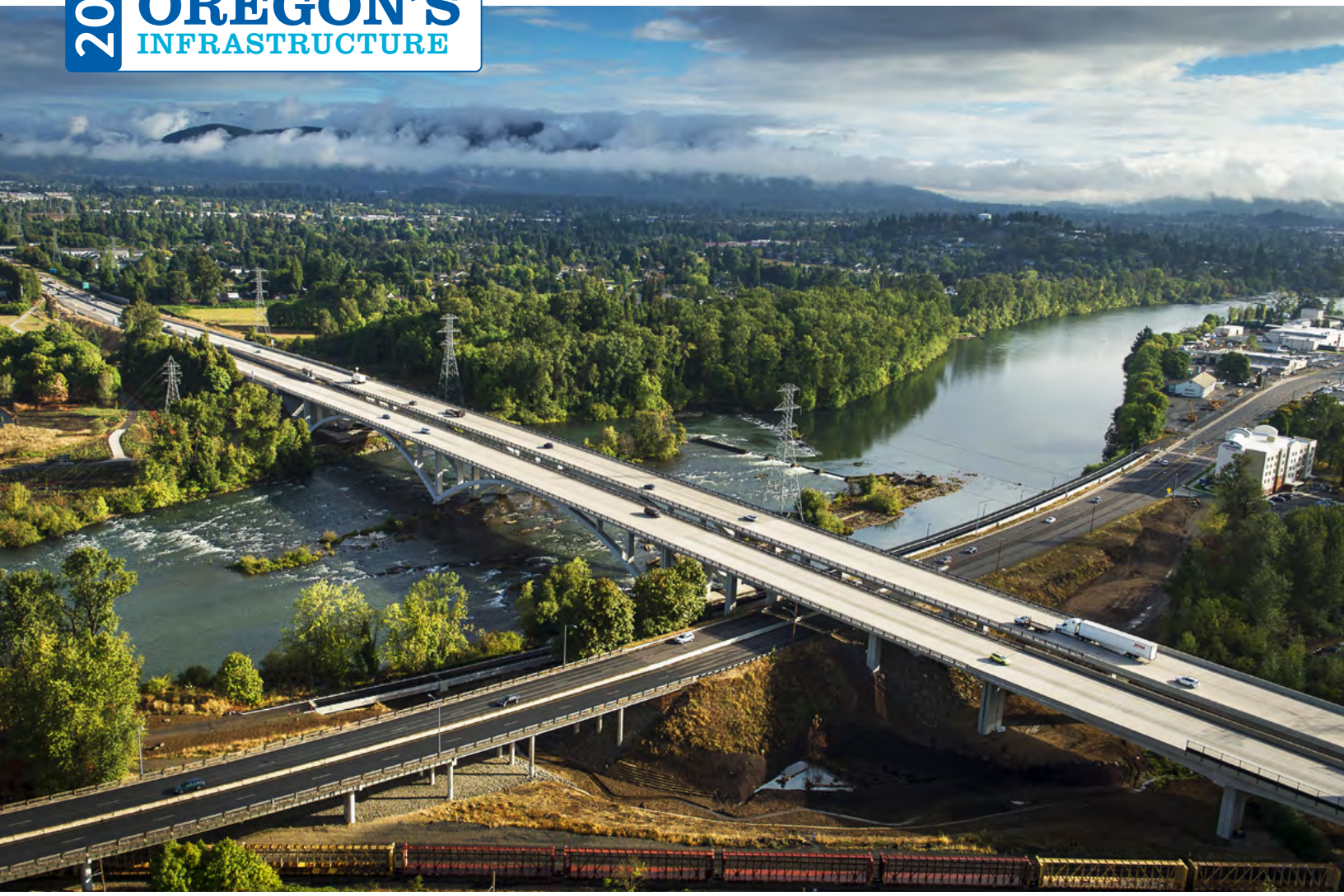
2019 REPORT CARD FOR OREGON'S INFRASTRUCTURE



Oregon Section of the American Society of Civil Engineers

INFRASTRUCTUREREPORTCARD.ORG/OREGON

ASCE

AMERICAN SOCIETY OF CIVIL ENGINEERS

COVER PHOTO: I-5 OVER WILLAMETTE RIVER, EUGENE, OR PHOTO: HDR

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EXECUTIVE SUMMARY

Infrastructure is critical to supporting the way Oregonians live, get to work, and stay healthy. Our roads take us to vacations in the Cascades or at the Coast, our bridges provide access to work, schools, and hospitals, and our water pipes bring us clean, potable drinking water. Our infrastructure is also critically important to commerce and trade, which Oregon depends on.

Oregon has a long history of supporting infrastructure through funding and innovation. We were the first state to implement a gas tax and we were home to the first transmission line in the U.S. More recently, we became the first state to pilot a road usage charge program to pay for necessary transportation infrastructure repairs.

Oregon's long legacy of supporting its infrastructure is something to be proud of. However, we face significant challenges that need to be addressed head on through substantial planning, strong leadership, and adequate financial assistance. Oregon's population continues to steadily grow and some of our infrastructure systems are experiencing capacity challenges. Meanwhile, many of Oregon's assets, including bridges, dams, and pipelines, were built 50 to 100 years ago and are at the end of their service life. Additionally, we now better understand the likelihood that Western Oregon will experience a potential of a 9.0 magnitude earthquake – "the Big One" – sometime during the next generation. Protecting our residents and our infrastructure against a major seismic event requires substantial funding.

The Report Card was created to help Oregonians 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 to share that information with the public. The Report Card provides a snapshot for residents and policymakers to engage in a conservation about where we are and where we want to be.

2019 REPORT CARD FOR OREGON'S INFRASTRUCTURE

ASCE OREGON SECTION

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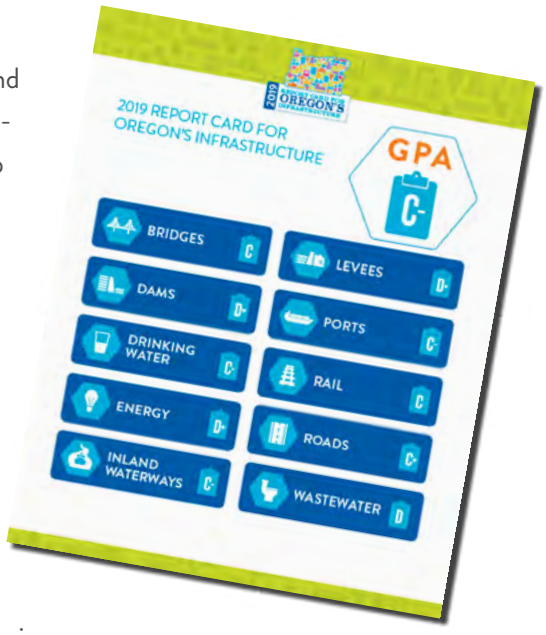
The ASCE Oregon Section would like to thank the volunteers who dedicated their time to the research, review, and writing of this report card. We would also like to thank the many other unnamed contributors who performed peer reviews, assisted in data collection and review, answered questionaires, or participated in other ways. Thank you all for your service to Oregon and our infrastructure.

ABOUT THE INFRASTRUCTURE REPORT CARD

GRADING CRITERIA

ASCE-OR's 2019 Report Card Committee is a group of dedicated civil and environmental engineers from Oregon, who volunteered their time to collect and analyze data, prepare, review, and revise each section, and develop the final Report Card. The committee worked with ASCE's Committee on America's Infrastructure and ASCE Infrastructure Initiative staff to provide Oregon with a snapshot of the state of our infrastructure, as it relates to us at home, and on a national basis.



The Report Card Sections are analyzed based on the following eight criteria:

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

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

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

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

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

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

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

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

2019 REPORT CARD FOR OREGON'S INFRASTRUCTURE

GRADING SCALE

EXCEPTIONAL: FIT FOR THE FUTURE

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

GOOD: ADEQUATE FOR NOW

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

MEDIOCRE: REQUIRES ATTENTION

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

POOR: AT RISK

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

FAILING/CRITICAL: UNFIT FOR PURPOSE

The infrastructure in the system is in unacceptable condition with widespread advanced signs of deterioration. Many of the components of the system exhibit signs of imminent failure.

2019 REPORT CARD FOR OREGON'S INFRASTRUCTURE

2019 REPORT CARD FOR OREGON'S INFRASTRUCTURE

GPA

C-

BRIDGES	C
LEVEES	D+
DAMS	D+
PORTS	C-
DRINKING WATER	C-
RAIL	C
ENERGY	D+
ROADS	C+
INLAND WATERWAYS	C-
WASTEWATER	D

SOLUTIONS TO RAISE THE GRADE

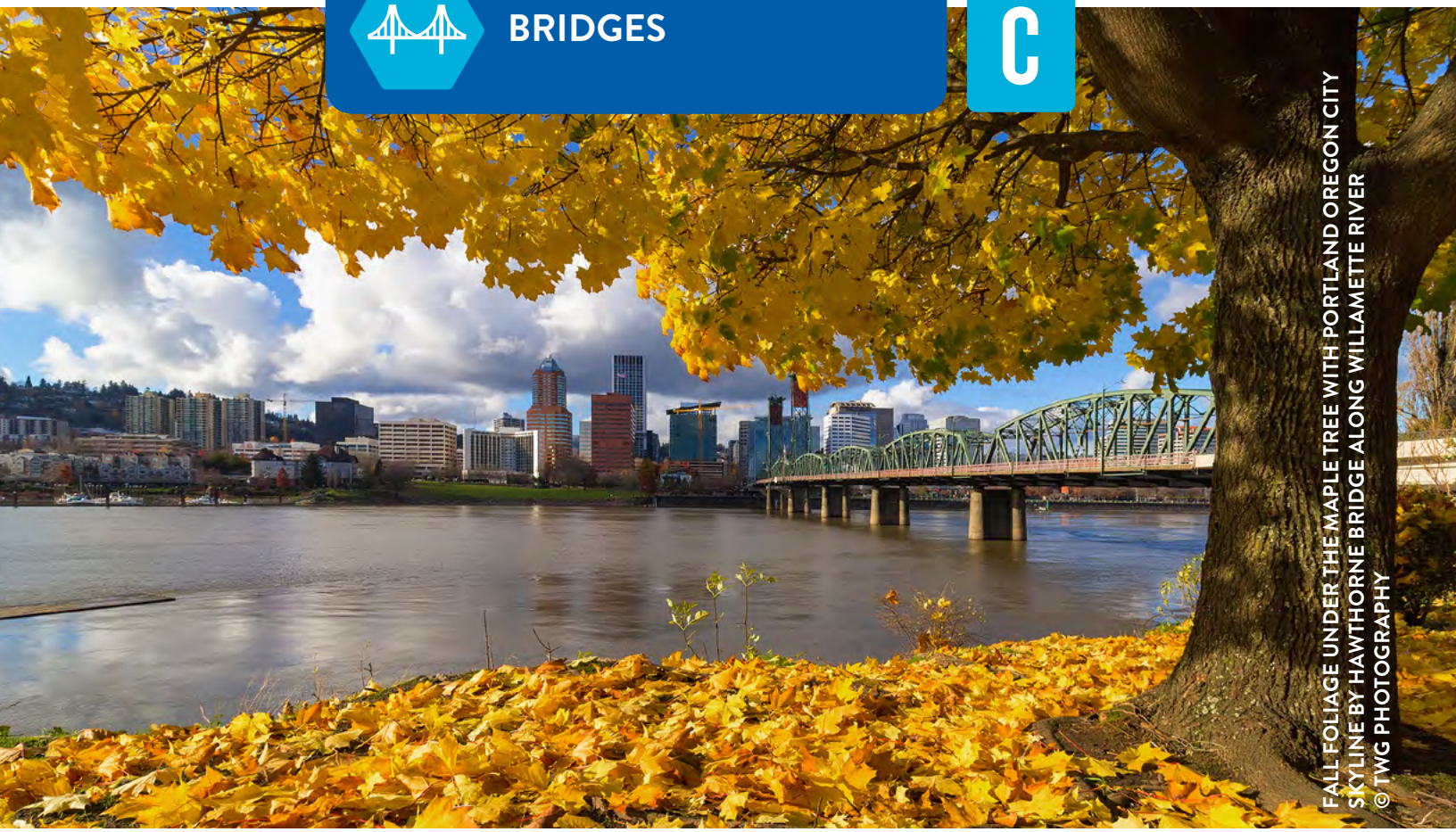
To raise Oregon's infrastructure grade, ASCE developed the following three recommendations:

1. **Improve our infrastructure's ability to withstand a major seismic event.** The likelihood of experiencing a 9.0 Cascadia Subduction Zone earthquake event over the next 50 years is about 20%. Our growing understanding of both the likelihood and severity of such an event requires immediate attention to our at-risk infrastructure. Bridges, dams, drinking and wastewater systems and more were not designed for ground acceleration that would come with such a largescale seismic event. We need strong leadership, extensive planning, and most importantly, robust funding to prepare our infrastructure to be resilient. Our built systems must aid recovery efforts, rather than hinder them.

2. **Prioritize investment in Oregon's bridges to protect the transportation network in the aftermath of a major seismic event.** The Oregon Resilience Plan calls for the development of a mitigation policy and retrofit plan for vulnerable bridges and other infrastructure. Bridges are critical lifelines to rural populations, not to mention metropolitan neighborhoods that reside on different sides of the Willamette and Columbia rivers. New bridges must be built to withstand a major earthquake, and old bridges must be retrofitted so that they can stay in service and provide access to communities. Emergency vehicles and supplies will need to be moved quickly and efficiently in the aftermath of a major earthquake.

3. **Provide additional funding to the Connect Oregon multi-modal, competitive grant program.** Connect Oregon has provided much-needed grants for Oregon's air, rail, marine, and bicycle/pedestrian infrastructure. The program has a proven track record of increasing connectivity, strengthening the freight system, and improving the overall condition of Oregon's transportation network. Robust funding should be provided by the state legislature to ensure the continuation of the program.

C



FALL FOLIAGE UNDER THE MAPLE TREE WITH PORTLAND OREGON CITY SKYLINE BY HAWTHORNE BRIDGE ALONG WILLAMETTE RIVER
© TWG PHOTOGRAPHY

BRIDGES
GRADE: C

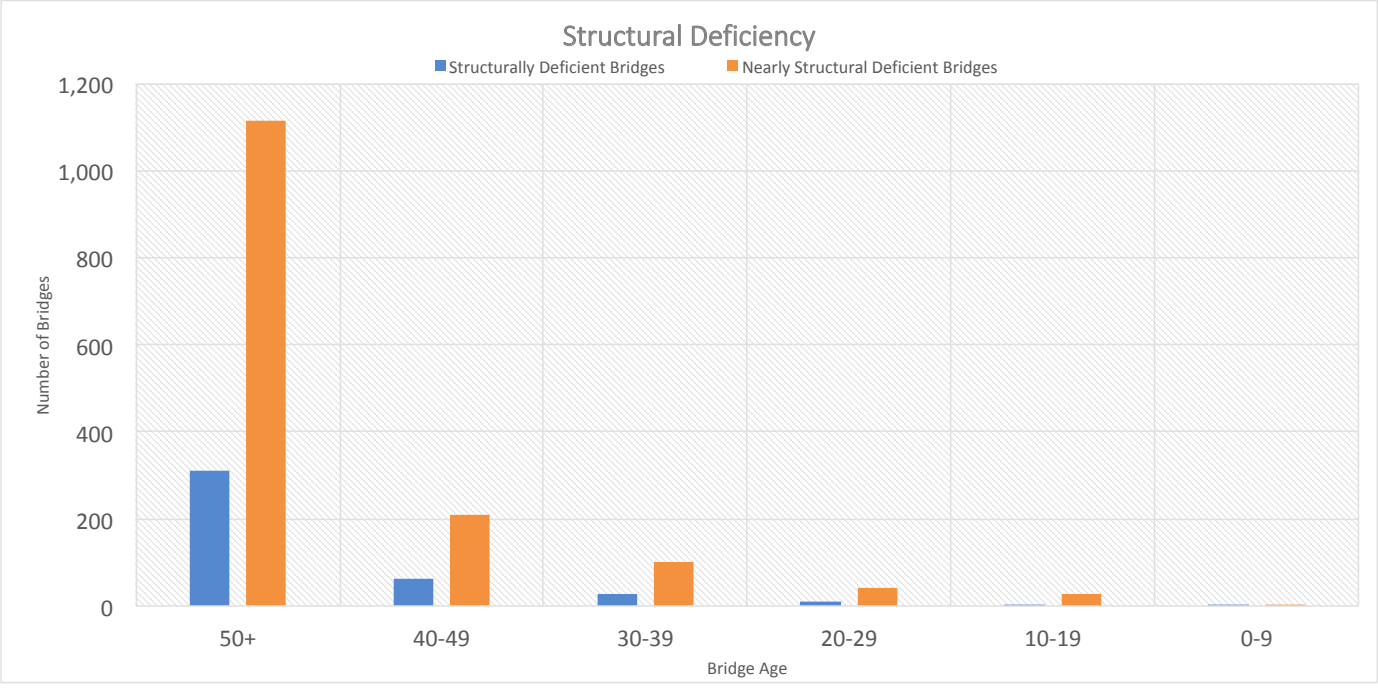
EXECUTIVE SUMMARY

Oregon has 7,615 bridges and 546 culverts listed in the Federal Highway Administration (FHWA) National Bridge Inventory (NBI) database. While the percentage of bridges in Oregon that are structurally deficient is just over half the national average, the average age of Oregon's bridge inventory is rapidly increasing. Nearly 20 percent of Oregon bridges are at risk of becoming structurally deficient in the near future, and the percentage of Oregon's bridges in good condition is lowest among the western states. While funding provided in House Bill 2017 (passed by the Oregon State Legislature in 2017) has improved funding for bridge infrastructure, maintenance needs are forecasted to grow and will require nearly three times the funding levels established by HB2017. Combined with the need to improve our seismic resilience, the funding for bridges is critically low.

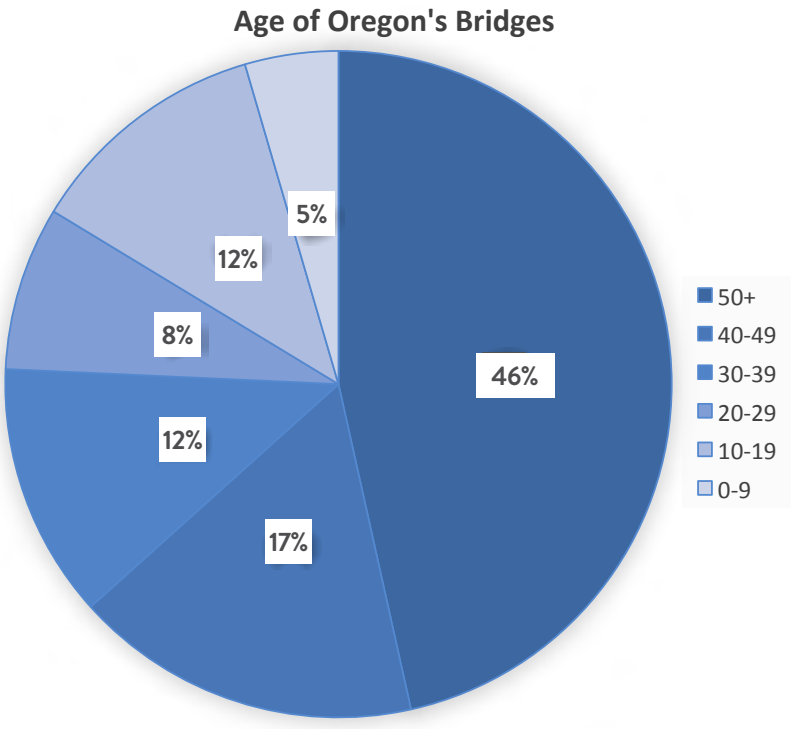
CONDITION & CAPACITY

Of Oregon's bridge inventory, 2,621 bridges are state-owned, 3,882 are county- or city-owned, and 1,112 are owned by Federal agencies or other jurisdictions. On average, state- and locally-owned bridges are in satisfactory condition, with federally-owned bridges in satisfactory to good condition. However, conditions are declining and many bridges are on the cusp of becoming deficient.

There are an average of 54.5 million trips taken on Oregon bridges each day, with that number expected to increase to 68.4 million trips by 2030. With a current state population of 4.2 million people, there are approximately 13 bridge crossings per person every single day. Of the 7,615 bridges, 422, or 5.2 percent are listed as in poor condition and considered structurally deficient. While this percentage compares favorably to the national average of 8 percent, the number of structurally deficient bridges in Oregon is more than double the amount from 10 years ago (178). An average of 1.4 million trips are taken over structurally deficient bridges every day, or one for every three people in Oregon. Encouragingly, Oregon's highly travelled bridges are not as likely to be structurally deficient, with only 2 percent of total trips crossing a structurally deficient bridge. Replacing the bridges that are currently structurally deficient would cost just over $412 million.



This substantial uptick in the number of structurally deficient bridges is an indicator of the aging nature of our state's bridge inventory. The average age of Oregon's bridges is 46 years old. This is older than the national average of 43 years old (and substantially older than the state average of 38 years old in 2008). While existing 1950s and 1960s era bridges were typically designed for a 50-year life, rehabilitation and preservation has helped extend their service life. Based on a typical design life of 75 years and the current bridge replacement rate of five to 10 bridges per year, the average age of Oregon's bridges will exceed their design life by 2051. Notably, an additional 1,495 bridges are on the verge of becoming structurally deficient. As our infrastructure continues to age, the percentage of Oregon's bridges that are structurally deficient could quickly exceed the national average. Only 21.9 percent of bridges by area are currently in good condition (FHWA rating of 7 or better). In the last 10 years, the number of Oregon bridges on the National Highway System (NHS) in good condition has been cut in half.



