2019 REPORT CARD FOR WASHINGTON'S INFRASTRUCTURE

American Society of Civil Engineers Seattle, Tacoma-Olympia, and Inland Empire Sections

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Infrastructure Matters

Infrastructure supports our economy and our way of life. In Washington, our infrastructure allows us to thrive in diverse climates and topographies. Our transit systems, including the largest ferry operation in the U.S., allows us to inhabit islands in Puget Sound and off the coast, while our road and bridge maintenance programs facilitate the necessary repair of infrastructure in climates ranging from temperate rainforests to dry deserts. Our infrastructure also protects our pristine natural resources from human development.

Unfortunately, infrastructure and the important role it plays can sometimes be overlooked — pipes deliver clean water, our light switches work as they should, and clicking "purchase" on our goods and services ensures they'll be at our doorsteps within two days. We tend to only pay attention when things break down or stop working as they should.

Reliable and safe infrastructure requires sufficient investment, thoughtful planning, and preparation for the future. For a long time, underinvestment at all levels of government threatened our competitive advantage and the health, safety, and welfare of our residents. Fortunately, the state and many local governments have taken recent measures to provide additional support for our infrastructure. While the new funding and higher prioritization is welcome, additional steps can still be taken to ensure Washington's infrastructure is fit for the future.

The Report Card was created to help Washington understand the state of our infrastructure. As civil engineers, our job is to plan, design, construct, and maintain our infrastructure networks. This document allows us the opportunity to share that information with the public. The Report Card provides a snapshot for residents and policymakers to engage in a conversation about where we are and where we want to be. We hope that this information provides the insight needed to start that conversation and ignite action.

Richard Fernandez, PE
Report Card Committee Chair
ASCE Seattle Section


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Solutions to Raise the Grade

1. **Leverage sustainable loan programs to finance necessary infrastructure projects around Washington.** State and federal support is available through various revolving loan programs, including the Water Infrastructure Finance and Innovation Act (WIFIA), the Transportation Infrastructure Finance and Innovation Act (TIFIA), federal-state partnership revolving funds, and the state's Public Works Trust Fund. These funds provide a valuable source of low-cost infrastructure financing to local governments. Financing from the Public Works Trust Fund, specifically, must be used for its intended purpose of modernizing infrastructure, rather than to offset spending elsewhere in the state budget.

2. **Balance the needs of urban and rural communities. Forward-thinking investments in categories like transit and schools are helping the Puget Sound region prepare for the future.** However, investment and priority should not be limited to urban areas. Rural communities require support for maintaining and improving water, roads, aviation networks and more. Funding for rural infrastructure will ensure all Washingtonians have equitable access to jobs and a strong quality of life.

3. **Meet the demands of a growing population. Recent changes in the state are stress-testing the civil infrastructure we use every day.** Population growth in Washington continues and Seattle has been the fastest-growing city in the country since 2010. Not only are transportation facilities congested, but demands on water supply, schools, and wastewater continue to grow. Service providers need investment to maintain and increase performance.

4. **Lead in environmental sustainability and resilience to natural disasters. Washington is home to vital natural resources, a pristine environment, and a booming population that treasures them.** The Governor, state lawmakers, and Washington voters have so far supported major investments in infrastructure as a means to prepare for our future and preserve what we have today. Looking forward, we need green stormwater infrastructure to protect fish and wildlife in Puget Sound, improved mobility to fight congestion, and to prepare for risks from extreme events, such as a Cascadia Subduction Zone earthquake or other natural disaster. All of these action items require robust, sustained investment in our infrastructure.

Ask your elected leaders what they're doing to make sure your infrastructure is reliable for the future. Use your zip code to find your list of elected officials at www.infrastructurereportcard.org/take-action.

Aviation

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Executive Summary

Each year, more than 25 million passengers and 600,000 tons of cargo are transported through the Washington state aviation system. Aviation is critical to the economy of Washington, the home to many global companies including Amazon, Costco, Microsoft, and Boeing. The aviation system has provided more than 300,000 jobs, $16 billion in wages, and $64 billion in total economic activity annually. While the future is bright, planned improvements must be realized before traffic demand exceeds capacity. The Washington State Department of Transportation (WSDOT) estimated that $3.6 billion is needed to grow and sustain Washington's 134 public airports during the next 20 years. Seattle–Tacoma International Airport (Sea-Tac) faces significant capacity challenges, but a new international arrivals facility will help accommodate passenger growth and enhance air traffic.

Capacity

Across all the airports in Washington State, there were nearly 25 million passenger enplanements in 2016. Of those, 99.8% were commercial enplanements at one of the state's 11 commercial service airports. These commercial service airports are listed in Table 1; they are responsible for the majority of passenger and cargo transport within the state.

Table 1: Washington Commercial Airport Enplanements

ID	City	Airport Name	2016 Enplanements	2015 Enplanements	% Change
SEA	Seattle	Seattle-Tacoma International	21,887,110	20,148,980	8.63%
GEG	Spokane	Spokane International	1,570,652	1,515,351	3.65%
BLI	Bellingham	Bellingham International	415,285	447,693	-7.24%
PSC	Pasco	Tri-Cities	374,301	348,990	7.25%
YKM	Yakima	Yakima Air Terminal/McAllister Field	70,993	63,747	11.37%

ID	City	Airport Name	2016 Enplanements	2015 Enplanements	% Change
PUW	Pullman	Pullman/Moscow Regional	61,833	50,883	21.52%
EAT	East Wenatchee	Pangborn Memorial	60,068	62,319	-3.61%
ALW	Walla Walla	Walla Walla Regional	47,439	41,272	14.94%
BFI	Seattle	Boeing Field/King County International	17,795	18,945	-6.07%
FHR	Friday Harbor	Friday Harbor	12,831	11,254	14.01%
ORS	Eastsound	Orcas Island	7,826	5,204	50.38%
Total			**24,526,133**	**22,714,638**	**8%**

Two types of airport capacity must be considered in assessing the aviation infrastructure of Washington: airside and landside. Airside capacity looks at the demand of aircraft, runways, and, subsequently, the demand of passengers. Landside capacity assesses terminals, the physical capacity of the infrastructure. Without sufficient airside and landside capacity, airport operations will be strained and result in passenger delays while compromising efficiency for airports, airlines, and passengers.

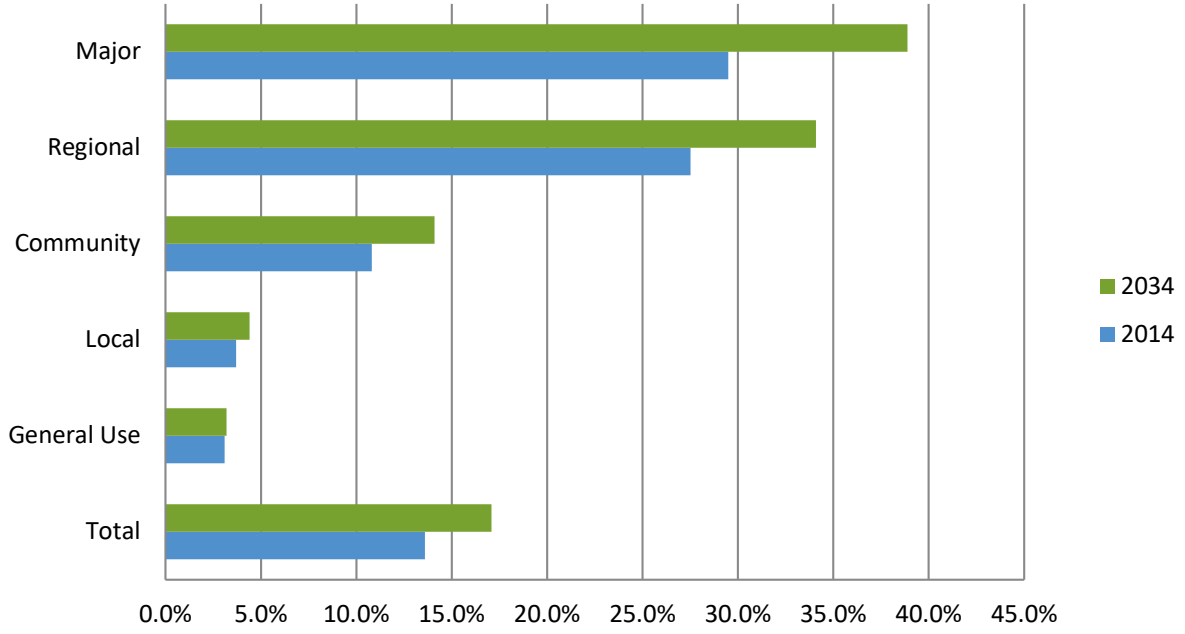
Table 2: Washington Airport Demand

Airport Name	Annual Service Volume 2014	Operations 2014	% Capacity Utilized
Sea-Tac International	533,000	340,078	63.8%
Harvey Field	230,000	141,739	61.6%
Auburn Municipal	230,000	164,539	71.5%

The Washington State Department of Transportation (WSDOT) reported results from a 2014 airport demand analysis in the Washington Aviation System Plan (WASP). Airport capacity is the ratio of actual operations to total annual service volume. For airports with capacity greater than 60%, the FAA recommends additional capacity planning. As of 2014, three Washington airports exceeded 60% usage of the annual service volume. Table 2 from the WASP report reflects which airports are at more than 60% of operations capacity.

Currently, demand has not exceeded capacity for any of Washington's airports. The key to maintaining high levels of airport operations is to plan for the future capacity needs of the state. Figure 1 illustrates 2014 versus 2034 Aircraft Operation Demand and Capacity Utilization.

Figure 1: 2014 vs 2034 Aircraft Operations Demand/Capacity Utilization by Service Classification



The capacity forecast indicates an increase in every category across the state. However, Seattle-Tacoma International Airport (Sea-Tac) is facing alarming capacity exceedance issues due to increasing international service demand and population growth. International passenger activity has doubled since 2005 and the Sea-Tac service area population is expected to add another 1 million people by 2040. Currently, Sea-Tac is expanding and building a new international arrivals facility to accommodate passenger growth and enhance air traffic flow. It is scheduled to open in late 2019. Twenty-year growth projections from the Port of Seattle indicate the airport will need to continue to make crucial facility improvements to serve a projected 66 million passengers and 540,000 annual operations in 2034.

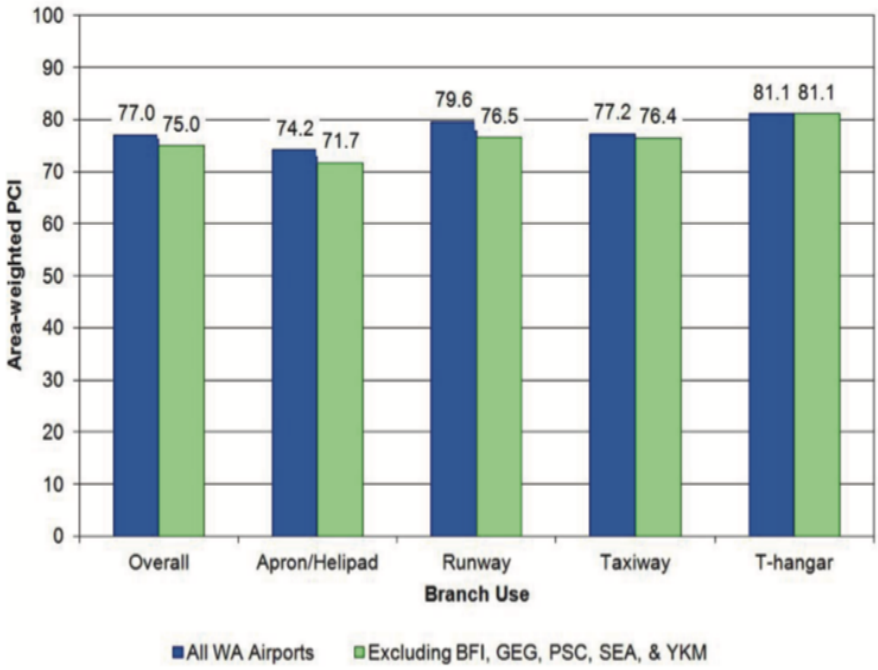
Similarly, Tri-Cities (Pasco) Airport has invested in and completed a 2017 terminal expansion project, doubling the size of the terminal and increasing passenger capacity to serve more than 1 million potential passengers. Both of these initiatives are evidence of Washington's response and commitment to invest in facility improvements to meet increasing capacity demands.

Condition

WSDOT's Aviation Division is updating its Airport Layout Plans (ALP) to address the airports' needs over the next 20 years. The ALP report evaluates infrastructure needs and provides guidance for future improvements that are cost-effective. Runway pavement is one of the most critical infrastructure elements to determine airport condition and is based on pavement condition index (PCI). As shown in Table 3, the PCI can range from 0 (failed) to 100 (perfect).

The last statewide survey of airport pavement condition was in 2012 and included 100 airports and approximately 150 million square feet of pavement. The average PCI of the 100 airports' pavement areas was 77. The pavement condition of primary airports exceeded that of non-primary airports. The study showed that 71% of the total pavement area was in need of preventative maintenance, 18% was in need of significant rehabilitation, and 11% was in need of reconstruction. Pavement was recommended for preventive maintenance if its forecasted condition was above the critical PCI based on the table shown below.

Figure 3: 2012 Area-Weighted Pavement Condition Index



The 2012 study stated that since 2005, only the primary airports had shown pavement improvement while non-primary airports had shown a significant decrease in condition.

Maintenance and rehabilitation funding for non-primary airports is at $4.5 million per year, and the study estimated that if current funding levels continue, the overall area-weighted PCI will drop from 75 to 71 by 2020. The estimated backlog of airport pavement rehabilitation and reconstruction projects for non-primary airports will increase by 68% to $301 million by 2020. The condition is rated poor to fair on a scale of excellent, good, fair, poor, and very poor. Washington should continue to continue to conduct systemwide studies of pavement conditions and allocate more resources to improve conditions at non-primary airports.

Operations & Maintenance

Preventative maintenance must be regularly performed to protect and preserve the airport infrastructure that provides so much value to the state of Washington. Budgets for improvement projects at airports largely rely on grants. When grants are awarded, there can be competing priorities between projects that must be addressed. As mentioned in the Condition section, with the current level of maintenance funding, the overall PCI is projected to fall from 75% to 71% in 2020. There must be an increase in attention and funding for airport maintenance to halt this rate of pavement degradation.

Currently, a study sponsored by the Federal Aviation Administration (FAA) and WSDOT's Aviation Division is underway to conduct pavement inspections and develop maintenance, repair, rehabilitation, and reconstruction recommendations for 100 of Washington's airports. The study will update the 2013 Washington State Airport Pavement Management System Report, which involved approximately 150 million square feet of pavement. The updated findings will help WSDOT and the FAA determine to what extent preventative maintenance remains cost-effective, and how much major pavement rehabilitation will be required in coming years.

Funding

Airport infrastructure development and preservation are critical to meet demands posed by rapid expansion and require a large amount of funding to support. Funding comes from a combination of federal, state, and local grants. Federal funding is provided from the Airport Improvement Program (AIP) and local funding is provided from passenger facility charges (PFCs). AIP funds originate from the Airport and Airway Trust Fund, which draws support from user fees, fuel taxes, and other revenue sources. The PFC allows airports to collect fees of up to $4.50 for every enplaned passenger at commercial airports with a maximum of two PFCs charged on a one-way trip or four PFCs on a round trip. Approximately $2 billion was collected through PFCs between 1992 and August 2018. In 2018, PFCs generated more than $51.5 million, and $1.5 million in interest.

The 2015 WASP lists 136 public airports in the state, and the FAA included 64 of those airports in the National Plan of Integrated Airport Systems (NPIAS) because they are significant to the national air transportation system. Airports listed by NPIAS are eligible to receive funding

through the AIP. A total of 10 out of the 64 NPIAS airports are primary, and the remaining 54 airports are non-primary.

At the state level, Washington's Airport Aid Grant Program provides approximately $1.4 million per year until 2034 for both NPIAS and non-NPIAS airports in the state. Revenues for the Airport Aid Grant come from aviation fuel taxes and aircraft registration fees. For 2017, 87% ($76.7 million) of the total $88 million in airport funding came from federal sources and WSDOT, while state and local aid contributed 13% ($11.3 million) in funds to 25 airports from 2017 to 2019.

In addition to funding required by airport infrastructure, airport operation and security demand a large amount of funding. The increased cost of airport maintenance and limited resources available for capital infrastructure projects contribute to Washington's airport funding challenge. WSDOT estimates that $3.6 billion is needed for Washington's 134 public airports over the next 20 years, which translates to an average annual need of more than $12 million. Due to the shortage of available funding, lower-priority projects and smaller airports are unable to obtain needed grants for improvements. Potential solutions to this challenge include identifying new funding sources, refining current funding programs, and establishing airport best management practices.

Future Need

One of the main challenges Washington is facing is the encroachment of incompatible land use development near airports. Incompatible land uses pose a serious threat to airports by reducing their service capabilities and compromising the public's investment in airport infrastructure. Development occurring near an airport can reduce property available for the airport to expand and provide for increased demand. It can also limit available space for operation and safety areas. To meet the challenge posed by encroachment upon public-use airport lands, Washington State Department of Transportation (WSDOT) Aviation Division created the Airport Land Use Compatibility Program, which supports partnerships between land use jurisdictions and airport sponsors and advocates for compatible land uses adjacent to airport facilities.

