton in 2016 to more than $55 per ton in 2019.[20] Similarly, O&M efforts for WTE facilities are also self-funded and prove to be most cost competitive in areas with limited available land and dense populations.[21]

While recycling has made dramatic gains over the last decade, more recent figures show a leveling off as global markets for recycled materials dramatically changed. In 2018, China instituted the National Sword policy which halted the import of many types of solid waste,[22] effectively closing off the destination for two-thirds of the world's plastic waste.[23] Available data suggest that this policy caused as much as 92% of U.S. plastic in the first part of 2018 to be sent to other Southeast Asian countries.[24]

Adapting to the loss of international markets, EPA's National Recycling Strategy focuses on improving and expanding domestic recycling markets.[25] Various companies plan to open new U.S. processing plants in Orangeburg, South Carolina, and Huntsville, Alabama. The companies will shred or pelletize materials like plastic food containers to make products such as artificial plants and hangers.[26]

There is, however, a lack of funding for research and seed capital to facilitate more marketable and innovative ways to manage MSW and recyclable materials for a useful purpose such as waste to energy (e.g., anaerobic digesters and plasma gasification) or through new technologies that prevent solid waste from entering a landfill. Additional funding mechanisms are needed to help transition to a system that recognizes MSW as more of a resource to be utilized than waste to be disposed.

WASTE-TO-ENERGY PLANT.

RESILIENCE AND INNOVATION

Landfills are often vulnerable to natural disasters such as hurricanes, earthquakes, and especially floods. Such events can have a large impact on groundwater conditions as well as the overall public health near landfills. Additionally, damage to other infrastructure systems such as roads, bridges, rail, the electric grid, inland waterways, and other systems causes interruption to MSW collection and disposal, which can lead to significant impacts on the public health.

New processes can help reduce waste, particularly plastics. There are researchers and companies in the U.S. that are implementing practices such as pyrolysis to break down polystyrene waste into its foundational material, styrene. Others are looking to use engineered enzymes that can break down polyethylene terephthalate (PET) into purified terephthalic acid (PTA). The advantage of using depolymerization processes to break down PET compared to mechanical processes is that it extends the usefulness of the reprocessed PET, it can deal with the impurities that occur as a result of single-stream recycling, and it can be used with a variety of different types of plastics, not just the high quality plastics like single-use bottles. However, the problem with these technologies is they are still very expensive alternatives, and the scale of facility with throughput capable of processing all the plastic discarded by Americans is not yet available.[27] Therefore, some municipalities across the country are trying to reduce the amount of plastics entering MSW landfills by implementing bans on single-use plastic. On a global scale, for example, since 2018, Starbucks has been working to replace all plastic straws with strawless lids and to develop a fully recyclable and compostable cup.[28]

Solid Waste

RECOMMENDATIONS TO RAISE THE GRADE

- Pass legislation limiting the amount of packaging used in various industries, setting standards for the recyclability of materials (e.g., single-use plastics), and addressing the true cost of waste by implementing deposits on bottles and fees on plastic bags.
- Strengthen domestic markets for recycled materials in the U.S. by supporting companies looking to build domestic reprocessing plastic facilities and reusing plastics.
- Change the way Americans think of solid waste beyond "garbage" or "trash," to understand that "waste is not waste until it is wasted." The materials Americans routinely discard are potential resources.
- Support research and invest in alternatives for the use of waste as resources, such as aerobic digesters and plasma gasification.
- Oppose federal legislation that would ban the interstate movement of municipal solid waste (MSW) to regional solid waste facilities designed in accordance with state and federal regulations, recognizing that such transport may be appropriate and beneficial in regional solid waste planning efforts.
- Encourage Congress to list polyfluoroalkyl substances (PFAS) as hazardous substances in Superfund.

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Stormwater

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EXECUTIVE SUMMARY

Stormwater systems range from large concrete storm sewers, roadside ditches, and flood control reservoirs, to rain gardens and natural riverine systems. While stormwater utilities are on the rise, with more than 40 states having at least one, the impervious surfaces in cities and suburbs are also expanding, exacerbating urban flooding, which results in $9 billion in damages annually.[1] Stormwater also affects water quality as polluted runoff from pavement enters water bodies. Nearly 600,000 miles of rivers and streams and more than 13 million acres of lakes, reservoirs, and ponds are considered impaired.[2] Federal funding, though up in recent years, averages about $250 million annually, which leaves a growing annual funding gap of $8 billion just to comply with current regulations. With few dedicated funding sources, complicated governance and ownership structures, expansive networks of aging assets, increasingly stringent water quality regulations, and concerning climate change projections, the expected performance of stormwater systems is declining. Many of the country's legacy stormwater systems are struggling with the high cost of retrofits needed to address urban flooding and climate change. Upgrading large networks of aging systems underneath densely populated areas carries significant costs and engineering challenges.

INTRODUCTION

Stormwater runoff is defined as rain or snow melt that travels over impervious surfaces such as roadways, buildings, or parking lots, and landscaped or agricultural areas and is then collected and conveyed into streams, rivers, lakes, bays, or oceans.[3] As impervious surfaces in increasingly developed cities and suburbs expand, so do the impacts of increased runoff from larger rainfall events which can lead to urban flooding.[4]

Nationally, stormwater infrastructure can take many forms, including piped systems, detention basins, ditches, canals, channels, and roadway conveyance systems.[5] In recent years, green stormwater infrastructure has been introduced in new developments and coupled with traditional "gray infrastructure" to maximize the benefits from natural hydrologic cycles using vegetation, soils, site grading, and natural filtration processes. Green infrastructure provides benefits by reducing runoff, minimizing erosion, and contributing to water quality improvements; examples include rain gardens, constructed wetlands, vegetative roadway bioswales, and permeable pavements.[6]

The United States Environmental Protection Agency (EPA) classifies stormwater systems as those that are publicly owned, discharge into waters of the U.S., and are not part of a sewage treatment plant such as Municipal Separate Storm Sewer Systems (MS4s). MS4s are regulated by the EPA under the National Pollution and Discharge Elimination System (NPDES) program.[7] Apart from EPA regulations, states, counties, and local governments may also require stormwater management practices through local ordinances, building codes, and development plans.

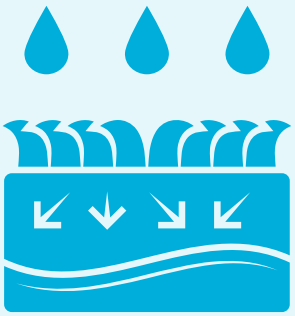
CAPACITY

While there is not yet a comprehensive national database of assets, estimates suggest there are 3.5 million miles of storm sewers, 270 million storm drains, and 2.5 million stormwater treatment assets across the U.S.[8 9 10 11 12 13 14] Under the NPDES MS4 program, municipalities are required to map their stormwater systems and, as of 2018, nearly 40% of stormwater utilities have taken this step.[15]

Stormwater infrastructure capacity is principally derived from the design standards used for construction. Terms like "10-year" and "100-year storms" (meaning those with a 10% and 1% annual probability of occurrence, respectively) are currently used to describe a system's capacity. However, such design standards have only been used in recent decades, and the standards differ within and between states.

While design standards govern a stormwater system's *theoretical* capacity, routine operation and maintenance (O&M), age, and the changing frequency and intensity of storm events, are the main drivers affecting a stormwater system's *actual* capacity. Given the recent increase in rainfall trends and urbanization, the actual capacity of a stormwater system is often less than the design standard.[16] Many of the country's legacy stormwater systems, such as those in Chicago and Philadelphia, for example, are now struggling with the high cost of retrofits that are needed to accommodate these changes. Upgrading large networks of aging systems that are now underneath densely populated areas carries significant costs and engineering challenges.

STORMWATER MANAGEMENT INFRASTRUCTURE IN WASHINGTON, D.C.



Given the recent increase in rainfall trends and urbanization, the actual capacity of a stormwater system is oftentimes less than the design standard.[16]

CONDITION

The condition of stormwater infrastructure is indicated, in part, by the system's age. Without better stormwater asset records, the average age of the system cannot be directly determined, so the lifespan of the primary construction material is used as a proxy. Stormwater conveyance systems may be constructed of corrugated metal, reinforced concrete, or plastic, and their lifespan is projected to be 50 to 100 years. Storage and treatment systems such as detention and retention ponds have an average lifespan between 20 to 30 years.[17] [18] Based on this, systems constructed in the 1970s or prior have exceeded or are nearing the end of their useful lives and are likely undersized given current stormwater management practices and climate change impacts.

Another key indicator of stormwater infrastructure condition is the system's ability to reduce negative impacts to local waterbodies. Under the NPDES program, stormwater systems are required to meet the overarching goal of reducing the discharge of pollutants from runoff.[19] [20] While water quality is a priority across the nation, from 2010 to 2018, the length of impaired rivers and streams increased from about 424,000 miles to more than 588,000 miles.[21]

FLOODING IN MADISON, WISCONSIN

OPERATIONS & MAINTENANCE

Stormwater infrastructure may be owned and managed by various public or private entities such as state or local governments, individual or corporate property owners, or homeowners' associations. All stormwater systems require some level of routine maintenance, but the ongoing management of stormwater systems can be complex and expensive. Storm sewers require jetting and cleaning, and stormwater detention basins, bio-retention facilities, permeable pavement, and bioswales all require unique maintenance tasks with specialized knowledge. This can be a challenge for all levels of government, private property owners such as shopping centers, or homeowners' associations.