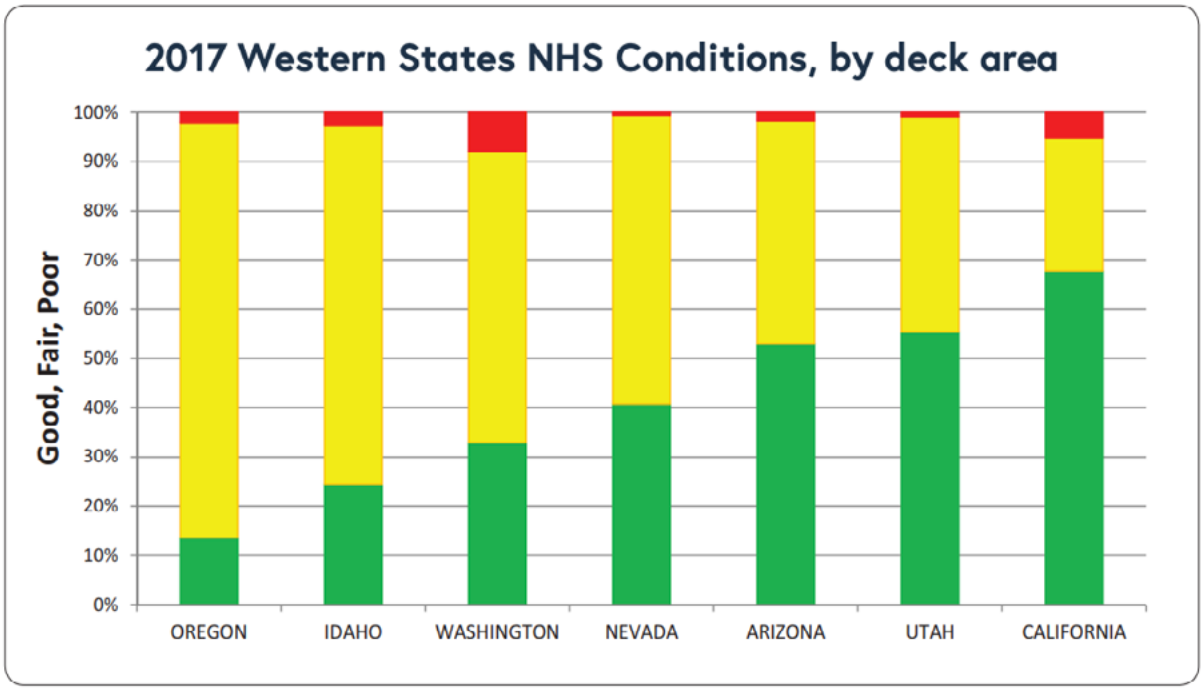
225 (3 percent) of Oregon's bridges are load restricted, meaning that travelers are legally prohibited from crossing with vehicles weighing more than the posted limit for the bridge. Seventy seven of these bridges are also structurally deficient, but the remaining 148 are in otherwise good or fair condition. Repairing or strengthening these additional 148 bridges would cost an additional $51 million.

O&M, FUNDING & FUTURE NEED

While the state of Oregon owns just over 1/3 of the state's total bridge inventory, those bridges make up nearly 2/3 of the total bridge area. Local agencies are responsible for 1/2 of the total bridge inventory and 1/4 of the total bridge area. Federal and other jurisdictions are responsible for only 4 percent of the total bridge area. With this distribution of ownership, nearly all the bridge operation and maintenance work in Oregon is the responsibility of the state and local governments.

Since the Oregon Transportation Investment Act (OTIA) program was completed, focus has shifted to maintaining existing inventory through repairs and bridge strengthening. Maintenance and preser-

vation actions can help hold bridge condition ratings level by fixing the most deficient element(s) on a bridge, but rarely results in improved ratings. Furthermore, these improvements are merely temporary, as the entire bridge continues to age and deteriorate. The passage of HB2017 has substantially improved funding for bridge preservation from $85 million/year to $122 million/year. However, even with this increased funding level, the condition of Oregon's bridges will continue to decline, with only 4.1 percent of Oregon's NHS bridges forecasted to be remaining in good condition by 2028.



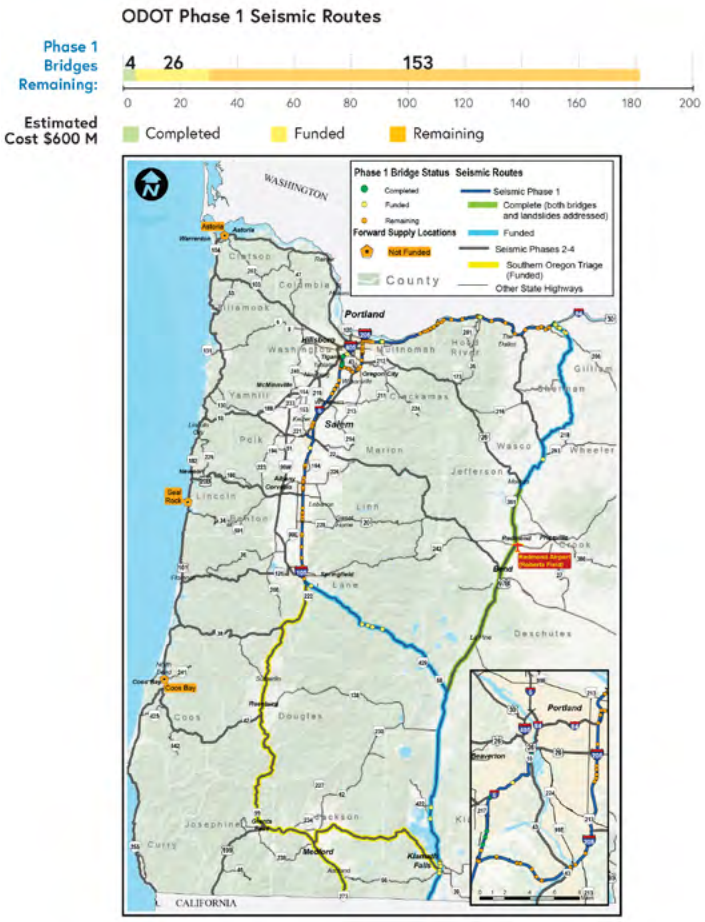
As bridge conditions continue to decline, existing funding levels will be insufficient to maintain this aging inventory. Furthermore, current ODOT Highway Division funding is derived primarily through flat-rate motor fuels taxes. Over time, due to the effects of inflation and vehicles becoming increasingly fuel efficient, existing funding sources are at risk of being compromised. Oregon's innovative weight-mile tax for trucks and the trial use of a distance tax for passenger vehicles may help alleviate this downward trend in funding, if fully implemented in the future.

To preserve at least 10 percent of Oregon's NHS bridges in good condition, the Oregon Transportation Commission estimates that funding for bridge maintenance will need to be $350 million/year. Current funding levels enable bridge owners to preserve their bridges and complete major rehabilitations in the short term.

Replacement of Oregon's oldest and most heavily travelled structures will tremendously improve the overall condition of Oregon's bridges, and reduce the annual cost of maintaining existing structures. Major infrastructure projects included in HB2017 are a step in the right direction, but more bridge replacements are needed as existing bridges continue to age. Using a 75-year bridge design life, an average of 103 bridges should be replaced annually to preserve current inventory conditions. However, of the 2,621 state-owned bridges, only seven were added in 2018, with only two replacing existing deteriorated bridges.

RESILIENCY

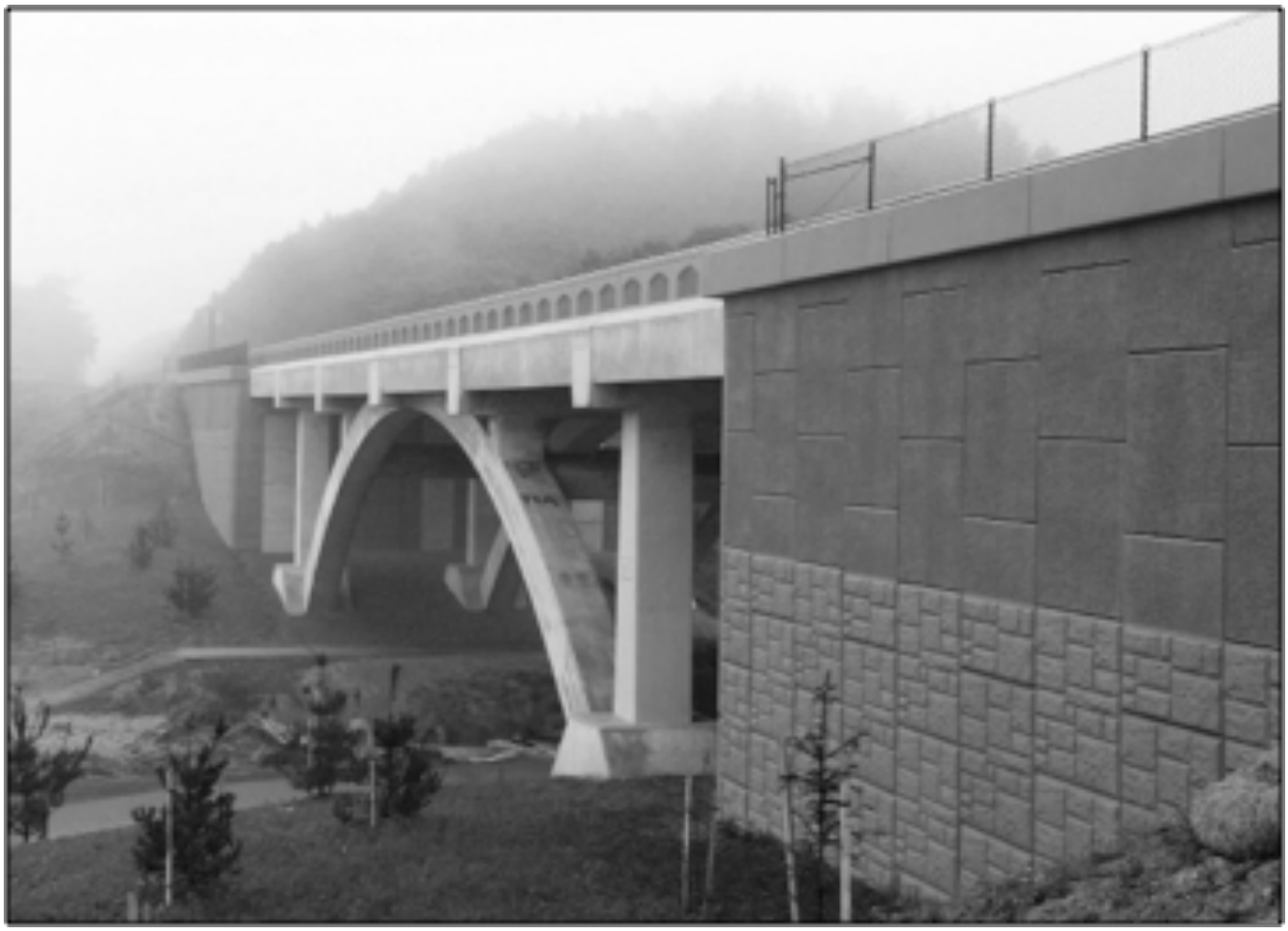
Natural threats to the resiliency of Oregon's bridges include tsunamis in coastal regions, flooding throughout the state, and earthquakes from both local and major offshore faults. Bridges provide a vital link between rural communities and major population centers and are part of the resiliency strategy for providing emergency response after a Cascadia Subduction Zone (CSZ) earthquake. To preserve this link, ODOT is leading a statewide effort to develop emergency response corridors ("lifeline" routes) that enable a more rapid emergency response after a major seismic event. Phase 1 of these routes is along I-5 between Portland and Eugene, Hwy 97 between the Dalles and Klamath Falls, and I-84 and Hwy 58 between these two north-south routes. The passage of HB2017 provided funding for some of the major seismic resiliency projects throughout the state. Additionally, ODOT is collaborating with local agencies throughout the western portion of the state to identify local lifeline routes and prioritize the retrofit of bridges on them, including tsunami preparedness where applicable. However, without a comprehensive funding for all bridges along these routes, the goal of a truly uninterrupted lifeline between major Oregon population centers will not be realized.



INNOVATION

Use of innovative materials such as ultra-high-strength concrete and high strength reinforcement are becoming more common on bridge projects throughout the state. These materials help improve construction quality, and lead to lower rates of deterioration over the bridge's service life. Major bridges in the state have been the subject of increasingly innovative preservation methods. Cathodic protection for many of the state's historic coastal bridges and a two-tiered performance-based seismic resiliency standard are examples of this approach. Further, response to recent major winter storms in the state's metropolitan areas have led to a reversion to the use of salt as a form of de-icing. Adjusting the state's inclement weather response strategy to include anti-icing strategies that do not further degrade an already aging bridge inventory would mitigate the damage done to infrastructure during weather events.

From a project delivery perspective, ODOT and Tri-Met are increasingly scoping projects using alternative delivery methods such as Design-Build and Construction Manager/General Contractor as appropriate. In delivering the projects identified in HB2017, ODOT is using a variety of contracting methods to match each project's specific requirements with an ideal delivery process. Impacts to public mobility during construction are being reduced due to renewed emphasis on the use of accelerated bridge construction techniques.



RECOMMENDATIONS TO RAISE THE GRADE

- **Prioritize replacement of aging bridges as a means of reducing the substantial cost of maintaining existing inventory.**
- **Provide funding to repair and replace the growing wave of bridges that are currently or will soon become structurally deficient.**
- **Identify a long-term, inflation-adjusted funding source for replacing Oregon's bridges at a rate of approximately 100 each year.**
- **Develop a maintenance strategy that provides mobility to the public during winter storms without exposing aging infrastructure to additional corrosive impacts.**
- **Achieve ODOT's goal of post-earthquake resiliency by completely funding the retrofit or replacement of bridges along "lifeline" routes**

DEFINITIONS

STRUCTURALLY DEFICIENT (SD) – Bridges that require significant maintenance, rehabilitation, or replacement. According to FHWA bridges are classified as structurally deficient if the deck, superstructure, or substructure are rated in "poor" condition (0 to 4 on the 10-point grading scale).

SOURCES

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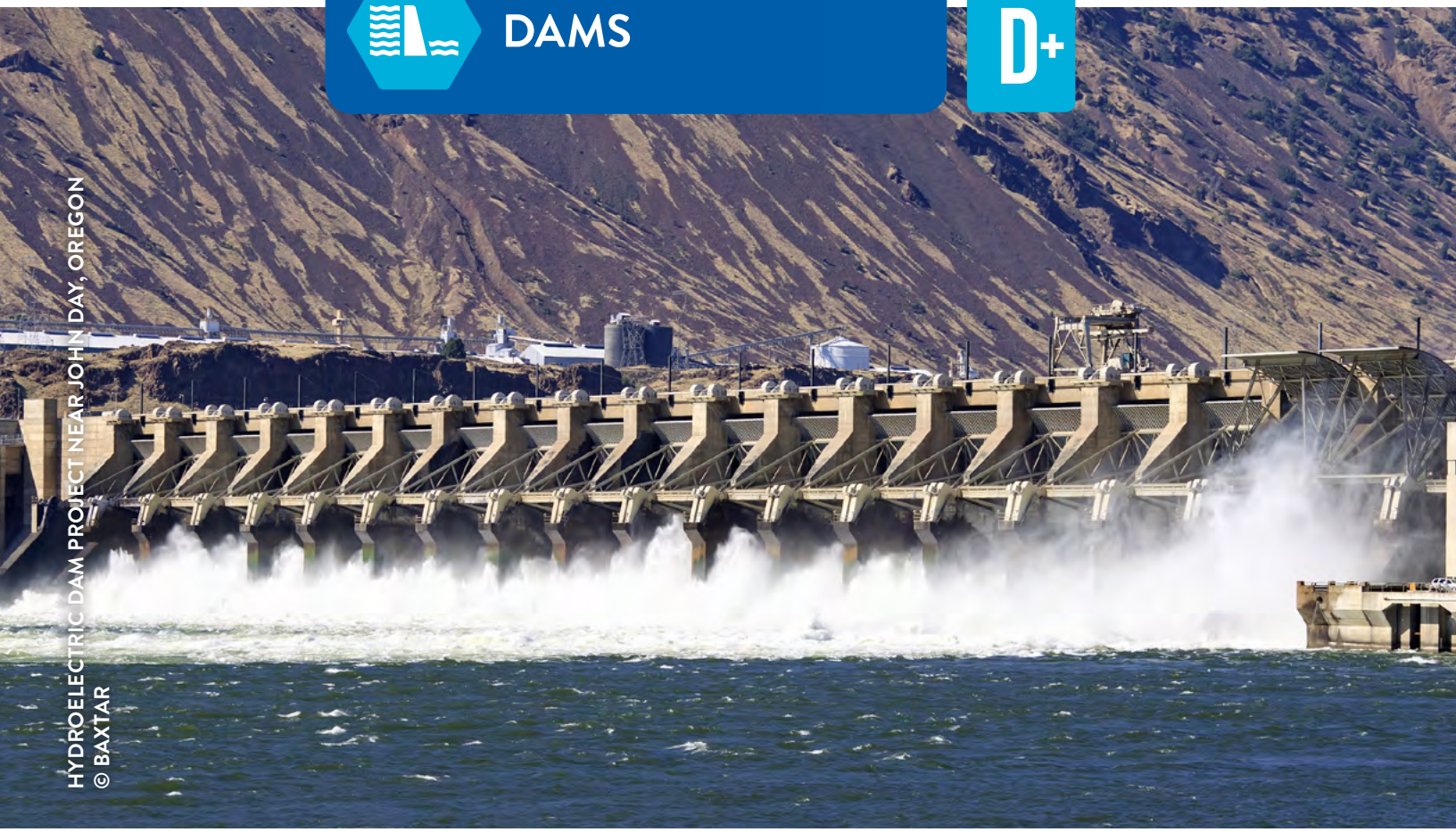
DAMS

D+



HYDROELECTRIC DAM PROJECT NEAR JOHN DAY, OREGON
© BAXTAR

DAMS
GRADE: D+

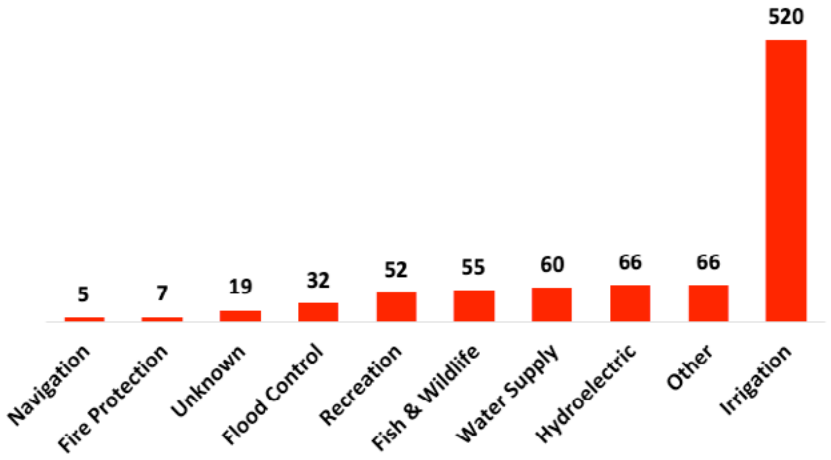
EXECUTIVE SUMMARY

Dams in Oregon provide flood control, drinking water, fish and wildlife protection, recreational areas, and hydroelectric power, among other social and economic benefits. Oregon has 882 dams recorded in the National Inventory of Dams 2018 database. 820 dams are regulated by the state. Over the last decade, Oregon has slightly improved funding for safety regulation of existing dams and increased the number of dams with Emergency Action Plans. Additional legislation is in progress to modernize Oregon dam safety regulations. However, Oregon dams are aging and there has been no change in funding made available for maintenance, repair, or replacement of state regulated private dams. About two-thirds of Oregon's dams are older than their typical 50-year design life and over the next five years, over 70% of these dams will be over 50 years old. Meanwhile, Oregon remains unprepared for extreme hydrologic and seismic events such as the Cascadia Subduction Zone earthquake.

BACKGROUND

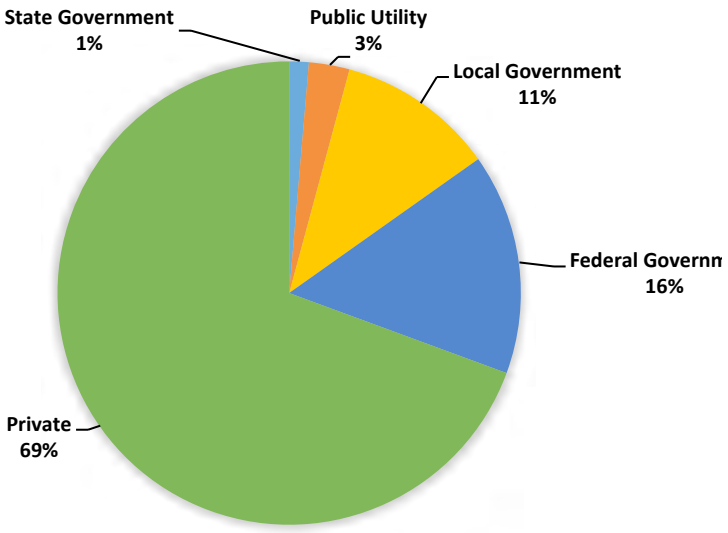
Dams in Oregon serve a variety of purposes that include irrigation, hydropower generation, water supply, fish and wildlife, recreation, flood control, fire protection, and navigation. Many of Oregon's dams were originally constructed to support irrigation operations and 520 of them still serve this original purpose.