Washington airports must also withstand an ever-increasing demand for e-commerce and online shopping activities. FedEx, DHL, and Amazon PrimeAir are all relying on the Sea-Tac hub for more freight transport operations. For the past 30 years, world air cargo traffic averaged 5% growth per year. In 2017 alone, world air cargo traffic increased by 10%. Washington state has increased its national air cargo market share market from 2.6% to 2.9%. Boeing, Airbus, the FAA, and the International Air Transport Association (IATA) are all forecasting an approximately 4% annual increase in air cargo traffic for the next 20 years. Air cargo will continue to be a defining element of Washington's airport infrastructure. Airport master plans are now focused more on freight transport than ever before.

Safety

WSDOT measures aviation safety based on the percentage of investments allocated to airport safety improvement projects, including runway obstruction removal, or runway safety area enhancements. According to the WSDOT 2016 Multimodal Safety Report, 50% of Airport Aid Grant funding that year was designated to safety projects.

In 2017, state and federal airport funding sources invested $30 million in safety-related projects. Runway realignment at Pullman-Moscow Regional Airport, separating runways and taxiways to reduce accident potential, was one major airfield improvement. Airport safety is determined by PCI, runway and taxiway layout, defined runway safety areas, and obstacles in primary approach surfaces.

Runway safety areas (RSA) are an added measure of insurance to protect aircraft in the event of an undershoot, overshoot, or excursion from the runway. This separately defined surface surrounding the runway helps reduce risk and is regulated by FAA safety standards. In Washington, only 36% of runways are currently RSA-compliant. The WSDOT Airport Information System Database reports that in 2016, 3% of general use airports met RSA length and width standards, while regional airports had the highest compliance as 66% of runways met RSA standards. Of all airports, 62% were compliant with taxiway safety.

The Washington Statewide Capital Improvement Plan for 2017-2021 lists hundreds of projects that will enhance airport safety across the state at all types of airports. About $15 million of project spending directly impacts runway and taxiway safety enhancements, and many activities are partially funded by the state. Some of the projects include grading and pavement updates in runway safety areas, reflector and runway lighting installation, updated fueling systems, inclement weather technology, and improvements to roadways, runways and taxiways. These improvements, particularly at smaller airports, will bring many airport facilities into compliance with FAA safety regulations.

Innovation

Three gamechangers are coming to Washington state aviation: unmanned aircraft systems (UAS), airport infrastructure funding challenges, and future air traffic management in NextGen, the FAA-led modernization of our nation's air transportation system. It is essential that innovative and technological advances take place in Washington to prepare for NextGen and the incorporation of UAS into our air transportation system.

The next major FAA NextGen milestone is in 2020. In 2013 and 2015, WSDOT Aviation participated in studies to enable integration of NextGen technologies. To equip airports for NextGen, four main technologies are required: wide area augmentation system (WAAS), GPS satellites, FAA satellite-based approach procedures, and WAAS-enabled aircraft instrumentation. WSDOT Aviation established action items and priorities for implementation,

including a statewide NextGen study, outreach to pilots to incorporate automatic dependent surveillance (ADS-B) enhancements, and the promotion of airport engagement and partnership in NextGen studies and implementation.

There are numerous safety and regulatory implications due to the emergence of UAS in public and commercial operations. In holding UAS operators responsible for regulatory compliance, WSDOT mirrors the FAA. UAS smaller than 55 pounds are the primary focus for integration into U.S. airspace. Washington State legislators have proposed bills regarding UAS policy, and the state must prioritize both safety and innovation to move forward.

Resilience

The Catastrophic Incident Planning Framework (CIPF), supported by FEMA, is an emergency planning framework to prepare for a catastrophic incident affecting Washington State. In order to respond effectively to a disastrous event, WSDOT has adopted the CIPF as well as the FAA's Airport Emergency Plan. For both international and regional airports in Washington, the targeted time frame for response is 0-24 hours, and the recovery time is three months to one year. Many Washington State airports

Solutions to Raise the Grade

1. Prioritize legislation that increases funding to airport investments directly from aviation taxes and fees.
2. Support regular reauthorization of the FAA to stabilize funding sources for investments in innovation and stronger infrastructure.
3. Continue to fund and maintain airport pavement, the most essential infrastructure in the aviation system. Capitalize on opportunities to perform preventative maintenance before full rehabilitation is required.
4. Enforce more protection plans for future airport development and expansion to prevent encroachment by incompatible land uses near airports.
5. Follow through on past commitments to improve safety and standards of operational excellence by complying with all safety regulations and standards at all airports in Washington.
6. Recognize airports that partner with industry, associations, and academia to develop new aviation mobility concepts.
7. Update airport condition assessments statewide, including the 2018 pavement, terminal, and layout condition studies.

Find Out More From These Sources

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Transit

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Executive Summary

Washington state has 33 transit agencies that provide bus, ferry, and light rail service to more than 7 million residents. The greater Seattle area continues to lead the nation in transit ridership growth; ridership increased by 4.7% from 2015 to 2016, and a record 122.2 million riders used transit in 2017. In 2016, voters approved a major expansion of Sound Transit's transit network, which will add 110 miles of light rail service to the Puget Sound region by 2040. However, in rural areas outside of urban and suburban centers there is less demand for transit to support adequate funding and quality service. Meanwhile, the state will continue to experience significant challenges due to population growth, regional geographic and geologic hazards, transit safety, limited funding, and equitable access. Transit is a vital solution to many of these challenges and is instrumental to Washington's economic success. Transit infrastructure needs to be improved, maintained, and expanded.

Introduction

Washington State has 33 transit agencies that include bus, ferry, and light rail service:

- 21 public transportation benefit areas (Asotin County PTBA, Ben Franklin Transit, Clallam Transit System, Community Transit (Snohomish County PTBA), C-TRAN (Clark County PTBA), Grant Transit Authority, Intercity Transit (Thurston County), Island Transit, Jefferson Transit Authority, Kitsap Transit, Link Transit, Mason Transit, Pacific Transit System, Pierce Transit, RiverCities Transit (Cowlitz Transit Authority), Skagit Transit, Spokane Transit, TranGO (Okanogan County Transit Authority), Twin Transit (Lewis County PTBA), Valley Transit, and Whatcom Transportation Authority)
- 5 city transit agencies (Everett Transit, Pullman Transit, Selah Transit, Yakima Transit, and Union Gap Transit)
- 3 county public transportation authorities (Columbia County Public Transportation, Garfield County Transportation Authority, and Grays Harbor Transit)
- 1 metropolitan county transit agency (King County Metro Transit)
- 1 unincorporated transportation benefit area (Whitman County UTBA)
- 1 regional transit authority (Sound Transit)
- 1 state ferry system [Washington State Ferries, owned and operated by the Washington State Department of Transportation (WSDOT) and Keller Ferry, which runs across the Columbia River in Eastern Washington, also operated by WSDOT]

Washington's geography features large, deep bodies of water with many peninsulas and islands, so ferries are a natural means of connecting communities in the region. Additionally, the WSDOT Travel Washington Intercity Bus Program (Grape Line, Dungeness Line, Apple Line, and Gold Line) also provides service between cities in some areas. Both of these programs fill gaps in the statewide transit system by providing connections to rural communities and underserved parts of the state.

Capacity

Washington is one of few states that experienced an increase in public transit usage during the past few years. Between 2012 and 2016, the average annual Unlinked Passenger Trip — a trip on one transit vehicle — increased 2.66%. While usage trends are encouraging, Seattle's population alone grew by 17,000 people from 2016 to 2017, and by 13.5% since 2010. The Puget Sound region has benefited from the expansion of several transit options; looking forward, however, adequate investment in transit will be key to addressing congestion and improving air quality.

In the immediate future, congestion challenges are expected to continue due to what transportation officials are referring to as the "period of maximum constraint," also known as the "Seattle squeeze." As early as March 2019, 570 buses a day will be evicted from the downtown tunnel when the Washington State Convention Center expansion project begins. Adding to the "Seattle squeeze" will be the SR-99 viaduct's permanent closure. Buses will be rerouted, and other modes of transportation are expected to be drastically impacted as well. This will be a powerful reminder that redundancy in the transportation network is key.

The majority of the state's transit agencies are located in urban or suburban Puget Sound. There is limited transit service in rural communities and, in many cases, a lack of adequate funding and quality service. One exemplary provider servicing rural communities is Ben Franklin Transit, which operates in southeast Washington. Ben Franklin Transit provides service for a total population of 200,000 people. The fixed round service operates in Kennewick, Pasco and Richland, while the vanpool operations fill in gaps in service. For $70 a month, rural residents have access to businesses and major employment centers.

Washington State Ferries (WSF) operates the largest ferry system in the United States and the fourth-largest ferry system in the world. Twenty-two ferries cross Puget Sound and its inland waterways, carrying more than 22 million passengers to 20 different ports of call. From Tacoma, Washington, to Sidney, British Columbia, travel routes up and down the Sound act as a marine highway for commercial users, tourists, and daily commuters alike. Every weekday morning, more than 75,000 Puget Sound residents commute to work or school on board a Washington State ferry.

Condition

King County Metro Transit worked with the Federal Transit Administration to develop a State of Good Repair Index for bus and trolley fleets. Metro Transit's 2015 assessment indicates that the fleet requires frequent minor repairs and infrequent major repairs. The average age of Metro's buses decreased from 9.3 years in 2014 to 8.9 years in 2015, as the agency placed 179 new buses into service. As a result, the fleet's total condition points went from 60 (2014) to 64 (2015) on a scale of 1-100. King County Metro Transit recently won an award for the 2018 best large transit system in North America from the American Public Transportation Association.

Much of the Sound Transit light rail is relatively new when compared to systems in other parts of the country. One of the two lines — the Tacoma Link — opened in 2003. The other, Central Link, opened in 2009. However, Sound Transit is continuing to invest in its light rail infrastructure and rolling stock. From 2019 to 2023, the transit agency plans to grow its fleet from 62 vehicles to 214.

The average age of the WSF fleet is 35.6 years. Washington State Ferries has built only one boat in the past 11 years, while the fleet has collectively aged by 231 years in that time. An additional 15 boats will be required over the next 30 years to retire existing vessels when they reach 60 years old, the end of their lifespan.

Operations & Maintenance

Operating and maintaining transit facilities involves scheduled operation and both scheduled and unscheduled maintenance. Routine periodic cleaning, inspections, preventive maintenance, and repairs during operation are essential to provide a safe, clean, and comfortable transit experience to users. Infrastructure related to transit also requires maintenance (i.e. roads, light rail, and port facilities). The optimization of operation and maintenance can result in significant cost savings and lead to increased efficiencies.

Sound Transit is building the Sounder Maintenance Base and an Operations and Maintenance Facility East (OMF East) so vehicles may be cleaned every night and regularly pulled out of service to perform routine maintenance. These facilities are essential to support expansion of the region's light rail system. There is a strong need for similar facilities in other areas.

As of 2018, there are 23 ferries on Puget Sound operated by the state. The largest vessels in this fleet carry up to 2,500 passengers and 202 vehicles. Washington State Ferry's terminal engineering maintenance group administers contracts for maintenance of ferries and terminals. These contracts address short-term maintenance issues identified through inspections of the facilities, prior to larger replacement projects. Maintenance issues decrease system capacity and necessitate the use of alternate operating schedules. Travelers can experience all-day wait times, voided reservations, and canceled plans.

Public Safety

Washington had eight transit-related fatalities in 2016 across all transit modes (bus, light rail, trolley bus, and vanpool), an increase from three in 2015. There were 321 transit-related injuries in 2016, an increase of 9% from 295 in 2015. Of the 321 injuries, 248 (77%) involved passengers either on, waiting for, or exiting a transit vehicle. In a combined 28 years of operation, neither Link light rail nor Sounder commuter rail has experienced a preventable collision or passenger or operator fatality.

Meanwhile, despite the number of ships and passengers WSF manages every year, there has not been a major accident in Washington involving a state ferry nor a fatality because of a ferry accident. Accidents through the years mostly involve minor collisions into docks or other water vessels, resulting in minor injuries or monetary damage.

Funding

Transit is funded with revenue from local, state, and federal sources, as well as through fare revenue. Local transit authorities and local governments provide 82 percent of direct transit agency funding. Federal agencies provide 14 percent and the state provides 4 percent.

Local funding for transit in the Seattle region is scheduled to increase in the near future. Sound Transit 3, passed by voters in November 2016, will extend the Link rail system to Tacoma, Federal Way, Everett, Issaquah, and the Seattle neighborhoods of West Seattle and Ballard. By 2040, 116 miles of light rail will serve the Puget Sound region between Everett and Tacoma and east to Issaquah. The extension is estimated to cost $53.8 billion in 2041 dollars, using $27.7 billion in new local taxes raised during the 25-year construction phase. Revenue comes from a 0.5 percent sales tax, a 0.8 percent motor vehicle excise tax (MVET), and a property tax of 25 cents per $1,000 in assessed value. State funding for the expansion comes from the MVET. The Regional Transit Authority (RTA) MVET is calculated from the depreciated value of a vehicle.

State funding for public transportation primarily comes from public transportation grants. WSDOT awarded public transportation grants for 651 projects, totaling more than $175.8 million for the 2015-2017 biennium. This is a significant increase in available funding, thanks to the Washington State Legislature and inclusion of all projects funded, not just those from the state's Consolidated Grant Program – a WSDOT program dedicated to public transportation projects.

Federal funding is provided from the federal gas tax and the Federal Transit Administration's Capital Investment Grant (CIG) program, among other sources. Sound Transit has stated strong concerns about the current administration's proposed elimination of the Federal Transit Administration's CIG program, the primary federal funding source for major grants, including a $1.17 billion funding commitment the agency is working to secure for Sound Transit's Lynnwood Link extension.

Public transit agencies also rely on fares as a source of revenue. Fare revenue increased by 5.6 percent from $314 million in 2015 to $331 million in 2016. Sound Transit, RiverCities Transit, and TranGo showed the largest increases in fare revenues, whereas Everett Transit, Yakima Transit, and Garfield County Transportation Authority showed the largest decrease in fare revenues. In 2016, Seattle metro area had a farebox recovery ratio — the total fare revenue divided by its total operating expenses — of 35%, and Sound Transit had a farebox ratio of 42%. In comparison, San Francisco Bay Area Rapid Transit (BART) had a farebox recovery ratio of 70% and New York City Metropolitan Transportation Authority (MTA) had a farebox recovery ratio of 47%.

The Federal Transit Administration provides 50 percent of the funds for the WSDOT Travel Washington Intercity Bus Program. Greyhound Bus Lines provides local matching funds that pay for the rest. The funding structure streamlines a coordinated approach to bringing transit options to parts of the state that are traditionally underserved.

WSF tolls and ferry fares are projected to generate $785 million during the 2017 – 19 biennium. This significant and growing portion of the state's transportation budget raises revenue for major capital improvements and system operations and improves traffic flow on key corridors. Ferry fares generate nearly 75% of the operating costs for the ferry system. Comparable ferry systems recover an average of 48.8%. WSF needs to fill an annual operating budget gap of $275 million.

Future Need

Washington's population grew from 4.1 million in 1980 to 6.7 million in 2010 and is expected to reach 8.8 million by 2040. In Spokane and Clark counties, the population is expected to grow to more than 500,000 people and Central Puget Sound is expected to add another million people in the coming decades. New highway and road construction is not expected to keep pace with population growth. Roads — both freeways and city streets — will invariably become more congested. Local jurisdictions see alternate modes of transportation, especially transit, as an important part of their strategies for maintaining mobility as both population and traffic congestion increase.

Transit provides connections between population and employment centers, across travel modes, and between communities. Recognizing that public transportation issues may be different in rural and urban areas, and in light of declining federal support, the Washington State Transportation Commission recommends the state continue investing more in regional mobility grants, intercity bus connections, and other programs that connect communities, improve access to employment and schools, reduce congestion, and improve air quality.

Resilience

Washington State is vulnerable to several natural hazards such as earthquakes, tsunamis, landslides, volcano eruptions, winter storms, and floods. Because mass transit systems — and public buses in particular — depend on the functionality of roadways and bridges, the recovery of mass transit will depend predominantly on the recovery of the network of major and minor arterials along which public transit routes run. WSDOT's work on resilience and transportation sustainability is supported by state and federal policy directives. A comprehensive resilience program aimed at making transit systems and infrastructure stronger and more reliable is recommended.

In 2017, WSDOT released guidance for its planners and partners recommending that climate change be considered during planning to allow for practical, long-term decisions that result in more resilient outcomes. The report utilizes the Washington Climate Change Impacts Assessment (University of Washington, June 2009; updated 2013) as its primary source for climate information. It also uses a qualitative assessment of risks to the state's transportation infrastructure from climate change — WSDOT's Climate Impacts Vulnerability Assessment.