The MS4 NPDES permitting process has been an effective regulatory lever influencing O&M practices and frequency due to the expectation of routine inspections. Under the NPDES program, all MS4s are required to have maintenance plans. However, private entities, cooperatives, and individual homeowners responsible for O&M are often not routinely monitored and left to manage critical and sometimes expensive components of the stormwater system on their own. Deferred maintenance increases the likelihood of urban flooding and increases threats to water quality protection.[22] [23]

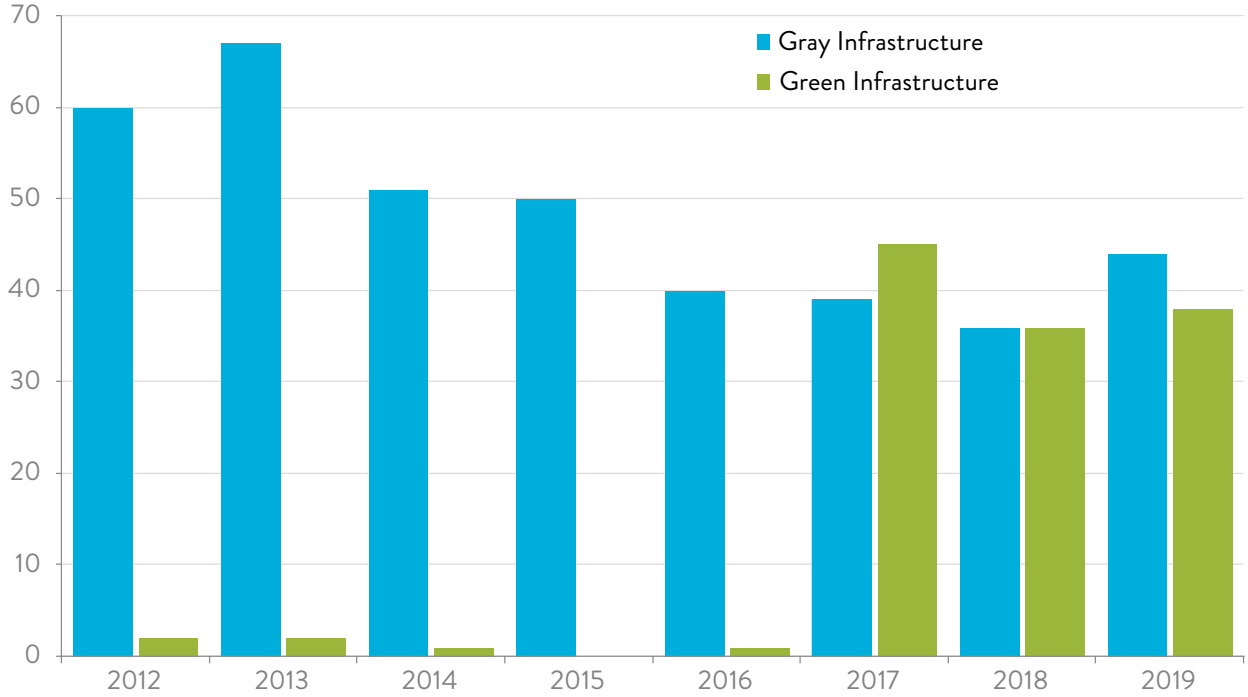
FUNDING

Funding for stormwater infrastructure across the country is limited and comes from multiple sources — local revenue, state and/or federal grants and financing, and non-traditional funding streams. Because the financial responsibility for managing stormwater systems can sometimes be unclear and draw from entities' general funds, hundreds of public entities in at least 40 states have taken the initiative to create stormwater utilities to collect fees based on property size, impervious area, and other site-specific characteristics. Out of communities with municipal MS4s, the percentage with stormwater utilities or fees has grown from approximately 19% in 2013 to upward of 26% in 2018.[24,25] For a single family home, the average monthly stormwater fee in 2018 was $5.34.[26]

For large capital improvements, state entities or municipalities may use general obligation bonds. They may also seek federal resources like those from the EPA's Clean Water State Revolving Fund (CWSRF) which has provided nearly $2.2 billion for more than 1,100 stormwater projects since its inception.[27] More recently, the CWSRF's program funding for stormwater projects has trended upward from more than $58 million in 2012 to more than $387 million in 2019 with the portion of funding for green infrastructure also increasing.[28] Though trends are improving, only 3% of all CWSRF funds have gone toward stormwater and similar types of projects.[29] Additionally, the EPA's Water Infrastructure and Finance Innovation Act (WIFIA) is another federal funding mechanism. In 2019, at least three stormwater infrastructure projects applied for $673 million in WIFIA loans out of the program's $7.7 billion in overall support.[30]

While there are limited and highly competitive grant programs at the local, state, and federal levels that cover a very small portion of the overall need, non-traditional mechanisms for funding stormwater infrastructure have also emerged and include public-private partnerships; leveraged synergies among solid waste, transportation, and/or wastewater sectors; and market-based solutions that monetize permit requirements like nutrient and/or stormwater volume trading.[31,32]

Projects Awarded Clean Water SRF Funds Over Time



Source: Clean Water SRF Program Information National Summary (2019) https://www.epa.gov/sites/production/files/2020-02/documents/us19.pdf

FUTURE NEED

As water quality measures for MS4 permitting become more stringent, local governments and stormwater utilities having to update or expand their systems, stretching their limited economic resources. In 2020, the Water Environment Federation's National MS4 Needs Assessment estimated that the sector's annual funding gap is $8 billion among MS4 permittees.[33] [34] Separately, an economic analysis by ASCE shows a water-related infrastructure investment gap of $434 billion over 10 years for drinking water, wastewater, and stormwater combined.

The trajectory of urban flooding impacts will likely continue the upward trend as our older stormwater assets cannot accommodate the changing rainfall patterns and intensity.[35]

Many utilities are behind in accounting for the condition of their assets, planning, and funding for short- and long-term maintenance, and strategizing necessary capital improvements. A clear picture of the existing assets and their condition is needed to provide flood projection models with data to identify areas of significant risk where limited, available resources may be targeted for improvements.

PERMEABLE PAVEMENT AND STORMWATER DETENTION IS BUILT INTO A PARKING LOT IN RESTON, VIRGINIA.

PUBLIC SAFETY

Flooding is one of the nation's greatest natural hazards, carrying catastrophic public safety and economic tolls. Annually, from 2004 to 2014, urban flooding alone cost communities an average of $9 billion in direct damages and 71 deaths.[36]

When stormwater systems become overwhelmed, there are acute and long-term public safety implications that create ripple effects to other infrastructure systems. Effects throughout the community may include sinkholes, flash floods, collapsed roadways, extensive property damage, inflow into sanitary systems which inundates wastewater treatment plants and pollutes waterways, and loss of life. Over the last two decades, to buttress the impact of these losses, the National Flood Insurance Program has more than doubled its enacted policies while the number of private insurance companies entering the market between 2016 to 2019 has also more than doubled.[37]

STORMWATER TREATMENT CHANNEL IN SOUTH FLORIDA

RESILIENCE & INNOVATION

Impacts from climate change will have variable effects on the form and frequency of extreme events across the nation. To withstand these effects, stormwater infrastructure is increasingly implemented with a context-sensitive approach, that leverages a localized understanding of flood risk, land use practices and regulatory expectations. This approach informs the types, designs, locations, and long-term sustainability of stormwater systems. Resilience for stormwater infrastructure is reflected by a mix of optimized green, gray, and natural infrastructure, land planning and urban growth, updated asset management and, in water-scarce areas, the productive reuse of stormwater.

Current innovations employed by utilities include the use of real-time control systems, complex modeling, cloud computing, data storage, and predictive analysis.[38] Large datasets can be used to optimize the capacity of stormwater conveyance, storage and treatment systems, investments in O&M activities, and other costs. The affordability of sensors has also improved, expanding the potential for system implementation of real time data and control.

Finally, some areas employ a regional approach to stormwater management through volume and nutrient trading within watersheds. This can economically incentivize stormwater innovation.