FIGURE 1- OREGON DAMS BY PRIMARY PURPOSE (SOURCE: NID)



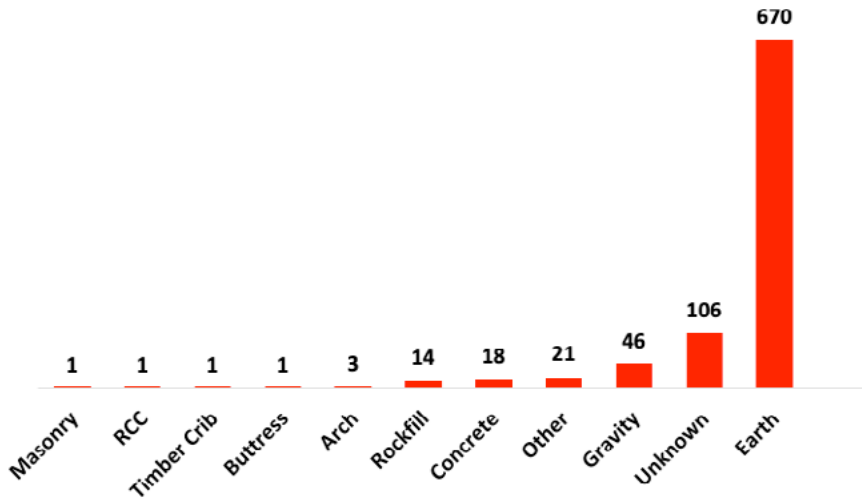
Oregon has both publicly and privately owned dams. Publicly owned dams include federally owned or regulated dams, such as those owned and operated by the U.S. Army Corps of Engineers (USACE) along the Columbia & Willamette Rivers. Hydropower generating dams, meanwhile, are regulated by the Federal Energy Regulatory Commission (FERC). The majority of state regulated dams and reservoirs in Oregon are non-federal structures.

FIGURE 2- OREGON DAM OWNERS (SOURCE: NID)



Oregon dams are constructed in a variety of sizes and materials, built to different heights with different water storage volumes. A breakdown of dam types is detailed in Figure 3.

FIGURE 3- OREGON DAM TYPES (SOURCE: NID)



Except for hydropower or municipal water dams, most of the small dams in Oregon generate little if any revenue. Most dam owners are farmers, homeowner associations, and flood control districts with limited funds. Many communities and agricultural interests depend on dams for living and livelihood.

CONDITION & CAPACITY

Both the Oregon Water Resources Department (OWRD) and USACE keep a database of all of Oregon's dams. These databases differ in their criteria for inclusion of dams but both agencies monitor similar physical and safety-related information. The largest reservoir by storage capacity located entirely in Oregon is Owyhee dam, storing 1.2 million acre-feet.

Oregon defines a statutory dam being greater than 10 feet in height and retaining more than 9.2 acre-feet of water. Oregon assigns a condition rating to each dam based on the following guidelines:

RATING	DESCRIPTION
Satisfactory	No dam safety deficiencies recognized or suspected.
Fair	A minor dam safety deficiency exists or is suspected. The minor deficiency can be remediated with maintenance or repair. Lack of maintenance or repair may not threaten the safety of the dam. A suspected deficiency under extreme loading conditions could result in a serious safety deficiency.
Poor	A dam safety deficiency is recognized or considered probable based on engineering review of loading conditions that may occur.
Unsatisfactory	A dam safety deficiency identified that under unusual but reasonably possible loading conditions could cause the dam to fail.
Under Analysis	An engineering analysis for a suspected hydraulic, seismic, or internal erosion deficiency is underway.

In addition, a three-tier classification system is used to prioritize all dams based on the consequence of dam failure.

CLASSIFICATION	DESCRIPTION
High hazard potential dams	A failure would cause probable loss of human life and substantial property damage.
Significant hazard potential dams	A failure would result in no probable loss of human life but would likely cause economic loss, disruption of lifeline facilities or other impacts.
Low hazard potential dams	A failure or misoperation would not likely cause loss of human life or substantial property damage.

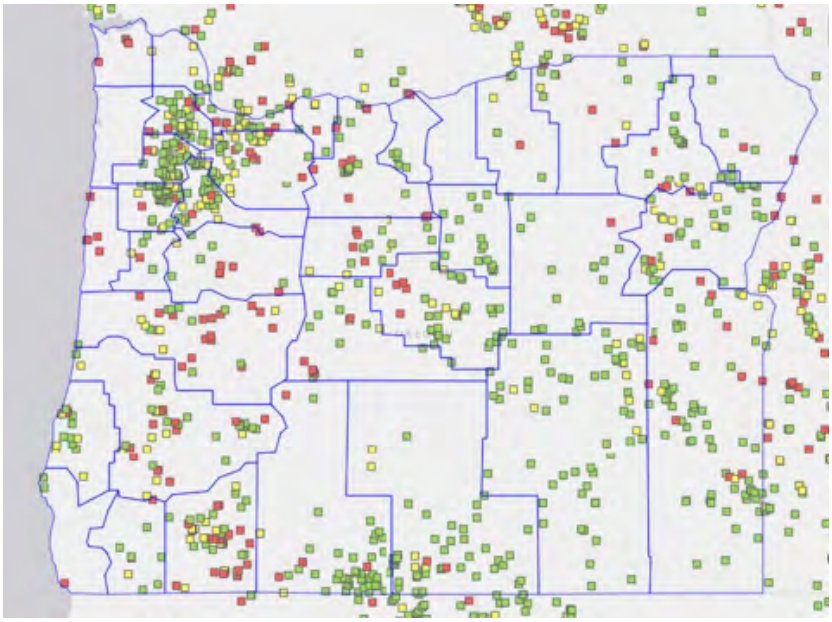
The USACE National Inventory of Dams (NID) database includes Oregon dams meeting one of the following criteria:

- High hazard potential
- Significant hazard potential
- Equal or exceed 25 feet in height, exceed 15 acre-feet in storage
- Equal or exceed 50 acre-feet storage, exceed 6 feet in height

There are a total of 882 dams in Oregon that meet the NID criteria. Dams that do not meet the NID criteria are not discussed in this report. Currently, 158 dams are rated as a high hazard potential. The federal government owns 57 of these dams, private interests own 45 dams, local governments own 43 dams, and power utilities own 13 dams. 21 of these high hazard dams have a condition rating of poor or unsatisfactory and the state considers seven to be deficient. As of early 2019, all high hazard potential dams are inspected annually and have emergency action plans (EAPs) in place. However, lower hazard dams, which account for the vast majority in the inventory, are subject to fewer inspections and rarely have EAPs. In 2019, there were three state regulated and at least one federally regulated high hazard dam that lowered reservoir elevations due to condition.

Dams are located throughout the state and are shown in Figure 4 below.

FIGURE 4 – DAMS IN OREGON (SOURCE: NID)



- RED indicates high hazard potential dams. There are 158 high hazard potential dams in Oregon.
- YELLOW indicates significant hazard potential dams. There are 172 significant hazard potential dams in Oregon.
- GREEN indicates low hazard potential dams. There are 552 low hazard potential dams in Oregon.

Most of the large federally owned or operated dams are in satisfactory condition with a few deficiencies. These include dams owned by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation and those non-federal hydropower dams regulated by the Federal Energy Regulatory Commission. Municipal water supply dams fair to satisfactory condition overall, except those closer to the Cascadia Subduction Zone, where there are special concerns regarding seismic deficiencies. Irrigation dams range from a few in satisfactory condition to near unsafe condition.

Infrastructure age can be an indicator of overall condition. However, a dam that is properly designed, maintained and upgraded can operate safely longer than the design life. About two-thirds of Oregon's dams are older than the typical design life of 50 years. Over the next 5 years, over 70% of Oregon's dams will be older than a 50 year design life. Additionally, at least 76 of Oregon's dams are over 100 years old. Many of these older dams require repair, rehabilitation, or, if considered unsafe, removal.

Most of the federal and private hydropower dams in Oregon operate on run of the river conditions with minimum flood storage capacity. While many of the state regulated municipal and privately owned dams east of the Cascade Mountains have sufficient spillway capacity, there are some concerns regarding rainfall studies and probable maximum flood (PMF) events west of the Cascade Mountains. The communities along the coast depend almost entirely on ground surface storage for drinking water. These areas have the highest risk of overtopping due to an extreme rainfall event.

OPERATION & MAINTENANCE

Proper operation, maintenance, and annual inspections are important to ensure dams are safe, meet their intended purposes, and reduce risk of failure.

Federally owned and non-federal hydropower dams are inspected by federal agencies at a level that is considered sufficient to meet national dam safety guidelines. State high hazard dams are inspected annually by two full time OWRD staff engineers. However, the state performs no regular in-depth review and analysis of the design and safety of these dams. Oregon has a Watermasters program, where a total of 21 Watermasters work under a Water Resources Director to regulate water distribution. The Watermasters conduct visual inspections of low and significant hazard dams every three years. There is no detailed review of these inspections by engineering staff.

Oregon does not have a comprehensive risk assessment program. Risk assessment can help to focus on identifying deficiencies and prioritizing repairs to the highest risk dams. The state currently has limited or no authority to analyze dams for deficiencies, or to require surveillance, monitoring or repairs.

FUNDING & FUTURE NEEDS

Dam failures threaten public safety and can cost the Oregon economy millions of dollars in damages. Failures are not just limited to damage to the dam itself. They can result in loss of life and damage to private property, roads, bridges, water systems, and other critical infrastructure.

Funds, like grants, need to be available for both public and private dam owners to repair, upgrade, or safely remove aging facilities. Oregon needs increased funds to rehabilitate deficient state regulated dams and to provide the staff necessary to manage critical aging infrastructure.

The dam safety incident at California's Oroville Dam in 2017 is a good example of how additional cost can be incurred as a result of overconfidence, inadequate priority for dam safety, and design vulnerabilities. The latest repair cost of Oroville is estimated to exceed $1.2 billion. This cost excludes lost revenues from water and power sales.

Federally owned dams have dedicated budgets for operation and maintenance and they include maintenance and repair as annual operating costs. Most non-federal hydroelectric dams also have revenue sources sufficient to meet current safety requirements and upgrades. However, most state regulated dams do not have dedicated revenue or funding to perform repairs, upgrades, or removal. Oregon has no program for repair, rehabilitation, or removal of state regulated dams. Oregon lacks a strategy to provide reliable funding to correct progressive deterioration of dams.

PUBLIC SAFETY & RESILIENCE

Loss of life and property damage are the common results of a dam failure. Oregon recorded 39 significant dam failures in Oregon over the last 122 years. The Goodrich Dam in Baker County failed in 1896, killing a family of seven. The Bully Creek Dam in Malheur County failed in 1925, flooding the town of Vale and causing widespread damage. More recently, the Simplot Waste Storage Dam near Hermiston failed in 2005. This dam failure washed out a highway and a major irrigation canal, damaged private property, and left mud deposits on agricultural land.

Resilience includes dam safety pre-disaster measures, effective response to emergencies, and rapid recovery from dam failures. Resilience is improved when regulating agencies have the personnel to provide support and enforcement authority to require appropriate risk reduction measures, when seismic and hydrologic hazards are understood so that appropriate risk reduction measures can be implemented, and when Emergency Action Plans are developed for pre-disaster planning.

Seismic and Hydrologic Hazards

Seismic (earthquake) risk in Oregon due to the Cascadia Subduction Zone earthquake event is extremely different from the previous understanding of seismic risks in Oregon. Dams that were designed for a peak ground acceleration of 0.05g, equivalent to light shaking expected to rock parked cars, now must withstand 0.6g to 1.2g, equivalent to violent shaking expected to shift buildings off their foundations. Most dams in Oregon were constructed prior to modern seismic provisions, and several need seismic retrofits. Damage and dam failures are expected at many dams along the Oregon coast during the Cascadia Subduction Zone event.

- Two City of Newport dams are just upstream of a water treatment plant and have known seismic deficiencies.
- Dams owned by the City of Brookings and Josephine County have known seismic deficiencies.
- Analysis of a dam above the Cities of Coos Bay and North Bend is underway to confirm a seismic deficiency.
- U.S. Bureau of Reclamation Scoggins Dam in Washington County is at risk during a Cascadia Subduction Zone earthquake. Scoggins Dam supplies drinking water for 400,000 people and a failure would cause large scale flooding in Washington County. Ongoing design efforts are underway to upgrade the dam, although complete remediation or reconstruction will take years.

Seismic and hydrologic studies are urgently needed to understand the risks imposed on a dam and to ensure continued safety of the downstream public. Hydrologic (flood) risk requires assessment and regular reanalysis to accommodate new storms that have occurred. There may be value in site specific hydrologic studies for some parts of Oregon, particularly in the intermountain areas in the southwest, where the 1961 Seymour Falls storm from British Columbia is used to create a design storm. There are questions about data limitations and storm relevance to mountainside geographies. Appropriate pre-disaster remediation measures should be implemented as soon as practicable following the identification of any deficiencies by seismic or hydrologic studies.

Emergency Action Plan

A preferred method for minimizing loss of life and property damage in the event of a dam failure is the establishment of an Emergency Action Plan (EAP), a formal pre-disaster planning document that identifies potential emergency conditions at a dam and specifies response actions for the dam owner and emergency management authorities. Federal dam safety programs require EAPs and periodic testing of EAPs for significant and high hazard federally owned or non-federal hydropower generating dams. Following 2017 legislation in the form of House Bill 3427, all high hazard dams have EAPs in place or under development. Prior to the bill, approximately 77 percent of state regulated high hazard dams in Oregon had EAPs. All Oregon high hazard dams now have an emergency action plan.

Limited Enforcement Authority

The state dam safety program is understaffed and does not currently possess the enforcement powers to carry out appropriate oversight. The OWRD has limited authority to order the breach of an unsafe dam following a lengthy hearings process, but not the authority to require a dam owner to take other safety actions, including the implementation of risk reduction measures to address seismic or hydrologic deficiencies. The Oregon HB 2085 was introduced into the 2019 legislative session. This bill significantly changes ORS dam safety statutes to modernize state laws; provide the opportunity to address seismic, hydrologic, and internal erosion deficiencies; identify roles and responsibilities; provide emergency response provisions; and clarify the enforcement authority of the OWRD. The bill or equivalent legislation should be passed to improve state enforcement authority and modernize Oregon state dam safety.

Staffing

State dam safety engineering staff perform critical tasks including high hazard dam inspection, review of Watermaster inspections, and support of Oregon dam owners as they manage seismic and hydrologic risks and develop EAPs. The OWRD Dam Safety Engineer provides input to the Oregon Cascadia emergency management playbook and to state flood and drought planning. Currently, the state dam safety program has two full time equivalent (FTE) engineering staff. Compared to similar states, Oregon has the lowest number of engineers and the lowest ratio of engineers to high hazard dams in the west. In contrast, federal dam safety programs are generally well funded and staffed. Three additional state dam safety engineering staff are necessary to match other states with similar dam safety needs.

RECOMMENDATIONS TO RAISE THE GRADE

- Adopt Oregon HB 2085 as proposed or enact equivalent legislation to modernize state dam safety laws, address state dam deficiencies, and clarify the enforcement authority of the OWRD.
- Provide funding for additional state dam safety staff to improve the dam inspection program and to support enforcement action for deficient dams. Three additional engineering staff are necessary to match other states with similar dam safety needs.
- Set up a dedicated state fund for the repair, replacement, or removal of unsafe or failing high and significant hazard dams.
- The state should develop a risk assessment program to prioritize dams in need of repair, rehabilitation, or removal.
- Implement a statewide awareness campaign to educate individuals on the location and condition of dams in their area and become more "dam aware."

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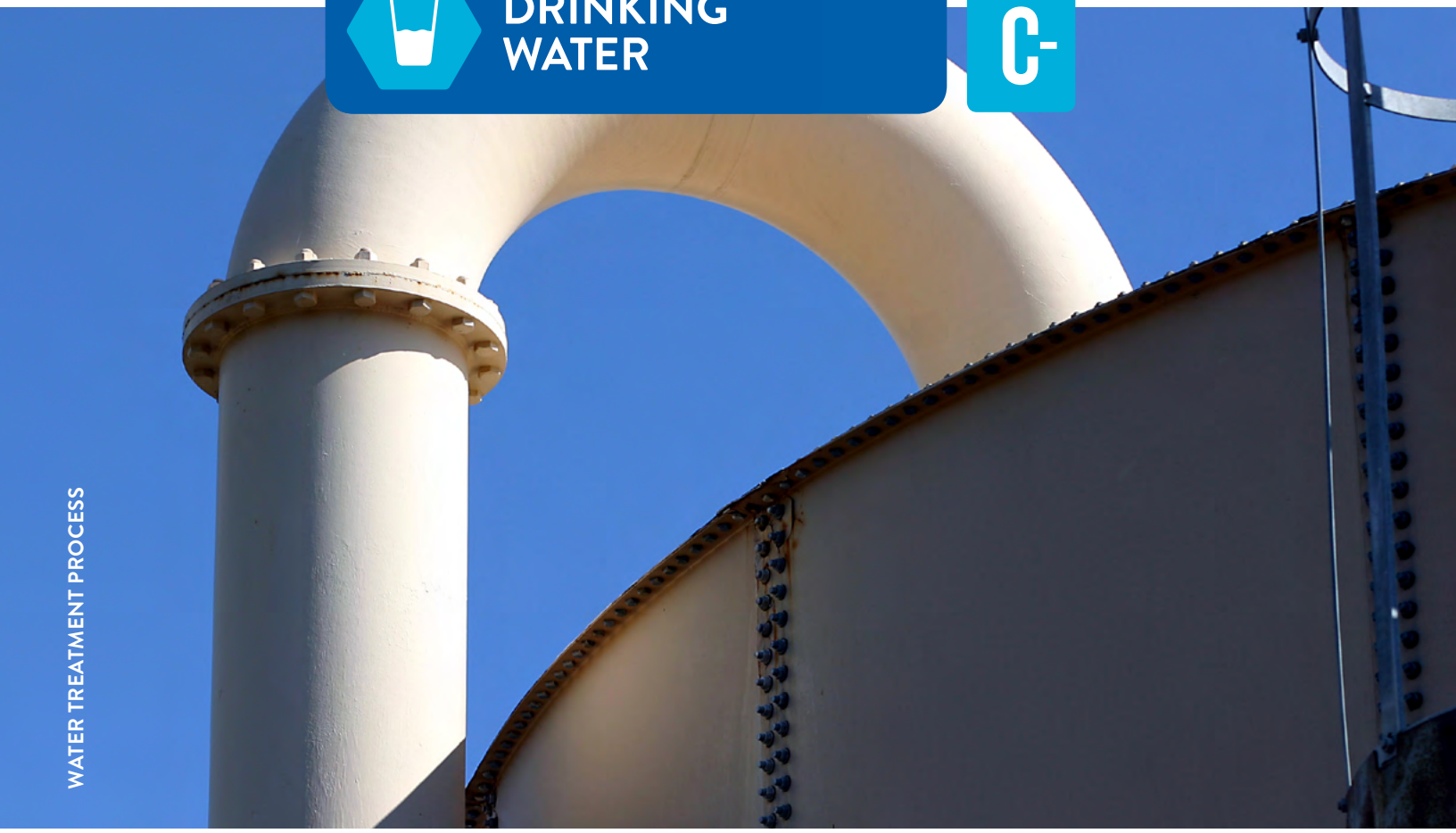


WATER TREATMENT PROCESS

DRINKING WATER
GRADE: C-

EXECUTIVE SUMMARY

Drinking water infrastructure in Oregon faces a variety of challenges. The state's population is growing rapidly, meaning continuous investment in drinking water infrastructure is necessary to expand treatment and distribution system capacity. Additionally, there is a need to replace old or failed components of drinking water infrastructure, including cast iron pipes that are over 100 years old and still in service in some places. While investments in new infrastructure are expensive, delaying needed system upgrades is not a viable alternative. Meanwhile, there is growing recognition of the challenge to the resiliency of Oregon's water systems posed by a major earthquake generated by the Cascadia Subduction Zone. Preparing for a major earthquake will require substantial additional funding to harden water networks so that they are capable of resisting this threat.

INTRODUCTION

There are an estimated 3,386 public drinking water systems currently in operation in Oregon that are subject to regulation under the federal Safe Drinking Water Act. Approximately 80 percent of Oregonians get their drinking water from public water systems, while the remainder rely on private wells or small private water systems. Of those that rely on public water systems, 35 percent of Oregonians rely solely on groundwater and about 10 percent rely solely on surface water. The remaining 55 percent have a combination of surface water and groundwater sources, most commonly with groundwater as an emergency backup or seasonal supply particularly for larger communities such as Portland, Salem, and Medford.

The population of Oregon has increased by more than 12 percent in the last decade, from 3.85 million in 2010 to more than 4.2 million today. Projected population growth will continue to increase demand. New surface and groundwater source development and the distribution of water to new users are challenges. Water conservation, reuse and non-potable water use may become increasingly important to reduce demand for drinking water and minimize the need to upgrade systems. Securing funding for capital projects represents the largest hurdle to meeting new capacity demands.

CONDITION

Drinking water systems typically require extensive transmission, water storage, and distribution systems consisting of pipelines, storage reservoirs, and pump stations to bring water from the source, to the treatment facility, and then to the customers. Each of these components typically has a fixed design life and many components were not designed or constructed to current engineering standards. Reservoirs and dams typically have a design life of 50 to 80 years, mechanical and electrical pumping stations have an expected life of 25 to 50 years, and the mechanical and electrical components in treatment plants can be expected to have a life of 15 to 25 years. Over time, these components wear out and must be replaced. Pipeline life expectancy can vary depending on the type of pipe material used and the installation methods in practice, but in many cases, pipes can still be in service well over 100 years old.