Innovation

RideshareOnline.com, managed by the Washington State Department of Transportation, is a resource that provides commuting options. It serves as a gateway to free information on travel options (Vanpool, Vanshare, Carpool, SchoolPool, TripPool, Community Van, and Real-Time Rideshare) and incentive programs for commute and non-commute trips. It also offers tools for employers to implement effective commute reduction programs.

King County Metro has been recognized by the American Public Transportation Association for launching the nation's leading reduced-fare program for passengers who earn lower incomes.

The Cities of Bellevue and Seattle have implemented an intelligent transportation system (ITS), an application that enables users to make "smarter" use of transport networks, which will facilitate future adoption of autonomous vehicles to aid in transit.

The Seattle City Council has approved the ORCA Opportunity program, which will give transit passes to high school students and students who attend Seattle colleges on city-funded scholarships. Seattle is the largest city in the country to give free, year-round transit service to more than 16,000 students.

Sound Transit has received a Popular Science 2017 Best of What's New award in the engineering category for the technology that will enable light rail trains to travel across Lake Washington on the floating Interstate 90 bridge when East Link opens in 2023.

In May 2018, WSF announced plans to convert its three largest vessels from diesel fuel to electric power over the next several years. Ultimately, the state hopes to install onshore charging stations that will allow the ferries to run solely on electric power by 2023.

Solutions to Raise the Grade

Transit is vital to Washington's economic success and is a crucial piece of statewide infrastructure that needs to be improved, maintained, and expanded. In order for transit to succeed in Washington, there are several improvements that can be made:

1. Continue the pursuit of innovative transit and infrastructure practices to respond to massive growth and congestion.
2. Continue to increase ridership and visibility by improving access to service, reliability, and comfort.
3. Require all transit agencies that operate in the state to have an asset management program.
4. Improve accountability by making asset management and safety program information available and easily accessible to the public.
5. Develop sustainable funding sources at the local and state level to support transit service and address funding gaps not met by fare revenues.
6. Implement triple bottom line (economic, environmental, and social) life cycle costing in planning, design, and construction of transit systems.
7. Implement a comprehensive resilience program aimed at making transit systems and infrastructure stronger and more reliable.

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Bridges

C+

Executive Summary

Washington is home to 7,410 vehicular bridges. Of these, 321 bridges are in poor condition, which equates to 6.6% of the inventory based on bridge deck area. In 2017, there were 4,979 bridges in need of repair. This includes replacing deteriorated bridge elements, such as floating bridge anchor cables, repainting steel bridges with a protective paint coating, and repairing concrete bridge decks. Additionally, there are 590 bridges that require a seismic retrofit in order to meet current earthquake design standards. The Washington State Department of Transportation (WSDOT) is implementing new bridge innovations to reduce construction time and bridge lifecycle costs. However, more funding is needed to perform necessary operation and maintenance work, repairs, retrofits, and replacements of existing bridges to keep Washington's infrastructure functioning.

Condition & Capacity

As years pass, Washington's bridge infrastructure continues to age and deteriorate. As of December 2017, 366 bridges in the state of Washington were considered to be in poor condition, compared to 364 in December 2016. Of these 366 bridges, 124 are part of the National Highway System. A bridge in poor condition requires repair or replacement of a certain component. If the condition is such that it no longer is able to carry its intended traffic loads, it may be weight restricted.

Additionally, 399 bridges in Washington are considered structurally deficient, up from 392 the previous year. While not yet unsafe, structurally deficient bridges require significant maintenance, rehabilitation, or replacement. Being structurally deficient does not imply that the bridge is in danger of collapse or unsafe to the traveling public. Approximately 5% of all bridges in the state of Washington are structurally deficient, a metric that has remained relatively constant over the last decade. This indicates that bridge repairs and restorations are not being completed fast enough.

Structural deficiency and condition ratings are not the only measures of bridge condition. Some bridges that are not considered structurally deficient may still have weight restrictions placed on them. In 2017, the state identified 4,979 bridges that required repairs. Examples of needed repairs include replacing deteriorated bridge elements, such as floating bridge anchor cables, repainting steel bridges with a protective paint coating, and repairing concrete bridge decks.

Age is an ongoing concern as well. While regular maintenance can significantly extend the lifespan of a bridge, such maintenance requires funding. In June 2018, WSDOT owned 266 bridges that were 80 years old or older; 24 of them had a poor rating. Many of these bridges

were designed under outdated standards, particularly with respect to scour (soil erosion around bridge foundations caused by moving water) and seismic design.

Operations & Maintenance

As with any structure, bridges require proper maintenance in order to continue successful operation. Bridges are inspected every two years as required by federal regulations to ensure they are safe for the public. The bridge inspections also note any repairs needed. Once identified, these repairs are included in a bridge maintenance and preservation program based on the severity of the repair and the budget available. Preserving and maintaining the components in a bridge allow the structure's service life to be extended; waiting to repair at a later date, on the other hand, can cause further deterioration and increase future repair costs.

In 2017, WSDOT began a new systematic preventive maintenance program, allocating $6 million to extend the service life of existing bridges through planned and focused preventative maintenance activities. Although this is a 38% increase in WSDOT's maintenance budget, this only covers a portion of the repair backlog and overall bridge preservation needs.

Funding

Bridge infrastructure is funded through a combination of federal, state, and local dollars, as well as private funding in some cases. On a state level, although Washington has the second-highest gas tax in the country at 49.4 cents per gallon, by 2027 71% of that gas tax will be going to pay off bonds issued for previously funded infrastructure projects, rather than new ones. The 2016 11.9-cent gas tax increase provided by the Legislature's Connecting Washington funding package provided funding to address the most critical needs for bridges and to supplement $300 million for fish barriers. Funding from local cities and counties is supplemented by the Local Bridge Program, a federally funded program that allots $45 million each year to repair or replace city- and county-owned bridges. On a federal level, the state depends on the Highway Trust Fund and the Federal Highway Reauthorization bill's passage to supplement the state's budget. Tolls also provide a source of revenue. The new SR 520 floating bridge, for example, is tolled to help fund its own cost of construction and is expected to raise $1.2 billion.

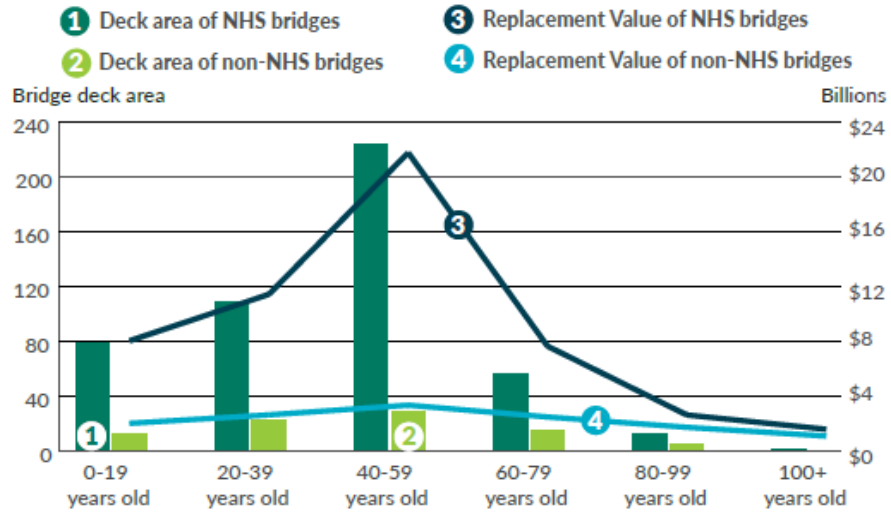
Refer to the Roads Section for more information on funding mechanisms.

Future Need

There is a significant future need over the next 10 years to maintain the state's bridge inventory at a safe and operable level. Many of Washington's bridges are reaching the end of their service life or require substantial preservation action. Replacing bridges that are 80 years or older alone would cost nearly $2.8 billion.

Majority of WSDOT's bridge deck area is located on the National Highway System and between 40 and 59 years old

As of June 2018; Bridge deck area in hundreds of thousands of square feet by age; Replacement value in billions of dollars



Data source: WSDOT Bridge and Structures Office.

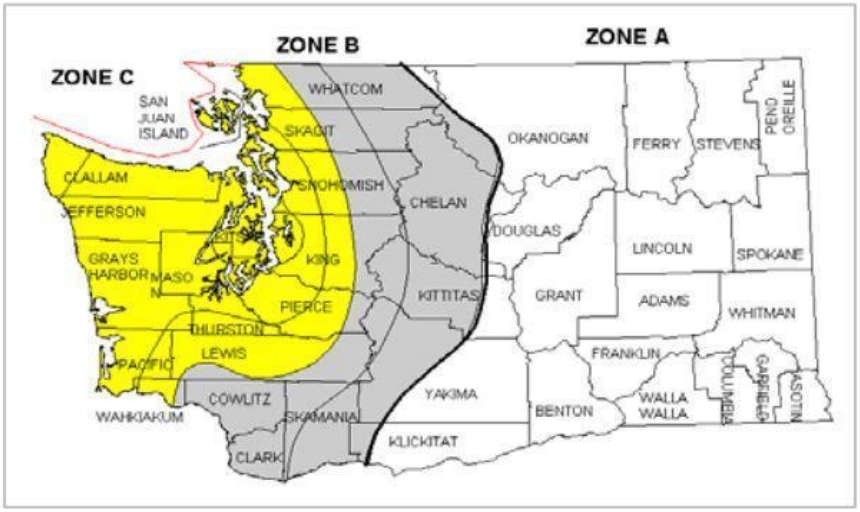
Notes: The graph above shows deck area on WSDOT-owned bridges only. Replacement value describes the cost to replace all bridges in each age range.

WSDOT estimates a need over the next 10 years to preserve and rehabilitate 616 concrete bridge decks at nearly $1 billion, paint 180 steel bridges at an estimated $780 million, and replace or rehabilitate 111 bridges at an estimated $711 million. Since 1991, WSDOT has invested $194 million in bridge seismic retrofits to increase their ability to withstand a seismic event; however, 590 of 909 bridges are still in need of a partial or full retrofit. In March 2013, a federal court set a deadline of 2030 for the state to repair or replace over 800 culverts that block habitat for salmon and steelhead, a cost estimated at $2.4 billion. Many culverts will need to be replaced with bridges to allow the passage of migrating fish. Additionally, there are city- and county-owned bridges that require their own repairs and replacements.

Public Safety

Most of western Washington is in a seismically vulnerable area, and a large-scale earthquake could cause catastrophic damage to and/or failure of existing bridges. Many bridges in Washington were constructed prior to the 1950s before the adoption of bridge design criteria for earthquakes and were not designed to today's seismic design standards. For example, the Alaskan Way Viaduct along SR 99 in Seattle was constructed in 1953 and carried 103,000 vehicles on a daily basis in 2007. Studies suggested that this bridge in its current state had a high risk of damage due to seismic activity. WSDOT is now working to replace the viaduct with the SR 99 tunnel, which is set to open February 2019. Through its bridge seismic retrofit program, WSDOT aims to retrofit existing bridges to mitigate the potential failure in the event of a large magnitude earthquake. As of June 2018, Washington had 316 bridges that had

received a complete retrofit, 119 that were partially retrofitted, and 474 that needed a retrofit (a total of 909 bridges). Over the next 10 years, WSDOT plans to complete retrofits on Interstate 5 from Joint Base Lewis-McChord south of Tacoma to I-405's southerly terminus, SR 518/1-5 to SeaTac Airport, I-405, I-90/I-405 to Snoqualmie Pass, and SR 526/I-5 to Paine Field.



On May 23, 2013, the northernmost span of the Skagit River Bridge on I-5 collapsed. The overhead support beam was struck by an oversize load. Fortunately, no fatalities directly resulted from the collapse. The bridge served as a critical link between British Columbia and Seattle, and closure of the route had international implications. Washington, unlike many other states, does not assign oversized tractor-trailers to approved routes, but instead leaves selection of a route up to drivers. Changes to this policy have been considered, but none have been enacted.

Resilience

Consistent with its efforts to adopt sustainable practices, in 2015 WSDOT studied the application of the INVEST tool, which allows users to self-evaluate the lifecycle of transportation projects through planning, development, and operations. Other third-party sustainability rating systems have grown from the prevalence of green building practices, such as LEED in the building industry, including the Envision and Greenroads sustainability rating systems. These systems provide insight into how to best plan for the full lifecycle of infrastructure and to do so sustainably. Looking at the full lifecycle requires the calculation of costs from the moment the project is initiated to the moment the project is decommissioned. In addition to the initial cost of construction, the total price tag in full lifecycle planning includes costs such as maintenance, repair, and demolition.

WSDOT has taken steps to encourage bridge designers statewide to understand and address the risks to infrastructure from climate change. Its 2011 publication "Climate Impacts

Vulnerability Assessment," explains the risks associated with the changing climate and how the performance of a bridge could be affected. Changes in temperature and seasonal weather patterns, declining snowpack, and variable water levels are all issues that designers examine prior to design. Failure of structures can also come from natural disasters such as earthquakes, floods, and tsunamis. Whatever the cause, the ability of a community to respond to and recover from natural disasters is highly dependent on the survival of its roads and bridges. Emergency services need access to respond to incidents, suppliers of materials and goods require access to support rebuilding efforts, and people need continued access for their livelihood.

Innovation

WSDOT is researching the application of new materials in bridge construction, as seen in its use of shape-memory alloy (SMA) rebar and engineered cementitious composite (ECC), a mortar-based composite reinforced with fibers. These new materials will allow for more flexibility and movement in bridges when an earthquake hits, reducing the likelihood of failure and minimizing repair costs. The new SR 99 Alaskan Way Approach Bridge is the first bridge in the world to use both of these new materials.

On the other hand, the damage shown in the photo below, taken after the Nisqually Earthquake in 2001, shows a typical bridge without these new materials. While this damage is significant, it is deemed acceptable from a design standpoint because it did not lead to a loss of life or collapse of the structure. Although this is an acceptable level of damage, it required costly demolition and reconstruction.

Engineers are implementing new design strategies to decrease construction time and increase the useful life of bridges. Washington state is home to four of the five longest floating bridges in the world. Floating bridges can provide cheaper alternatives to traditional bridges when crossing bodies of water. SR-520, for example, which crosses Lake Washington, was replaced between 2012 and 2016. Had it been designed using conventional support systems, the new bridge would have required foundations more than 400 feet deep. Additionally, earthquakes do not affect floating bridges and traditional bridges in the same manner. Floating bridges like the SR-520 structure are supported by pontoons, which allow a more flexible response during a seismic event.

Other innovative solutions are being implemented in the foundation systems for bridges. Geosynthetic Reinforced Soil – Integrated Bridge System (GRS-IBS) is a method of bridge support that can provide an alternative to deep bridge foundations in varying soil types and thereby reduce construction time. This system incorporates granular fill material with closely spaced geosynthetic fabrics to create a jointless interface between the bridge and its

approaches. In 2008, WSDOT implemented its Accelerated Bridge Construction (ABC) strategic plan, which intends to develop department standards, guidelines, and key policies for accelerated bridge design. In 2015, the WSDOT ABC workshop addressed various ABC methods and implementation scenarios, including new developments in ABC techniques, bridge bent systems, steel bridge systems, and rapid column systems. These techniques are generally geared toward faster construction, reduced construction costs, and safer structures, primarily for seismically active regions. In addition to practices already being implemented, WSDOT launched its Innovations Challenge in 2017, which aims to find "innovative solutions to everyday problems and issues that maintenance employees encounter."

Solutions to Raise the Grade

1. Increase funding at all levels of government (federal, state, and local) to reduce the number of bridges in poor condition.
2. Encourage the federal government to provide additional funding sources for the Highway Trust Fund and pass the Federal Highway Reauthorization bill.
3. Consider the use of alternative local funding mechanisms such as user fees, tolls, or different taxation methods to make funding more equitable to road users.
4. Base the cost of a bridge on its entire lifecycle cost rather than its initial construction cost to fully understand the long-term financial implications of bridge projects.

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Dams

B-

Executive Summary

There are 1,130 dams in Washington, 39% of which are categorized as significant- or high-hazard dams. Most of Washington's dams are regulated by the Washington State Department of Ecology Dam Safety Office (DSO) and are privately owned. Washington's dams are generally in acceptable condition, but some are aging and do not meet current seismic standards. Some dams have safety deficiencies and are considered unsatisfactory, but do not pose an imminent threat to public safety. Emergency action and operation and maintenance plans have been prepared for 90% of the state's high-hazard dams, compared to 77% nationally. Although the number of state-regulated dams per full-time DSO employee is considerably better than the national average, staffing numbers still fall short of recommended levels. Additionally, available funding has dropped; the DSO budget was $1.1 million in 2017, down from $1.33 million in 2011. Aging dams, coupled with the lack of a funding program for the repair of private dams, continues to be a challenge. Moreover, as new seismic designs and code updates are adopted, funding needs will continue to grow.

Overview

Of the 1,130 dams in Washington, 89% are regulated by the Washington State Department of Ecology Dam Safety Office (DSO), while 11% are either federally owned or are regulated by the Federal Energy Regulatory Commission (FERC). Most DSO dams are privately owned.

Capacity

Reservoirs can be used for many different purposes, including flood control, recreation, power generation, and water supply. The capacity of a dam often refers to its reservoir storage capacity.