HURRICANE HARVEY SUMMER FLOODING IN TEXAS

Stormwater

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund and disseminate information from the EPA's Clean Watersheds Needs Survey on a routine basis (every four years) and elicit more stormwater-related detail, including information about maintenance, repair, pollution prevention, and urban flooding.
- Develop a stormwater-specific funding and financing program based upon the best practices from the existing Clean Water State Revolving Fund.
- Stormwater infrastructure and design regulations are critical for protecting communities from costly urban flooding and protecting water quality in our waterways. Stormwater systems should be a combination of gray, green, and natural infrastructure and should be mainstreamed in planning and development processes nationwide.
- Develop state-based peer-to-peer partnerships to build local government capacity to create and manage stormwater utilities that sustainably fund, operate, maintain, assess, and, when necessary, expand stormwater infrastructure.
- Establish a grant program for 21st century technical career training for "green collar jobs" in the stormwater sector that recruit the next generation's talent and mainstream tools for data-driven decision-making, such as asset management software, life-cycle cost analysis, and affordable rate structuring.
- Expand the inclusion of current and forecasted climate variability in codes and standards for the design, operation, maintenance, and expansion of stormwater infrastructure and routinely provide funding to NOAA to update the climate data.
- Ensure stormwater infrastructure is fully eligible and aggressively pursued via federal funding and financing mechanisms that are supporting the nation's drinking water and wastewater systems.
- Develop a comprehensive education campaign on the true costs, savings, risks, and avoided hazards associated with stormwater infrastructure investments, and disseminate these details through broadly accessible platforms.
- Educate communities on best practices for creating stormwater utilities that institute rates that reflect the true cost of treating and handling stormwater runoff.
- Point source and nonpoint source pollution should be addressed through a watershed approach that encourages regional coordination to improve impacts from stormwater-induced flooding.

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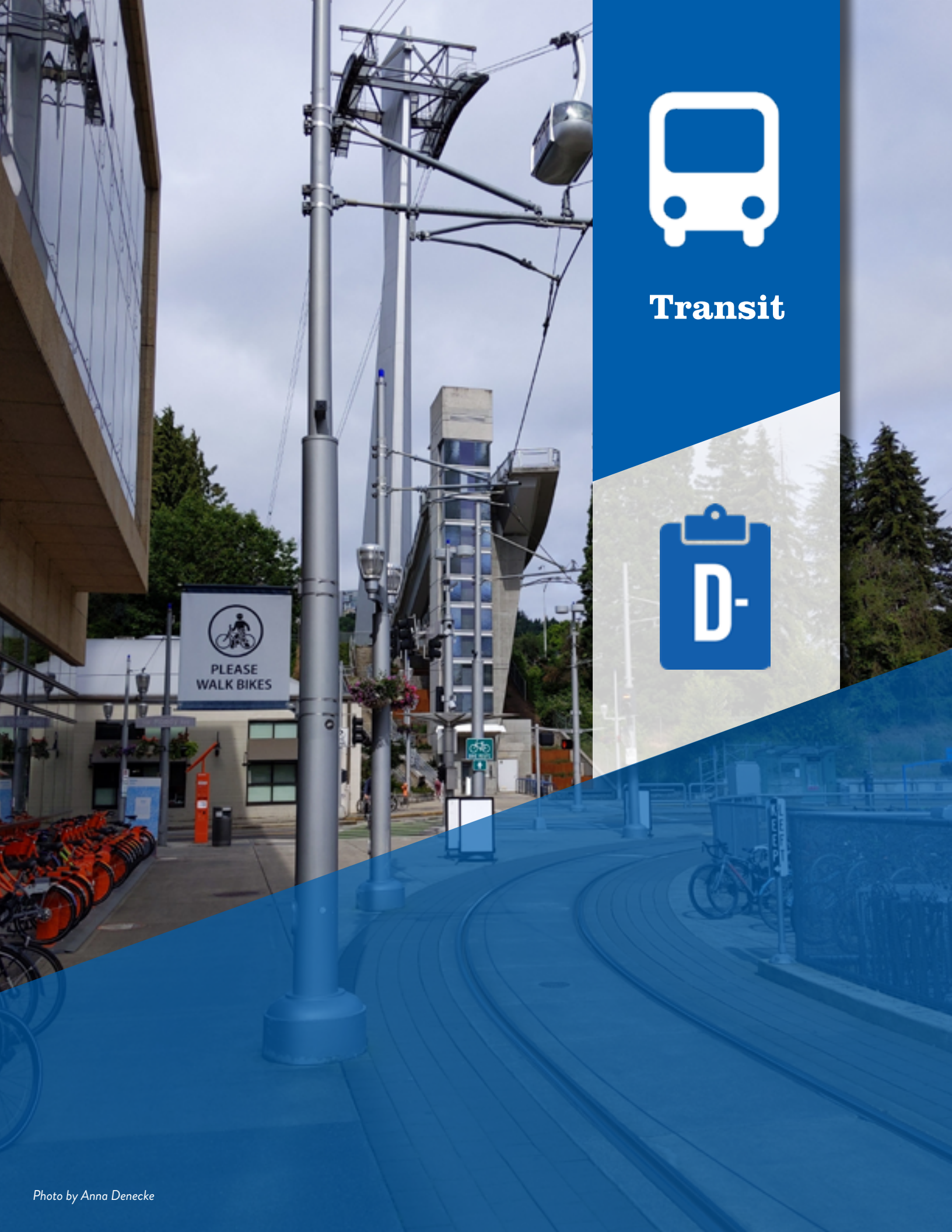


Transit

D-

Photo by Anna Denecke

EXECUTIVE SUMMARY

Public transit is essential to everyday living in communities across the country, providing access to jobs, schools, shopping, healthcare, and other services, while enabling equitable access and sustainable mobility options. Unfortunately, 45% of Americans have no access to transit. Meanwhile, much of the existing system is aging, and transit agencies often lack sufficient funds to keep their existing systems in good working order. Over a 10-year period across the country, 19% of transit vehicles, and 6% of fixed guideway elements like tracks and tunnels were rated in "poor" condition. Currently, there is a $176 billion transit backlog, a deficit that is expected to grow to more than $250 billion through 2029. Meanwhile, transit ridership is declining, a trend compounded by the COVID-19 pandemic. Failure to address the transit revenue shortfall will only exacerbate ridership declines as service cuts mean that trip delays and reliability issues become more frequent. This stands to increase congestion, hamper the economy, and worsen air quality in the coming years.

CAPACITY & CONDITION

Transit has a presence in every state and community across the nation, whether it's heavy rail systems in New York, Atlanta, San Francisco, or Washington D.C.; light rail transit in Boston, Denver, or Minneapolis; bus rapid transit lines in Los Angeles, Cleveland, and Albuquerque; or bus networks and paratransit services that connect urban and rural communities across the country.

In total, there are about 6,800 organizations in the U.S. that provide transit services. In 2018, the Federal Transit Administration reported 2,207 transit systems received federal grant money, 928 of which were in urbanized areas and 1,279 in rural areas. Since the 1970s, transit has shown long-term growth in ridership, especially as networks have expanded beyond their traditional footholds. While the overall number of transit passenger trips has increased by 37% over the past 50 years, the total number of trips has decreased by 8% since its peak in 2014. The COVID-19 pandemic has only sharpened this decline, with the

BUS STOP IN HUNTINGTON BEACH, CALIFORNIA

American Public Transportation Association (APTA) reporting at the beginning of the pandemic that stay-at-home orders caused some agencies to experience a 70% passenger decline.[1][2][3][4]

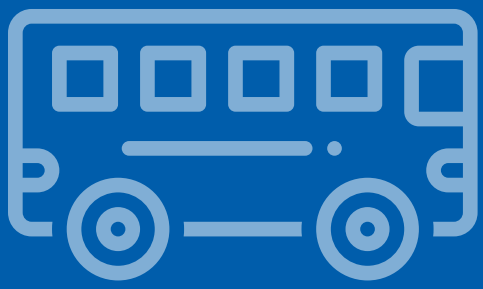
Between 2017 and 2019, there was a slight decline in total ridership from 10.1 to 9.9 billion passenger trips. Over this period, bus ridership continues to be the most used form of public transit, averaging 4.7 billion passenger trips annually, followed by heavy rail at 3.8 billion, light rail at 524 million, commuter rail at 503 million, demand response at 207 million, and trolley bus at 81 million passenger trips annually.[5]

Many transit systems have invested in expansion to improve access and service levels. Over the last two decades, 52 new systems and 124 extensions have opened, resulting in a total of 1,393 additional segment miles. In 2019, this expansion resulted in the nation's transit system comprising over 240,000 route miles. Additionally, buses operate on over 226,000 miles of streets and roads. While most bus services operate in mixed traffic, service is also provided on 4,864 miles of exclusive and controlled right-of-way, of which 1,105 miles are exclusive fixed guideway, where only transit can operate, allowing for greater travel time reliability. Furthermore, commuter and hybrid railroads operate over a combined 9,227 miles, a 12% growth in miles over a 10-year period, while light rail/street cars operate on 1,811 miles, a dramatic 30% increase over that same 10-year period.[6]

It has been reported that 41.7% of U.S. households have only one vehicle or less and could benefit from transit options, and 45% of Americans have no access to transit. System growth has the potential to increase capacity, but it must be coupled with routine maintenance for the older parts of the system. Unfortunately, capital investments for a growing number of state-of-good-repair needs has not taken place. As a result, transit users face increased delays due to service interruptions, and agencies are grappling with growing maintenance and vehicle procurement costs. Under the most recent 10-year projections, spare vehicle costs are expected to grow to $770 million, while vehicle maintenance costs are likely to grow to $7.3 billion. These delays will cost passengers nearly $1.2 billion over the next 10 years.[7][8][9]

Unfortunately, the COVID-19 pandemic has caused major disruptions across all transit agencies. Nationally, transit ridership and fare revenues were down in April 2020 from April 2019 by 73% and 86%, respectively. As the pandemic drags on and continues to negatively impact ridership, this trend will continue to create difficult financial situations as agencies look to improve their transit infrastructure.