For example, the Cities of Portland and Salem still have extensive footages of cast iron pipe that is well-over 100 years old and still in service in their systems. Water utilities are continuously challenged by the need to replace old pipeline, and most utilities have limited programs for annual pipeline replacement. Replacement decisions are driven by pipe age, condition (breakage history) and capacity issues. Breaks in distribution (<24" diameter) system piping are repaired as quickly as possible, yet water main breaks are an accepted "fact of life" which water utilities continuously have to deal with.

Most knowledgeable engineers rate cast and ductile iron pipe as both having an estimated useful life of 125 years. Proof of this claim is provided by the Ductile Iron Pipe Research Association (DIPRA), which ductile and cast iron longevity through the Cast Iron Pipe Century Club, which recognizes water utilities that have cast iron pipe still in service that is at least 100 years old. There are currently 534 utilities listed on the DIPRA website as members of the cast iron pipe Century Club, and an additional 23 utilities that are members of the cast iron pipe Sesquicentennial Club for having cast iron pipe at least 150 years old that is still in service. Both Salem and Portland provided data on their cast iron pipe -lengths that are still in service. Both utilities commented that they have no plans to remove and replace this old pipe, as long as it continues to perform well (i.e., no leaks). Cast iron pipe data for both utilities are provided below as Tables 1 and 2.

TABLE 1 - CITY OF SALEM CAST IRON PIPE DATA

TIME PERIOD	FOOTAGE OF CAST IRON PIPE INSTALLED	MILES OF CAST IRON PIPE INSTALLED
1890 – 1895	2,601	0.49
1895 – 1900	-	-
1900 – 1905	33,203	6.29
1905 – 1910	1,469	0.28
1910 – 1915	25,214	4.78
1915 – 1920	6,587	1.25
1920 – 1925	14,895	2.82
1925 – 1930	34,409	6.52
1930 – 1935	3,870	0.73
1935 – 1940	27,823	5.27
1940 – 1945	4,380	0.83
1945 – 1950	42,177	7.99
1950 – 1955	41,182	7.80
1955 – 1960	41,007	7.77
1960 – 1965	64,567*	12.23
Total:	**343,384 ft**	**65.03 mi.**

*: During this time period, most cities in the US were converting to ductile iron pipe, so this high number may be a combination of both cast and ductile iron.

Data courtesy City of Salem Public Works Dept.

TABLE 2 – CITY OF PORTLAND CAST IRON PIPE USAGE

AGE COHORT	FOOTAGE CI	MILES CI (MI)
UNK Date	170,362	32.25
Pre 1900	70,276	13.31
1900-1904	226,670	42.93
1905-1909	416,592	78.39
1910-1914	1,433,573	271.51
1915-1919	244,781	46.36
1920-1924	673,147	127.49
1925-1929	865,286	163.88
1930-1934	206,069	36.93
1935-1939	152,011	28.79
1940-1944	234,221	44.36
1945-1949	302,808	57.35
1950-1954	537,768	101.85
1955-1959	656,040	124.25
1960-1964*	527,630	99.93
Total:	**6,717,234 ft.**	**1272.20 mi.**

*: During this time period, most cities in the US were converting to ductile iron pipe, so this high number may be a combination of both cast and ductile iron.

Data courtesy Portland Water Bureau

There is no statewide database for the collection of water pipeline age data, so it is not possible to prepare statewide estimates of pipeline age, however, most municipalities maintain pipeline age data for their individual water systems. It is likely that the bulk of drinking water pipelines in Oregon are less than 100 years old.

In addition to the ongoing need to replace aged and worn out components of the state's water infrastructure, Oregon is also facing major challenges associated with a growing understanding of the risks to water systems from a major (9M+) potential earthquake generated by the Cascadia Subduction zone off the Oregon coast. This risk is primarily confined to coastal areas and the Willamette Valley. As the magnitude of this threat to water system integrity has become widely understood in western Oregon, water utilities have undertaken programs to "harden" their water systems and make them better able to survive a major earthquake and remain in service. Hardening measures include improving the foundations and wall-to-foundation anchorage of above ground reservoirs and pump stations and using restrained joint pipe wherever possible to reduce the risk of pipes being pulled out of their sockets during an earthquake.

PUBLIC SAFETY

An estimated 600,000 Oregonians get their drinking water from individual domestic wells not covered by either state or federal drinking water standards. According to the Oregon Water Resources Department (OWRD), there are currently 250,000 water supply wells in the state, although about 90 percent of licensed wells are used for irrigation purposes.

The majority of wells are shallow (<200 feet) and are located in unconfined aquifers in Oregon's river valleys. These shallow wells are considered the most vulnerable to pollution and many are identified by OWRD as highly sensitive based on the characteristics of the well or spring and of the aquifer that serves the well or spring. Domestic drinking water supply wells are not routinely tested for water quality and state law only requires testing at the time of a real estate transaction.

Assuring the safe quality of drinking water supplies in Oregon is a collaborative responsibility of both the Oregon Health Division Drinking Water Program and the individual Oregon water system owners. The vehicle for assuring that all water systems are providing safe water to their users is compliance with the water quality standards contained in the federal Safe Drinking Water Act. All Oregon water system operators are required to abide by the provisions of the Safe Drinking Water Act, maintain meticulous records of routine laboratory testing, and must self-report all violations to the Oregon Health Division Drinking Water Program.

Data from 2018, the most recent year for which full-year water quality violation data are available, shows that a total of 181 violations were reported, involving a total of 82 separate water systems. Drinking Water Program staff commented that these totals for 2018 were "about average" for the state and cover a wide-range of causative factors from treatment process upsets at treatment plants due to operator error, changes in influent water quality due to environmental or weather factors, system mechanical failures that required emergency repairs, and a variety of other factors. Drinking Water Program staff noted that 2018 violations occurred in both small and large water systems and reflect the fact that drinking water systems are complex engineered systems that require constant supervision and ongoing maintenance, and that even the "best" water systems are not immune to upsets and water quality violations. In our opinion, the Oregon Health Division Drinking Water Program is functioning well, and provides a vital safeguard to the state's drinking water supplies.

A VALVE CONNECTING TWO LARGE IRON PIPES. CLOSE UP SHOT. © VICTORIA SHAPIRO

TABLE 3. OREGON DRINKING WATER QUALITY REPORTED VIOLATIONS FOR 2018

FEDERALLY REPORTED KEY CONTAMINANT GROUPS 2018	MAXIMUM CONTAMINANT LEVEL (MCL) VIOLATIONS	
	NUMBER OF VIOLATIONS	NUMBER OF WATER SYSTEMS WITH VIOLATIONS
Volatile Organic Chemicals	0	0
Synthetic Organic Chemicals	0	0
Inorganic Contaminants	0	0
Nitrates	9	5
Arsenic	33	9
Coliform Bacteria	16	16
Surface Water Treatment Rule	79	26
Groundwater Rule	32	14
Lead and Copper Rule*	4	4
Disinfection By-Products	8	8
Radiologicals	0	0
Totals:	181	82
* Lead and copper rule review of violations:		
did not install Corrosion control treatment	1	1
corrosion control treatment technique	3	3
did not report corrosion control recommendation,		
public education late,		
routine tap monitoring (90%)		

Data provided by Oregon Health Division Drinking Water Program

Drinking water systems provide a critical public health function and are essential to life, economic development, and community growth. Disruptions in water service can hinder disaster response and recovery efforts, expose the public to waterborne contaminants, and cause damage to roadways, structures and other infrastructure, endangering lives and resulting in significant financial losses. Water main breaks and washouts are just some of the examples that illustrate this risk. Adequate water supplies are also critical to fire suppression as was recently highlighted by the 2017 Eagle Creek Fire in the Columbia River Gorge.

FUNDING

Funding for drinking water infrastructure projects is largely derived from user fees collected by individual utilities. Funding from rate payers can be leveraged with support from federal funding provided to the state, either under the U.S. Environmental Protection Agency's Clean Water State Revolving Fund or the Water Infrastructure Finance and Innovation Act (WIFIA) Program. These funds help states have the flexibility to fund a range of projects that address their highest priority water quality needs such as constructing municipal wastewater facilities, control nonpoint sources of pollution, etc. The Oregon Economic and Community Development Department's (OECDD) Water/Wastewater Fund Program utilizes federal programs to then provide significant funding to communities seeking financing for projects to correct compliance issues. The Safe Drinking Water Revolving Loan Fund (SDWRLF) and the Drinking Water Source Protection Fund (DWSPF) are used within the state to fund drinking water system improvements needed to maintain compliance with the Federal Safe Drinking Water Act. Additionally, the Oregon Safe Drinking Water Fund is funded by yearly grants from the EPA and matched with funds from the state Water/Wastewater Financing Program and management by the Oregon Health Authority and the Oregon Infrastructure Finance Authority. As of June 30, 2015, the SDWRLF, with the help of the EPA, has provided more than $250 million toward these water system improvements since its inception.

In the 2018 selection round, the City of Hillsboro (COH) and the Tualatin Valley Water District (TVWD) (joint applicants) successfully competed at the national level and won a long term, low-interest rate loan from the US EPA under the WIFIA program in the amount of $617 million to construct the Willamette Water Supply Program, which will supply the two users with additional resilient water supply capacity. Phase 1 will provide 60 million gallons per day (MGD) of drinking water to TVWD and COH. The loan covers upgrades to the existing intake, 6.2 miles of raw water pipeline, a new 60 MGD water treatment facility, 25.3 miles of finished water pipeline, and 30 million gallons of terminal storage capacity. Other Oregon communities and water partnerships should consider this competitive funding source for future major water system expansions as well.

Some water utilities have implemented policies of making small rate adjustments on an annual basis to provide additional funding over system operational and maintenance requirements covered by the basic water rate structure to accumulate funds for needed system improvement projects.

FUTURE NEED

According to the League of Oregon Cities' 2016 Infrastructure Survey (Water) Report, $7.6 billion is required for several critical drinking water projects in Oregon, including new or rehabilitated drinking water storage, treatment, and distribution facilities. Of this amount, $4.3 billion is needed for water treatment projects while the remainder should be allocated toward water supply, transmission and storage needs. This is a 70 percent increase from the $4.48 billion that was reported in the 2010 Infrastructure Report Card. As can be expected, areas with more people were more likely to need additional water storage.

Considering the recent wild fire events throughout the state, greater fire-fighting storage capacity will also be necessary for catastrophic events, such as the expected Cascadia Subduction Zone earthquake. According to the Oregon Resilience Plan, nearly all reservoirs and tanks are likely to experience some damage at the connection between the buried pipe system and the reservoir structure. On a positive note, about 13 percent of the state's water storage tanks were built after 2000 to seismically-resistant design standards and will most likely remain intact due to modern stringent lateral force requirements for design earthquake forces.

In general, per capita water usage is declining. This can be attributed to successful water conservation education efforts by utilities in recent years, the implementation of progressive rate structures, and greater overall system efficiency (i.e. pipeline repair/replacement) in select areas throughout the state. However, with a continuously growing population and aging infrastructure, more investment is needed.

RESILIENCE

The risks of Oregon's drinking water systems experiencing major damage in a Cascade Subduction Zone major earthquake were well-documented in the February 2013 Oregon Resilience Plan. As noted in the plan, drinking water pipeline networks have numerous points of potential failure. Further, these networks "are highly dependent on other seismically vulnerable resources, such as power, transportation, chemicals, and skilled staff." Of further concern is that many aspects of the drinking water network, including reservoirs, pump stations, and treatment plants, were built before seismic risks were well understood and codes and standards were upgraded. Should a Cascadia subduction zone earthquake strike the region today, most water system facilities along the coast would likely be damaged beyond repair and many (particularly older facilities further inland that have not yet been seismically upgraded) would likely be unable to return to full operation for months or possibly even years.

ARTIST'S CONCEPT OF THE CITY OF PORTLAND WASHINGTON PARK RESERVOIR IMPROVEMENT PROJECT (CURRENTLY UNDER CONSTRUCTION), WHICH HAS BEEN ENGINEERED TO WITHSTAND ONGOING LANDSLIDE ENCROACHMENT AND FUTURE SEISMIC EVENTS.

Source: Portland Water Bureau

Another seismic-related threat to Oregon's drinking water systems is related to soil liquification. Should a major earthquake hit the Northwest region, alluvial and fill deposits along rivers would begin moving towards riverbanks. Older cast iron water pipelines would fail and newer PVC and ductile iron pipelines would be pulled apart, resulting in a total loss of water pressure. Such incidents would leave Oregonians without access to clean, potable drinking water for weeks, months, or even years.

This growing understanding of western Oregon's water systems seismic vulnerability is beginning to be translated into the inclusion of seismic resilience components into the design of new water system infrastructure projects, such as installing seismically-activated shutoff valves on reservoirs and pump stations, which has become a standard best practice. Nevertheless, there is more significant work needed to complete the necessary water system seismic upgrades and system expansion and replacement projects to protect these systems in a major earthquake.

INNOVATION

Many drinking water utilities throughout the state are employing innovative practices to enhance public outreach and service for their customers. For example, the Portland Water Bureau has developed an interactive online tool called WaterWorks where customers can find out real-time info on water repairs happening in their neighborhood.

Another major innovative development in recent years regarding how major water system improvement projects can be financed is through the creation of water partnerships for a given watershed or water service area. A partnership allows adjacent communities within a service area to pool water rights and financial resources, thereby spreading the risk and the project costs over a broader customer base than would be possible for any single community or water utility alone, with a reduced impact on individual water rate payers. Two recent examples are the Lake Oswego – Tigard Water Partnership, which successfully leveraged a $250 million major upgrade to construct a new 38 MGD water treatment plant within the footprint of the existing Lake Oswego water treatment plant, including a new intake on the Clackamas River, transmission pipeline, and additional storage capacity. A second example is the new Willamette River intake, treatment plant and transmission pipeline project for the Joint Water Commission in Washington County for the Cities of Beaverton, Forest Grove, Hillsboro and the Tualatin Valley Water District.

1960S VINTAGE CITY OF LAKE OSWEGO WATER TREATMENT PLANT BEING DEMOLISHED FOR CONSTRUCTION OF NEW LAKE OSWEGO – TIGARD WATER PARTNERSHIP PLANT MOSTLY WITHIN THE OLD PLANT FOOTPRINT

Lake Oswego-Tigard Water Partnership

NEW FILTER BEDS BEING POURED FOR LAKE OSWEGO – TIGARD WATER PARTNERSHIP PLANt

Lake Oswego-Tigard Water Partnership

RECOMMENDATIONS TO RAISE THE GRADE

- **Conduct a thorough seismic resiliency risk assessment of all key water system components, particularly above-ground reservoirs and water treatment and pumping plants for all water systems in Oregon.**
- **Initiate an extensive public information campaign to raise public awareness of supply and infrastructure shortcomings, particularly related to seismic resilience and create support for increasing user rates.**
- **Create a seismic risk assessment and mitigation plan for each water system in western Oregon following a seismic event**
- **Work closely with Oregon's Congressional representatives to ensure full funding of the federal EPA State Revolving Loan Fund Program, which provides the "seed" money to the state to fund loans to local water utilities.**
- **Increase the research and development of sustainable and policy solutions to water shortages**
- **Create and increase public awareness for a state-wide water conservation program.**

SOURCES

City of Salem, Public Works Dept.

Lake Oswego – Tigard Water Partnership

Portland Water Bureau

Oregon Health Division – Drinking Water Program

US EPA Water Infrastructure Finance and Innovation Act (WIFIA)

US Census Bureau, Portland State Oregon Population Statistics Center

Ductile Iron Pipe Research Association (DIPRA)

FIGURE 3: WIND AND SOLAR GENERATION IN CLOSE PROXIMITY IN EASTERN OREGON (PHOTO: ALEX LOCKARD)

ENERGY
GRADE: D+

EXECUTIVE SUMMARY

Oregon benefits from reliable and affordable energy resources and ranks among the top five states in terms of renewable energy production. Excellent strides are evident in energy efficiency, renewable energy expansion, reduction of fossil fuel consumption as well as energy sector innovations. While renewable energy infrastructure is generally newer and in good condition much of the time, the existing energy grid is aging. Electrical transmission capacity has less reserve capacity than in the past, causing bottlenecks and constraints regarding operation of the grid. Most petroleum transmission systems and equipment are over 50 years old and storage tanks are over 100 years old. Additionally, a major concern is the ability of the energy network to perform in the instance of a major Cascadia earthquake. Large portions of the petroleum energy system would be rendered unusable, as transmission and distribution networks lack redundancy and currently exhibit poor conditions.

BACKGROUND

Oregon's energy sources can be categorized into three areas: electricity, natural gas, and liquid petroleum-based fuels. The infrastructure required to deliver energy to homes and businesses include generation or supply, long-distance transmission, and local distribution. Virtually all Oregon commerce and industry, as well as all other infrastructure categories, rely on an adequate and stable energy supply. State-level governing bodies in the energy sector include the Oregon Department of Energy and Oregon Public Utility Commission (PUC), which regulates investor-owned electric and gas utilities.

Oregon's energy resources are closely tied to geographic features and climate conditions. The mighty Columbia River cuts through the Cascade Range forming the Columbia Gorge, creating an area which has proven ideal for wind power generation. Large dams along the river, fed by runoff from the Rocky Mountains, generate most of the hydroelectric power not only in Oregon, but throughout the Pacific Northwest. The high desert in eastern Oregon is well-situated for wind, solar and geothermal energy development. The mild temperatures and abundant rainfall in the western part of the state contribute to rapid tree growth, which, along with agricultural waste-products, are ample sources of biomass for power generation. While the state is endowed with many natural resources that support renewable electricity generation, it lacks resources in the areas of natural gas and liquid fuels; virtually all of those energy supplies are imported from out of state.

CAPACITY

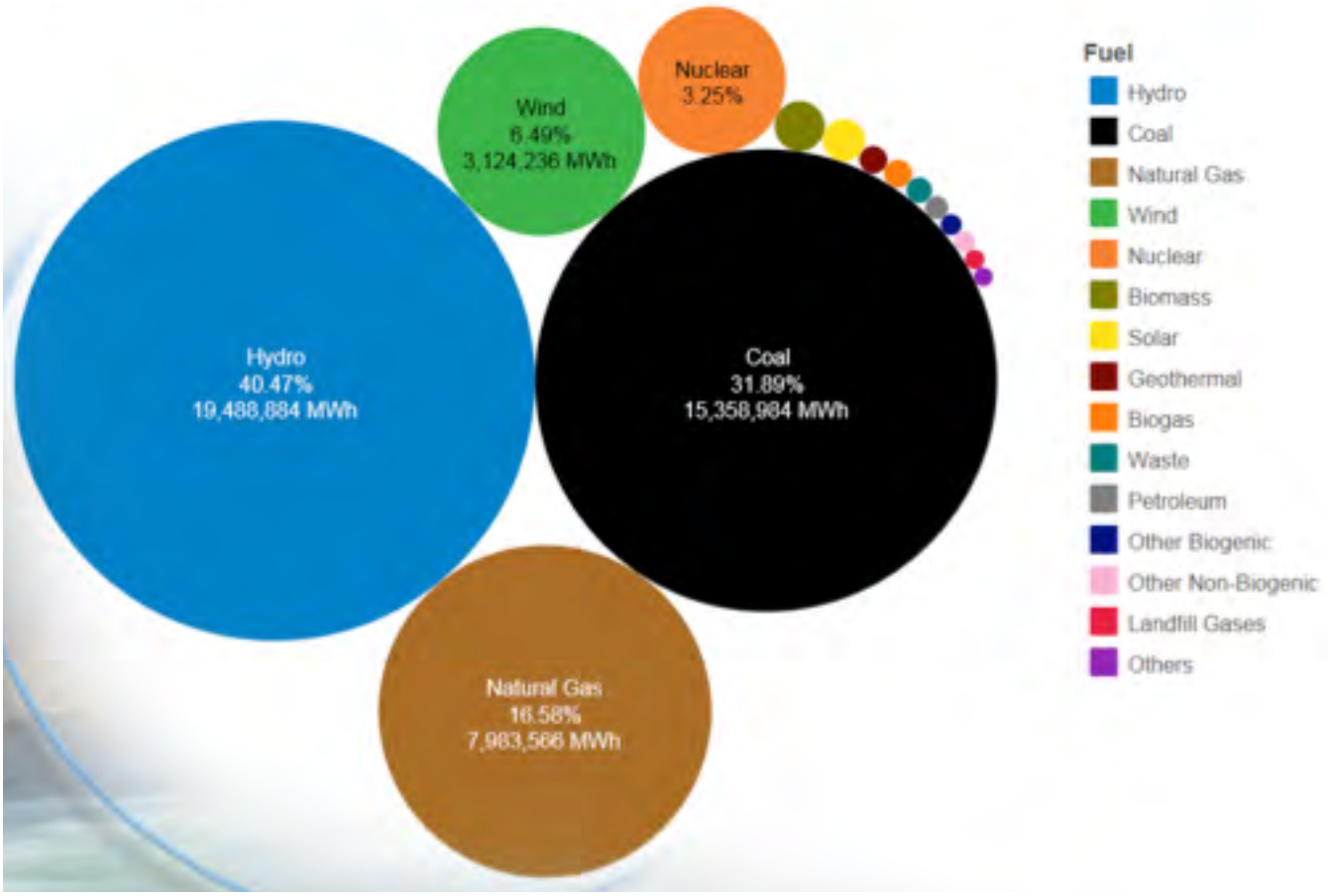
Oregon's current capacity for electrical generation and natural gas are adequate, but the capacity for petroleum is strained. Oregon is one of the top three hydroelectric power producers in the nation, accounting for more than 12 percent of U.S. hydroelectric generation in 2017. Regional power plants built in past decades, including hydro and fossil fuel facilities, continue to provide service at the same time renewable energy is rapidly increasing. New power plants and power lines are needed to serve growing energy demand. In addition, Boardman, the state's only coal-fired power plant, plans to end the use of coal by December 31, 2020 due to the 2016 passage of the "Clean Electricity and Coal Transition" bill. Thus, the amount of coal in Oregon's electricity resource mix will be greatly reduced and other resources that comprise Oregon's electricity resource mix will increase.