Washington State contends with diametrically opposed climates — Western Washington receives ample rainfall, while the region east of the mountains can suffer from extended droughts. The state's Department of Ecology (DOE) Office of Columbia River (OCR) prepares and submits the water supply and demand forecast to the state Legislature every five years to help meet the economic and environmental needs of Eastern Washington. The 2016 Columbia River Supply and Demand Forecast reported a potential shortage of capacity in water resource infrastructure generally. In Washington, reservoirs and dams are a significant tool used to address such shortages. The report's overall findings forecast that while irrigation demand will decrease on average, management of the state's water resource infrastructure will be increasingly challenged by climate change, causing seasonal shifts in water supply and demand.

Dam failure can result from a variety of factors, including inadequate spillway design, debris blockage, settlement, slope instability, uplift pressure, and uncontrolled seepage, as well as from environmental causes such as earthquakes and severe storms. Approximately 34% of dam failures result from overtopping, while 30% result from foundational defects. Piping and seepage account for 20% of such failures, and inadequate or failed conduits, valves and other issues account for the remaining 16%.

Condition

A downstream hazard classification system is used in the National Inventory of Dams (NID) and DSO databases. This classification system is based on downstream population at risk, potential for economic loss, and potential for environmental damage. The hazard classifications vary between the NID and DSO databases, but essentially include low-, significant-, and high-hazard potential ratings for each dam, and produce similar results. The DSO periodically submits the state's most recent rating data to the U.S. Army Corps of Engineers (USACE) to update the NID database. In 2018, DSO informed USACE that 693 dams in Washington are defined as low-hazard dams, 174 are significant-hazard dams (19 with deficiencies), and 263 are high-hazard dams (31 with deficiencies). A high-hazard dam is one whose failure would put more than seven people and/or three inhabited structures at risk. Sixty-one of the high-hazard dams and 20 of the significant-hazard dams are federally regulated. There has been a sharp increase in the number of identified high-hazard and significant-hazard dams over the past decade, primarily due to an initiative undertaken by the DSO in 2008. Dams of jurisdictional size that were constructed without prior approval, design review, or construction visits by the state were located and inspected, with the goal of eventually bringing them into compliance. For significant and high-hazard dams, safety deficiencies were found in 15% of state-regulated structures in 2018 — slightly better than the national average.

The DSO's condition rating system includes satisfactory, fair, poor, and unsatisfactory, depending on the severity and immediacy of safety deficiency risks. About 80% of Washington's dams were rated satisfactory, and those remaining were either rated fair, poor, or unsatisfactory (or not rated). Fair or poor ratings usually require repairs, but do not pose an immediate threat to public safety. Two dams regulated by the DSO currently have an unsatisfactory rating.

Emergency Action Plans (EAPs) have been approved for 99% of high-hazard dams regulated by the DSO, compared to the national average of 75%. A significant-risk dam is a dam where one to six people and/or up to two inhabited structures would be at risk in the event of failure. The recent discovery of previously unknown dams, or construction of new dams, has resulted in the EAP shortfall. The DSO has a goal of ensuring 100% EAP compliance for high-hazard dams.

EAPs have been approved for 90% of the state's high-hazard dams listed on the NID. However, the NID defines a high-hazard dam as the potential loss of one life and a significant-hazard dam

as one whose failure has the potential to cause economic loss, environmental damage, or disruption in lifeline facilities.

The percentage of significant- or low-hazard dams with EAPs is much lower, on the order of 35%, and 49% listed on the NID database. However, low-hazard dams are not required by Washington State to have EAPs. The DSO has a goal of establishing EAPs for significant-hazard dams within about five years.

The DSO uses a Federal Emergency Management Agency (FEMA) grant to fund a staff position to track compliance and to assist private owners of significant- and high-hazard dams in drafting EAPs, which helps them operate safer dams and come into compliance with regulations. The DSO has found this approach to be more effective in achieving EAP compliance than simply citing deficiencies.

Public Safety

The state's DSO regulates non-federal dams and has a staff of professional engineers who perform inspections and reviews and approve construction permits. DSO staff members provide valuable resources for dam owners and engineers. In contrast, dams owned by the federal government are regulated by federal agencies that include the USACE, U.S. Bureau of Reclamation, and the U.S. Department of the Interior. The safety of these dams is overseen by dam safety experts within those respective agencies. Federally regulated dams are generally found to be compliant with safety regulations as funding has been historically consistent. Periodic inspections are conducted and EAPs reviewed and updated as required.

Two incidents/failures associated with state-regulated dams occurred between 2012 and 2018 but resulted in no injuries and only minor damage. By comparison, between 1990 and 2010, 17 such incidents occurred, resulting in three injuries. Over the past several decades, the number of safety incidents/failures has been decreasing.

Hydroelectric dams owned and/or operated by federal agencies are regulated through their own dam safety and hydropower programs. However, the Federal Energy Regulatory Commission (FERC) regulates and provides licensing for non-federal hydropower projects. The agency requires that independent experts undertake periodic safety evaluations of the dams under its purview. Owners of FERC-regulated dams, generally power producers with ratepaying customers, usually have an adequate funding stream and a consistent regulatory framework under FERC for proper operation and maintenance of these dams.

Funding

The state's DSO program is primarily supported by the state general fund. Revenues are also contributed by the annual inspection fee paid by the owners of all high- and significant-hazard dams as well as by fees charged for construction permits issued for the construction of all new dams or the modification of any existing dam. The DSO budget was $1.1 million in 2017, down

from $1.33 million in 2011. Current staffing levels at the Washington DSO are such that there is an average of about 170 dams per regulator and 34 high-hazard dams per regulator. Recommended staffing levels include 25 dams per regulator. However, the national average for state programs is 208 dams per regulator, so Washington has a relatively well-funded program compared to other states.

DSO was recently authorized to hire an additional staff person to focus on dam safety compliance and data management. This will greatly improve its ability to monitor and encourage compliance actions between engineer inspections.

Between 2007 and 2010, DSO safety grants from the National Dam Safety Program, managed by the Federal Emergency Management Agency (FEMA), totaled over $250,000. These monies were used to fund the unpermitted dams initiative, improve emergency preparedness, and provide outreach and education to dam owners. However, funding for the DSO was reduced between 2010 and 2011; subsequently, the number of regulatory staff also decreased. In 2018, FEMA provided the state with $87,000 for the year.

The Association of State Dam Safety Officials (ASDSO) tracks data on staffing levels in terms of full-time equivalents (FTE) relative to the number of dams. According to ASDSO, in 2015 Washington State had just over 20 state-regulated high-hazard dams per FTE compared to the national average of more than 30.

The DSO's philosophy for correcting deficient dams is to provide technical assistance and work collaboratively with the owner to achieve voluntary compliance and use formal enforcement action only as a last resort. Some owners of deficient dams struggle to obtain sufficient funding for repairs. Unless outside grants or loans become available for repairing and maintaining existing dams, many owners will not be able to afford repairs. While there are new public funding sources for high-hazard, non-federal publicly-owned dams, no funding programs are on the horizon for privately owned dams. Despite these challenges, the gap between deficient and compliant dams has been steadily closing for over 25 years.

Funding for operation and maintenance and inspections of dams are limited. Federal funding can be internally competitive between different districts or regions, and slow due to congressional requirements and federal bureaucracy. Congressional pressures on the federal agencies in the region push to expend 99% of all allocated funds for federal dams before the fiscal year's end. This leads to inefficient spending and/or overallocated budgeting into the following year in an attempt to compensate for unknown emergency repairs. Additionally, there is added pressure on the need for future federal tax revenues due to consistently unbalanced budgets and deprioritized investments in infrastructure.

Some private owners of dams that do not produce power lack funds for operation and maintenance. There are currently no grant or loan programs available to assist them. For situations where dam owners are unable to correct unsafe situations, the DSO has authority to

require changes to dam operations as necessary to bring the dam into compliance with safety regulations. In extreme cases, DSO also has authority to decommission unsafe dams.

Future Need

A growing population is leading to an increase in development downstream from dams. As a result, the hazard classifications of dams that were originally rated as low-hazard and were not designed to the more stringent requirements of high- and significant-hazard dams are being reassigned. Emphasis should be placed on establishing communication with and elevating the awareness of members of adjacent communities that may be impacted by potential hazards.

The consequences of climate change require greater understanding of its potential effects on dam management in Washington State. In some areas, it is anticipated that precipitation will become more frequent and more severe; in some areas, it is anticipated that drought will become more frequent and more severe. More severe precipitation may lead to floods that exceed the capacity of the dam, which could yield catastrophic floods downstream and trigger landslides that alter downstream watercourses. Sustained drought and increasingly destructive wildfires eliminate vegetation that helps attenuate runoff entering a dam impoundment.

No current data were found to quantify the funding gap for the future need in terms of dam maintenance and repair.

Resiliency

The average life expectancy of a dam is about 50 years. More than 40% of Washington's dams are at or beyond that age. The age of a dam may be a factor in its stability as some materials may deteriorate under continued load and environmental conditions. In addition, as with any technology, there have been enhancements in dam materials and improvements in design and construction techniques over the years. For example, seismic design methods to address the Pacific Northwest's significant earthquake potential have advanced greatly over the past half-century. Consequently, some older dams may not fare well under the dynamic conditions posed by an earthquake.

Earthquakes and intense storms can cause sudden dam failure and downstream flooding with little to no warning. Other types of dam failures can take much longer to occur — from days to years — as a result of lack of maintenance, improper operation, poor design and construction, vandalism, or acts of terror. The state provides laws, regulations, written guidance, periodic inspections, and technical assistance to help reduce the probability of any of these types of dam failures.

Innovation

Advancements in construction techniques and field monitoring have increased the life expectancy of dams constructed in recent years. Additionally, software and improvements to

post-construction monitoring systems have helped mitigate risks associated with dams that are at or near their original design life. Among these new innovations are:

- Monumentation. For dams 15 feet and higher, installation of settlement monuments and staff gauges is required to help monitor conditions.
- Survey techniques. Laser-scanned topography (e.g. LiDAR) and global positioning system (GPS) equipment have allowed for better and more readily available mapping of topography, including topographic changes over time.
- Remote monitoring. Sensing equipment tied to telemetry (radio and satellite) has improved mitigation efforts related to the absence of onsite tending of dam infrastructure. For example, USACE dams can remotely open or close gate structures via telemetry.
- Software. Asset management software programs make it possible to efficiently track and prioritize minor and major maintenance projects and make the best use of maintenance funds.
- Improved communications. Advancements in communications such as satellite phones make it possible to notify the public of potential failure events from very remote areas. DSO has created an email listserv and will commence sending information to dam owners and other interested parties.

Operations & Maintenance

An appropriate operation and maintenance program, including annual inspections, routine maintenance, and timely rehabilitation, are important factors in securing a satisfactory dam condition assessment rating. Federally-owned dams undergo regular maintenance and have the resources to maintain an acceptable operation and maintenance program. FERC-regulated private dams are required to have third-party inspections to verify the proper operation and maintenance license. Improper operation and maintenance can impact the FERC license, which can lead to decommissioning of the dam. Dams that are regulated by the DSO are the responsibility of the dam owners, who have varying resources available for operation and maintenance programs. All owners of jurisdictional dams in Washington are required to perform and submit annual inspections. Staff focus is on increasing annual inspection submittal compliance, first on high-hazard dams and, secondarily, on significant-hazard dams. In addition, the DSO performs thorough, independent inspections of high- and significant-hazard dams every five years, at a minimum.

As of 2018, safety deficiencies were identified by the DSO on 60 significant- and high-hazard dams.

Solutions to Raise the Grade

1. Improve funding sources for ongoing operations and maintenance of dams. Specifically, create low-interest loan programs to assist private dam owners with needed repairs and maintenance.
2. Maintain adequate funding of federal and state dam safety programs to allow for timely and appropriate inspections, tracking of corrections made to deficient dams, permit reviews, education, and training.
3. Improve sharing of resources and communication with local communities whose residents reside downstream of significant- or high-hazard dams.
4. Increase outreach to dam owners and improve public outreach and awareness. Educate dam owners on compliance requirements, new owners of dams.
5. Require triple bottom line (economic, environmental, and social) lifecycle cost analysis for approval of new dam construction.
6. Improve documentation of dam history, including condition assessments for continuity as dam ownership changes over time. Continue progress on standardization of report templates associated with inspections and condition assessments.
7. Continue to research potential hazard-related impacts associated with climate change.

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Roads

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Executive Summary

The Puget Sound region is experiencing the largest annual population increase in the nation. There was a 3.11% growth in population between 2015 and 2016, in part thanks to the continuing tech boom. Annual vehicle delay along major Washington highways increased by up to 173% between 2014 and 2016. While capacity remains a major challenge, the condition of roadways is improving. Currently 92% of the Washington State Department of Transportation's pavements are in a fair and better condition, meaning the state is exceeding its goal of 90%. Some local agencies are starting to see an increase in their pavement condition ratings as well, and are greatly benefited by the Washington State Transportation Improvement Board grant program. Operation and maintenance costs are extremely important for the condition of our roadways. New capital projects need to be resilient to natural disasters. Even with innovations in roadway technologies, the lack of funding — especially from federal sources — hinders the state's ability to catch up to the ever-growing needs.

Capacity

Washington has around 80,400 miles of centerline roadway. Of the total number of miles of centerline roadway, 50% is under county jurisdiction, 22% city, 11% federal, and 9% state. The remaining roadways belong to townships and other entities. Seventy percent of the state system is situated in rural areas that do not suffer from capacity issues. The remaining 30% of state highways are situated within the three major urban areas — Seattle/Tacoma, Spokane, and Vancouver/Portland. Sixty percent of the state's population is located in these three urban areas and is subject to more traffic congestion.

The Texas Transportation Institute's (TTI) 2015 Annual Mobility Report for the Travel Time Index, a composite measure of how long commutes take during rush hour compared to normal conditions, reported that Seattle ranked third-worst in the nation, a significant increase from the 2012 report, in which the metropolitan area was ranked 10th. Additionally, the Portland/Vancouver area ranks seventh-worst nationally and had previously been ranked sixth. Spokane came in at 54th nationally, and previously ranked 74th.

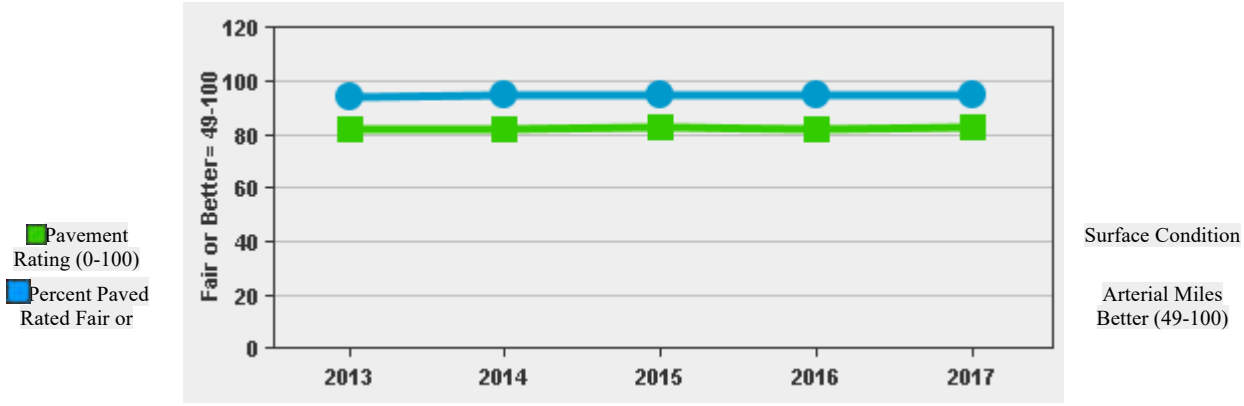
In 2016, the per person (per capita) vehicle miles traveled (VMT) on all Washington roads was measured at 8,471 miles — about 139 miles (or 1.7%) higher than in 2014 (8,332 miles). That means that drivers are traveling farther distances, which also contributes to congestion. Between 2014 and 2016, urban highways throughout the state saw double- and triple-digit percentage increases in delay during peak periods, with primarily single-digit increases in VMT — indicating substantial increases in congestion.

Condition

The Washington State Department of Transportation (WSDOT) evaluates the pavement condition based on surface cracking, rutting, and smoothness. These criteria are used to classify pavement conditions within four categories: good/very good, fair, poor, and very poor. WSDOT's goal is to have at least 90% of pavements in fair and better condition. Currently, 92% of pavements are in a fair and better condition; WSDOT has done a good job maintaining its pavements at their current condition over the past several years.

The pavement condition of city and county streets has also been maintained, as shown in the chart below that shows the condition of county arterials. Some local agencies are starting to see an increase in their pavement condition ratings. Small cities and counties in Washington State have greatly benefited from funds available through the Washington State Transportation Improvement Board (TIB) — an independent state agency that directs street construction and maintenance grants to 320 cities and urban counties throughout Washington. Counties have also benefited from the County Road Administration Board (CRAB). Both TIB and CRAB encourage good pavement management practices.