Transit vehicles and physical infrastructure must both be in good condition for the system to perform to expected levels. Yet, in 2017 the Department of Transportation reported that over a 10-year period, 36.4% of facilities (bus and rail maintenance buildings and equipment/storage yards), 21.4% of systems (train control, electrification, communications, and revenue collection), 18.5% of vehicles, 6.4% of fixed guideway elements (tracks, tunnels, and bus guideways), and 5.5% of stations rated in "poor" condition.[10] As a result, reliability challenges

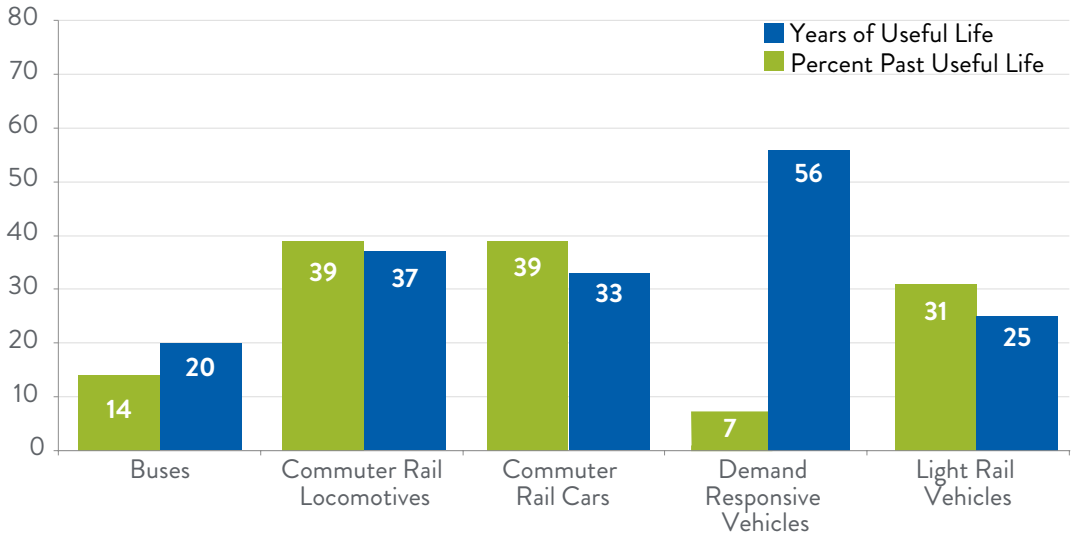


Transit users face increased delays due to service interruptions, and agencies are grappling with growing maintenance and vehicle procurement costs.

frequently plague our nation's transit systems. Failure to address these systemic problems will likely cause more trip delays and travel time uncertainty, perpetuating ridership declines that result in reduced funding available for operation and maintenance.

Aging assets mean that state and local governments must increasingly fund transit system operations and maintenance work. The American Association of State Highway and Transportation Officials (AASHTO) recently reported that more than $19 billion was spent by state DOTs on transit systems, $11.5 billion was spent on operating costs, $4.4 billion on capital, $3.1 billion on unrestricted, and $6.5 million was spent on planning.[11]

Transit Vehicles Past Useful Life



FUNDING & FUTURE NEED

Transit system operating budgets traditionally rely on fare revenue and state and local funding. In 2018, total transit funding increased by 1.8% to $74.2 billion from the previous year total of $71.1 billion. The Federal Transit Administration (FTA) also reported in 2019 that directly generated revenues funded 35.7% of transit operating expenses, state sources covered 23%, local resources covered 34.2%, and federal funding covered the remaining 7.1%. Under these conditions, a backlog of $176 billion for transit investments has emerged and is expected to grow to more than $250 billion through 2029.[14] [15]

As part of transit's federal funding, the Fixing America's Surface Transportation (FAST) Act provided roughly $60 billion to the FTA, both through general fund authorizations and Highway Trust Fund (HTF) contract authority through the Mass Transit Account. Of this $60 billion, $12 billion is authorized under general fund appropriations to be directed to numerous FTA programs, including the Capital Investment Grant (CIG) program. CIG serves as the primary federal discretionary source of funds for transit expansion. While it is currently authorized at $2.3 billion, recent efforts in both fiscal year (FY) 2018 and 2019 have seen an increase to $2.6 and $2.5 billion, respectively. The remaining $48 billion is directed out of the Highway Trust Fund (HTF) to support transit infrastructure, including a combined $12.9 billion for state-of-good-repair needs. In October 2020, Congress passed a one-year extension of the FAST Act, which extended the law's FY 2020 authorization levels to FY 2021. This includes a total of $12.5 billion for FTA and $2.3 billion for CIG.

The COVID-19 pandemic has at least temporarily increased the federal government's funding role for transit. While much is yet to be determined for stabilizing this system, $25 billion in emergency relief funding for operating expenses went to transit agencies as part of the CARES Act to mitigate lost tax and passenger revenue during the pandemic. Under the Consolidated Appropriations for FY 2021, Congress provided an additional $14 billion in relief.

Federal funding is critical to supporting robust transit systems. However, the state and local role is similarly essential to ensuring populations have access to transit and these systems are kept in good working order. There has been a slight increase in state transit funding, from $18.1 billion in 2016 to $19.2 billion in 2018. Additionally, local support for transit investment has also continued to grow. Since 2017, APTA reported that over 70% of all transit-related ballot initiatives in the U.S. were approved. Recent success has provided additional funds and demonstrated a public interest in further investment in our transit systems, as seen in Table 1.[16 17 18 19]

Ballot Measure Results for Transit, 2018-2020

	2018	2019	2020
Public Transit Measures on the Ballot	38	20	52
Wins for Transit	31	16	47
Losses for Transit	7	4	5
Revenue Total (Billion $)	$2.28	$7.23	$1.88

BART TRAVELS ABOVE GROUND IN THE BAY AREA.

PUBLIC SAFETY

In 2018, there were 255 transit-related fatalities across the nation. Over a three-year period, total transit-related fatalities have remained relatively stable with a slight uptick in incidents. Comparatively, motor vehicle fatalities have remained high, exceeding 35,000 deaths a year since 2017.[20 21 22]

Recent studies have found that areas with strong public transportation networks have significantly lower overall traffic fatality rates. Metro areas with high transit ridership have half the traffic fatality rates as metro areas with less transit ridership. Specifically, metro areas with over 40 annual transit trips per capita have about half the traffic fatality rate of metro areas with fewer than 20 transit trips per capita. Robust investment in transit systems develops life-saving benefits because this mode provides an alternative for high-risk and vulnerable road users as well as compact development that encourages safer traffic speeds.[23]

CONSTRUCTION FOR THE LOS ANGELES REGIONAL CONNECTOR

RESILIENCE

Transit systems' resilience has been strained in recent years due to a variety of hazards, such as sea level rise, extreme winter weather, and the global health pandemic.

Transit resilience must accommodate the needs of individual communities, including system availability and accessibility, to promote healthy, economically viable, and environmentally friendly communities. Recent studies have shown that improved transit access has the potential to increase employment opportunities and broaden overall economic activity. Seen over a 20-year period at current wage rates, for every $1 billion invested in public transportation, roughly 49,000 jobs are created.

In recent years, transit agencies have taken strides to minimize their environmental impact, moving fleets toward less reliance on fossil fuels, which accounted for a reduction in fuel consumption by 4.16 billion gallons in 2017, and a decrease of another 1% the following year. Twenty-five years ago, 95% of the nation's bus fleet was diesel powered, but that number has dramatically decreased now to only 42%. Furthermore, hybrid electric buses saw an increase from just 1% in 2005 to 18% in 2019. Meanwhile, natural-gas–powered buses saw an increase from 18% in 2009 to 29% in 2019. [24] [25]

New resilience challenges have also emerged amid the COVID-19 pandemic. While transit has played a key role in safely moving essential workers, an emerging task from the pandemic will be to establish and maintain new passenger safety measures amid large revenue declines. Additionally, transit agencies will need to build consumer confidence in the public health and safety of riding on transit systems.[26] [27]

INNOVATION

In recent years, many transit agencies have entered partnerships with mobility providers, as these services complement public transit by providing service during irregular hours, making first/last-mile connections, or providing transportation service in underserved areas. Emerging Mobility on Demand (MOD) and micromobility services, such as transportation network companies and bike or scooter share, have played a critical role in expanding the definition of public transit. Though MOD is still evolving, these services can provide solutions to equitable transportation access, payment options, travel updates, multimodal connections, and enhanced communication between the user and MOD systems.[28] [29]

Nearly overnight, micromobility began to have a presence in communities of all sizes across the country. Over a near 10-year period, we have seen annual micromobility trips rise from roughly 320,000 to nearly 1 billion. In 2018, there was a total of 84 million shared micromobility trips; this included 38.5 million scooter trips, 36.5 million station-based bikeshare trips, and 9 million dockless bikeshare trips, of which 6.5 million were on e-bikes.[30]