Electrical transmission capacity has less reserve capacity than in the past, causing bottlenecks and constraints regarding operation of the grid, particularly when hydro production is slack. In contrast, the distribution capacity is adequate to meet current demands.

For natural gas, additional transmission assets will be needed to meet future growth, whereas distribution capacity is adequate. Gas storage is limited to peak shaving facilities and would be unable to meet demand in Oregon.

For petroleum, Oregon is dependent on the largely linear and non-redundant supply chain, which has a strained capacity. Similar to larger, heavier trucks that strain older, under-capacity bridges, petroleum terminal operations involve use of marine vessels that are larger than originally intended.

FIGURE 1: FUELS USED TO GENERATE ELECTRICITY USED IN OREGON



CONDITION

Overall, Oregon's existing infrastructure is aging, but new energy and transmission projects are coming online each year, including renewable energy projects. The condition for the electricity, natural gas and petroleum infrastructure is largely controlled by the age of the assets (e.g., Puget Sound refineries and pipeline capacity).

For electricity, the majority of transmission system and equipment are greater than 50 years old. Bonneville Power Administration (BPA) owns and operates the majority of the transmission grid in the Pacific NW, including Oregon. BPA began building transmission infrastructure in the late 1930s and continues to do so today. In contrast, renewable infrastructure is mostly less than 10 years old.

The majority of natural gas transmission infrastructure was constructed in the 1960s and 1970s. When maintained properly, these assets can remain in service for many more years. Of concern is infrastructure that is 60+ years old and the increasing expense of maintaining older facilities. Gas storage facilities in Oregon have undergone modernization projects over the past two years.

The earliest age of the petroleum infrastructure dates back to the early 1900s. Based on observations, the facilities are in poor condition and mitigation techniques are insufficient. The transmission pipelines were largely constructed in the 1960s. Some storage tanks are over 100 years old. Most storage is on hydraulic fill, which is susceptible to liquefaction.

FIGURE 2: PORTLAND FUEL TERMINAL, DEMONSTRATING POOR CONDITION OF SOME COMPONENTS (PHOTO: YUMEI WANG)

FUNDING

Funding for energy capital projects, operation, and maintenance is largely controlled by private utilities, as well as regulators. Currently, Oregon legislature is studying adoption of a cap and trade program for carbon, which could alter the energy generation landscape and funding of future projects.

Regional power plants built in past decades, including hydro and fossil fuel plants, continue to provide service at legacy prices. However, new power plants and power lines are needed to serve growing energy demand and will pressure prices upward.

For renewable energy, the Production Tax Credit (PTC) and the state Renewable Portfolio Standard are significant contributors to the growth of the industry. The PTC is set to expire soon, however, and the wind industry is proactively gearing up for growth in the post-PTC world where ecomomic viability of new plants will have to be realized on their own merits versus tax incentives.

End-user electricity prices in Oregon are generally low with prices up to 15 percent below the national average. Natural gas prices are typically comparable to the national average.

FUTURE NEED

Looking ahead, Oregon has significant opportunities for increased energy generation capacity, particularly with wind, solar, geothermal, biomass, and wave. While Oregon's total energy consumption is increasing, the per capita consumption in the state is decreasing. The decrease in per capita consumption is a result of technological advances in energy generation and consumption along with consumer awareness and education.

For electricity, Oregon's renewable energy portfolio standard requires that, by 2040, the state's largest utilities acquire 50 percent of the electricity from renewable energy sources. Smaller utilities have a target of 10 percent renewable electricity by 2025, and the smallest utilities --those serving less than 1.5 percent of the state's power demand -- have a target of 5 percent.

For natural gas, the transmission pipeline capacity is limited, but conservation and storage help offset new demand. Additional pipeline capacity and alternate sources of supply will be required to meet future demand and ensure continuity of service.

For petroleum, the supplier options and existing transmission pipeline capacity is limited. Conservation, newer and advanced technologies, and further innovation will help offset new demand. Improving conditions at existing facilities is needed. New transmission pipelines and storage facilities will be required to improve public safety and disaster resilience. Improved distribution options may also be needed.

OPERATION AND MAINTENANCE

As Oregon's existing infrastructure ages and regulations change, maintaining the infrastructure's condition while complying with regulations has its challenges.

Oregon's electricity and natural gas companies generally maintain their existing infrastructure through continued prioritized maintenance and capital improvement programs, resulting in systems which are generally in adequate-to-good condition. Although Oregon has recently been in the top 12 states for number of annual power outages, the state ranks well in overall electricity reliability when other factors such as duration and severity of outages. All natural gas providers are regulated by the Oregon Public Utility Commission and meet regulatory compliance standards to operate. Many, but not all, of Oregon's electricity providers are regulated by the Oregon PUC and meet compliance standards.

For petroleum facilities, operations and maintenance practices vary widely depending on the owner and operator.

Oregon's electricity delivery system has a good reliability ranking being in the top 34 percent in the US.. Oregon has a good public safety record both in protecting the public from hazards associated with physical assets and from a reliable transmission system with few outages. By following ASCE Standards and Manuals of Practices, transmission in Oregon often exceeds the standards set forth by National Electrical Safety Code (NESC). On the other hand, distribution usually only meets the minimum requirements of the NESC leading to low reliability and thus the high incidences of power outages in the state.

PUBLIC SAFETY

In general, the energy sector has consistently maintained a high level of public safety. However, with the growing recognition of society's increased reliance on the energy sector, there are new concerns about public safety. Starting in 2017, the State of Oregon has been requiring proposed energy facilities to consider disaster resilience and future climate in their proposed design.

Natural gas transmission lines located in High Consequence Areas receive integrity assessments at regular intervals to maintain public safety. Safety designs in the physical system are included, such as automated shut-off valves, which can be used to isolate areas mitigating possible negative consequences.

The petroleum sector has various regulators, but none have adequately addressed significant seismic hazards. Interstate pipelines are regulated by U.S. DOT's Pipeline and Hazardous Materials Safety Administration (PHMSA), but the agency does not require seismic evaluations nor mitigation on existing seismic deficiencies. Existing equipment and components at Portland fuel terminals used for storage and distribution are seismically vulnerable and pose significant public safety concerns.

RESILIENCE

Many hazards were unknown or did not exist when older facilities were constructed, including the Cascadia earthquake threat and cyber-attacks. During normal day-to-day conditions, the performance of Oregon's energy infrastructure is widely considered to be satisfactory.

Continued improvements to the three energy sector components are needed to increase the resiliency of the existing systems. In 2013, the PUC started to require investor owned utilities to conduct seismic vulnerability analyses and implement mitigation plans. Significant investment will be required to achieve desired recovery goals indicated in Oregon Resilience Plan (www.oregon.gov).

Natural gas transmission facilities are at risk due to natural forces such as land movement and seismic activity. The distribution system is designed for redundancy and resiliency. Underground gas storage facilities are expected to fare well. Existing LNG facilities are designed to contain product but return to service would likely take an extended period of time.

Petroleum is the state's most vulnerable and least resilient energy sector due to the system's low redundancy, existing conditions and lack of seismic safety preparedness.

INNOVATION

Future innovation needs involve both increased capacity and improved efficiency of existing facilities and by consumers. Further advancing innovative projects involving smart grid, microgrid projects, biofuel and possibly nuclear are warranted.

In addition to advancing renewables, innovation for energy infrastructure is needed to assist in repairing or replacing aging infrastructure and constructing new infrastructure to adjust for the state's increasing population, as well as to increase resilience of energy generation, transmission and distribution.

Oregon is in the early stages of tapping its marine and hydrokinetic energy resources. The U.S. Department of Energy's National Renewable Energy Laboratory deployed buoys off the Oregon coast during the summer of 2017 to record wave and tide movements in support of projects designed to convert energy from waves into electricity. Oregon State University is building a wave energy test facility, which is expected to be operational by 2020.

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RECOMMENDATIONS TO RAISE THE GRADE

- Continue to invest in operations and maintenance, public safety and resiliency, including multi-hazards, Cascadia earthquake preparedness, and cybersecurity.
- Mitigate Oregon's petroleum supply chain vulnerabilities, including transmission, storage and distribution. This will improve Oregon's most significant energy sector vulnerability.
- Implement a systems approach for resilience, including for rehabilitation projects as well as new projects. As an example, evaluate life cycle costs and disaster preparedness when making decisions for components, systems, and systems-of-systems.
- Increase new investment in public safety, reliability, and resiliency of Oregon's energy sector; specifically, ASCE Standards and Manuals of Practices should be followed for the electric distribution infrastructure

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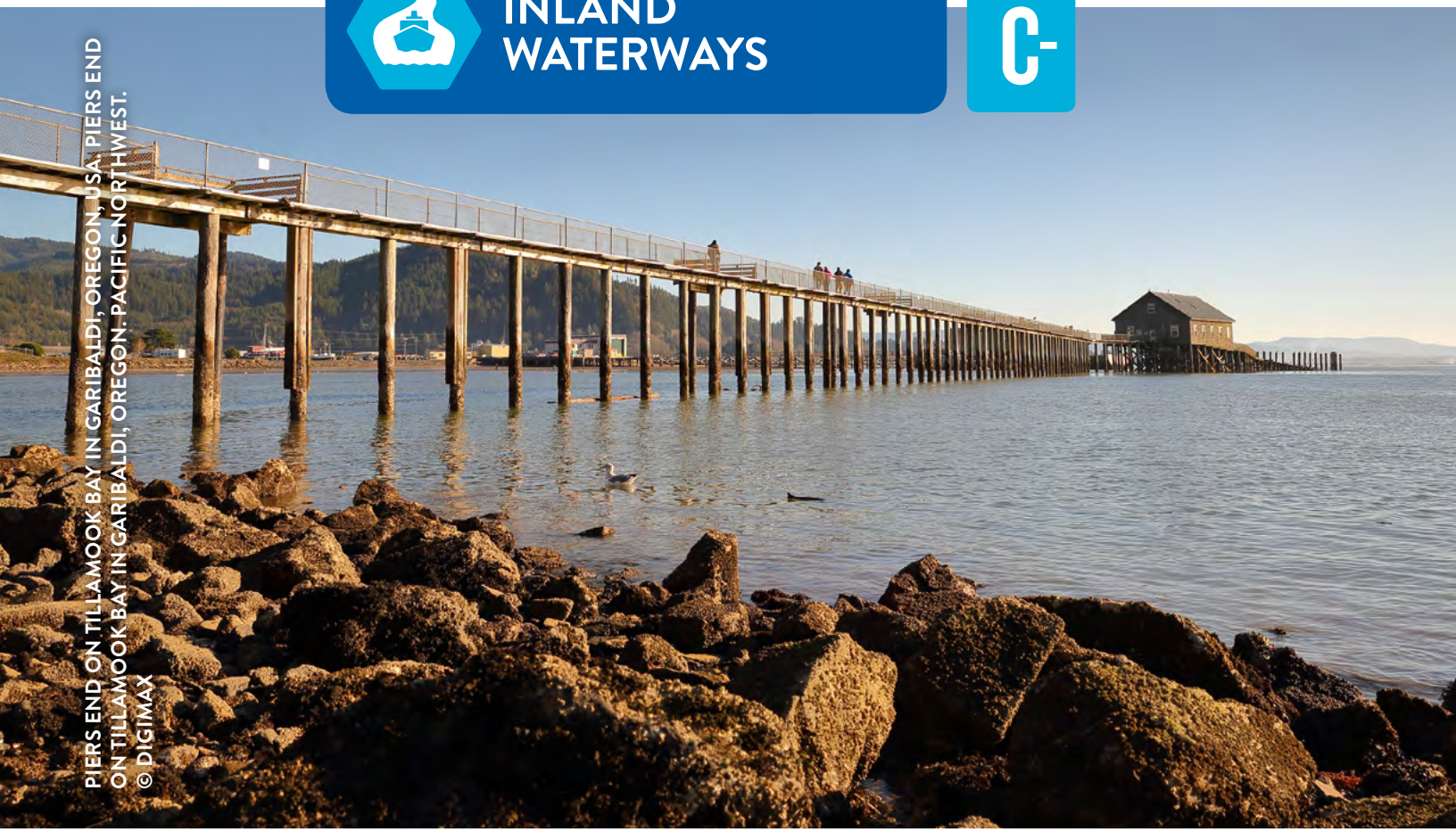


PIERS END ON TILLAMOOK BAY IN GARIBALDI, OREGON, USA. PIERS END ON TILLAMOOK BAY IN GARIBALDI, OREGON. PACIFIC NORTHWEST. © DIGIMAX

INLAND WATERWAYS
GRADE: C-

EXECUTIVE SUMMARY

Oregon is home to two major waterways– the Columbia and Willamette rivers – that are used to move wheat, soybeans, grain, wood, mineral bulks, vehicles and more. These 681 miles of waterways and ports in Oregon support close to 21,000 jobs and contribute $3.6 billion to the economy. Although the inland waterway network has sufficient capacity, and the infrastructure is in adequate condition to accommodate current cargo and vessel movements, much of the infrastructure is in need of repair or upgrades. Current funding has maintained the status quo and is not adequately addressing the aging and deteriorating jetties, locks, and pile dike structures. There are inadequate turning basins, anchorages, and stern buoys to accommodate the larger vessels transiting the Columbia River. With industry trends to move cargo in larger and deeper draft vessels, Oregon's deep draft channels cannot fully accommodate these large vessels and will likely require additional deepening to accommodate the larger ships and remain viable in the future.

COLUMBIA RIVER

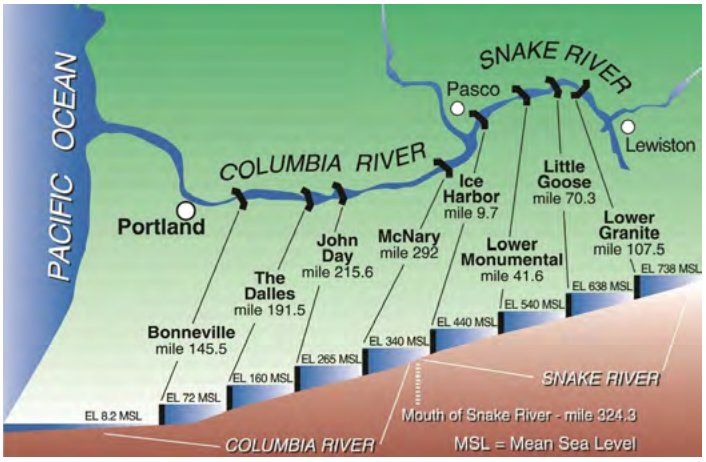
Over $24 Billion of manufactured goods, agricultural and food products and basic chemicals were shipped to and from Oregon through Oregon's waterways and ports. Oregon's 681 miles of navigable waterways and ports support 20,925 Oregon jobs and directly contribute $3.6 billion to Oregon's economy.

Photo courtesy of Port of Portland

BACKGROUND

Oregon's primary navigable waterway is the Columbia River and lower section of the Willamette River that makes up the Portland harbor. The Columbia Snake river system is a critical gateway for a large geographical area of the U.S. that includes Oregon, Washington, Idaho, Montana and Wyoming. According to 2016 data, the Columbia River system was the nation's number one export gateway for wheat, the number two gateway for soybeans, and the third largest grain export corridor in the world. The Columbia River system is also the West Coast's number one wood and mineral bulks export gateway and a leading importer/exporter of vehicles. In 2017, the Columbia & Lower Willamette Federal Navigation Channel was used to transport 47.5 million tons of cargo valued at $16 billion.

COLUMBIA SNAKE RIVER SYSTEM



DEEP DRAFT CHANNEL FACTS:

- 105 miles, 43 feet deep
- Over 50 million tons of international trade in 2016
- At least $21 billion in cargo value
- 40,000 local jobs are dependent on this trade

INLAND NAVIGATION FACTS:

- 360 miles, 14 feet deep, from Portland/Vancouver to Lewiston, Idaho
- Over 9 million tons of commercial cargo in 2014
- Important gateway for U.S. wheat and forest products
- Over 18,000 cruise passengers in 2017, with $15M in direct economic benefits to the region

(Image and facts Courtesy of PNWA website)

TILLAMOOK BAY

The 12 waterways systems along the Oregon coast provide access to the Pacific Ocean for the 14 coastal ports and commercial fishing and recreational marinas located along the coastal rivers and bays. The coastal waterways include large scale jetties or breakwater structures, channels, harbors, turning and boat basins of varying depth and width needed to provide ship and boating access to the marinas and ports along the Oregon coast

Photo courtesy of OPPA

CAPACITY

Overall, Oregon's waterways have sufficient shipping capacity for the current cargo volumes. The lower Columbia River was deepened in 2010 to 43 feet, which increased deep draft cargo ship capacity. Although 1,473 ships called the Columbia River in 2018, well below the 2,283 recorded in 2000, cargo volumes continue to break records as larger and deeper draft vessels navigate the river.

Unfortunately, while the mouth of the Columbia and the lower Columbia River deep draft channel has capacity for more vessels, the channel depth as currently maintained is a constraint for many of the larger cargo ships in the transpacific fleet that require drafts greater than 43 feet.

There is currently no way to accurately evaluate the Columbia's waterway capacity to meet future demands. The current river data only evaluates the load and there is not a study that has evaluated all of the waterways systems carrying capacities.

CONDITION

The condition of infrastructure on both the Columbia River and the Willamette River varies. In general, the Columbia River channel is in good condition, due to adequate funding appropriations in recent years for channel maintenance dredging. However, many of the deep draft channel turning basins (which are used for ships that exceed the 600-foot channel width to turn around) were not deepened to 43 feet and cannot accommodate the larger ships. Also, there are a limited number of deep draft 43-foot anchorages and stern anchor buoys along the channel that allow ships to anchor outside the channel and not restrict vessel movement in the channel. Existing dredged material placement sites are nearing capacity and new sites may be needed for the estimated 6 to 8 million cubic yards of materials to be dredged each year. Overall the locks on the Columbia River are in good condition, primarily due to recent progress by the Corps to repair and upgrade the aging locks.

The 11.5 mile Portland Harbor on the Willamette River was not deepened to 43 feet, nor has there been any recent channel maintenance dredging in the Harbor. This will continue to be a constraint for the Terminals in the Harbor until resolution of the Harbor Clean Up project. In another challenge, the Willamette Falls lock is currently closed restricting vessel movement up the Willamette River beyond Oregon City.

Increased storm activity has severely damaged many of the coastal jetties and has taken a toll on their structural integrity. The U.S. Army Corps of Engineers (USACE) has been working to repair and restore the jetty structures to acceptable levels of reliability in recent years, but more work still needs to be done. Additionally the pile dike structures are aging with many in poor condition and no recent funding to address the necessary repairs. The coastal waterways are in adequate condition, but in recent years are often underfunded for the ongoing maintenance and repairs needs.

PILE DIKE STRUCTURE (PHOTO COURTESY USACE PORTLAND DISTRICT WEBSITE)

FUNDING & FUTURE NEED

The funding for Oregon's inland waterways maintenance and construction is primarily dependent on the annual federal budget treasury authorizations to the USACE and two other federal funding sources, the Harbor Maintenance Trust Fund (HMTF) and the Inland Waterways Trust Fund (IWTF). The HMTF supports dredging and other waterside infrastructure maintenance for coastal harbors but does not fund construction or major rehabilitation project like the jetties. HTMF collections have far exceeded actual funds appropriated for harbor maintenance and have been used for purposes unrelated to the account's intended purposes. Meanwhile, the IWTF supports necessary repairs to locks and dams along the nation's inland waterways and is funded by a fuel barge tax, but does not fund operation and maintenance. In 2014, Congress enacted a fuel barge tax increase, which has helped address the significant backlog of needed projects along inland waterways. However, IWTF and related appropriations are still insufficient to meet needs. As a result of these challenges, many of the Oregon's waterways maintenance and repair needs have not been adequately funded in recent years, creating a backlog of projects that need to be addressed.

Significant future funding is needed to address Oregon's waterways and harbors backlog of projects. The Columbia River Channel Deepening project spurred significant private investments in bulk handling terminals along the Columbia River, but did not address other necessary improvements associated with deepening the channel. At some point, the deep draft channel may need deepening to accommodate larger vessels. Many of the ports that are local sponsors for harbor and channel maintenance projects are financially constrained and will require funding support from state or local property taxes to satisfy Federal funding match requirements. Business Oregon administers Oregon's Marine Navigation Improvement Fund that provides partial funding for federally authorized navigation improvement projects on channels and harbors on the Oregon coast and along the Columbia River. The fund is administered by Oregon Business Development Department for the Oregon Infrastructure Finance Authority and funding is subject to state budget authorizations. Recent funding authorizations are well below the anticipated needs. Also, Connect Oregon, which has been a supplemental funding source for ports, did not allocate any funding for ports in the last authorization.

OPERATION & MAINTENANCE

Ongoing maintenance, repair, and improvements to Oregon's waterways and locks are primarily the responsibility of USACE. USACE recently developed a comprehensive asset management program for its infrastructure, which is a positive step toward improving operations and management in the inland waterway network.

Dredge material placement sites on the lower Columbia River are filling up and new sites are needed as well as innovative dredging practices to address the annual maintenance dredging volumes to keep the channel navigable for the future. The US Army Corps of Engineers and lower Columbia River Ports are conducting a Lower Columbia Channel maintenance plan to ensure the Navigation Channel is maintained and operational for another 20 years. The plan will evaluate alternatives to reduce dredging and minimize environmental impacts.