County-Owned Paved Arterial Network Average



Operations & Maintenance

Maintenance and operation of the state's roadways includes preservation not only of the roadway surface, but all auxiliary services that enable the roadway to function — systems such as traffic signals, striping, culverts, mowing, illumination, and snow removal. The Draft Regional Transportation Plan highlights the fact that the state and most local agencies are not currently able to fully fund the operation and maintenance of the transportation system. Without adequate maintenance and operation, the entire system will deteriorate. Consequently, the backlog of repair projects is growing. The state is currently spending less than what is needed to keep the existing system in good shape. Even though pavement conditions throughout the state have generally been maintained, pavement conditions will eventually decline if funding for

maintenance operations does not increase. The same trend can be observed in the cities and counties.

The 2015 Connecting Washington legislative funding package provided significant amounts of new funding for highway investments through 2030, but basic highway maintenance was not prioritized. The plan's financial strategy also identified the difficulties faced by cities and counties to sustain local commitments to transportation infrastructure due to revenue constraints.

Funding

The primary revenue source for the state is from motor vehicle fuel tax, which provides 39% of total available funding. Twenty-two percent of additional revenue comes from license permits and fees, 14% from bond sales, and 12% from federal funds. The remaining funds are from ferry revenue, tolls, and vehicle sales tax. Washington's motor vehicle fuel tax is currently 67.8 cents per gallon. This includes 18.4 cents per gallon in federal gas tax and 49.4 cents per gallon in state gas tax. Washington State has the second-highest fuel tax in the nation. The state portion of the tax was last raised in 2016.

The fuel tax is also used to help fund roads belonging to cities and counties. Nineteen percent of cities' transportation revenue and 27% of counties' transportation revenue comes from the state fuel tax. However, the primary revenue source for cities and counties is locally generated. Cities primarily rely on sales taxes, while counties rely on property taxes.

As vehicles become more fuel-efficient, drivers are purchasing less gas and paying less in fuel tax overall. To ensure the long-term sustainability of Washington's transportation funding account, the Washington State Transportation Commission is looking into pay-per-mile tax structures. The commission's pay-per-mile pilot tests four methods of tracking miles:

- Prepaid: Buy a block of miles and drive until they are up.
- Post-pay: Have your odometer read or even text in a picture of your odometer to be charged for miles used.
- Device: Use a GPS-enabled mileage meter similar to what many insurance companies use with their customers.
- Smartphone app: Use an app that would track miles driven.

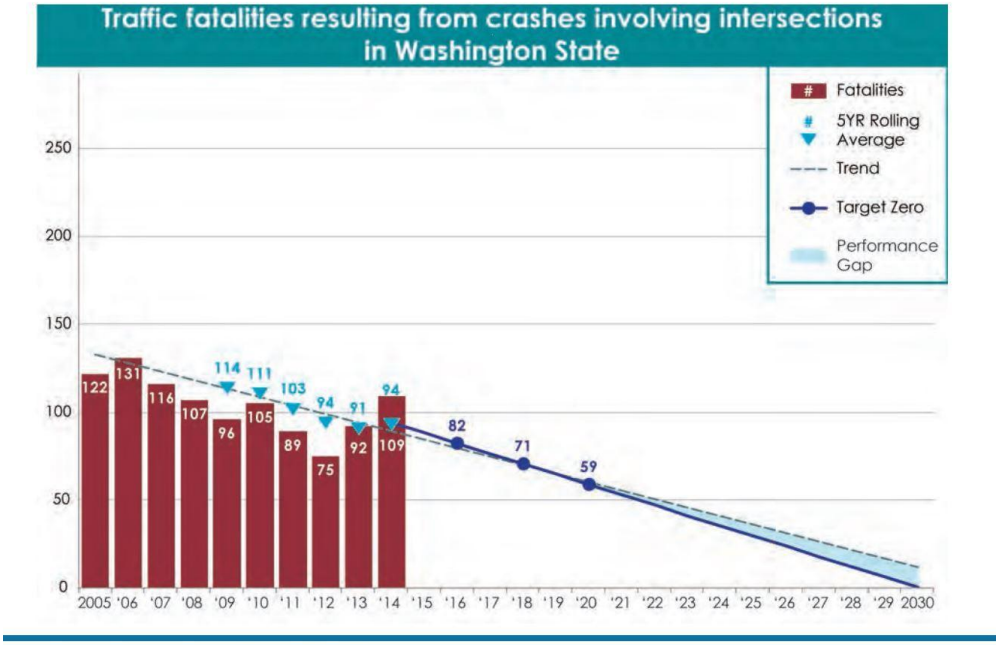
Future Need

Seattle and surrounding cities are experiencing the largest annual population increase in the nation, thanks to the continuing tech boom in the Puget Sound region. A 3.11% increase in population occurred between 2015 and 2016. As population continues to grow, an increase in available transportation capacity and even options will become vital.

In 2016, WSDOT spent $5.1 billion on projects targeting congestion relief alone. In 2017, the governor's proposed budget included $4.5 billion for roadway construction projects. Over the next 16 years, the state expects to invest $16 billion in transportation. As part of this investment, the state will spend approximately $1.2 billion on the existing backlog of asphalt pavement, concrete pavement, and bridge needs.

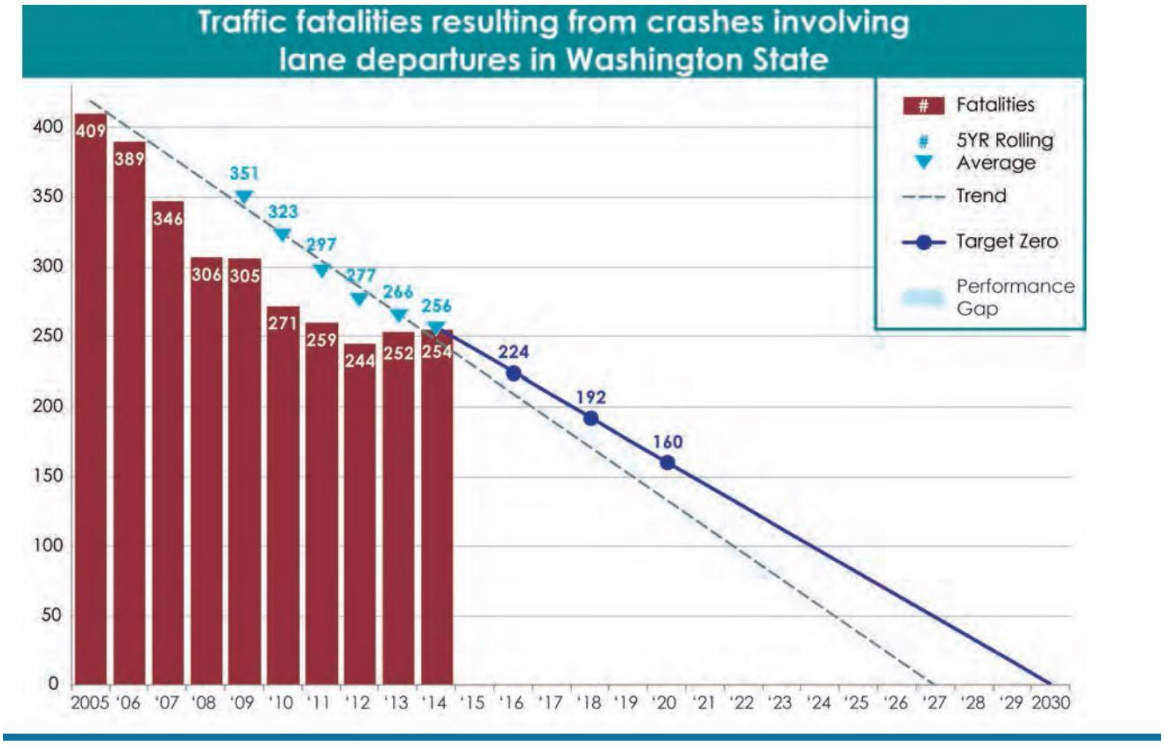
Public Safety

As more people are utilizing the roads and bridges each day in Washington, an increase in drivers has led to overcrowding on the roads. Generally, there has been an increase in the number of roadway accidents and fatalities each year. In 2016, there were 537 motor vehicle fatalities, 81 motorcyclist fatalities, and 84 pedestrian fatalities. Of the 537 motor vehicle fatalities, 376 occurred in crashes not related to alcohol. The number of fatalities per VMT or per capita exhibits similar trends. Total traffic fatalities per 100 million vehicle miles traveled generally increased between 2012 and 2015 (from 0.77 to 0.92) but decreased in 2016 to 0.88.



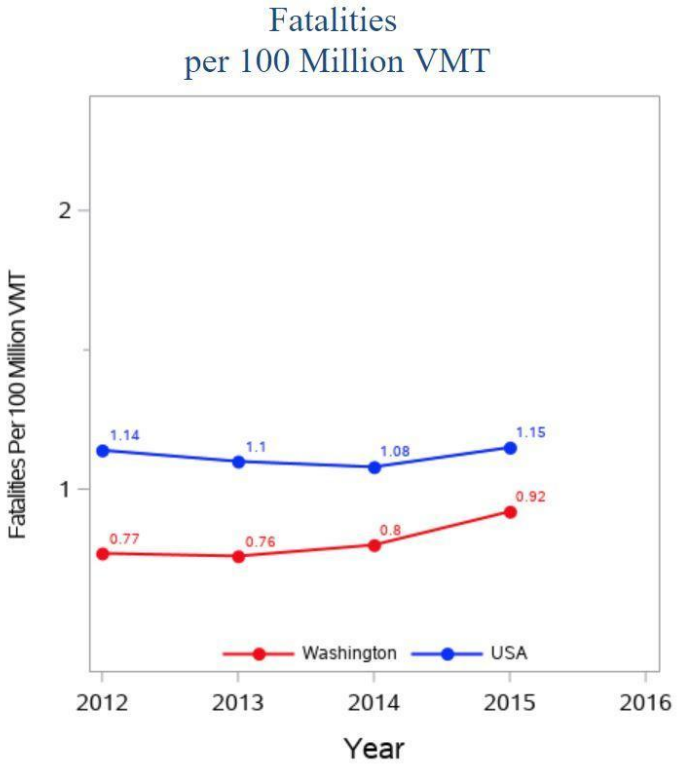
Crash Type: Intersection Related

The increase in roadway fatalities has led WSDOT to create the Target Zero initiative, which aims to reduce the number of vehicle-related deaths to zero. From its adoption in 2000 through 2014, the number of traffic-related deaths dropped by 27 percent, even as the state population increased by approximately 18 percent.



Crash Type: Lane Departure

As part of the Target Zero initiative, WSDOT has identified two main types of traffic-related deaths that are connected to infrastructure: intersection and lane departure fatalities. From 2012-2014, 21 percent of all roadway fatalities, or 276 deaths, were intersection-related. This was an increase from previous years, but was also an outlier since the overall fatalities have maintained a general decreasing trend. In 2014, 56% of all traffic fatalities were a result of lane departure. This is also part of a generally decreasing trend and if the trend continues, deaths related to lane departure would reach zero by 2027.



Resiliency

A 2015 article in The New Yorker highlighted the fact that a rupture of the Cascadia Subduction Zone in the Pacific Northwest could result in an earthquake of up to 9.2 magnitude. This article increased the public's awareness of the damage that could be inflicted by such earthquakes. Such an event would impact our infrastructure, including our roadways. The longer our roads are out of service, the more difficult it would be to return to pre-disaster conditions.

Washington state's transportation infrastructure was evaluated by the Washington State Emergency Management Council's Seismic Safety Committee in 2012. It determined the estimated time needed for recovery after a worst-case scenario earthquake and set targets for recovery to minimum, functional, and operational levels. The committee developed recommendations to improve the recovery time. Among them were recommendations to develop interagency agreements between WSDOT and local jurisdictions to facilitate detour rerouting, and for cities and counties to set priorities for the rehabilitation of lifeline corridors and bridges. As seen below, the committee concluded it could take up to three years to be able to restore some facilities after a major earthquake.

KEY TO THE TABLE

TARGETS TO ACHIEVE DIFFERENT LEVELS OF RECOVERY:

Minimal *(A minimum level of service is restored, primarily for the use of emergency responders, repair crews, and vehicles transporting food and other critical supplies.)*

Functional *(Service is not yet restored to full capacity, but is sufficient to get the economy moving again—e.g. some truck/freight traffic can be accommodated. There may be fewer lanes in use, some weight restrictions, and lower speed limits.)*

Operational *(Restoration is up to 80–90% of capacity: A full level of service has been restored and is sufficient to allow people to commute to school and to work.)*

TIME NEEDED FOR RECOVERY TO 80–90% OPERATIONAL GIVEN CURRENT CONDITIONS: ×

For a number of components, the timeframes marked in the table reflect the estimated recovery period following a worst case scenario earthquake. See the notes in Workshop Report II for details.

TARGET STATES OF RECOVERY: WASHINGTON'S TRANSPORTATION SECTOR

	Event occurs	0–24 hours	1–3 days	3–7 days	1 week–1 month	1–3 months	3 months–1 year	1–3 years	3+ years
Interstate 5									
Puget Sound (center & north)								×	
South end (Chehalis south)							×		
Interstate 90									
Puget Sound (Snoqualmie Pass west)								×	
Cascades to eastern WA (Snoqualmie to Idaho)							×		
Interstate 405									
South end (Tukwila to I-90)								×	
North end (I-90 to Lynnwood)								×	
Ferry operations							×		
Floating Bridges									
SR 520								×	
I-90							×		
Hood Canal					×				

This call to action and similar reports released over the past three decades have largely been ignored by state politicians due to the cost and legislation needed to implement them. Washington is behind states like California and Oregon that face similar risks, with California leading the nation in earthquake resilience and post-disaster preparedness.

More focus should be placed on retrofitting existing infrastructure. As the cost to retrofit the entire system is substantial, the focus should be on minimizing damage to lifeline corridors.

Innovation

Budgets to repair our transportation infrastructure are limited, but innovation can help. Innovation can improve the durability and life expectancy of roads, minimize maintenance and operational needs, and reduce construction costs.

Considering the volume of asphalt concrete needed to pave roads, improvements in the asphalt could provide a substantial benefit by extending the life expectancy of the pavement. WSDOT is researching ways to accomplish this by changing the mix design, using permeable pavement, and recycling crushed concrete as aggregate.

Photo credit: Civilogistix

There is room for innovation in how we operate our roads as well. The University of Washington's Mobility Innovation Center (MIC) is researching ways to improve our transportation system. The MIC is exploring the use of new technologies to improve incident response, how cities can plan for the future of autonomous vehicles, the use of mobile apps by vehicle users to determine vehicle tax, and other projects.

Some agencies, including Pierce County, the City of Vancouver, and Clark County, are using innovative treatments for pavement preservation. These treatments include microsurfacing — the application of a mixture of water, asphalt emulsion, aggregate, and chemical additives to an existing pavement surface — as well as other surface treatments intended to extend life expectancy, including the use of bonded wearing courses, slurry seals, cape seals, and asphalt rubber chip seals. These treatments extend pavement life at a fraction of the cost of traditional treatments such mills and inlays and/or overlays.

Solutions to Raise the Grade

1. **Evaluate options for reducing congestion.**
2. **Use triple bottom line lifecycle costing.** Build the right project and build it right, while considering economic, environmental, and social costs for the life of the project.
3. **Increase use of public transit**. Provide transit-only lanes and improve the availability of public transit (buses, light rail lines, separated bike lanes) to decrease congestion and increase roadway safety.
4. **Increase funding** for pavement preservation.
    - Continue to explore different methods of user-based taxes.
    - Increase the federal gas tax, which has not been raised since 1993. The federal government is a partner and must provide resources to states to ensure the economy and our quality of life remain strong.
5. **Put more emphasis on pavement preservation.** Funds spent on preservation avoid more costly repairs in the future.
6. **Implement resilience recommendations** presented by the Seismic Safety Committee and other committee reports through state funding.
7. **Maintain critical routes** for resilience post-disaster.
8. **Use new, innovative technologies** to reduce lifecycle costs and improve the lifespan of roadways. Increase research funding in these fields and modify regulations to promote use of these technologies in new construction and repairs.

Definitions

Lane departure – Lane departure crashes involve a vehicle which unintentionally leaves its lane of travel. This includes both vehicles leaving a lane to the right (run-off-the-road crashes) as well as vehicles leaving a lane to the left (either opposite-direction crashes or run-off-the-road crashes).

Resilience – A resilient state is one that maintains services and livelihoods after an earthquake or other catastrophic event. In the event that services and livelihoods are disrupted, in a resilient state recovery occurs rapidly with minimal social disruption and results in a new and better condition.

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Drinking Water

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Executive Summary

Community public water systems (PWS) provide water to more than 6.28 million of Washington's 7.31 million residents. The remaining population is served by private systems, including individual water wells. There is a clear divide between the well-funded large-to-medium sized PWS versus the small-to-very-small PWS. While large PWS comply with water quality regulations, meet water supply, and maintain and operate their infrastructure effectively, smaller PWS are having difficulty satisfying all regulatory requirements on a consistent basis. Washington State will need approximately $11.73 billion over the next 20 years to keep up with the growing demand and aging transmission, distribution, treatment, storage, source, and other related infrastructure. Deferred capital reinvestment and emerging infrastructure resiliency demands are contributing to the growing funding needs. Washington is not alone in this situation, as other states across the nation are experiencing similar funding shortfalls.