Connected and autonomous vehicles (CAVs) are also changing the way our transit agencies are operating. Across the U.S., several transit agencies have begun to offer service on autonomous buses, and many low-speed automated pilots have begun. Additionally, dozens of pilot programs have identified funding and are in various stages of planning and implementation. While this technology currently operates on a small scale, the FTA continues to implement the Strategic Transit Automation Research (STAR) Plan, which studies the opportunities and associated automation risks and suggests that this technology will continue to be incorporated into the system.[31]

Transit

RECOMMENDATIONS TO RAISE THE GRADE

- Transit is essential to creating more surface transportation system capacity and should be at the forefront in how communities develop multimodal connectivity. This includes integrating transit and micromobility options with equitable access for all.
- Congress and the Administration should fix the Highway Trust Fund (HTF) by adding 25 cents to the current motor fuels user fee over the next five years and then index future increases against inflation using a multi-year rolling average of key indicators, such as the Producer Price Index or Consumer Price Index. As part of the solution to fix the HTF's funding shortfall, there should be an effort to explore future long-term revenue solutions.
- Increase investment from state and local governments as well as the private sector to reduce the backlog of rehabilitation needs and increase transit mode share. Continue increased investment in federal grant programs that improve and support capital development.
- Encourage the continued implementation of new technology into our transit system to leverage innovation and mobility options. Together, these will continue to expand and enhance the transit ecosystem to provide better access for all communities.
- Apply asset management best practices to minimize long-term lifecycle costs and improve the system's overall condition.

Transit

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Wastewater

D+

Photo by Ivan Bandura

EXECUTIVE SUMMARY

The nation's more than 16,000 wastewater treatment plants are functioning, on average, at 81% of their design capacities, while 15% have reached or exceeded it. Growing urban environments signal a trend that these facilities will increasingly accommodate a larger portion of the nation's wastewater demand. Though large-scale capital improvements have been made to systems experiencing sanitary sewer overflows, efforts have slowed in recent years. As many treatment plants and collection networks approach the end of their lifespans, the financial responsibilities for operation and maintenance will become more costly. Estimates indicate that utilities spent over $3 billion in 2019, or more than $18 per wastewater customer to replace almost 4,700 miles of pipeline nationwide. Recently, the more prevalent use of asset management plans enables 62% of surveyed utilities to proactively manage wastewater infrastructure maintenance rather than reactively respond to pipeline and equipment failures. In 2019, though the annual water infrastructure capital investment gap is $81 billion, the sector has made strides to address current and future needs through resilience-related planning and innovations that produce profitable byproducts or cost savings from wastewater treatment.

INTRODUCTION

A critical component that influences the well-being of any community is its system for removing and treating wastewater for the protection of human and environmental health. Wastewater infrastructure includes a network of sewer pipes that collect and carry household, business, and industrial effluents to wastewater treatment systems — onsite or centralized facilities. Within these treatment systems, wastewater undergoes processes to remove harmful constituents and reduce pollution to the Environmental Protection Agency (EPA) and/or state-regulated levels prior to being discharged into nearby waterbodies or, in some cases, recovered for water, energy, and nutrient reuse.

AXIAL HYDRODYNAMIC FLOW PUMP IN WASTEWATER PLANT.

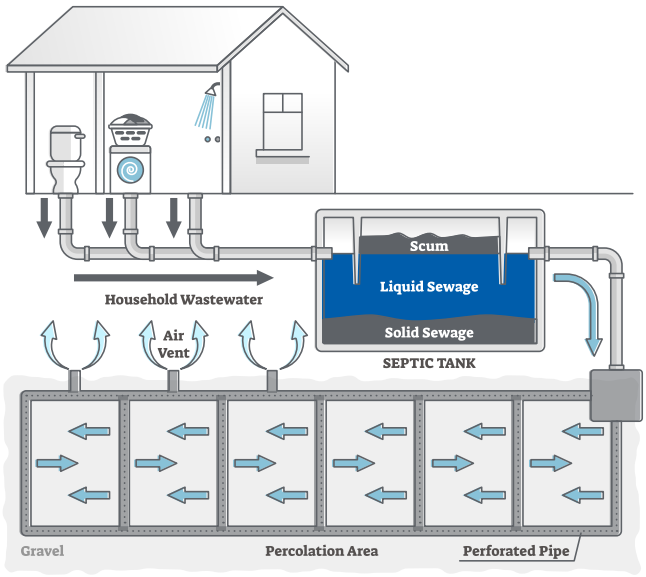
CAPACITY

There are more than 16,000 publicly owned wastewater treatment systems of various sizes serving the majority of wastewater needs in the United States.[1] The remainder of the population — approximately 20% of Americans — rely on onsite wastewater systems such as septic tanks.[2] Although the nation's population growth projections are modest,[3] a 2018 Pew Research Center study expects 86% of this growth to occur in urban and suburban areas.[4] Growing urban environments signal a trend that centralized wastewater treatment plants (WWTP) will increasingly accommodate a larger portion of the nation's wastewater demand. Currently, 62.5 billion gallons of wastewater per day is being treated by centralized WWTPs. Across all sizes of WWTPs, systems are operating at an average of 81% of their design capacity, while 15% of systems are at or have exceeded that threshold.[5]

In addition to WWTPs, the nation's wastewater footprint also includes a network of over 800,000 miles of public sewers and an additional 500,000 miles of private lateral sewers that connect homes and businesses to public sewer lines.[6]

CONDITION

The majority of the nation's WWTPs are designed with an average lifespan of 40 to 50 years, so the systems that were constructed in the 1970s, around the passing of the Clean Water Act in 1972, are reaching the end of their service lives.[7] However, smaller onsite systems, such as septic tanks, have a shorter average lifespan of 20 to 30 years.[8] Most states do not collect condition data for these smaller systems, so an accurate assessment of the remaining lifespan or current condition is nearly impossible to determine. In 2015, the National Association of Home Builders estimated that the median age of owner-occupied housing across the U.S. was 37 years old, an indication that, without proactive homeowner maintenance, there may be significant needs for upgrading and/or replacing onsite wastewater infrastructure.[9]



Nationwide, the drinking water and wastewater pipes in the ground are on average 45 years old,[10] [11] while some systems have components more than a century old.[12] The typical lifespan expected for wastewater pipes is 50 to 100 years.[13] As collection systems age and decline in condition, groundwater and stormwater enters the networks through cracks, joints, or illicit connections as inflow and infiltration. When collection systems are overtaxed, sanitary sewer overflows (SSOs) can occur. Between 2012 and 2016, the EPA reports that improvements were made to more than 180 of the nation's large sanitary sewer systems, which typically accommodate over 10 million gallons of wastewater per day, and are prone to episodic SSOs.[14] In recent years, the progress has slowed.[15] Aside from SSOs, conveyance systems are also susceptible to other failures like blockages caused by consumer products such as wipes and paper towels.

In 2015, the National Association of Home Builders estimated that the median age of owner-occupied housing across the U.S. was 37 years old, an indication that, without proactive homeowner maintenance, there may be significant needs for upgrading and/or replacing onsite wastewater infrastructure.[9]

OPERATION & MAINTENANCE

Wastewater infrastructure may be owned by a public, private, or cooperative entity, and the operation and maintenance (O&M) may be conducted by the same party or subcontracted elsewhere. As utilities face the challenges of meeting increasingly stringent water quality regulations, funding significant infrastructure replacements, and affordably providing services amid growing public and environmental health risks, the option of merging (utility consolidation) may unlock financial, technical, and managerial resources to meet current needs and adapt to future demands.[16]

According to the U.S. Conference of Mayors, trends among municipal WWTPs show that nationwide O&M expenditures have increased by approximately 4% annually from 1993 to 2017, an increase partially due to deferred capital expenditures.[17] Depending on the type of WWTP and the collection system, O&M spending varies. In rural areas where decentralized systems are common, the responsibility to coordinate and finance O&M activities ranging from $250 to $500 every three to five years falls on homeowners.[18] However, with little to no instruction or oversight from state regulatory agencies, if O&M goes unaddressed, systems may fail, costing homeowners between $3,000 and $7,000.[19]

Thousands of miles of the nation's aging pipes are buried beneath increasingly urbanized cities and will require more and more inter-agency collaboration and data sharing, particularly as maintenance needs grow.[20] In a 2019 American Water Works Association report, as much as 62% of wastewater pipeline maintenance performed by combined utilities occurs through the proactive execution of asset management plans; the remaining 38% is completed as a reactive response to failures.[21] The report goes on to mention, since 2017, replacement rates for wastewater collection pipes have essentially stagnated. Nevertheless, in 2020, Bluefield Research estimated that utilities throughout the country will spend more than $3 billion on wastewater pipe repairs and replacements, addressing 4,692 miles of wastewater pipeline. This value translates into more than $18 per wastewater customer, a cost that is projected to grow by an average of 5% annually.[22]

FUNDING

Wastewater infrastructure may be funded by local user fees and taxes, state-specific grants or discretionary set-asides, and federal grants or financing mechanisms. Funding and financing differ through the simple fact that infrastructure financing, like any loan or bond, requires repayment over a 30- to 50-year period.[23] According to the Congressional Research Service, the federal government's share of capital investment has fallen from 63% in 1977 to less than 9% in 2017.[24] State and local entities shoulder the majority of capital projects and O&M expenses, which were approximately $20 billion in 1993 and increased to $55 billion by 2017.[25] [26]

Though utilities are seeking to address affordability challenges in vulnerable communities, decreasing usage due to water conservation appliances, persistent leaks from aging infrastructure, and increasing inflation have all contributed to the 24% increase in rates reported from 2008 to 2016.