Map Courtesy of USACE Columbia River Channel Maintenance Plan

Vessel operations on Oregon's waterways is a coordinated effort between the Corps, the Coast Guard, pilots, automated data information systems, and vessel operators. Adequate USACE funding in recent years for ongoing channel maintenance dredging and continual hydrographic surveys help ensure vessels have the authorized water depth available and waterway operations have not be adversely affected. Shallow anchorages and turning basins have created challenges, and if not addressed in the future, these challenges could adversely affect vessel operations on the deep draft channel. Recent channel maintenance on coastal waterways and harbors has been adequate, but the 40-foot channel depths are becoming a constraint for larger ships to access deep draft Coastal Ports. Recent closures of the locks on the Columbia for major repairs and improvements, while strategically planned to limit impacts, have significantly impacted vessel operations on the Columbia inland waterway.

PUBLIC SAFETY

Oregon's inland waterway conditions do not currently present a significant safety risk to the general public. Investments in training and navigational technology by USACE, U.S. Coast Guard, and the Columbia River Steamship Operators' Association (CRSOA), Columbia River Pilots and Columbia River Bar Pilots, and the tug and towboat industry have increased the safety of vessel operations and movements. However, degradation of coastal jetties is a potential safety risk for boaters and fishing industry. The Columbia North Jetty has receded well in excess of 800 feet from its constructed length. This contributes to hazardous surf condition at the Columbia River entrance and to shoaling in the Channel. Shoaling occurs when currents in the river moves material into the channel and decreases the water depth. Annual channel maintenance dredging removes shoals that are created from sediments moving down the river. In addition to making passage into the river safer for vessels, the jetties also prevent sand from adjacent beaches to migrate into the channel. Damage to jetties results in more mainte-

nance dredging from the increased shoaling. From a resiliency prospective, if the channel and jetties are properly maintained the recovery period from a disaster is much shorter as well.

RESILIENCE

Oregon's waterways are affected by winter storms that can damage jetties and result in flooding. Flooding from storms and annual high-water spring freshet on the Columbia River results in shoaling in the channels, that if not dredged, can lead to draft restrictions for larger vessels. Ongoing channel maintenance dredging helps minimize the shoaling effects but is subject to federal funding authorizations. Repairs to the jetties are also subject to federal funding. Recent funding has been sufficient to address these impacts so most storms have minimal impact on the waterways ability to resume vessel traffic.

The Corps has two dredges with their home base in Oregon (Dredge EYASSONS and Dredge YAQUINA) that can be readily mobilized for emergency dredging if necessary.

A much greater risk to Oregon's waterway systems is a Cascadia subduction zone earthquake that would create significant damage to the coastal waterways, jetties, and the 43 foot Columbia River channel. The channels will likely experience significant shoaling due to lateral spreading within the channels, and failures of pile dike structures and jetties. The coastal waterways could also be impacted by landslides and will be impacted by the resulting tsunami. Additionally, most of the coastal bridges that span the waterways are anticipated to collapse. The repairs needed to resume all navigation operations could take several years. The upper Columbia River inland waterway and associated locks are significantly inland from the Cascadia subduction zone off the Oregon coast and are not anticipated to experience significant damage from a Cascadia earthquake.

INNOVATION

The USACE has implemented innovative materials and process as they become available, usually after a period of testing and evaluation by the Engineering Research and Design Center. The USACE dredges have been upgraded with more efficient pumping capabilities and state of the art controls.

There have been significant technology improvements related to data collection that have improved safety and efficient vessel movement. Transview 32 Automated Identification System (AIS) data on vessel traffic, Water Management System CWMS hydrological data forecasting, the Corps E-hydro system, and the LOADMAX numerical hydraulic analysis stage prediction tool optimizes available navigational depths and allows river pilots to plan the optimum time to move loaded vessels on the river. In addition this technology has improved environmental/ecological planning and analysis, including hazardous material spill response and river flow management and flood warnings.

RECOMMENDATIONS TO RAISE THE GRADE

- Increase Connect Oregon and Oregon Marine Navigation Improvement funding and allocations for Oregon Ports sponsoring USACE waterways projects in Oregon.
- Promote additional USACE funding to adequately address the deteriorating jetties, pile dikes, and locks, increase Columbia River anchorages and turning basin capacity, additional stern anchor buoys and implement coastal channels deepening projects.
- Promote and implement State and Federal grants to specifically address failing infrastructure and/or seismic upgrades to critical lifeline facilities.
- Protect the federal Harbor Maintenance Trust Fund from being used for other, non-port related purposes.
- Ensure that full use of the Inland Waterways Trust Fund continues to be appropriated, and increase the amount spent on operations and maintenance of the inland waterways each year.
- Protect the water flows provisions in Columbia River Treaty so navigation on the Columbia is not adversely impacted.
- Advocate and implement cleanup of the Willamette River in a timely and cost effective manner.

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Columbia River Pilots
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Estimating Economic Benefits from NOAA PORTS® Information: A Case Study of the Columbia River Report prepared for the Port of Portland by Dr. Hauke Kite-Powell of the Woods Hole Oceanographic Institute Marine Policy Center. June 2010

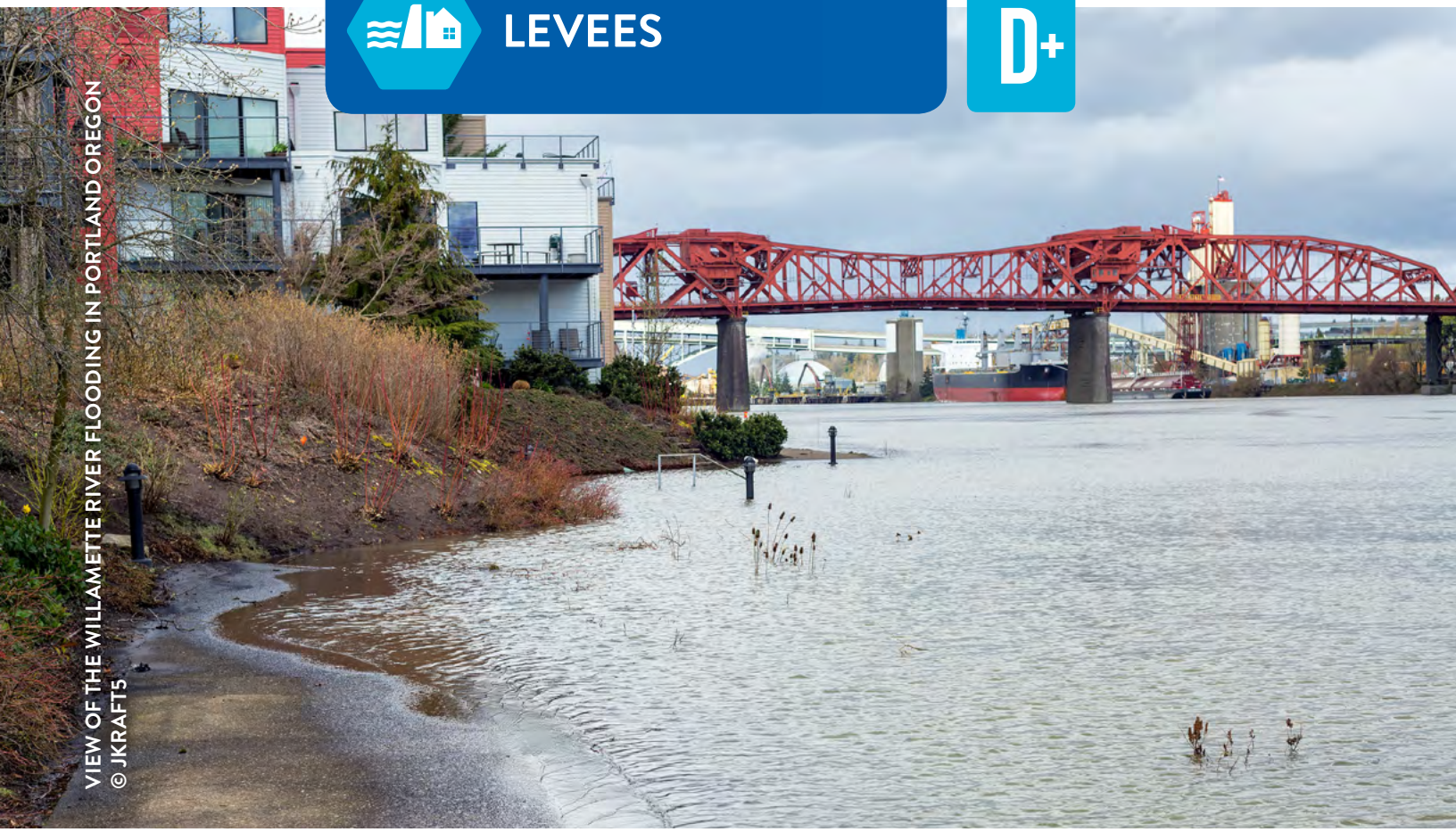
Lower Columbia Region Harbor Safety Committee Anchorage Guidelines 2017 Edition

Surveys
Conducted an on-line survey via Survey Monkey.

Interviews
Conducted interviews and attended Oregon Public Ports Association meeting,

LEVEES

D+



VIEW OF THE WILLAMETTE RIVER FLOODING IN PORTLAND OREGON
© JKRAFT5

LEVEES
GRADE: D+

EXECUTIVE SUMMARY

Based on the U.S. Army Corps of Engineers (USACE) National Levee Database (NLD), over 100,000 Oregonians live or work behind levees. However, this estimate only includes the levees in the NLD as Oregon does not have a complete inventory of its levees – especially the ones outside USACE's portfolio. While many levees were constructed or improved using federal funding, local communities are responsible for ongoing operation and maintenance (O&M) costs associated with levees. Oregon provides limited funding assistance to levee owners, but many communities have been unable to access this assistance or find it insufficient to cover the cost of improvements required for Federal Emergency Management Agency (FEMA) certification. Of levees inspected by the USACE, approximately 11 percent (124 miles) of Oregon levees are rated "Minimally Acceptable." About 30 percent (113 miles) are rated "Unacceptable." The remaining levees are of unknown condition. Currently only 14 of Oregon's 236 levees are certified by FEMA.

FIGURE 1: VANPORT FLOOD IN 1948 (MCDD)

BACKGROUND

The USACE's National Levee Database (NLD) catalogs many of Oregon's levees, but generally consists of levees known by USACE through prior involvement and only includes a portion of levees outside USACE's portfolio. The NLD should not be viewed as a comprehensive inventory of Oregon's levees, but it represents the best available data at this time. Following Congress' passage of the Flood Control Act of 1950, the USACE improved some of the levee systems around Oregon. Many were then turned over to local jurisdictions to manage ongoing O&M activities, which continues to this day.

According to the NLD, there are 236 levee structures in Oregon extending over 360 miles in 27 of Oregon's 36 counties. Nearly 100,000 Oregonians live and work in approximately 22,000 buildings behind levees. These structures represent about $12.7 billion in assessed property value, $7.3 billion of which is located behind the Multnomah County Drainage District (MCDD) levee serving the Portland International Airport and 59,000 jobs.

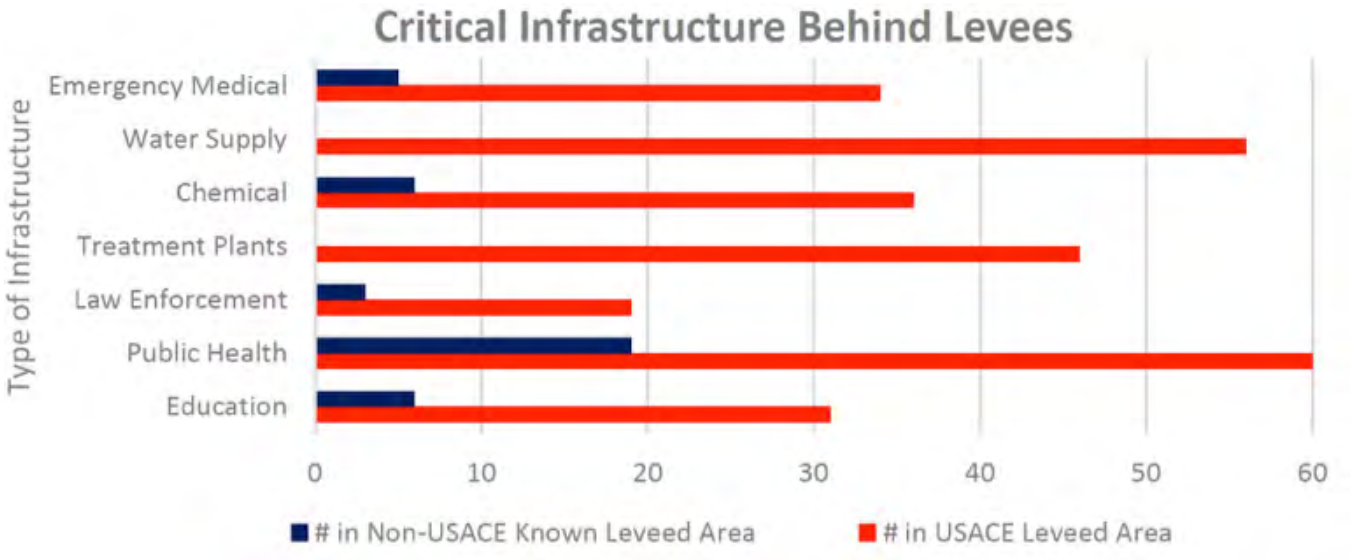
A significant amount of critical infrastructure is located behind levees, including emergency medical and public health facilities, water and wastewater treatment plants, law enforcement services, chemical storage, airports, and schools (Figure 2).

CONDITION & CAPACITY

The condition of Oregon's levees varies greatly throughout the state, from robust, well-maintained levees to failed levees that have not been repaired. USACE administers a formal inspection program for levees improved by USACE or in its portfolio. Approximately 11 percent (124 miles) of Oregon levees in the NLD are rated "Minimally Acceptable" and about 30 percent (113 miles) are rated "Unacceptable." None of Oregon's levees inspected by USACE exceeds the "Minimally Acceptable" rating. The remaining levees are of unknown condition.

Levees operated and maintained consistent with USACE requirements can be eligible for financial assistance after a flooding event through USACE's Rehabilitation & Inspection Program (RIP). Assistance, however, is limited to repairing the levee to the same condition it was in prior to the flood event and does not cover O&M items. In contrast, unless a non-federal levee system has taken steps to be eligible in the RIP, USACE does not inspect them, and these systems are ineligible for federal assistance. Approximately 50,000 people are estimated to live or work behind these uninspected levees, occupying buildings and property with a combined value of about $6 billion.

FIGURE 2: CRITICAL INFRASTRUCTURE BEHIND OREGON'S LEVEES



Source: Homeland Security Infrastructure Program Data 2015

Many Oregon communities are interested in pursuing FEMA certification of their levees, a requirement to qualify for lower flood insurance through the National Flood Insurance Program. Without certification, flood insurance may be cost prohibitive with lending institutions reluctant to finance real estate transactions. Certification typically requires geotechnical investigations, which can be cost prohibitive for many communities. Currently, only 14 of Oregon's levees are FEMA certified.

OPERATION & MAINTENANCE

The level of O&M activities performed on local levees varies greatly by community, largely depending on funding and local ability to perform the activities.

Scrutiny on the readiness of Oregon's levees has increased since Hurricane Katrina and many levee communities have been required to increase O&M efforts, resulting in increased cost. This added cost has been difficult for some communities to afford. Oregon voters approved Measures 5 (1990) and 50 (1996) establishing limits on Oregon's property taxes. These measures have made it difficult for some communities to invest in levees systems to pursue FEMA certification, respond to changing regulations and increase O&M efforts.

Additionally, land use behind the levees and environmental considerations have changed day-to-day operations and required local sponsors to balance flood risk and environmental concerns. For example, USACE levee management practices require vegetation to be mowed regularly and trees be removed from levees. Due to the proximity to rivers; however, levee vegetation is often considered riparian and critical for threatened and endangered species. As a result, many levee districts face conflicting requirements with regard to maintaining levees to USACE standards.

For levees outside the USACE portfolio, O&M activities are not tracked, and a 2018 survey of levee operators indicated that many non-federal levees are not maintained.

FUNDING & FUTURE NEED

Lack of funding for levees continues to prevent communities from making repairs, which limits their ability to obtain FEMA certification. According to the 2018 ASCE survey, communities need resource assistance and believe the state and federal governments should do more to help.

In 2015, the state enacted the Business Oregon's Infrastructure Finance Authority loan program to help communities with resource challenges related to FEMA accreditation. Some communities, however, do not qualify for the program because they cannot afford to repay the loan, even at the state's modest interest rates. The program also offers grants, but they are capped at $50,000 per biennium. Levee sponsors have indicated this amount is generally insufficient for meaningful improvements.

FIGURE 3. REEDSPORT FLOODWALL

No other resources exist for levees at the state level, and the state's official role in levee safety is unclear. The Oregon Department of Geology and Mineral Industries and Department of Land Conservation and Development have tried to gather information on levees outside the federal portfolio, but their efforts have been limited to desktop studies without field verification. Additionally, the Oregon Water Resource Department can conduct general risk assessments if funded by a local sponsor, but they cannot assist in designing repairs, and local communities bear all construction costs.

Oregon's approach is different from California and Washington, which have created robust technical and financial levee assistance programs. The Washington legislature has funded comprehensive planning and flood control maintenance and improvement projects through the Flood Control Assistance Account Program for over 30 years. Washington State also administers a partnership of local, state, federal, and private organizations that focuses on coordinating investment for multi-benefit projects that improve flood safety for communities and benefit the ecosystem. The California Governor's Office of Emergency Services helps local communities identify and apply for funding. California's Local Levee Assistance Program helps local agencies obtain geotechnical information required for FEMA accreditation and awards funding to evaluate levees and design and construct repairs. California voters have also approved large bond measures to improve aging flood control infrastructure.

PUBLIC SAFETY, RESILIENCE & INNOVATION

Oregon has a history of devastating floods, including the 1894 and 1948 floods on the Columbia River and the 1964 and 1996 floods on the Willamette River. Fortunately, Oregon has not experienced significant flooding on these rivers since 1996. This means, however, that many of Oregon's levees have not been tested in more than 20 years. Communities may not be aware of this, increasing public safety risk.

Following the Flood Control Act of 1950, USACE was authorized to construct and improve Oregon levees in partnership with willing communities. Many levees in USACE's portfolio were initially designed and constructed to withstand a minimum 200-year-flood event. Today, due to the high costs of obtaining levee certification and accreditation, some communities are opting to certify to the minimum FEMA standard 100-year flood elevation. While this approach may be less costly, such actions can reduce overall levee efficacy, leaving communities at potentially higher risk than originally intended.

If climate change occurs as some models predict, the Pacific Northwest is anticipated to have wetter winters and drier summers. These models indicate increased flood pressures on levees, increasing risk.

Additionally, levees are not generally designed to withstand seismic events under the justification that a major flood and earthquake would not be coincident. If the area experienced a large seismic event, levee instability, including sloughing and settlement, could be expected, likely requiring repairs prior to the next flood event.

FIGURE 4: FLOOD FIGHTING 1996 FLOOD (MCDD)

RECOMMENDATIONS TO RAISE THE GRADE

- **GET INVOLVED** – The State of Oregon should establish a levee safety program that works directly with levee communities and federal partners, including FEMA and USACE. Of primary importance is identifying the conditions and risk associated with levee systems outside the federal portfolio.
- **INVEST** – Levee communities are interested in improving their infrastructure, but are often limited to O&M and cannot raise the capital for certification and resiliency planning. Investment increases from state and regional government's leveed communities to facilitate levee safety to levee communities would raise the grade.
- **GET PREPARED** – Many of Oregon levees have not been tested in over 20 years. Some individuals may not be aware they live or work behind a levee and need to be reminded of the risk. The state and local communities should develop flood risk awareness programs, specifically targeting leveed communities.
- **GET ORGANIZED** – The State could play a role in providing levee communities with a venue to communicate their needs as part of a larger, levee safety community.

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PORTS

C-

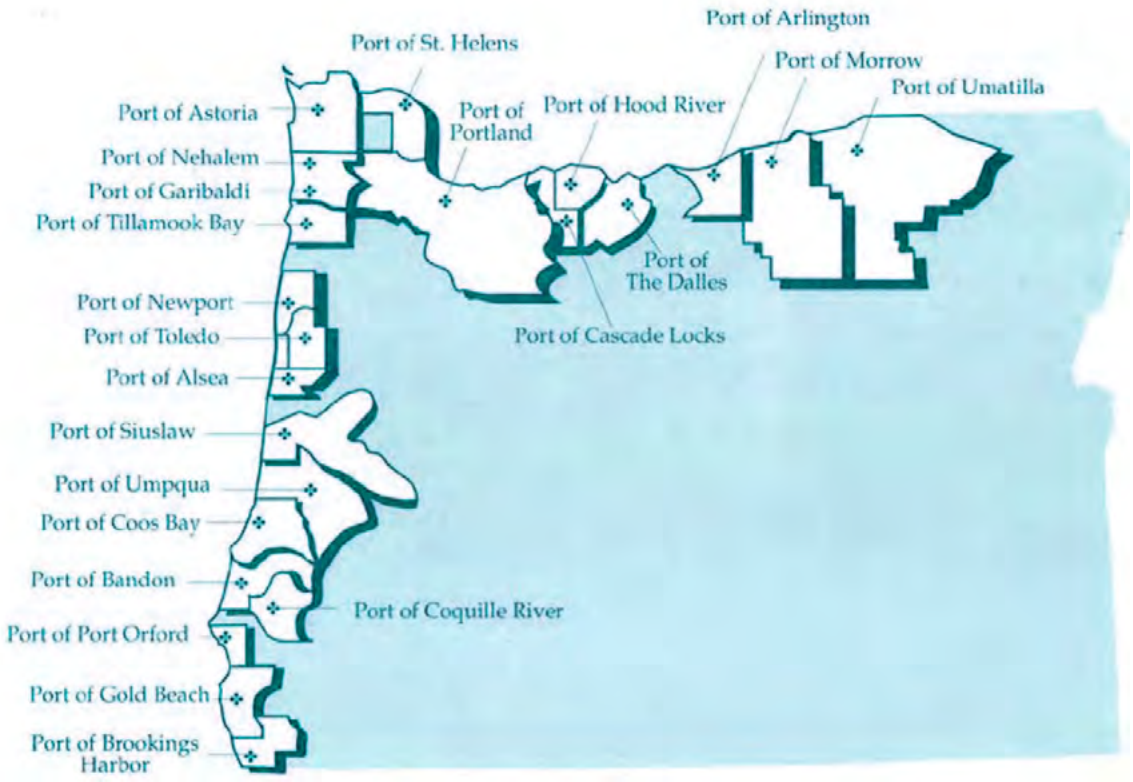
THE LOWER WILLAMETTE RIVER AS IT TIES INTO THE COLUMBIA RIVER.