Introduction

Washington Community PWS can be divided into two groups, A and B. Group A PWS provide service to more than 15 connections or more than 25 people per day for at least 60 days per year. The Department of Health regulates Group A systems. Group B PWS provide service to fewer than 15 connections and fewer than 25 people per day. Washington's Office of Drinking Water and local health jurisdictions regulate Group B systems. Table 1 summarizes Washington's water systems based on December 2017 public water system inventory data.

More than 90% of Washington's 6.28 million population is served by 242 Group A PWS — these are large systems with over 1,000 connections. Group B systems serve about 2% of the population but are comprised of approximately 13,389 PWS, accounting for over 86% of the number of public water systems in Washington. This report will predominantly focus on Group A PWS.

Table 1: PWS in Washington

Group A	No. of Community PWS	Population Served	Percent of Total PWS	Percent of State's Population Served by PWS
Large >1,000 Connections	242	5,672,499	1.5	90
Medium 100 - 1000 Connections	561	374,533	3.6	6
Small <100 Connections	1,394	126,428	8.9	2
Group B	13,389	110,842	86	2
Total	**15,586**	**6,284,302**		

Source: Washington State Department of Health Water System Data

Capacity & Future Need

Overall, Washington's water system capacity has changed little since it was assessed in 2013 by the state's Infrastructure Report Card, but new state regulations have been introduced since then which may impact capacity. Capacity of larger water systems is generally adequate to plentiful, while smaller water systems struggle to maintain adequate capacity.

Two recent state Supreme Court decisions and state law changes have significantly impacted the ability to drill new wells and obtain new water rights due to potential impacts on streamflow. This has hampered both individuals and water systems seeking such rights.

Essentially, the 2015 "Foster" and the 2016 "Hirst" decisions nearly halted the drilling of wells and allocation of water rights throughout the state and significantly impaired the potential for water banking (transferring water and water rights to other areas that need it). State legislation enacted in 2018 clarified streamflow restoration requirements and took steps to improve the ability of rural communities to obtain new water sources. Work is presently underway to implement these changes and understand their impact on water supply. Water systems large and small are closely monitoring mitigation pilot projects and state legislative task force recommendations.

Condition

The condition of water infrastructure affects the ability to provide a reliable supply of water to communities, including residential, commercial, and industrial customers.

In order to maintain a high quality of water, reduce leaks and pipe breaks, and minimize potential contamination, agencies are investing resources in their systems through their capital improvement/investment plans/programs (CIP).

As an example, in the city of Bellevue's CIP, replacement of aging infrastructure, along with maintenance (water, wastewater, and storm and surface water), makes up 72% of the city's 2017-2023 budget. Bellevue has budgeted almost $234 million for its water infrastructure, which includes 611 miles of distribution and transmission mains, 24 reservoirs with 39.5 million gallons of storage, and 22 pump stations. This funding is for operation and maintenance, infrastructure replacement, and new construction.

While larger utilities have water systems that are in good to very good condition overall, smaller utilities in rural areas tend to have a higher risk of failure. According to the Black & Veatch 50 Largest Cities Water/Wastewater Rates Survey, those utilities are more "likely to fail to properly monitor for contaminants, make timely repairs, or replace faulty materials". Water system failures can result in health hazards to communities or environmental damage (flooding and erosion can impact local water bodies). The Washington State Department of Health (WDOH) has recommended that all new small water systems located in critical water supply service areas be required to first request a connection to an existing larger system to reduce issues of maintenance and quality of water. Under this scenario, these smaller, financially disadvantaged water systems can go into receivership to an authority that will repair and improve the water system.

Operations & Maintenance

Proper operation and maintenance (O&M) improves the reliability of any infrastructure system and reduces the risk of failures. Many jurisdictions, like Tacoma Public Utilities, Seattle Public Utilities, and the City of Bellevue have implemented strategic asset management plans for major components of their infrastructure and invested in hydraulic modeling analysis to reduce the risk of service interruptions and failures. Programs like these allow jurisdictions to operate and maintain water treatment plants, water transmission pipelines, and appurtenances more efficiently and effectively. Many smaller jurisdictions are limited in resources and are not able to provide consistent preventative maintenance to their systems, which leads to more emergency repairs. As infrastructure ages, these types of repairs become costly for systems that are not well maintained or funded.

Funding

Funding needs in Washington have increased over the last 20 years. Jurisdictions have rate-based programs to help fund day-to-day operations and routine maintenance, but for larger replacements and increases in capacity, rates are often not enough and additional funding is required. In Western Washington, the average drinking water utility rate ranged from $13.50 to $61.43 per month (2013 dollars), but agencies providing water transmission and upgrades for

treatment still rely on low-interest loans to finance the improvements and grants to supplement utility rates.

Based on the 2015 Drinking Water Infrastructure Needs Survey and Assessment, Washington State will need approximately $11.73 billion (2015 dollars) over the next 20 years to safely and efficiently deliver water and keep up with growing demand and aging transmission, distribution, treatment, and storage facilities. While there are several loan and grant funding programs offered throughout the state, many programs are not able to fully fund projects. For example, in 2017, the Drinking Water State Revolving Fund (DWSRF) received 25 loan applications totaling $40.69 million but was only able to fund eight projects totaling $19.73 million (six of the 25 projects were ineligible or bypassed). Project applications for funding included water main extensions, reservoir rehabilitations, and consolidation projects, as well as groundwater well installations or improvements. The DWSRF program awards funding for projects that address health risks, but construction overruns and emergency projects may also be selected for funding.

In recent years the DWSRF has provided significant funding to large projects in Washington. As a result, the amount of DWSRF funding available in the near-term will be limited until repayments begin on the loans previously awarded.

In 2018, the state's capital budget was passed and the Public Works Trust Fund (PWTF), administered by the Washington Public Works Board (PWB), began accepting applications for its preconstruction and emergency loan funds for the first time since 2012. PWB was created in partnership with local governments to assist in addressing infrastructure needs through a local funding pool, much like the DWSRF, but it is managed by a citizen's board comprised of local infrastructure representatives. The restoration of funding to PWTF will make a significant difference in the ability to design and construct much-needed infrastructure projects throughout the state.

Public Safety

Washington is subject to federal regulations that limit the levels of contaminants in drinking water to ensure it is safe for human consumption. Furthermore, Washington is required to provide an annual report detailing violations of the federal drinking water regulations that have occurred among its PWS. This annual report can be used to gauge the safety of the state's public drinking water supply.

According to the 2015 violations report, 72% of Group A PWS subject to federal water quality requirements did not report any violations. The remaining 28%, which serve a total population of 2,830,440 water consumers, reported a total of 2,024 violations. However, approximately 94% of these violations were a result of monitoring or reporting violations and not directly related to confirmed water quality violations.

For example, WDOH requires Group A systems to provide customers with a Consumer Confidence Report (CCR). The annual report includes water quality data to ensure that Washingtonians make informed choices about the water they drink. If a CCR is not provided, a system is considered noncompliant.

Many smaller PWS are challenged by a lack of resources required to maintain a public drinking water system and are unable to meet federal regulatory requirements on a consistent basis.

Washington does not have any major lead concerns, largely due to effective corrosion control and the lack of lead in Washington water sources and systems. Following the national attention on lead pipe and appurtenances in water systems, several Washington water systems have proactively sought to remove the remaining lead components from their systems.

Resiliency

Two of the most significant concerns for Washington water system resiliency are seismic events and extreme weather patterns. A large seismic event could impact the ability of infrastructure to supply water, while changing weather patterns (i.e. droughts, wildfires, and flooding) could impact the water supply.

A large portion of Washington's population is served by water sources located in reservoirs, dams, and natural watersheds that are many miles from urban centers. Water is transported to these areas through large transmission pipelines. These pipelines travel long distances through various site conditions, geology, and topography. Some transmission mains are sited in areas vulnerable to seismic activity: liquefiable soils and geological faults, for example. In a seismic event, these pipelines may be at risk for failure, resulting in limited water supply for many Washingtonians. Many PWS owners do not adequately understand the vulnerability of their systems and are not prepared for such an event. Additional planning to identify these vulnerabilities and define a post-earthquake level of service should be conducted by many of the large PWS.

Extreme weather patterns may also impact near-term water supply for Washington. In 2015, Washington experienced drought conditions where reservoir levels for the largest PWS were under stress. Many PWS owners implemented conservation programs and requested voluntary reductions in water use. Warmer weather during the winter can result in less snowpack and earlier snowmelt, ultimately reducing the water available in the summer when usage is the highest. Washington needs to develop tools to better understand long-term management of existing water resources and investigate alternative water sources to ensure water availability despite changing weather patterns and in anticipation of future increases in population.

Innovation

Washington PWS have been working to implement innovative methods in asset management, pipe construction, hydraulic modeling, and water system condition assessments. Generally, this

innovation is occurring much faster in larger systems where more staff and funding resources are available (such as Spokane, Bellevue, Seattle, and Tacoma).

Managing assets to lower life cycle costs has become prominent throughout the state. Risk assessment calculations are one example of innovation in asset management. For instance, monetized economic modeling of the timing of water main replacement is being used to cost-effectively extend the life of pipe assets. Innovative condition assessment techniques include the use of nondestructive acoustic measurements to determine pipe wall thickness, electromagnetic corrosion assessment of metallic pipes, and the use of satellites for leak detection. Two examples of innovative pipe construction techniques used in larger water systems are pipe lining in lieu of complete replacement, which results in significant cost savings, and the installation of earthquake-resistant pipe to improve water system resiliency in critical areas.

Advanced metering infrastructure (AMI) is also being implemented more quickly by larger water systems that see value in providing more granular metering data to customers and improving the metering process.

Solutions to Raise the Grade

1. Continue to fund and distribute loans and grants through the local PWTF and the DWSRF to allow projects throughout the state to be funded and delivered on time to ensure communities have continued access to clean drinking water.

2. Small PWS struggling to meet regulatory requirements should consider being integrated into larger and more robust PWS with better funding, operations, and maintenance capabilities.

3. Ensure drinking water rates provide for the full cost of service including operation, maintenance, and capital improvements.

4. Consider issuing bonds or levying taxes to fund larger projects in the event DWSRF funding is limited in the near-term.

5. Retrofit existing water infrastructure or construct new infrastructure to incorporate seismic resiliency.

6. Conduct emergency response exercises to improve strengths and reduce weaknesses in the event of a catastrophic event.

7. Develop tools to better manage and plan water resources in the expectation that extreme weather patterns and population increases will continue.

8. Continue to implement innovative programs that improve maintenance and lower the life cycle cost of assets.

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Stormwater

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Executive Summary

Washington State is a leader in innovative and sustainable methods for managing stormwater as its own separate resource. Within the last decade, many cities and counties have taken proactive steps to manage stormwater and the impacts that development has had on our natural environment. King County recently began construction on a $262 million treatment plant to handle large combined sewer flows in the Duwamish River basin, which will treat a great deal of polluted stormwater. The City of Tacoma completed its Point Defiance regional stormwater treatment facility project in 2016. This facility treats storm runoff for a large basin in the North Tacoma neighborhood and protects a sensitive part of Puget Sound. The City of Seattle has started construction on a $570 million combined sewer overflow storage project to reduce untreated stormwater and wastewater flows to the Lake Washington Ship Canal. While the concept of stormwater management is relatively new, much of the stormwater infrastructure itself is beyond its design life and in need of repair or replacement. Asset management practices, along with study and preparation for a changing climate, will be critical to making infrastructure funding decisions about how best to manage limited dollars for investing in deteriorating systems in the coming years.

Introduction

Stormwater is water that originates from precipitation events. Runoff from precipitation is stormwater that is not picked up by plants or the soil. Runoff is the most significant source of non-point pollution entering natural waterways in the United States. In urban environments, it picks up contaminants from the surface such as debris and brake dust in the streets. In rural environments, the most concerning pollution is runoff from agricultural fields. The runoff normally contains suspended solids, nutrients, and dissolved heavy metals. By contrast, wastewater is the water that originates from drains in homes and commercial structures and it typically contains a very different pollutant profile.

Historically, wastewater and stormwater were collected and treated as combined sewage, regardless of whether it was from a domestic source, such as a home, or from runoff during a rainstorm. The goal was to remove the water as quickly as possible and drain it to the nearest ditch, stream, lake, or river. This past practice has resulted in combined sewer overflows, which are addressed separately in the Report Card's Wastewater section, and deterioration to the natural environment. Studies in recent decades have indicated that a new approach is needed: stormwater and wastewater should be managed separately from one another due to damage from erosion and pollution in the runoff.

Figure 1: Biofiltration with check dams

Stormwater systems are designed to collect and convey drainage from roofs and pavement to natural waterways. It is important to remove excess water from buildings and streets to prevent damage from flooding or soft soils. Municipal storm sewer systems are similar to wastewater systems, but they do have some differences. Like wastewater systems, stormwater systems are a complicated network of interconnected private and public pipes, maintenance structures, and facilities. But stormwater systems also have treatment and detention facilities which are scattered throughout the system. They serve to store and release water at key points in the system and to reduce pollutants in the water. A typical stormwater system does not have a centralized treatment plant or a single discharge point. A few examples of decentralized stormwater facilities are shown in Figures 1 and 2.

Figure 2: Wet swale detention facility

Stormwater can be more difficult to treat than sewage because it comes from a wider area of point and non-point sources and does not generally flow to a single treatment plant or collection point. Additionally, the 1977 amendment to the Clean Water Act allows certain exemptions to the regulation of stormwater sources, including agricultural runoff.

Washington State is one of the country's leaders in innovative and sustainable methods for managing stormwater as its own, separate resource from wastewater. Various Native American nations, the salmon industry, and watchdog environmentalist groups in Washington actively advocate for the responsible management of stormwater. In addition, the state's commercial fishing and ecotourism economies, which are valued at $2.5 billion annually and support almost 29,000 jobs, rely on having good water quality in our natural waterways.

The state's Department of Ecology (Ecology) is the main regulatory agency that oversees permits related to the quality of stormwater. Ecology issues a variety of permits for stormwater discharge, but the type of permit which most concerns the public and legislators is the municipal separate storm sewer system permit, commonly referred to as a municipal separate storm sewer system (MS4) permit. The Ecology issues several types of MS4 permits to local jurisdictions such as cities, counties, and entities like ports or jails. Such permits are referred to as Phase I permits or Phase II permits. Phase I permits are generally held to a higher standard because they serve larger populations. Currently, there are only six MS4 Phase I permit holders in the state: Seattle, Tacoma, Snohomish County, King County, Pierce County, and Clark County.

Capacity

The analysis of the capacity of a storm sewer system can be broken down in to two components of the system: the conveyance capacity and the treatment capacity. The conveyance capacity of the system is what determines how much water can move through the system. The treatment capacity is what determines the condition of the water when it reaches a natural waterway.

The capacity analysis of the conveyance features includes analyzing constraints that result in flooding the system and combined sewer overflows (CSOs) through outfalls into receiving waters without treatment. Typical constraints are due to debris buildup, deterioration of the pipe system, or undersized pipes. The engineering means of assessing the capacity of the conveyance system are straightforward, but many jurisdictions lack the data necessary to perform such an analysis. As asset management practices by public agencies continue to evolve and improve, it is expected that there will be a clearer answer as to the capacity of the network.

The treatment system capacity is more complicated to analyze than the capacity of the conveyance network. Generally, it is expected that treatment facilities are of adequate capacity because most treatment installations are at the beginning of their service lives and have been designed to current or recent standards. However, not all parts of the stormwater system have treatment capabilities. In most systems, it is still the case that the majority of the stormwater is released without treatment via outfall structures and drainage ditches.

Stormwater infrastructure assets have typically been poorly tracked and maintained after installation. However, there has been some progress developing asset management databases

and field mapping programs. Some of the entities that are developing these databases and programs include the State of Washington and the cities of Tacoma, Seattle, and the surrounding metropolitan area. Asset management programs can track a variety of information for stormwater infrastructure such as pipe age, type, cost, work orders, location, inspection photos, costs, conditional rating, etc., and this data can be used to develop conditional assessments. This information increases efficiency with preventive maintenance and helps prioritize limited maintenance resources between all the infrastructure assets. The State of Washington is currently mapping existing stormwater infrastructure. This is the necessary initial step to start developing conditional ratings on stormwater infrastructure.

Condition

Many agencies are in the initial phases of collecting field data for the purpose of building asset management programs, so limited information is available for condition ratings. Ecology is currently in the process of developing guidance on asset management practices to local governments. From the limited information available, the condition of public storm systems is the same as typical wastewater systems. Until more condition and asset management information is available for existing infrastructure, it is assumed that most pipes in the system are beyond their design life and in a deteriorating condition. As asset management programs develop and expand, more information will be available to make a more accurate assessment of the condition of both public and private stormwater infrastructure.