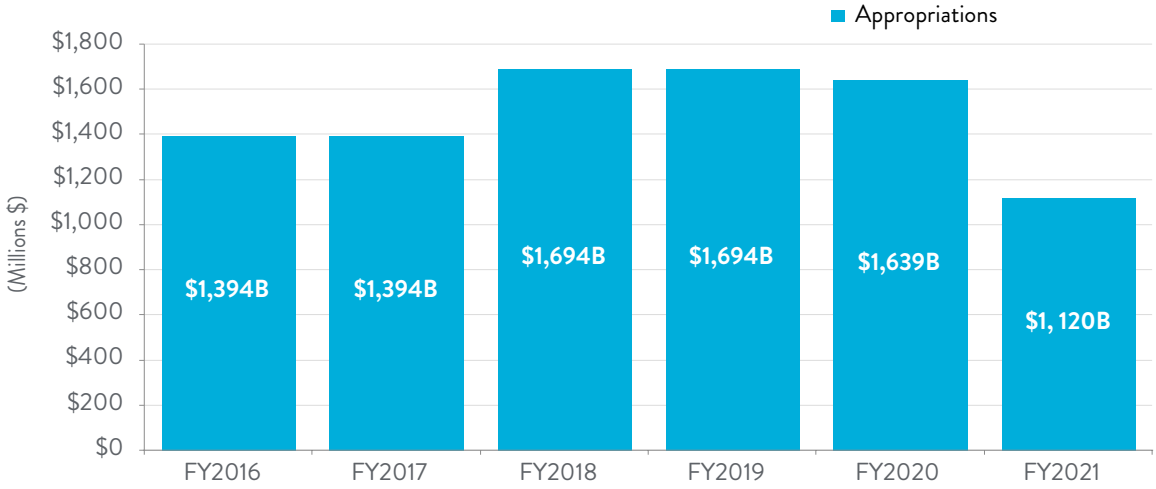
Nationally, a single-family residence pays an average rate of $504 annually for wastewater collection and treatment.[27] [28] Since 2008, user rates have trended upward to reflect the true cost of service and also due to dwindling revenues for many wastewater utilities.[29] Though utilities are seeking to address affordability challenges in vulnerable communities, decreasing usage due to water conservation appliances, persistent leaks from aging infrastructure, and increasing inflation have all contributed to the 24% increase in rates reported from 2008 to 2016.[30]

Some WWTPs are recouping savings and generating profits by implementing innovative technologies that reuse water, recover energy, and recycle nutrients.[31] Furthermore, state leaders have turned to levying

local taxes, initiating restoration fees, and creating legislative set-asides as a means to invest in wastewater infrastructure and to close the funding gap.

While wastewater utilities are responsible for covering the majority of their expenses, many also look to federal financing mechanisms, particularly for large capital projects.

EPA Clean Water State Revolving Fund Appropriations



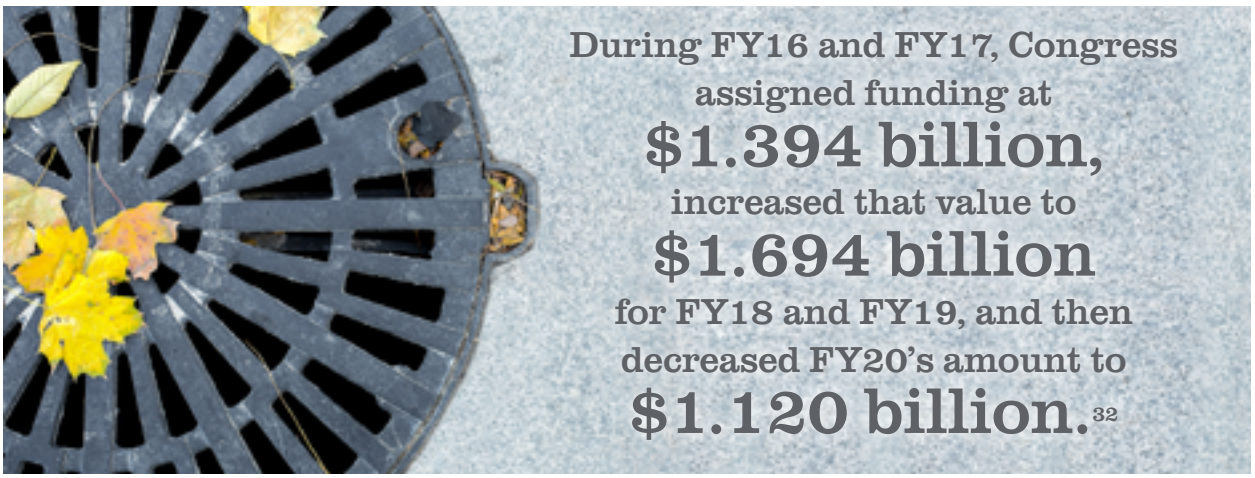
Wastewater Funding and Financing Mechanisms

Federal Agency	Program	Details
U.S. Department of Agriculture	Rural Utilities Service: Water and Waste Disposal Programs	The purpose of this program is to provide basic human amenities, alleviate health hazards, and promote the orderly growth of the nation's rural areas (communities with populations of 10,000 or less) by meeting the need for new and upgraded drinking water, wastewater, stormwater, and solid waste infrastructure.
U.S. Department of Housing and Urban Development	Community Development Block Grants (CDBG)	The program's primary objective is to develop viable communities by providing decent housing and a suitable living environment, and by expanding economic opportunities, principally for persons of low and moderate income. Accordingly, CDBG resources are not limited to drinking water, wastewater, and/or stormwater infrastrucure, but these projects must compete with other eligible activities including historical preservation, energy conservation, lead-based paint abatement, and more. The block nature of the CDBG distribution enables local government's to exercise discretion and on-the-ground knowledge when selecting appropriate projects that achieve program objectives.
U.S. Environmental Protection Agency	Water Infrastructure Finance and Innovation Act Program (WIFIA)	Established in 2014, the WIFIA program provides credit assistance through long-term, low-cost supplemental loans for regionally and nationally significant infrastructure projects. WIFIA authorizes EPA to provide credit assistance directly to an eligible recipient for a broad range of drinking water and wastewater projects that generally cost $20 million or more.
U.S. Environmental Protection Agency	Clean Water State Revolving Fund Loan Program (CWSRF)	Established in 1987 by amending the Clean Water Act, federal funds are directed to CWSRF programs in all 50 states and Puerto Rico to capitalize state infrastrucutre loans. CWSRF resources must be matched by 20% state-backed funds. Various projects from CWSRF include new construction and upgrades of wastewater treatment plants, stormwater infrastructure, nonpoint source pollution management plans, and more.

THE BALTIMORE BACK RIVER WASTEWATER TREATMENT PLANT

For instance, the EPA's Clean Water State Revolving Fund (CWSRF) provides resources to state agencies enabling them to act as "infrastructure banks" that grant funds and oversee low-interest loans. CWSRF grants require local entities to put forth a 20% match to the funds requested. During FY16 and FY17, Congress assigned funding at $1.394 billion, increased that value to $1.694 billion for FY18 and FY19, and then decreased FY20's amount to $1.120 billion.[32] In 2019, Bluefield Research reports that state agency requests for CWSRF funding exceeded $55.9 billion, indicating that the total, nationwide need significantly outpaces available funding.

Working in conjunction with EPA's CWSRF program, the Water Infrastructure and Finance Innovation Act (WIFIA) is an additional long-term, low-cost funding mechanism for regionally and nationally significant, large-dollar-value projects. From FY17 to FY19, Congress has increased WIFIA's lending capacity from $2.5 to $6 billion with more than $21 billion being requested for over 150 applicants



nationwide. In FY19, the federal government invited more than a dozen wastewater and water reuse projects to apply for over $2.3 billion in loans.

The U.S. Department of Housing and Urban Development manages the Community Development Block Grants program under which urban, economically disadvantaged areas may apply to receive grant funding. However, rural communities, those that cannot financially bear the responsibilities of long-term loans, may look to the U.S. Department of Agriculture's (USDA) Rural Utilities Service — Water and Environmental Program — for grant and financing options tailored particularly for their needs.

THE SOUTHWESTERN PARKWAY COMBINED SEWER OVERFLOW BASIN PROJECT

FUTURE NEED

In 2019, the total capital spending on water infrastructure at all levels was approximately $48 billion, while capital investment needs were $129 billion, creating an $81 billion gap. This underscores a chronic trend of underinvestment in critical water-related infrastructure —drinking water and wastewater systems. With this gap, only 37% of the nation's total water infrastructure capital needs were met. Assuming the water and wastewater sectors continue along the same path, the total gap will grow to more than $434 billion by 2029.