PORTS
GRADE: C-

EXECUTIVE SUMMARY

Oregon's system of 23 public ports are a critical part of the state's multimodal freight transportation system. Ports facilitate the movement of timber, agricultural, and manufacturing products to regional and international markets. Each port faces different issues due to differences in waterway conditions, surrounding transportation infrastructure, and goods shipped. The condition of port infrastructure varies from good to poor and ongoing maintenance continues to be a challenge. However, in most cases, port infrastructure is nearing the end of design life and current revenue sources are inadequate to properly maintain or upgrade facilities. Funding to upgrade and/or modernize facilities are dependent on state or federal grants, and those opportunities have declined in recent years. The ports also rely on the Harbor Maintenance Trust Fund (HMTF) to pay for dredging and harbor maintenance projects to maintain access to port facilities. Unfortunately, Congress has redirected revenue from the HMTF to offset unrelated portions of the federal budget. As a result, available USACE funding has been inadequate to address the dredging needs of many harbors.

OREGON PORT DISTRICTS



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BACKGROUND

The 23 Oregon public ports are comprised of 14 coastal ports and nine that are located on the Columbia and Willamette Rivers. In addition to the private terminals, the public ports serve as state, national, and international transportation gateways and provide recreational, commercial, and economic services to residents and businesses in Oregon. Most public ports own industrial parks and commercial property, and some also operate the local airports. They are a key component in sustaining Oregon's economy and quality of life, and support thousands of family wage jobs.

Oregon's ports and waterways contribute $3.6 billion to Oregon's economy. One out of six Oregon jobs is directly or indirectly tied to cargo, recreation, industrial, commercial or other activities at Oregon's ports. Oregon is one of the most trade dependent states in the US, ranks 10th highest nationwide when it comes to the value of exports as a share of state GDP. Additionally, the economic impact is larger than this as many other states' products ship through Oregon ports on their way to destinations along the Pacific Rim.

All of Oregon's ports were incorporated as special districts that are regulated under Oregon Revised Statues. With the exception of the Port of Portland and the Port of Coos Bay (whose boards are appointed by the Governor and confirmed by the Oregon Senate) ports are run by locally elected boards of commissioners.

PORT OF NEWPORT

The 14 coastal ports are critical to the economic health of coastal port communities. A 2014 State of Oregon study shows that the Oregon coastal ports contribute 15,759 direct/indirect jobs and $904 million to the state GDP. NOAA's 2015 Fisheries of the U.S. report ranked the State of Oregon seventh in the nation for 2015 domestic fish landings, with 195 million pounds, valued at $115.7 million.

Photo Courtesy of Oregon Public Ports Association

PORT OF PORTLAND TERMINAL 5

The nine Oregon public ports on the Columbia and Willamette are part of the Columbia Snake River system. Three are deep draft (43 feet deep) ports along the Columbia and Willamette rivers and six are located along the 14 feet deep inland navigation channel above the Columbia River dams. Ports along the upper Columbia River play an important role in serving rural areas as a point of collection and distribution for commodities (such as grain, corn, and petroleum products) as well as food products, which then utilize rail or barge to send goods to the deep draft ports for export. The deep draft ports also serve as gateways for foreign bound exports for seafood/wood products (from coastal areas), soda ash (from Wyoming) and potash (from Saskatchewan). The Port of Portland also serves as gateway for automobile imports and exports.

Photo Courtesy of Port of Portland

CAPACITY

In general, most of Oregon's port facilities can accommodate current and future anticipated needs related to the movement of cargo. After the Columbia River channel deepening to 43 feet in 2010, there was significant investment by the grain and bulk terminal operators to modernize and increase their storage capacity on the Columbia and Willamette Rivers. There also was private investment to increase the growing auto export business in Portland.

On the upper Columbia River, some ports have expanded their facilities to accommodate developing freight movement. Most of the coastal ports and some of the Columbia River ports own marinas that support commercial fishing industry and recreational boating. Most are adequate for current needs.

The recent loss of regular ocean container ships calling the Port of Portland has created a challenge for the region's exporters that relied on lower shipping costs associated with service from Terminal 6. The Port is pursuing new container service and developing a rail transloading facility for containers transported by barges from the upper Columbia and local containers to be transported more economically to Seattle or Tacoma.

CONDITION

Although most of the cargo terminals are in good condition, conditions of docks varied widely. Generally, facilities at larger ports are in better condition than facilities at smaller ports. The coastal ports, according to a 2018 ASCE survey, generally rate their facilities conditions as fair to poor.

Some ports have improved and modernized their facilities through federal and state grants and passage of local bond measures. However, for the majority of ports in the state, the ability to maintain and/or replace outdated facilities is an ongoing challenge and the condition of many facilities is expected to continue to deteriorate. Most structures are 30 years or older and many are nearing or have exceeded the end of useful life. Attention to the condition of the docks, in-water pilings, and mooring structures requires ongoing attention. Escalating costs and regulatory processes to maintain berths and slips is also a challenge.

FUNDING & FUTURE NEED

All Oregon ports receive property taxes from residents and businesses within the port districts. However, as a percentage of total revenue, these taxes are significantly less compared to what many Washington ports receive from their local communities. Revenue from leases, dockage and other fees make up the rest of the revenue that the ports collect. In general, revenue does not cover the costs to adequately maintain or modernize port cargo facilities. Most port districts rely on grants from federal and state programs to fund modernization or expansion of their facilities. Although most ports have received some of these competitive awards, the available funding from federal and state investment programs are insufficient to meet all the anticipated needs. Often, ports have to compete for the limited grant opportunities. Smaller ports are particularly challenged to successfully compete for limited grant opportunities due to requirements for matching funds from the local level.

Some ports, such as the Port of Alsea, have been able to pass local bond measures to make improvements. However local measures are often competing with other local infrastructure measures and find it difficult to gain support. Ports that own marinas also compete for grants offered by the Oregon State Marine Board.

Following statutory changes enacted by the State Legislature in 2007, the Oregon Business Development Commission adopted a strategic business plan for Oregon's statewide Port system, known as Ports 2010. This plan requires the Ports to develop and maintain strategic business plans as a basis for access to department funding. In addition the Ports entered into Intergovernmental Agreements with Oregon Business Development Department **(OBDD)** that defines how the Ports and OBDD will implement the adopted business plans. Although Ports 2010 has provided a consistent approach to determining the Ports funding needs, there has been little funding authorized to help the Ports implement their plans.

Connect Oregon was created in 2005 as a $100 million lottery-bond-based initiative to invest in air, rail, marine, and transit infrastructure. Ensuing projects focused on connections between the highway system and other modes of transportation. The projects were distributed statewide and selected by the Oregon Transportation Commission (OTC) with the use of criteria specified in statute along with stakeholder and regional transportation advisory committee consultation. An additional requirement was that 15 percent of the proceeds were to be spent in each of ODOT's five regions. Historically, ports competed for grants and received 16 percent of the total allocation. They've also benefited from the funding for rail projects, as some rail projects improve access to rail at port facilities. Unfortunately, Connect Oregon funding authorizations have decreased in recent years. The most recent $60 million authorization from Connect Oregon VII in 2017 offered no funding opportunities for ports.

CONNECT OREGON MODAL ALLOCATION SUMMARY I, II, III, IV, V & VI (2005 – 2017)				
Mode	Award Amount	% of Total Awarded	Leveraged (Project Cost)	% of Total Leveraged
Aviation	$97,929,433	23%	$353,493,724	58%
Bike/Ped	$13,981,618	3%	$12,877,790	2%
Marine/Ports	$66,507,533	16%	$47,857,702	8%
Rail	$173,732,015	41%	$105,416,589	17%
Transit	$49,694,000	12%	$75,116,627	12%
Multimodal	$15,546,400	4%	$10,826,800	2%
Total	**$419,859,759**	**100%**	**$605,589,232**	**100%**

Table from Connect Oregon Website

The Clean Up of the Lower Willamette superfund site also presents a financial challenge for the Port of Portland and terminals located along the Portland Harbor. Although allocation of the cleanup costs has yet to be determined, early cost estimates are significant and could have detrimental effects on those entities ability to fund ongoing maintenance and operations.

OPERATION & MAINTENANCE

In general, most port cargo facilities are in good enough condition that day-to-day operations are not adversely impacted. Maintenance, on the other hand, continues to be a challenge due to the age of the most facilities. Many of the facilities have exceeded their design life and require on-going repairs. Funding constraints often prohibit proper replacement, resulting in minimal repairs, referred to as "band aid" repairs.

Berth and slip maintenance is of particular concern. Due to ever changing weather conditions and subsequent impacts to the waterways, berth maintenance costs are difficult to predict and are further complicated by the regulatory processes associated with in water work. Often, regulatory requirements have cost and schedule implications that are made more difficult by escalating construction costs.

PUBLIC SAFETY

Most port cargo handling operations are located within an industrial area and away from high traffic or even visible areas, which allows operations to be conducted without any potential harm to the general public. However, old and outdated facilities can present a safety risk to tenants, contractors and operators that use port facilities. Ports typically have their operators and tenants apply any appropriate safety protocols and procedures that are necessary for their industry. Public marinas are subject to Oregon State Marine Board oversight which helps insure public safety is not adversely jeopardized.

RESILIENCE

Oregon's coastal ports are subject to the unique climate patterns of the Pacific ocean that can significantly elevate sea levels for several months as well as generate damaging high wave and storm surges and flooding of coastal rivers. Sea level rise in the coming decades is anticipated to create more flooding at the coastal ports, particularly during El Niño weather events that can raise coastal sea levels for several months. Although seismic strains along the Cascadia subduction zone has raised the Oregon coast evaluation over time, a Cascadia event earthquake could cause parts of the coast to immediately drop 3 to 7 feet and relative sea level to suddenly rise, compounded by the resulting Tsunami. Inland ports are subject to less severe storms than the coast, but flooding events can affect the Columbia river ports, the most recent example being the 1996 flood. Most of the port cargo facilities were not designed to withstand current earthquake standards. A Cascadia Subduction Zone earthquake will have significant impacts to the coastal ports and detrimental impacts to the lower Columbia River ports. With the exception of a partial seismic upgrade to Terminal 6 at the Port of Portland, no seismic upgrades have been implemented.

INNOVATION

Ports that have constructed new facilities are being engineered with the innovative techniques, materials, and technologies that are within project budgets. Some ports have implemented innovative stormwater treatment features, such as the use of pervious pavements at auto storage yards in lieu of conventional storm water collection methods. New technology for gate security and for processing and management of containers at Terminal 6 were implemented in recent years. However, funding constraints have limited innovation at many port facilities.

RECOMMENDATIONS TO RAISE THE GRADE

- **Increase Connect Oregon and Oregon Marine Navigation Improvement Fund and allocations for ports as envisioned by the "Ports 2010" strategic business plan.**
- **Identify additional funding opportunities for capital investment within ports and find ways to fund local matches for large federal grant programs.**
- **Promote and implement state and federal grants to specifically address failing infrastructure and/or seismic upgrades to critical lifeline facilities.**
- **Streamline land use and regulatory processes so there is a consistent approach that ports can plan for.**
- **Protect the federal Harbor Maintenance Trust Fund by ensuring the fund receives full use of revenues and that they are being used for their intended purpose.**
- **Prevent and address dredging backlogs and support USACE structural repairs.**
- **Promote and implement planning for ports and communities to address sea level rise and advocate for State and Federal grants to address necessary infrastructure upgrades.**

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Conducted two surveys, one questionnaire and the other an on-line survey via Survey Monkey.

Interviews
Conducted interviews and attended Oregon Public Ports Association meeting,

RAIL

C

LANDSCAPE IN THE COLUMBIA RIVER GORGE WITH A TRAIN PASSING BY NEAR PORTLAND, OREGON
© JKRAFT5

RAIL
GRADE: C

EXECUTIVE SUMMARY

Oregon has 2,782 route miles of track, over half of which is operated by Union Pacific Railroad Co. (UP) and BNSF Railway Co. (BNSF). The remainder is operated by a mix of regional, local, and switching and terminal railroads. The state's two longest short line railroads today are the Portland & Western (PNWR) and the Central Oregon & Pacific (CORP). Oregon rail freight tonnage in 2017 was 64.8 million tons, up from 54.4 million tons in 2012. In 2015, railroads employed 2,026 Oregonians and those employees earned $214.8 million in wages and benefits that year. Principal commodities carried by trains are wood and paper products, farm-related products, and chemicals (largely soda ash or potash). Oregon is currently served with passenger train service by the daily Amtrak Coast Starlight that runs between Seattle and Los Angeles, and by Amtrak's daily Empire Builder between Portland and Chicago. Passenger rail operates on trackage owned by UP and BNSF.

CONDITION & CAPACITY

Freight System

Class I Railroads

The two Class I railroads in Oregon, Union Pacific (UP) and BNSF, together operate 51 percent of all active rail mileage in the state. They handle the vast majority of freight traffic, including virtually all interstate shipments, and all Amtrak passenger service is operated over these lines.

TABLE 1: CLASS I RAILROAD OPERATING CHARACTERISTICS IN OREGON

NAME	EMPLOYEES	PAYROLL (MILLIONS OF DOLLARS)	MILES OPERATED	ORIGINATING CARLOADS	TERMINATING CARLOADS
UP	1,511	$137	1,073	215,732	319,512
BNSF	332	$25	336	96,103	159,274

Source: UP statistics from Union Pacific in Oregon fact sheet for 2017; BNSF statistics from BNSF Railway in Oregon fact sheet, 2017.

Union Pacific Railroad

Omaha-based Union Pacific Railroad is the largest rail operator in Oregon by mileage and traffic volume. In 2017, the firm operated trains over 1,073 miles of track in Oregon, with a staff of 1,511 and a $137 million payroll. UP's Oregon network consists of two primary corridors: an east-west transcontinental route, and a north-south route linking California with the Pacific Northwest.

UP primarily operates on single track. The company relies on sidings, which are parallel sections of track where trains pull off to allow other trains to pass in the same or opposite direction to facilitate bi-directional movements. The railroad's top inbound commodities include mixed freight handled in containers and trailers, recyclables/waste, soda ash, fertilizers, and assembled automobiles. Top outbound commodities were dominated by mixed freight handled in intermodal service, lumber and building materials, cement and miscellaneous minerals, paper, and frozen/refrigerated foodstuff.

BNSF Railway

BNSF is the second largest operator in Oregon, and relies on 230 miles of owned track and 106 miles of trackage rights. In 2017, BNSF employed 332 people in Oregon, with a payroll of $25 million. In addition to extensive operations in the Portland region, approximately 313 miles of BNSF trackway comprise a north-south corridor that forms part of BNSF's through route along the West Coast, between California's Central Valley and the Pacific Northwest. Often referred to as the Inside Gateway, the Oregon portion is comprised of the segment beginning at the state line near Wishram, WA on the Columbia River and extending through Bend, Chemult and Klamath Falls to Malin on Oregon's southern border with California. Although beyond Oregon's borders, the Washington portion of BNSF's mainline is critical to service in Oregon. It is comprised of trackage along the north bank of the Columbia River, between Pasco, Wallula, Wishram and Vancouver, Washington.

Top inbound commodities consisted of mixed freight moving in intermodal service, agriculture products and industrial products. Top outbound commodities were dominated by mixed freight and forest and industrial products. Almost all of BNSF's network in Oregon consists of single track mainline.

Non-Class I Railroads

While the Class I mainline railroads provide the primary arteries for the movement of goods throughout the state, Oregon's Class III railroads provide important collector/distributor services for the larger railroads and local rail services for rural shippers.

Class III railroads in Oregon primarily operate former Class I branch lines that were sold or leased after deregulation of the industry began in the 1980s. These small railroads have been instrumental in preserving rail service to rural sectors of Oregon hosting a variety of agricultural, forestry, mining and manufacturing enterprises. Oregon has no Class II carriers.

TABLE 2: OREGON 2019 TOTALS

		MILES OPERATED	
	NUMBER OF FREIGHT RAILROADS	EXCLUDING TRACKAGE RIGHTS	INCLUDING TRACKAGE RIGHTS
Class 1	2	1,111	1,421
Regional	2	694	809
Local	15	461	468
Switching & Terminal	6	20	24
Tourist & Other	4	59	
Total	29	2,345	2,722

Passenger System

Oregon is currently served with passenger train service by the daily Amtrak Coast Starlight that runs between Seattle and Los Angeles, and by Amtrak's daily Empire Builder between Portland and Chicago. The states of Oregon and Washington cooperate to sponsor a regional passenger train service between Eugene and Vancouver, B.C., branded as Amtrak Cascades.

In calendar year 2017, total combined ridership on the Oregon-funded Amtrak Cascades trains and the Portland-Eugene segment of the Coast Starlight was 183,632 passengers. Another 83,164 persons traveled the Portland-Eugene corridor in 2017 aboard Amtrak Thruway ODOT POINT buses. From 1996 to 2012, the Oregon passenger rail system and its allied bus network showed sustained annual ridership growth with the exception of 2009, a year hard-hit by the recession. Ridership peaked in 2013 and has fluctuated at lower numbers since then.

Condition

The condition of mainline track in Oregon is generally good, but the number of trains that can be safely and efficiently carried depends on several factors, such as the presence and complexity of a signal system and the length of, and intervals between, sidings. These additional lengths of track are critical because the majority of Oregon's mainlines are single-track.

Until the onset of the economic recession in 2008, traffic on short lines had grown substantially, as operators improved service, upgraded track and equipment, and attracted new customers. However, the condition of some segments of Oregon's short line network are still affected by a legacy of deferred maintenance and will not allow freight speeds of 25 miles per hour, the state's minimum goal for secondary line operation.

Additionally, a number of bridges and tunnels on the state's short line system are aging. Most of Oregon's short line bridges are timber trestles built between 1930 and 1950. Of the 24 tunnels on the short line system, all but one were dug between 1883 and 1916, and some retain significant portions of their original timber rib lining.

Most Oregon businesses that ship by rail, whether on a major railroad or short line, have access to only one of the state's two interstate railroads. This lack of competition is of concern to shippers and the short lines.

O&M, FUNDING & FUTURE NEED

Freight System

Except for three of five publicly owned short lines, Oregon's railroads are run by private companies that pay federal, state, and local income taxes, as well as property taxes assessed on their individual rights-of-way, buildings, and locomotives. All railroads, whether public or private, maintain their own equipment, track, and rights-of-way. They pay annual fees based on gross revenue for state track and equipment safety inspections and for facilitating the regulation of public rail crossings. Both federal and state highway funds support rail crossing improvements, but very little federal money has been allocated to the states for other track improvements.

Key Needs for Freight

Class I Needs

Today's Class I rail network in Oregon is arguably in the best condition since the dawn of the highway era. Both BNSF and UP have very robust investment programs to maintain and improve their infrastructure throughout the state. All Class I trackage in Oregon is capable of carrying the standard 286,000- (286K) pound freight rail cars, and all but 54.4 miles of BNSF's Oregon Trunk and 87 miles of its Gateway Subdivision are signalized with Centralized Traffic Control (CTC). However, tunnel clearances preclude moving double-stack containers over the Oregon Trunk and Gateway Subdivisions.

Improvements needed for increasing capacity and eliminating bottlenecks on the mainline network in Oregon:

- Siding and mainline track upgrades.
- Signal system upgrades, and elimination of "dark territory" segments on BNSF's Inside Gateway line.
- Other upgrades to reduce bottlenecks and increasing speed.
- Increasing vertical clearances in tunnels on the Inside Gateway to permit passage of double-stack containers.

In general, responsibility for adapting to increasing freight traffic falls on the railroads themselves.

Class III Railroad Needs

The major operational issues that traditionally face railroads include speed restrictions, weight restrictions, and vertical clearance restrictions often caused by bridges and tunnels. These issues are most distressing for Class III railroads in Oregon, and often their inability to accommodate heavier and/or larger equipment affects their financial performance, limits their growth and sometimes threaten their existence. For example, over 250 miles of Class III rail mileage cannot accommodate 286K loads, placing the shippers on those lines at an economic disadvantage due to the fact that they are unable to fully benefit from the efficiencies of rail.

The Oregon Department of Transportation (ODOT) estimates the cost of upgrading deficient lines in the state to accommodate 286K-pound cars to be $125 to $150 million.

Connect Oregon was created in 2005 as a $100 million lottery-bond-based initiative to invest in air, rail, marine, and transit infrastructure. House Bill 2017 (2017) made significant revisions to the Connect Oregon program and funded four named rail projects, for a total of $60 million:

- a Mid-Willamette Valley intermodal rail facility ($25 million);
- a Treasure Valley intermodal rail facility ($26 million);
- a rail extension at the Port of Morrow ($6.55 million); and
- building a new passing siding between Salem and Portland ($2.6 million).

Rail Funding Task Force

Oregon's lack of dedicated, sustainable funding for rail investments is one of the primary challenges to maintaining a viable rail system for both passengers and freight in Oregon.