In Washington State, many of the concerns over the stormwater systems stem from their impacts to fish and wildlife. Pollution from stormwater systems discharge to fish-bearing streams and riparian areas. Because of a lack of dedicated funding for protections and comprehensive condition data, poor stormwater condition is best documented by complaints and actions through the legal system that cite non-compliance with the Clean Water Act. One such case is a recent lawsuit filed in November 2018 that alleges the City of Anacortes has failed to comply with permits that regulate discharge of stormwater into streams, rivers, lakes, and Puget Sound, posing a threat to water quality.

Other examples are the separate consent decrees issued by the U.S. EPA and the Department of Justice that formalize agreements with the City of Seattle and King County to reducing combined sewer overflows to protect public health and the environment.

One case where the condition of stormwater infrastructure has been of great interest is in the case of Washington v. United States. In 2018, the U.S. Supreme Court ruled on this case. As a result, Washington State was required to provide for fish passage when removing and replacing culverts throughout the state. Culverts are structures, often little more than large pipes, which carry streams underneath obstructions like roads. The case alleges that the culverts — which were installed decades ago — present barriers to salmon migration upstream and prevent salmon from reaching historic breeding and fishing grounds. Moreover, they are in poor condition and require replacement. Native American tribes have argued that the reduction in

available fish violates treaty rights signed in the 1850s. The State was ordered to restore salmon habitat by providing fish passage when removing and replacing culverts at an estimated cost of somewhere between $2.4 and $3.7 billion, based on estimates from the Washington State Department of Transportation. These projects are to be completed by 2030, but current funding levels do not provide for completion by that date.

Funding

In recent years, agencies and studies have begun to separate stormwater needs from wastewater needs. This has allowed the needs for stormwater infrastructure to be quantified similar to the way the needs of other infrastructure are quantified. For example, the first time that stormwater management controls appeared as a category for funding in the EPA Clean Watershed Needs Assessment was 2004. Prior to that, it had not been recorded separately. Since 2004, the recorded financial need for the next five years in Washington State has increased from $179 million to $221 million. The needs documented by the EPA are related to controlling the entry of stormwater into sanitary and combined sewer systems. In other words, those funds are not strictly dedicated to the maintenance or improvement of separate storm sewer systems.

Funding for stormwater infrastructure projects comes to jurisdictions in a few ways. Many jurisdictions throughout the state actually have drainage utilities through which they can bill residents, just like a wastewater or a water utility can. These utilities operate like other utilities financially. Drainage utilities are a relatively new concept, nationally speaking, and not all cities have them. These ratepayer funds are helpful in paying for infrastructure.

Jurisdictions can also apply for loan and grant funding for capital projects through state and federal programs. For example, the state Ecology administers loan funds through its Water Quality Combined Funding (WQCF) program, which draws on funding from three grant programs and the State's clean water revolving loan program. In 2018, Ecology's WQCF Program had a total of about $180 million available and received applications totaling about $325 million in requests. Ecology also has smaller programs for funding capacity improvements and stormwater improvement projects with regional benefits.

The Water Infrastructure Finance and Innovation Act (WIFIA) of 2014 created a federal credit program for water infrastructure projects. The program is administered by the EPA. Competition for the funding is fierce, but King County was successful in winning some of the first loan money ever awarded by the program with its Georgetown Wet Weather Treatment Facility. The project won $134 million from the program, saving ratepayers a substantial sum of money.

Future Need

It is a challenge to quantify future financial needs for stormwater infrastructure, but it is clear that there is an increasing demand for public funding dollars to construct or enhance stormwater

infrastructure. The funding gap in Ecology's WQCF Program in 2018 was about $145 million. In 2019, the gap is projected to be $260 million. Counts for projected fiscal year 2020 are still underway at the time of this writing.

As development and redevelopment projects boom in the Puget Sound region along with population, storm drainage infrastructure is often installed to account for the increased impervious surface, generating increases in stormwater runoff. In many cases, these improvements do not extend to the downstream storm drain systems lower in the basins. With the increased development, investments in the publicly-owned and downstream stormwater facilities are needed to prevent public health hazards, such as flooding, and environmental effects from discharging hazardous substances with urban stormwater flows.

The demand for funding is expected to continue as regulation evolves and cities redevelop and densify. Regulation is likely to drive a great deal of the increased need, as stormwater regulation is not as developed as wastewater regulation. The regulations for stormwater discharge permits become more restrictive each time the stormwater code is updated, and it is anticipated that more communities will be held to the more stringent Phase I standards as regulations develop.

Operations & Maintenance

Maintenance of a modern storm system is a complicated task that requires significant resources. Historically, stormwater infrastructure has lacked the necessary attention because other infrastructure maintenance needs have been more highly prioritized. Maintenance needs exceed the available means of dealing with maintenance problems in most systems. A survey conducted across the state in 2013 suggests that 50 percent of storm sewer jurisdictions reported insufficient funding for routine maintenance activities.

Some jurisdictions have resources dedicated to sampling water at key points and tracking contaminants in the system to their sources, a practice referred to as "source control." This practice is expected to become more common as more jurisdictions are required to comply with Phase I permit standards.

Maintenance of public storm systems is becoming even more challenging with the implementation of low impact development (LID) infrastructure. Operation is generally automatic, but only as long as the facility remains in good repair and is maintained regularly. Ecology provides guidance to local municipalities on maintaining these types of facilities, but it is up to the local jurisdiction to find the funding and employees necessary to maintain them.

Public Safety

Public safety can be impacted by stormwater infrastructure from flooding and pollution. The results of flooding are well understood by the public, but the effects of pollution are not always as obvious. Pollution can result in health hazards in natural waterways and increase costs associated with the fishing industry. It can also make seafood unsafe for consumption.

According to the Washington Department of Fish and Wildlife, the economic value of commercial and sport fishing in Washington is estimated at a combined total annual value of $2.5 billion, supporting almost 29,000 jobs. Tourism that depends on the health of the marine ecosystem is valued at $1.5 billion and supports an estimated 26,000 jobs.

Underground storm pipe networks and infiltration facilities can have negative impacts on groundwater if they are not kept in good repair. Since stormwater typically carries pollution from the surface, it can pollute aquifers if it leaks out of pipe systems in poor condition. Since the construction of infiltration facilities is becoming more popular, these facilities must be constructed and maintained with care to avoid having negative impacts to the underground aquifers they feed.

Stormwater can also have significant public safety implications where development takes place on or near steep slopes. When development encroaches on steep slopes, stormwater runoff can increase the risk of landslides if not properly managed. The state has seen several devastating landslides in recent years, such as the Oso landslide, that highlight the potential for these deadly events. The risk has increased even more as wildfire seasons have become more extreme and subsequent rainy seasons saturate the denuded slopes.

Resilience

Stormwater infrastructure is reactive by nature, designed to handle various levels of "wet weather events," or storm intensities. As an example, a typical conveyance pipe is designed to convey either a 25- or 50-year storm — a storm that occurs, on average, once every 25 or 50 years. The design approach is inherently based in statistics; as the climate changes, storm events change as well. That makes stormwater infrastructure particularly vulnerable to changes in climate and weather patterns.

Climate change affects different parts of the country in different ways. For example, the historical consistency of storms in Western Washington has allowed engineers to anticipate the amount of water from a storm and design pipes accordingly. However, as climate change has started to affect the region, storms have become shorter in duration and more intense, sometimes overwhelming older parts of the system. This results in more frequent localized flooding.

The resiliency of a storm system is also dependent on the ability of the natural receiving waters to absorb pollutants. Ecology sets the acceptable limits of various types of pollutants for natural bodies of water. If the systems draining to a natural water body are below those limits, the ability of the natural system to absorb pollutants during an unusual storm event is a little higher. That makes it important to keep pollutants out of natural waters so that when extreme events do occur, the natural system has more capacity to absorb the damage.

Innovation

Washington State is one of the nation's leaders in stormwater management because it strives to take progressive steps in research and regulation. Research and emerging technologies are the primary drivers behind increased regulation. As society becomes more aware of the impacts from non-point source pollution on waterways and natural resources, it is expected that new rules will be developed to increase responses to those threats.

New studies are published on a regular basis that identify sources of pollutants and the effects they have on natural waterways and the wildlife they support. As an example, it has been demonstrated that zinc is carried by stormwater to natural waterways and has negative impacts on fish health. Zinc comes from galvanized metal surfaces subjected to marine environments, such as piles for docks, or surfaces subjected to wetting in rainstorms. The implications of the study are enormous, because galvanized metal has been a standard material in the construction industry for decades. Even so, some jurisdictions have already written the material out of their codes for certain types of construction.

Ecology has put significant investment into developing resources and guidance materials for civil engineers in Washington. Some of these resources include detailed stormwater manuals for both Eastern and Western Washington. These manuals provide design guidance specific to each region, minimum requirements, and recommendations for LID, green stormwater infrastructure, and stormwater control.

Other technical resources available to engineers include customized stormwater modeling software, LID technical guidance, and a rain garden handbook. Modeling software, such as the Western Washington Hydrology Model, has the ability to model LID facilities and the unique storm patterns experienced on the western side of the state. This tool is unique to the region and there are not very many comparable models for other parts of the country.

The state has experienced an increase in innovative stormwater practices within the last 15 years or so. This is in part due to local legislative support, EPA Consent Decree action, and guidance and multiple resources from Ecology. A few recent innovative stormwater practices in the state include:

- The recent budgeting of $1.1 billion dollars by Washington Governor Jay Inslee to protect the 74 southern resident orcas in Washington State waters and increase their number by 10 over the next decade. This still requires passage in the state Legislature.
- King County's Georgetown Wet Weather Treatment Station within the Seattle metropolitan area was recently featured in ASCE's May 2018 magazine issue. This $262 million treatment facility was designed to treat up to 70 million gallons per day of combined sewer overflow within the county. The area served by the plant is mainly

industrial, containing a lot of pavement and buildings, so the plant receives large volumes and peak flows during wet weather events.

- The Manchester Stormwater Retrofit Project, completed in December 2016, includes water quality treatment for urban stormwater runoff in Kitsap County. The project serves a large drainage basin of approximately 100 acres. It includes green infrastructure integrated into a community park with four interconnected treatment cells, and discharges to Puget Sound.
- The Venema Natural Drainage System Project located within the Seattle metropolitan area involves retrofitting six residential city blocks to reduce stormwater runoff and improve overall water quality. The project uses underground injection control cells and bio-retention cells.

Solutions to Raise the Grade

1. **Institute condition assessments and asset management programs specific to local stormwater infrastructure.** These will:
    - Identify specific stormwater infrastructure financial shortfalls and identify systemic/systemwide projects.
    - Identify gaps or unserved areas for future stormwater strategic planning.
    - Provide aggregate condition and capacity data for the State's various agencies
2. **Update the State's stormwater resources and design guidance manuals.** These can:
    - Consider more stringent regulations regarding development on or near critical areas such as steep slopes and wetlands.
    - Simplify the implementation of low impact development (LID).
    - Provide educational resources for all types of stormwater projects, including agricultural runoff.
3. **Leverage and expand revolving funds to finance stormwater infrastructure projects.** This type of financing can especially help rural communities deliver water quality projects.

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Wastewater

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Executive Summary

Washington State has approximately 250 wastewater treatment facilities that serve close to 6 million residents. Wastewater systems generally consist of collection systems, treatment facilities, and outfalls for discharging to receiving water bodies. These systems vary in size and ownership across the state. Most utilities and treatment works are publicly owned and operated. The remaining population is served by privately owned, on-site septic systems. Washington's wastewater utilities project an increase of 40% in population served by treatment works by the year 2032, to approximately 8.3 million people. Most of the state's wastewater systems are beyond their design life and the conveyance networks as a whole are in poor condition. The condition of privately-owned sewer assets, such as side sewers and septic systems, is also a problem. The capacity of sewer networks is of growing concern and, as densification occurs, older parts of the system struggle to accommodate the higher flows. Despite barriers in funding and public opposition to increased rates, the state's wastewater systems are doing a fair job of keeping the public safe and healthy and protecting our environment.

Capacity

The capacity of a wastewater system is determined by the capacity of the conveyance network and the treatment plants as two separate components of the system. It is difficult and costly to add capacity to either component of the system. In areas served by combined sewer systems — where stormwater and wastewater are conveyed in the same set of pipes — the frequency of untreated combined sewer overflows into receiving waters are a good indicator of a lack of capacity in those systems.

Some jurisdictions keep hydraulic models of their wastewater systems to aid in identifying and correcting capacity problems. It is critical to have good information about the system to be able to generate these models. Many jurisdictions are still gathering information about their systems through asset management practices and do not have a comprehensive hydraulic model. Most capacity concerns in conveyance networks are in pipes that serve older areas. In these areas, redevelopment and densification put increased demand on infrastructure built a long time ago for much lower flows. As cities densify, the debate over who should shoulder the cost of replacing and upsizing old pipes is contentious. For example, in Seattle, approximately 1,421 miles of sewer pipe have a median age of 80 years; furthermore, the system was not designed for the city's growing demand.

Adding capacity to treatment plants is also expensive: they cannot be taken offline for improvements or maintenance because sewage demand does not stop. Adding capacity to

plants can often require more space. Many of the largest plants are located in highly developed areas, making property acquisition difficult. Funding for treatment plant work is limited and funds to expand plants must compete with funds to improve plants so that they comply with increasing water quality regulatory requirements. For example, Pierce County's Chambers Creek Regional Wastewater Treatment Plant completed a $342 million expansion in 2017 to meet county population and economic growth through 2030.

Condition

The condition of wastewater systems varies widely across the state. Wastewater conveyance systems are usually designed for a useful life of 50 to 100 years. Large parts of the systems were built at different times as cities developed and expanded over time. During that period of system expansion, demand on these systems also changed due to population growth, infiltration, and inflow from storm flows. New development normally includes new infrastructure, but redevelopment in older parts of the network does not always improve the system as needed. In consideration of these factors, in 2017 King County identified new conveyance system improvements to accommodate future flow from both the projected growth in population and infiltration and inflow (I/I) through 2060.

Utilities and local governments are turning to asset management programs to manage their complicated systems. System owners use remotely controlled cameras to inspect the pipes from within, allowing them to make an assessment of the structural soundness of the pipe and to see connections to pipes. This helps owners update system maps and make more informed maintenance and replacement decisions.

A collection system that has many breaks or leaks in its pipes will convey less water than expected to the treatment plant under dry conditions and much more than normal when it rains due to I/I. This not only indicates that the collection system is leaking, but it also presents operational challenges at the treatment plant because diluted sewage negatively impacts the effectiveness of treatment. A leaky system can also send untreated sewage into groundwater. To address this challenge, Tacoma has undertaken an aggressive inflow and infiltration program aimed at upgrading or replacing old sewer pipes, funded at $4 million a year.

The condition of treatment works themselves is even more variable. Treatment facilities receive a great deal of attention from regulatory authorities. Although funding is not what it should be for treatment upgrades, the funding situation tends to be better for treatment because of the regulatory attention. For example, in the Spokane Valley, the Spokane County Regional Water Reclamation Facility, a $173 million advanced wastewater treatment plant, was constructed in 2009. It serves to eliminate the use of septic tanks and improve water quality in the region. Tacoma also operates two award-winning, state-of-the-art wastewater treatment plants.

The condition of the public system is not the entire story. Private properties are all connected to the public conveyance network by means of privately-owned pipes, also known as side sewers.

Each municipality or utility decides exactly where the limit of private-public ownership is, but there is always a portion of the line that is privately owned and maintained. The side sewers in most developed parts of the state are in the same condition as the public systems to which they connect: inadequately maintained and beyond their design life. For example, in Seattle, city records show a steady increase in the number of permits for repairing or installing new side sewers: from 3,255 in 2011 to 4,675 in 2015.

The combined effect of this private system should not be ignored. On a typical residential block, for instance, there is as much or more linear footage of buried private pipe as there is public main. That means that even if the utility or municipality invests in fixing the public main, it has only renewed half (or less) of the system on that block. Deteriorating private pipes are significant sources of groundwater contamination and inflow during rain events.

Funding & Future Needs

The U.S. Environmental Protection Agency (EPA) periodically conducts a survey called the Clean Watersheds Needs Survey (CWNS). The intent of the survey is to identify funding needs from utilities in the state that are anticipated over the next 20 years. In 2012, the CWNS estimated the state's total funding needs to be about $3.69 billion dollars.

Local governments and wastewater utilities rely on ratepayer income for day-to-day operational costs and on grant funding or loans for major capital improvements. In Washington State, the Clean Water State Revolving Loan Fund, Centennial Clean Water Grant Program, Section 319 Grant Program, and Stormwater Financial Assistance Program collectively funded approximately $2.5 billion in projects since the inception of these programs in 1988.

Revenues from sewer rates set by local governments attempt to keep rates low for affordability and are challenged to keep up with expenses. For a utility to be truly sustainable, it must set rates based on the lifecycle cost of assets and forecast the cost of constructing new assets required by growth or regulatory changes. According to the U.S. Department of Energy and the U.S. Geological Survey, the average monthly sewer bill per household in the United States is about $30. The average monthly sewer bill in Washington State is about $57 per household, 90% higher than the national average.

The number of residents served by treatment works is expected to increase by 40 percent in the next 20 years, reflecting the increase in urbanization and the tremendous rate of population growth the state is expecting. These factors combine to suggest that the future funding need for wastewater infrastructure will only increase.