Also influencing the wastewater sector's future needs are the growing O&M costs that are outpacing available funding. As system components near or exceed their expected lifespans, O&M for water infrastructure become costlier. In 2019, 90% of the nation's $104 billion O&M funding need was met, leaving an annual gap of $10.5 billion. If trends continue, the country will face a single-year O&M shortfall of $18 billion in 2039.

The implications of unaddressed capital and O&M future needs are particularly pervasive within the nation's water-reliant businesses and healthcare industry. Economic projections indicate that by 2029, chronic service disruptions would cost water-reliant businesses $111 billion and American households a cumulative $378 million in healthcare costs.[33]

PUBLIC SAFETY

In some communities where legacy infrastructure exists, wastewater and stormwater systems are integrated into a combined sewer network. When these areas experience heavy rainfall or rapid snowmelt, the capacity of the combined system is overtaxed and results in combined sewer overflows where large volumes of partially treated or untreated wastewater bypass the treatment process and enter local waterbodies. According to the EPA, there are approximately 860 combined sewer systems throughout the country.[34] Over the last two decades, more than 200 of the nation's largest combined sewer systems (those serving > 50,000 people) have been identified and had actions taken to reduce overflow discharges that degrade water quality.[35]

Additionally, utilities grapple with treating and disposing of byproducts containing contaminants of emerging concern such as per- and polyfluoroalkyl substances (PFAS, forever chemicals) or novel biological components (antibiotic-resistant genes).[36] [37] EPA studies state that the PFAS family of chemicals is persistent in both the environment and human bodies, which means they are likely to accumulate over time. Furthermore, evidence shows that exposure to PFAS can lead to adverse human health effects. As these threats increase, so too does the need for costly improvements in wastewater treatment systems.[38] [39]

RESILIENCE

Utility managers, WWTP operators, engineers, and elected officials are increasingly incorporating aspects of resilience — a system's ability to withstand and adapt to the impacts of natural and/or man-made disasters — into the design, siting, and planning phases of their wastewater infrastructure. However, the suite of wastewater infrastructure vulnerabilities varies by geographic location, type of treatment system, age, and ownership status, so there is not a "one size fits all" solution.

For instance, some wastewater systems are in low-lying areas that are especially prone to the impacts of flooding, while others may be in drought-prone regions or areas with increasingly frequent wildfires.[40] Rather than continuing to operate under a "business as usual" framework, some critical infrastructure decision-makers are shifting their efforts from singularly addressing short-term metrics like population growth, capacity demands, and affordability, and are incorporating long-term, resilience-related factors into planning such as sea level rise, frequency, intensity, and likelihood of natural disasters, cybersecurity threats, and post-interruption recovery time.[41] For instance, the drinking water sector recently set a resilience precedent that may be instructive for many wastewater stakeholders. In 2018, resilience planning was streamlined within drinking water utilities with the signing of America's Water Infrastructure Act (AWIA) which requires drinking water systems to routinely develop and update Risk and Resilience Assessments and Emergency Response Plans.[42]

Across all sizes of wastewater treatment systems, technological and scientific innovations have made significant contributions to addressing the sector's challenges.

INNOVATION

Across all sizes of wastewater treatment systems, technological and scientific innovations have made significant contributions to addressing the sector's challenges. For example, water conservation appliances have reduced the volume of wastewater entering the system, treatment process innovations have more efficiently utilized existing capacity and limited resources, and real-time conveyance network monitoring can pinpoint and prioritize areas suffering from inflow and infiltration or in need of O&M.

Sensors and monitoring innovations are being installed to collect real-time data on the wastewater conveyance network's condition to inform and prioritize the system's O&M schedule. After a wastewater utility in San Antonio, Texas, implemented in-pipe sensors, data was collected to optimize the network's cleaning schedule, saving thousands of dollars in each location a sensor was installed.[43]

Additionally, in recent decades, resource recovery has increasingly shifted the traditional wastewater treatment mindset away from generating a product solely for disposal but reconceptualizing this "waste" as a "resource." Innovations such as anaerobic digestors, indirect potable reuse, and biosolids reuse systems can recover water, energy, and nutrients from treated wastewater and may contribute to the resilience of treatment facilities, communities, and entire watersheds.[44] [45]

Wastewater

RECOMMENDATIONS TO RAISE THE GRADE

- Infrastructure owners should engage in asset management practices across infrastructure sectors to extend the lifespan of assets and prioritize limited funding. Asset management must include continuous assessment of the condition of assets and prioritize investment decisions based upon a comprehensive suite of data.
- More collaborations between researchers, technologists, wastewater utilities and operators, and federal decision-makers will be needed to develop and quickly deploy effective regulations, systems, public safety education, and policies that address 21st century concerns such as per- and polyfluoroalkyl substances (PFAS, forever chemicals) or novel biological components.
- Expand EPA's CWSRF program and the Water Infrastructure and Finance Innovation Act (WIFIA) with additional long-term, low-cost funding mechanisms for regionally and nationally significant, large-dollar-value projects.
- Identify new grant programs and funding mechanisms whose goal is to eliminate and/or decouple the nation's remaining combined sewer systems.
- Develop a federal grant pilot program for publicly owned wastewater treatment plants whose purpose is to create or improve waste-to-energy systems that increase wastewater treatment efficiency.
- Incorporate geographically specific projected impacts of climate change into wastewater infrastructure planning and long-term funding decisions.
- Utilities should ensure their rates cover the full cost of service including operation, maintenance, and capital needs; clearly communicate rate increases to the public; and balance local issues of affordability.
- As all wastewater systems face multiple and increasing natural threats, a rule similar to America's Water Infrastructure Act of 2020 should be implemented to direct utilities to develop, update, and implement vulnerability (risk and resilience assessments) and emergency response plans.

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Spotlight on Broadband

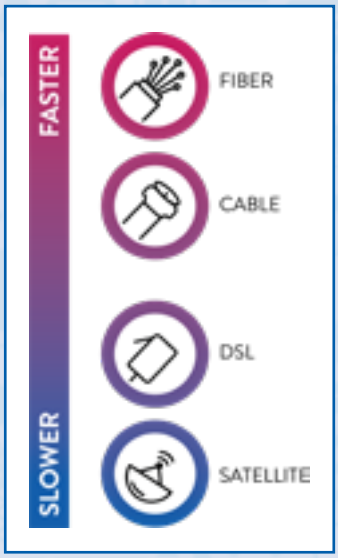
A NOTE ON THIS SPOTLIGHT:

The importance of broadband infrastructure has grown exponentially as we increasingly rely on it to support our connected lives. Meanwhile, civil engineers play a growing role in broadband installation, and high-speed internet is increasingly critical to the operation and modernization of our legacy infrastructure systems. Because of this, the ASCE Committee on America's Infrastructure felt it important to make recommendations on how to improve broadband infrastructure. However, the committee determined there was insufficient information on broadband infrastructure to justify a category grade.

SPOTLIGHT ON BROADBAND

Broadband, a generic term for high-speed internet access, enables students of all ages to learn online and businesses to reach customers and co-workers; facilitates electronic and verbal communications; provides access to healthcare and job openings; and can be the deciding factor of where a company chooses to expand. When the coronavirus pandemic forced millions of Americans to stay home in 2020 and 2021, an estimated one in five school-aged children lacked the high-speed internet connection needed to access lessons and other materials.[1]

The Federal Communications Commission (FCC) defines advanced telecommunications capability as a download speed of 25 megabits (MGB) per second or higher, and upload speeds of 3 MGB or higher. Internet can be provided by satellite, digital subscriber line (DSL), cable, microwave, or fiber. Presently, the FCC does not consider wireless connections, e.g., cell phones, in its assessment of broadband access. Infrastructure includes tower-supported antennae/repeaters (wireless), and fiber optic or copper wire (wired). Wired communications also involve a significant amount of underground duct-installed circuiting.



Estimates paint a fuzzy picture at best on how many Americans can access broadband internet speeds. According to the FCC, 93.5% of the U.S. population has access to high-speed internet. However, there are significant disparities in the FCC's estimate, which defines "access" as one or more locations per census block capable of accessing download speeds of 25MGB or more. The National Association of Counties (NACo) estimated in 2020[2] that 65% of counties have average connection speeds lower than the FCC's definition of broadband. NACo reported counties of all sizes had connectivity issues, but the majority of small and medium-sized counties (populations of <50,000 and 50,000-499,999, respectively) experienced slower speeds, as compared to less than 20% of larger counties (population >500,000).

President Trump signed the Broadband Deployment Accuracy and Technological Availability (DATA) Act in early 2020 that requires the FCC to update their broadband maps to more accurately reflect broadband coverage. However, the timeline for this update is unclear, and the FCC has stated more resources are needed to carry out the DATA Act mandate.[3]

Notably, disadvantaged and rural communities are typically worse off when it comes to being able to access broadband internet. A study by the Center for Public Integrity reports that families with household incomes over $80,700 are five times more likely to have access to broadband than a household with income below $34,800 (the top fifth and lowest fifth income thresholds, respectively).[4]

Americans' reliance on fast internet is only forecasted to grow in the coming years. According to the Cellular Telecommunications Industry Association (CTIA), data use in 2018 was 73 times higher than in 2010.[5] To meet the demand for data, the telecommunications industry is expanding and deploying more cell sites, launching 5G, and looking at the next generation of wireless. Reliable and widespread access is also a prerequisite for communities looking to integrate communications and data into transportation and utilities infrastructure systems.

Americans' reliance on fast internet is only forecasted to grow in the coming years.

As elected officials and decision-makers work toward increasing access, the role of civil engineers in the deployment of broadband is important. Expanding broadband infrastructure typically involves right-of-way issues and "dig once" or co-location policies that have heavy involvement from civil engineers. Additionally, civil engineers manage construction and design and deliver poles, structures, and towers across the country that will play an increasingly important role in hosting 5G receptors, as well as assess the structural integrity of buildings that host transmitter and receiver antennas.

Federal, state, and local governments and the private sector are working to close the digital divide. CTIA reports the telecom industry has spent over $253 billion in capital investments since the launch of 4G in 2010. In 2019, telecom invested $27.4 billion in expanding capacity, increasing coverage, developing infrastructure, and upgrading technology to support 5G. However, it is important to note that private companies do not have a natural incentive to invest and expand service in rural areas with smaller or less affluent customer bases, contributing to service gaps in many of those regions.

Some public funding is available to help support the deployment of broadband to previously unreached communities. Through the FCC, the federal government disbursed over $15 billion by funding various programs across the U.S. between 2000 and 2018. In 2020, the agency launched the Rural Digital Opportunity Fund, a 10-year, $20 billion program that will finance deployment of faster broadband networks to underserved rural areas.[6] Other public agencies are also focused on closing the digital divide. The U.S. Department of Agriculture awarded $600 million in rural telecom grants between 2009 to 2016. Governors and state legislatures have established broadband deployment grants and requested coordinated policy from relevant state agencies.

Of course, significant work remains, and the accelerated deployment of broadband should involve careful planning and productive partnerships between all levels of government and the private sector. These planning efforts must recognize that rapid growth and expansion is necessary to avoid technical obsolescence, also leverage legacy infrastructure to the extent possible.

Increasingly, other infrastructure sectors are relying on telecommunication capabilities to modernize and improve safety. Everything from autonomous vehicles reading road signs to water pipes embedded with leak detection sensors will depend on broadband access. Looking forward, the pressing need to modernize our infrastructure networks will require information on where broadband service is lacking and a clear vision of where we're headed.

Broadband

RECOMMENDATIONS TO RAISE THE GRADE

- Ensure the updated maps required by the Broadband DATA Act are developed in a timely fashion and in close coordination with state, local, and private stakeholders, including service providers.
- States and municipalities should develop broadband plans aimed at closing the gap in digital for all. These plans should foster stakeholder engagement; identify and remove limitations to improve data collection and mapping; support strategic buildouts and deployment efforts; and encourage the preservation of conduit and right of way for future technologies.
- A coordinated approach is needed to ensure broadband is built out to underserved populations, similar to the Rural Electrification Act of 1936.
- Co-location of broadband should be planned with existing infrastructure, especially in the instance where public funding is provided. This includes above-ground infrastructure and the codification of "dig once" policies where service providers install broadband conduit as other infrastructure is installed.
- Enact and enforce codes and standards to ensure that utility poles and other structures that support 4G/5G and future telecommunications equipment are structurally sound, reliable, and resilient.

DEFINITIONS

BROADBAND – Wired or wireless data streaming (internet) operating at speeds of at least 25 megabits per second downstream, 3 megabits per second upstream.[7]

4G (MOBILE WIRELESS) – 4G data streaming at approximate speeds between 12 and 36 megabytes per second. This equates to a roughly six-minute download time for a feature-length movie.

5G (MOBILE WIRELESS) – 5G data streaming as supporting up to 300 Mbps or greater. A feature-length movie can be downloaded in as little as 15 seconds.[8]

FIBER OPTIC BROADBAND – Wired technology that converts data-carrying electric signals to light, which can then be transmitted through glass fibers approximately the diameter of human hair. According to the FCC, fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps.

WIRELESS BROADBAND – Data streaming (internet connection) to a home or business connects between the customer's location and the service provider's facility. Wireless broadband can be mobile or fixed.

SATELLITE BROADBAND – The FCC defines satellite broadband as another form of wireless broadband, useful for serving remote or sparsely populated areas. Speeds can be slower than DSL and cable modem, but 10 times faster than the download speeds of dial-up internet access. Extreme weather conditions can disrupt satellite service.

Broadband

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2021

REPORT CARD FOR AMERICA'S INFRASTRUCTURE

OUR INFRASTRUCTURE VISION

Decision-makers at all levels of government increasingly recognize the critical role our infrastructure plays in supporting our quality of life and economy. Voters and lawmakers alike have championed smart infrastructure policy and increased investment in our multimodal freight system, drinking water networks, and more. We must not let this hard-earned progress slip away if we want healthy, resilient communities and a strong economic foundation for the future. This down payment on our infrastructure bill has contributed to *modest but meaningful improvements.*

Acting now will save us money in the long-term. Our investment gap is already ballooning, and we are underspending on infrastructure by nearly $260 billion per year. Just as cars demand tune-ups and roofs require incremental repairs, our infrastructure needs robust and sustainable funding to make continued needed improvements over time. Putting off investment now will cost us and future generations down the line.

As we look for opportunities to create high-paying jobs, strengthen the backbone of the next century's economy, build resilient communities, and compete in the global marketplace, sound infrastructure policy and robust investment is the path forward.

#GAMECHANGERS

Game Changers:

ASCE has combed through successful solutions across the major infrastructure sectors to identify the most innovative infrastructure #GameChangers. These are ground breaking infrastructure projects and programs that represent the latest innovations in transportation, water, and energy infrastructure that are transforming the way engineers plan, build, and adapt to the nation's infrastructure needs. ASCE's list of #Gamechangers must meet one of the following criteria: innovative technologies, creative funding mechanisms, and unique collaborations between agencies or private firms.

https://www.infrastructurereportcard.org/solutions/gamechangers/

INFRASTRUCTURE REPORT CARD HISTORY

The concept of a report card to grade the nation's infrastructure originated in 1988 with the congressionally chartered National Council on Public Works Improvement report, Fragile Foundations: A Report on America's Public Works. A decade later, when the federal government indicated they would not be updating the report, ASCE used the approach and methodology to publish its first Report Card on America's Infrastructure in 1998. With each new report in 2001, 2005, 2009, 2013, 2017, and now 2021 – the methodology of the Report Card has been rigorously assessed so as to take into consideration all of the changing elements that affect America's infrastructure.

In 1988, when Fragile Foundations was released, the nation's infrastructure earned a "C," representing an average grade based on the performance and capacity of existing public works. Among the problems identified within Fragile Foundations were increasing congestion and deferred maintenance and age of the system; the authors of the report worried that fiscal investment was inadequate to meet the current operations costs and future demands on the system. In each of ASCE's seven Report Cards, the Society found that these same problems persist. Our nation's infrastructure is aging, underperforming, and in need of sustained care and action. Elected officials from both sides of the political aisle and at all levels of government regularly cite the Report Card, beginning with the very first release in 1998, when President Bill Clinton referenced the Report Card's grade for Schools. News reports reference the Report Card on a daily basis, with mentions in The Wall Street Journal, The New York Times, USA Today, The Washington Post, and the Los Angeles Times, as well as on National Public Radio, NBC's Today Show, 60 Minutes, CBS Evening News, and HBO's Last Week Tonight with John Oliver, among many others.

CATEGORY	1988**	1998	2001	2005	2009	2013	2017
Aviation	B-	C-	D	D+	D	D	D
Bridges	—	C-	C	C	C	C+	C+
Dams	—	D	D	D+	D	D	D
Drinking Water	B-	D	D	D-	D-	D	D
Energy	—	—	D+	D	D+	D+	D+
Hazardous Waste	D	D-	D+	D	D	D	D+
Inland Waterways	B-	—	D+	D-	D-	D-	D
Levees	—	—	—	—	D-	D-	D
Ports	—	—	—	—	—	C	C+
Public Parks & Recreation	—	—	—	C-	C-	C-	D+
Rail	—	—	—	C-	C-	C+	B
Roads	C+	D-	D+	D	D-	D	D
Schools	D	F	D-	D	D	D	D+
Solid Waste	C-	C-	C+	C+	C+	B-	C+
Stormwater	—	—	—	—	—	—	D
Transit	C-	C-	C-	D+	D	D	D-
Wastewater	C	D+	D	D-	D-	D	D+
GPA	**C**	**D**	**D+**	**D**	**D**	**D+**	**D+**
Cost to Improve**	**—**	**—**	**$1.3T**	**$1.6T**	**$2.2T**	**$3.6T**	**$4.59T**

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Karen Donohue with KLD Design

Maria Matthews

Brian Pallasch

Heather Smith

Ironistic

LGND

Weymouth Watson

WordsFresh