Operations & Maintenance

The majority of the state's wastewater systems are publicly owned and operated. Some small utilities outsource maintenance and operations to private services. Many utilities do not have funding or staffing sufficient to address all of their maintenance needs in the time frame within

which they would like to address them. Asset management programs have been helpful from an operation and maintenance perspective because they allow utilities to prioritize problem areas and develop preventative maintenance plans, sometimes allowing them to stop problems before they start. The Municipal Research and Services Center (MRSC), a nonprofit organization that helps local governments across Washington State, has developed a series of webpages to help local governments develop effective financial policies, with an emphasis on asset management.

The maintenance of private wastewater systems is also of concern. It is not always clear to homeowners when septic systems have failed. When failures do occur, the repairs often cost thousands of dollars, which can be a burden on homeowners. In addition, there is not much regulatory oversight of these systems beyond the initial construction standards, and local government typically lacks an enforcement mechanism to compel private property owners to address maintenance problems or failed septic systems.

Public Safety

The major concerns for public safety with regard to wastewater are sanitary sewer overflows (SSOs), combined sewer overflows (CSOs), and contamination of drinking water sources fed from natural streams and lakes. Agencies can be fined, ordered to make corrections, or both. It is important to remember that in many cases, taxpayers and ratepayers shoulder the burden of paying penalties.

King County's West Point Treatment Plant spilled 250 million gallons of sewage in 2017. Most sources blame the spill on mismanagement and failure to invest in safety and monitoring equipment. King County estimated the damage to the plant to be about $25 million. The state's Department of Ecology (DOE) issued a $361,000 fine and ordered about $1 million be expended in plant investment and staff training.

Naval Base Kitsap has also experienced a series of sewage spills. In January 2018, a release of 84,000 gallons forced a recall of some 2,000 oysters grown in a farm near Dyes Inlet. The overflow was due to a pump failure. In August, a blocked pipe caused 80,000 gallons to spill and resulted in a no-contact advisory for Sinclair Inlet. In September 2018, the base discovered a leak estimated at 450,000 gallons over two years. The leak occurred because sewer pipes were improperly connected to storm drainage pipes.

Combined sewers are sewer systems that accept wastewater and stormwater in the same pipes. These combined sewer systems are known public health hazards, as they can overflow to receiving waters in large storm events and release untreated sewage directly into streams, rivers, and Puget Sound. According to the DOE, 11 communities in Washington State own and operate combined sewers, including Seattle and Spokane. Tacoma undertook a voluntary project to separate its combined sewers in the 1960s and has very few combined sewers left in service.

Addressing CSOs is a top priority for both sewer utilities and regulators. Approved plans are in place to bring most of the CSOs in the state under control by the early 2020s, and all of the CSOs in the state under control by 2030. The state's public agencies have done an excellent job of solving the CSO problem through coordinated, proactive efforts and deliberate funding measures. However, combined sewers still pose a threat. In 2015, Lake Washington was closed due to a combined sewage spill. In August 2018, DOE fined King County taxpayers $118,000 for a CSO. It also fined King County $63,500 for violations that occurred in 2015. The city of Seattle was fined $33,500 for 10 violations in 2015. The city's $570 million Ship Canal Water Quality Project, currently under construction in partnership with King County, will address the majority of its CSOs.

Aside from representing a threat to the wildlife relying on the impaired water body, this can cause a health hazard for humans. Shellfish are especially susceptible to contamination by E. coli. Many independent Native American nations around the Puget Sound area have rights to harvest shellfish from designated areas and are vulnerable to these impacts. The nations keep an inventory of the condition of each shellfish bed and regularly must limit or prohibit harvesting from certain areas due to E. coli contamination.

Resilience

Regions with large ratepayer bases can more easily afford expensive upgrades to make wastewater systems more resilient to natural disasters. For example, the City of Tacoma recently completed a $9 million flood wall project to protect its Central Wastewater Treatment Plant against large storm events. The flood wall better ensures that millions of gallons of untreated wastewater do not flow into Puget Sound and related equipment is not damaged or destroyed in such an event.

In general, most of the resources available go to maintenance of existing systems and upgrades needed to comply with new treatment rules and regulations. Most utilities have struggled to find funds to address measures that make a wastewater system more resilient to natural disasters or a changing climate. Projects that make wastewater systems more resistant to natural disasters are typically extraordinarily expensive. Examples of these types of projects include:

- Seismic retrofitting of treatment works, pump stations, and critical elements of the conveyance system
- The installation of flood protection measures at central treatment works, which are typically built at the lowest elevation of the area and sometimes within floodplains
- Installation of redundant control and communication technologies which help keep the system online following a major natural disaster
- Secondary containment measures that prevent waste from escaping plants and pump stations in the event of a leak or damage to the primary system

- Projects that address infiltration and inflow, which fix leaky pipes and reduce the impact of rain water on pipe and treatment capacity

Capital projects are one way to address the resiliency of a system, but there are also administrative and operational measures that can be taken for a fraction of the cost. An example of both is Seattle Public Utilities' adopted policy to incorporate climate change factors (7%) to flow demand projections in its peak flow models for new capital projects.

Many utilities have emergency response plans and invest in training employees for various emergency scenarios. One example of this is how local agencies participated in the Cascadia Rising exercise led by the Federal Emergency Management Agency. These kinds of emergency response exercises can highlight areas where agencies can make improvements to be more prepared for all kinds of emergency situations.

Innovation

Washington State is one of the country's leaders in policy related to the sustainable management of water resources, and that attitude extends to the way that its utilities treat wastewater. The state's utilities have implemented innovative policies and projects to address problems and increase the sustainability of their systems.

Managing stormwater using alternative methods, such as low-impact development and green stormwater infrastructure, can sometimes have a tremendous impact on wastewater utilities by reducing the amount of inflow to the system due to rain events. This is especially true in combined sewer systems. Washington State is known as one of the country's leaders in sustainable stormwater management practices and regulations.

The state is also generally quite progressive with its attitude toward alternative energy sources and waste as a resource. In the wastewater sector, this can include projects like biogas recovery, water reuse, and land application of biosolids. For example, the City of Tacoma partnered with Puget Sound Energy to construct a pipe link between the natural gas system and the wastewater treatment plant to supplement natural gas with biogas. Biogas is "scrubbed" and refined before it is sent to the system.

Most people think of technology when they think of innovation, but innovative policymaking can have just as much impact on making progress. For example, the City of Tacoma has a grease protection policy and an oil-water separator policy. The grease protection policy is applied to commercial users, such as restaurants, as a way to pre-treat waste flows containing a high fat content. Fats and greases tend to clog the public conveyance system and are difficult to treat at the plant, resulting in an undue public burden on maintenance and treatment costs. Oil-water separators are required at fuel stations and parking garages for the same reasons. These policies offer a higher degree of protection for the public system and preserve capacity either in the conveyance system or at the treatment plant.

Solutions to Raise the Grade

1. **Educate the public via an awareness campaign about the true cost of wastewater infrastructure.** Some utilities do not have sustainable rate structures that can fund the operation and maintenance of the system into the future because of affordability priorities to keep rates low. Rates should reflect the full cost of service. One way to set sustainable rates is to perform a cost-of-service study that takes into account not only operational costs, but also lifetime costs of capital assets.
2. **Continue to manage and fund the various grant and loan programs that provide funding for wastewater-related projects in a responsible and progressive manner.** Consider adding money to the revolving funds now to help offset higher demands later.
3. **Encourage private investment in renewing the private system and subsidize through the State of Washington or provide a low-interest loan program at the state level.** Rebate programs may also provide an incentive for private property owners to take proactive action.
4. **Make funding go farther by reducing roadblocks to public spending on infrastructure.** Some examples of policies that drive up the cost of infrastructure include:
    - Laws that prohibit municipalities and utilities from self-performing work
    - Laws that prohibit cities from partnering with private developers in ways that would save costs
5. **Streamline regulatory and permitting processes to make taxpayer dollars go further.** Advocate for universally supported infrastructure to be delivered to the public sooner.
6. **Implement asset management programs to ensure proper maintenance of collection systems and treatment facilities.** Analysis of this data on a statewide level is also encouraged to provide a more accurate assessment of the condition and capacity of wastewater networks. An agency such as the Department of Ecology (DOE) could perform this analysis or require utilities to perform the analysis.

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Schools

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Executive Summary

Public schools are the backbone of our communities as they help provide our future generation with the education and social skills needed to contribute to the economy of the future. Washington's 295 school districts range in size from four students to more than 53,500 students, with a total prekindergarten through 12th-grade student enrollment of 1.12 million in 2018. Washington State has recently increased funding to reduce class sizes to meet constitutional requirements. This is a positive step, but local districts now face a shortage of physical classroom space. Many communities have supported bond measures for new construction or modernization projects, but it will take time for these needs to be met statewide.

Capacity

Enrollment growth in Washington State has exceeded 6% over the past five years, outpacing national projections. Per a recent Office of Superintendent of Public Instruction (OSPI) study, the U.S. Department of Education's National Center for Education Statistics has projected a 15%-26% enrollment change in Washington State over the next decade.

Washington's 295 school districts range in size from four students to over 53,500 students with a total prekindergarten through 12th-grade student enrollment of 1.12 million in 2018. Washington State allocates an average of 145.3 square feet of class space per student, which is below the national average of 170.6 square feet per student.

As a result, approximately 5,000 portables are used in districts across the state, an average of two portables for each permanent school. State legislation passed in the 2009-2011 biennium expanded instructional programs by providing all-day kindergarten and K-3 class size reduction, resulting in additional needed classroom space across the state. In 2015, the state Legislature provided $234.5 million in grant funding as part of the capital budget, but this is not sufficient for the increased student population.

Condition

In 2012, OSPI implemented the Information and Condition of Schools (ICOS) software program, which is used to document and store information and condition details of school district facilities and sites. A comprehensive system used to track the condition of school facilities across the state had been lacking previously. This system can be used to help determine and track capital construction need and for assistance in the allocation of construction funding in districts across the state. Districts requesting state funding through the School Construction Assistance Program (SCAP) are required to complete a study and survey assessing the district's needs,

physical condition of the facilities, and availability of adequate instructional space. In 2015, the OSPI requested that districts completing a study and survey enter the information directly into ICOS. These study and surveys are required every six years if a district is pursuing state funding for a construction project. Each school district determines who is authorized to have access to the data.

A study conducted by Washington State University (WSU) and a 2009 OSPI study found that "approximately half of the schools in Washington were built before 1992."3 The WSU study found that many schools are well-designed and well-maintained in districts with large tax bases, while many small, rural districts have small, outdated schools that do not accommodate modern instructional tools and approaches. The 2009 OSPI study identified a need for school repairs totaling $1.8 billion.2

Funding

New school construction, additions, and modernizations are funded primarily by the local school districts and, if the districts are eligible, with partial financial assistance from the state. Local school districts raise construction funds by passing bonds, which are repaid over a 20- to 30-year period with property taxes. School bonds require 60% voter approval to pass. One of the criteria for eligibility to receive state funds is that the local district must pass a bond or have funds available to cover construction costs not covered by the state. A district's ability to pass a bond varies across the state; smaller and less wealthy districts pass bonds less frequently.

The state biennial capital budget includes money for K-12 construction assistance and is funded by state property tax dollars. These funds are distributed to school districts through the SCAP, administered by OSPI. SCAP funding is based on a preset formula based on the school district's available space and projected enrollment, a state-set cost-per-square-foot construction cost allocation (CCA), and a state funding percentage based on the school district's assessed land value per student compared to the statewide average of assessed land value per student. The funding formulas have not increased to address the additional classroom space needed for the mandated class size reduction. The CCA is significantly lower than the actual total cost of construction, thereby transferring this burden to local districts. Not all construction project costs are eligible for state funds. In 2017, the state Legislature established a task force to review improvements to the SCAP program..

Additional grant programs are available for funding specialty programs such as K-3 class size reduction, emergency repairs, and STEM grants for construction and modernization of science and science lab classrooms. If a district receives funding through the K-3 class size reduction grant program, those funds reduce that district's eligibility for SCAP funds, limiting districts' ability to modernize while also reducing class sizes.

Washington State's 2017-2019 budget included $933 million for K-12 construction, $10 million in capital funding for STEM Capital Grants, $3 million in capital funding for Health & Safety Urgent Repair Grants, and $15.5 million in grants for school facilities modernizations in small, rural school districts with enrollments of 1,000 or fewer students. The state provided $792 million for K-12 construction assistance in 2007-2009 and $690 million in 2009-2011.

Future Need

School districts located in growing areas of Washington state anticipate additional growth in their student population. The school age population between 5-17 years will increase by about 14% by 2040, according to the state's Office of Financial Management.

Communities in these school districts support large capital bonds about once every 30 years. To accommodate the anticipated future growth in this 30-year time period, some school districts have begun including future capacity considerations in their preliminary design investigations.

The OSPI Facilities Manual encourages use of master planning and pre-design as critical tools to be used prior to requesting funding from the community and state taxpayers for construction projects. The pre-planning process varied significantly from each school district, and OSPI found that only a handful had completed a pre-design feasibility study. The lack of a detailed pre-planning phase may significantly impact project budgets.

The ability of school districts to respond to anticipated future growth varies across the state. The ability to fund future school construction projects is generally connected with the relative wealth of the local community. In 2015, the state Legislature provided $234.5 million in grant funding, but this is not enough for anticipated future student populations.

Operations & Maintenance

Operation and maintenance is typically funded at the district level. State funding is only available every 20 or 30 years to help address major renovation needs, and the formula used to calculate the state's share significantly underestimates actual construction costs, thereby transferring increased burden to districts. A 2010 study found that districts have unmet repair needs of approximately $16 per square foot across their building portfolio. This funding need often is addressed in conjunction with a major capital project, which can skew the apparent costs of a bond. This also places low-wealth districts at a disadvantage and leads to higher building costs in the long term as deferred maintenance needs can lead to larger future repairs.

New technologies such as predictive maintenance may improve the repair planning process, but likely requires a deliberate initial investment to be effective.

Public Safety

Washington State has a wide range of potential geologic hazards. A recent OSPI Hazard Mitigation Plan considered six natural hazards that pose the greatest risk: earthquakes, tsunamis, floods, wildland/urban interface fires, volcanic events, and landslides. These hazards affect different regions of the state in different ways.

The Washington Geological Survey (WGS) found that about 72% of schools in Washington are located within a high to very high seismic zone. A study conducted by the University of Washington estimates that more than 50 tsunami evacuation structures are required in Washington.

Earthquake risk is heavily dependent on the design and age of construction for each school. Understanding of earthquake hazards has increased significantly over the years, and the Cascadia Subduction Zone was not factored into statewide building codes until about 2000. As a result, many older school buildings are at significant risk of damage or collapse in a major earthquake.

Since school design and construction are managed at the local level, OSPI currently lacks data on the overall earthquake safety of school buildings in Washington. There appears to be some momentum at the state level to study earthquake safety more holistically and factor these needs into future capital investments.

Other evolving threats such as an active shooter could force districts to choose between security upgrades and other needs such as seismic upgrades during future renovation projects.

Resiliency

Schools can lead the community in several aspects of resilience. They are often used as community resources during disasters to assist with emergency response and initial recovery activities. This short-term need should be balanced against the long-term goal of getting students back to school and parents back to work to assist with the recovery process.

In addition, OSPI has minimum sustainability goals for new construction and renovation projects. Some districts exceed these requirements based on local support for sustainable buildings and environmental stewardship.

In both examples, schools can engage members of the public in this process by showing what they get in return for a higher initial investment, thereby leading the way for improved resilience and sustainability.

Innovation

Cross-laminated timber (CLT)

The Washington State Department of Enterprise Services oversaw a pilot project to construct 20 K-3 classrooms using cross-laminated timber (CLT) in 2017. This pilot project was completed in five school districts across Washington State. CLT construction comprises of placing pre-fabricated wooden panels with doors and windows cut out together on-site. Use of these prefabricated panels reduces construction time and environmental impacts.

Earthquakes

An earthquake early warning (EEW) system is currently in development for the West Coast in collaboration with the U.S. Geologic Survey (USGS) and several West Coast universities. This early warning system will provide enough time to notify the public and allow them to take protective action. The system will expand and upgrade the infrastructure of regional seismic networks.

Tsunami

An innovative solution was developed to build the nation's first vertical tsunami refuge in Washington. Another community designed a man-made hill near its elementary school to provide a place of refuge for the community. These ideas proved cost-prohibitive for small coastal communities. A new gym built in the Ocosta School District in Grays Harbor County was built tall enough to exceed the height of the tsunami wave and strong enough to support 2,000 people on the roof. Residents of this small community passed a $16 million levy after their application for FEMA funding to cover part of the cost was denied.

Solutions to Raise the Grade

1. Ensure OSPI matching-fund calculations are keeping pace with current market trends of inflation and escalation.
2. Develop a formalized program to assist facility managers with managing regular maintenance to extend building lifespan to the greatest extent possible.
3. Encourage that infrastructure seismic performance be factored into the regular study and survey process required by OSPI.
4. Create a mechanism that also allows less-affluent districts to modernize and replace their facilities.
5. Modify the CCA to accurately reflect construction costs.

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