Oregon has historically lacked a dedicated revenue stream available to provide the required match for federal funds to improve passenger rail service or to maintain or operate infrastructure or support rail grade crossing projects.

In 2011, ODOT convened a Rail Funding Task Force made up of 14 diverse representatives of Oregon industries, passenger rail advocates, local governments, and community leaders to identify a long-term sustainable funding source for passenger and freight rail in Oregon. The funding recommendations would generate an estimated $75 - $80 million annually for rail. To date, none of these funding strategies have been pursued.

Passenger System

AMTRAK, PRIIA, AND FUTURE FUNDING

Passenger rail funding discussions in Congress are inevitably tied to the discussion of Amtrak's future. In 2002, Amtrak was on the brink of closing lines. Missing Congressional deadlines to be operationally self-sufficient, Amtrak reorganized and in 2011, overhauled its accounting processes. Except for the Northeast Corridor, Amtrak's ticket revenue does not cover operating costs. The company's cross-country trains show the highest losses. Affected communities and states are urging Congress to more fully support the system, as it provides an alternative to automobile and air travel, particularly for rural communities. Under the provisions of the Passenger Rail Investment and Improvement Act (PRIIA) of 2008, Amtrak's Cascades service, beginning in October 2013, required significantly greater financial operating support from Oregon and Washington as a state-supported service. Long distance service (Coast Starlight and Empire Builder) will continue to require federal support to the extent that it doesn't 'break even' from an operating perspective. All of Amtrak's operations are on freight railroad trackage and the responsibility for track maintenance and infrastructure capital funding lies with the freight railroads. Installation of federally required Positive Train Control (PTC) for both UP and BNSF was completed in 2018 and is in daily operation in Oregon.

PUBLIC SAFETY, RESILIENCE & INNOVATION

The federal government is primarily responsible for regulation of railroad safety. A brief review by the Office of Legislative Counsel found that state and local governments are preempted from regulating railroads. There is a narrow exception for laws of general applicability that are intended to protect public health and safety, such as fire and building codes. While there are several federal agencies and boards that have a regulatory role, the Federal Railroad Administration (FRA), a branch of the U.S. Department of Transportation (USDOT), has primary responsibility for railroad operational safety. The FRA has delegated some of its authority to ODOT's Rail and Public Transit Division.

ODOT's Rail Safety Unit has responded to the growth in crude oil transport by focusing on increasing safety through prevention. ODOT's inspectors regularly monitor train speeds, track conditions, train car placement, and tank car worthiness. Members of the unit also walk track, inspect cars, review operating procedures, evaluate safety at crossings, and check hazardous materials shipping documents for accuracy. ODOT is also reviewing and revising Oregon Administrative Rules pertaining to requirements for railroads to report the types and quantities of dangerous commodities moving through Oregon communities. The emphasis on safety by prevention appears to have been successful: from 2004 through 2013, Oregon experienced an 81 percent reduction in derailments. This trend has generally continued, with derailments dropping from 20 in 2013 to 16 in 2017.

UNION STATION TRAIN STATION IN PORTLAND OREGON. © RIGUCCI

RECOMMENDATIONS TO RAISE THE GRADE

- **Improve capacity to keep up with the anticipated increase of freight expected to use Oregon's freight rail system.**
- **Implement recommended changes from the 2010 Oregon Rail Study and the Oregon State Rail Plan when it relates to shared common tracks.**
- **Seek to continuously increase the resiliency of the state rail network. Identify weak points and fund projects to systematically address these weaknesses.**
- **Support more double-stack intermodal clearance projects.**
- **Modernize and/or remove at-grade crossings.**
- **Support innovative, public-private financing agreements for freight projects.**
- **Seek new, innovative sources of federal and state funding for rail passenger and freight investment to specifically reduce highway congestion and improve the overall level of transportation safety in the state and to fund larger projects supported over multiple contract years.**
- **Inventory and aggressively market freight connections in land packages to prospective business owners looking to bring business to Oregon.**

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American Association of Railroads

American Association of State Rail Officials (AASHTO)—particularly the rail committees

American Short Line and Regional Rail Association

ROADS

C+

THE ROAD THROUGH MT. HOOD'S FRUIT LOOP WITH MT. HOOD MOUNTAIN LOOMING IN THE BACKGROUND IN OREGON © MELISSA KOPKA

ROADS
GRADE: C+

EXECUTIVE SUMMARY

Oregon has over 74,000 total miles of roads, which is 2 percent of the national mileage. An improving economy and a growing population have contributed to significant capacity challenges, particularly in the Portland metropolitan region. Fortunately, Oregon lawmakers acted to provide significant new funding for the transportation system beginning in 2017. From 2017 to 2027, $5.3 billion of additional State Highway Fund revenue will be available to go towards projects that alleviate congestion and improve roadway conditions. Additionally, Oregonians benefit from roads that are generally well-maintained. Statewide, 66 percent of pavement was in good condition, 24 percent was in fair condition, and 10 percent was in poor condition in 2018. Oregon's highways exceeded pavement condition targets, with 90 percent in fair to good condition. However, the state's roadways face challenges in the future related to population growth and seismic resilience.

Photo by adrian on Unsplash

CONDITION & CAPACITY

Oregon's need for reliable, resilient, and safe roads has grown since the first automobile arrived in 1899. Oregon now has 4.1 million registered vehicles and 3.1 million licensed drivers. Vehicle Miles Travelled (VMT) has continued to increase, but much more slowly than in the 1980s and 1990s. In 2017, there were 36.8 billion VMT total statewide on public roads. With an 11 percent growth in population since 2010, vehicle travel increased by 8 percent between 2010 and 2017.

Oregon has over 74,000 total miles of roads, which is 2 percent of the national mileage. A majority of mileage falls within county jurisdictions, but the top two agencies by ownership are the Bureau of Land Management and the Oregon Department of Transportation. Approximately 81 percent of Oregon's public roads are rural and 19 percent are urban.

SUMMARY OF MILEAGE AS OF DECEMBER 2017 (ADAPTED FROM ODOT).

JURISDICTION	MILEAGE	PERCENTAGE
Oregon Department of Transportation (State Highway System)	8,033	11%
County & Local Access	32,831	44%
City	11,222	15%
Other State Agencies	648	1%
Federal Agencies	19,647	27%
Bureau of Land Management	13,510	18%
U.S. National Forest	5,610	8%
National Park Service	103	0.1%
Army Corps of Engineers	98	0.1%
U.S. Military	27	0.0%
Other Federal Agencies	299	0.5%
Tribal Government & Bureau of Indian Affairs	1,726	2%
Total	74,106	100%

Oregon's top five chokepoints are in the Portland Metro region, the state's largest metropolitan area. A majority of these chokepoints are at highway interchanges, such as the I-5 Columbia River Crossing and I-5/I-84/I-405 Interchange. The Portland Metro area ranked 20th in total congestion cost and 11th in cost per auto commuter (with $1,273 for travel time delay and excess fuel consumption per year) out of all U.S. urban areas, according to the Texas A&M Congestion Rankings.

Poor roadway conditions also take their toll. According to TRIP, Oregon motorists pay $267 per person in extra vehicle repairs and operating costs due to driving on roads in need of repair. This is a cost of $764 million per year for Oregon motorists.

Beginning in 2019 with the passage of Keep Oregon Moving (House Bill 2017), counties and cities are required to report pavement conditions to the state to improve transparency, accountability, and performance. Oregon counties reported 68 percent good condition pavement road-miles, 22 percent fair, and 10 percent poor. For cities, the total reported was 59 percent good, 26 percent fair, and 15 percent poor. In Portland, the conditions were lower – 40 percent good, 30 percent fair, and 31 percent poor. State highways consisted of 65 percent good, 25 percent fair, and 10 percent poor. Oregon set a target of 85 percent fair or better pavement conditions for state highways, which was exceeded in 2018 with 90 percent fair or better.

OPERATION & MAINTENANCE

The statewide pavement condition report outlines the current status and future needs of the state highway system estimating an annual need of $200 million dollars. Priority between ODOT and cities is on maintenance and preservation. While the state now has more resources to address operations and maintenance thanks to HB 2017, localities continue to struggle. Not only do new projects lack funding, but often maintenance is deferred due to lack of funding. County governments with high road mileage (length) and smaller populations are particularly challenged to properly maintain their roadway infrastructure due to significant needs and a smaller tax base to pay for them.

One area cities struggle with is snow removal. Some cities have snow removal equipment; others rely on ODOT. In Oregon, a severe winter storm can literally wipe out a city's street budget. There is no good data on average time for snow removal, especially in smaller cities.

The League of Oregon Cities, in a 2016 transportation needs study of its members, determined that $3.7 billion was needed to fully address the street and road maintenance needs of Oregon Cities.

FUNDING

ODOT receives revenue from a variety of state and federal sources. The primary sources of federal and state revenue for roads are taxes and fees associated with the ownership and operation of motor vehicles. For the period 2017-2019, 57 percent of funding available for highway related projects and programs in Oregon is derived from state sources and 43 percent is from federal sources.

The current state tax rate on a gallon of gas is 34 cents. The rate is scheduled to increase to 36 cents in January 2020, and if statutory triggers are met, increase by an additional 2 cents in January 2022 and another 2 cents in January 2024.

The current state tax rate on a gallon of diesel is 34 cents and is subject to the same schedule of increases as set for gasoline. The diesel tax rate is for vehicles less than 26,000 pounds gross vehicle weight. For vehicles operating at above 26,000 pounds, payment of per gallon fuel taxes is replaced by payment of weight mile tax.

Under state law, Oregon cities and counties are permitted to assess local per gallon taxes on gasoline and diesel. Information on Oregon local jurisdictions currently imposing fuel taxes is available at the following website: https://www.oregon.gov/ODOT/FTG/Pages/Current%20Fuel%20Tax%20Rates.aspx. A few examples are listed below:

LOCAL GASOLINE TAX RATES

JURISDICTION	TAX RATE	ADMINISTERED BY
City of Eugene	$0.05	ODOT FTG
City of Sandy	$0.02	City
City of Sisters	$0.03	City
City of Tigard	$0.03	ODOT FTG

Oregon's transportation network is also supported with federal gas tax receipts, vehicle registration fees, and electric vehicle fees. The current federal gas tax is 18.4 cents per gallon and the federal diesel tax is 24.4 cents per gallon. Oregon's 2-year vehicle registration fee is $112. Hybrid and electric vehicles will be charged $110 beginning in 2020 and the funding will be programmed for maintenance and capital projects.

With gas tax revenue expected to decline, Oregon has been a leader in closing the gap between fuels tax revenue and road usage. In 2015, Oregon was the first state to establish a tax program on actual road usage for light vehicles, called OReGO.

FUTURE NEED

In Oregon, it is predicted that population growth will continue, leading to an overall increase in travel. This will likely lead to higher levels of congestion in many areas of the state. Oregon is working to curb congestion. Local jurisdictions are required to prepare Transportation System Plans that plan for future populations and examine land uses and transportation systems needed to support that growth.

Local agencies within metropolitan areas are also required to help reduce the reliance on automobile travel by planning for transportation options that include walking, biking, and transit, along with demand management techniques to help lower travel demand. ODOT is also investing significant funds into non-highway infrastructure for walking and biking. With assistance from revenue derived from HB 2017, the state agency is also expanding transit systems.

ODOT is working to curb congestion through strategic operational improvements such as ITS technologies and low-cost improvements to smooth traffic flow without adding capacity to the system. These strategies include ramp meters, coordinated traffic signal systems, variable speed zones, addressing merging/diverging deficiencies, travel information services, and more. Included in this area is financial support to travel demand programs such as travel options programs in metropolitan areas, van pools, car sharing, and other Transportation Demand Management type strategies. Finally, thanks to support from the Oregon legislature, ODOT is making strategic investments to address congestion and system bottlenecks that have been identified from state and local planning efforts. Included in this is the effort to evaluate system pricing options within the Portland Metropolitan area to help improve system congestion.

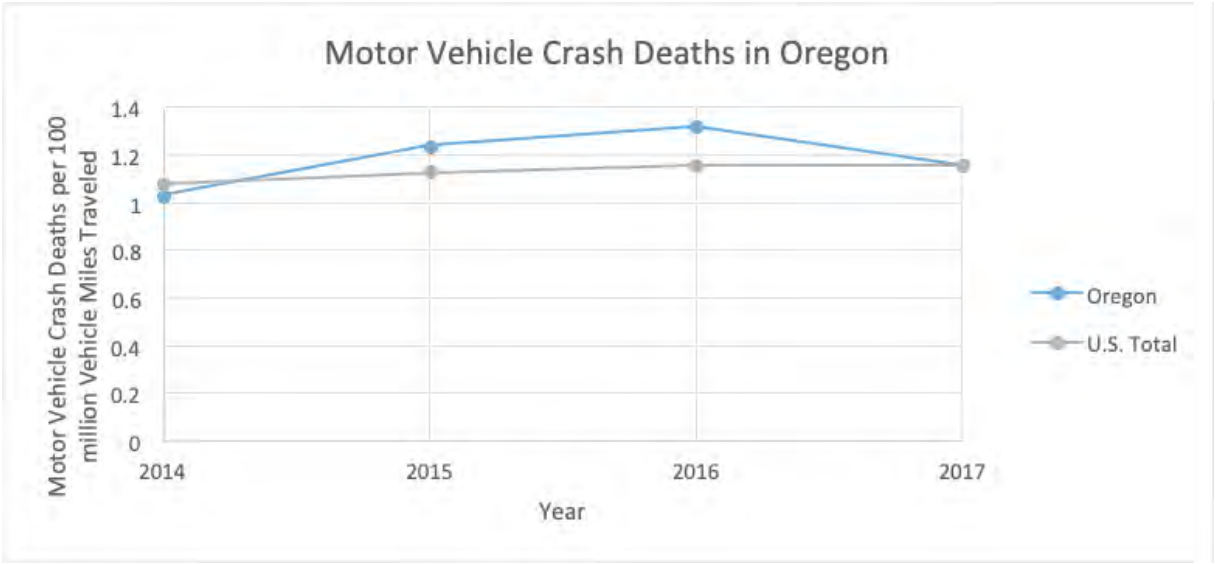
ODOT does not have a total needs calculated for future highway construction and maintenance other than the high-level estimates from the Oregon Transportation Plan and Oregon Highway Plan. These are very generic and high level and again are not project specific.

Projected pavement maintenance cost is generally addressed in the OTP. ODOT will be preparing a risk-based Transportation Asset Management Plan for the National Highway System (NHS) that will address highway pavement preservation needs and strategies to meet targets per federal requirements. Projected revenue funding levels for the state highway system provide about one-half of the actual need for pavement preservation and major repairs.

PUBLIC SAFETY

According to a 2017 report by the Insurance Institute for Highway Safety (IIHS), there were 437 fatalities on all Oregon roads, which was about 1 percent of the fatalities nationwide. Oregon's number of deaths per 100 million vehicle miles traveled matched the national average of 1.16. 65 percent of motor vehicle crash deaths occurred in rural areas and 35 percent occurred in urban areas. Most deaths have been on non-Interstate roads, and common errors of drivers in fatal crashes have been driving too fast for conditions, failing to maintain lane, and exceeding the posted speed.

MOTOR VEHICLE CRASH DEATH RATES IN OREGON (BASED ON IIHS DATA)



Oregon has a goal of having no deaths or life-changing injuries on the transportation system by 2035 (see the Oregon Transportation Safety Action Plan). The state is working towards improving safety measures such as driving behavior, equipment standards, and the use of safety belts and child seats. Oregon is among the top three states with the highest percentage of observed seat belt use. Using both "systematic" and "hot spot" approaches to identify crash locations with fatalities and serious injuries, Oregon is able to improve safety by prioritizing benefit-to-cost ratios and areas with high crash concentrations.

"STAY ALIVE ON I-5" BY ODOT IS LICENSED UNDER CC BY 2.0.

Crashes and vehicle safety are not the only public safety concerns. Oregon asthma rates are higher than national rates, which are worsened by smog. The main air pollutants in Oregon are particle pollutants, and the Bend-Redmond-Pineville and Portland-Vancouver-Salem areas are within the top 50 most polluted areas in terms of short-term particle pollution. To combat car exhaust, the Oregon DEQ has a commute options rule that requires many employers to provide commuter incentives for alternatives such as carpooling, telecommuting, or biking.

RESILIENCE

The Governor's Transportation Vision Panel and the Legislature's Joint Committee toured the state listening to Oregonians about the needs of the transportation system. The need to preserve and maintain the transportation system, to protect it and make it resilient to a major earthquake, was a major issue that came up as a concern.

The Oregon Resilience Plan focuses on plans for the next Cascadia earthquake and tsunami. With the potential of rockfalls, landslides, and collapsed roadways, there is expected to be catastrophic failures and long closures following the earthquake. Oregon has Seismic Lifeline Routes, which are intended to facilitate the response of emergency services and support economic recovery after a disaster. It would take one to three years for Tier 1 Seismic Lifeline Routes (highest priority) in the Willamette Valley and Central Oregon to become 90 percent operational, given the current conditions. The estimated time in the Coastal Zone is over three years.

Oregon participated in FHWA's Climate Resilience Pilot Program (2013-2015), which included studies by DOTs and MPOs to assess vulnerability to climate change and extreme weather. The most vulnerable highways were in the Coast Range (where rock falls and landslides occur), along larger road cuts or fill slopes, in low-elevation areas subject to flooding (rivers and estuaries), and coastal areas subject to storm surge and inundation from sea level rise. All designated Lifeline Routes were found to be vulnerable to climate impacts.

INNOVATION

Oregon has a strong focus on transportation research and implements pilot projects to test innovative approaches to roadway construction. The state is home to one of five national University Transportation Centers funded by the U.S. DOT, the Oregon Transportation Research and Education Center that has the goal of conducting interdisciplinary research on transportation issues. Oregon also implements FHWA's Every Day Counts initiatives for pavement, roadway design, and construction innovations. ODOT is part of a pooled fund study that includes intelligent compaction, thermal profiling, ground penetrating radar, and pavement smoothness. 3D models have progressively been used for design and construction applications. ODOT has used automated machine guidance on recent projects such as Pioneer Mountain – Eddyville, Newberg-Dundee Bypass, and Bly Mountain. 3D milling, which combines 3D design models and automated machine control, has been used on short pilot project sections.

In 2012 ODOT completed a Greenroads Pilot Project, the US 97: Lava Butte – S. Century Drive Section that increased capacity and improved safety on the highway, while incorporating sustainability. With the installation of two wildlife under-crossings as part of the project, there has been an 86 percent decline in wildlife-car collisions since 2012.

RECOMMENDATIONS TO RAISE THE GRADE

- **Construct projects that will relieve bottlenecks on Portland area freeways.**
- **Incorporate more cost-reducing preservation treatments, recycled materials, energy-saving measures, and environmental considerations in designing future roadway improvement projects.**
- **Roadway stakeholders, including governmental, private sector, and other interests, should meet regularly to discuss infrastructure challenges and paths toward solution implementation.**
- **Better address the effects of stormwater contamination, erosion and sediment coming from roads and its effect on waters of the U.S. Oregon should look towards a requirement for a Pollution Prevention Plan for new road construction-related projects.**

DEFINITIONS

HISP	Highway Safety Improvement Plan
ITS Technology's	Intelligent Transportation System
KOM	Keep Oregon Moving
MPO	A Metropolitan Planning Organization (MPO) is made of local government authorities and represents an urbanized area with a population greater than 50,000 people and is responsible for planning metropolitan transportation processes.
NHS	The National Highway System (NHS) is a highway network of roadways important to the nation's economy, defense, and mobility including the Interstate Highway System, Other Principal Arterials, Strategic Highway Network, Major Strategic Highway Network Connectors, and Intermodal Connectors.
ODOT	Oregon Department of Transportation
OTP	Oregon Transportation Plan
Smog	Anthropogenic air pollution consisting of coal combustion, industrial, and vehicular exhaust emissions.
TDM	Transportation Demand Management
VMT	Vehicle miles traveled (VMT) is the total number of miles traveled by vehicles per year.

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SANITARY SEWER OVERFLOWS SUCH AS THE ONE SHOWN ABOVE IN AN EXISTING CREEK THREATEN AQUATIC HABITATS AND DRINKING WATER SOURCES.

WASTEWATER
GRADE: D

EXECUTIVE SUMMARY

Population growth, state-wide asset deterioration, and disaster response are the primary contributors to Oregon's wastewater infrastructure deficiencies. Oregon's compliance with Clean Water Act standards depends on its ability to manage substantial demand increases on systems designed for much less capacity and address aging infrastructure on the brink of failure. These needs alone are challenging enough to fulfill but are now magnified by the threat of an upcoming natural disaster. Many of the wastewater systems are beyond useful design life and will soon need replacement or full rehabilitation. Estimates show a total investment need for Oregon's wastewater infrastructure of approximately $5 billion. Engineers, planners, and managers must collectively decide during the creation of capital improvement plans how to allocate precious available funds, which almost always fall short of the funds needed to achieve comprehensive system improvements.

CONDITION & CAPACITY

While specific challenges vary with size and demographic of individual service populations, wastewater service providers across the state are faced with at least one common problem: aging infrastructure that is beyond its estimated useful design life leading to increased frequency of failures and costly system inefficiencies. Degraded infrastructure and insufficient capacity are direct causes of sanitary sewer overflows, which occur regularly throughout the state, and can threaten drinking water sources, contaminate groundwater, destroy aquatic habitats, and lead to costly public and/or private property damage.

In many cases, conveyance system assets are well over 100 years old, but with so many competing needs for funding each year, service providers have no choice but to rely on these aged systems to convey wastewater volumes far exceeding their original design capacities. Unfortunately, projects that address aging, undersized, and/or high-risk assets are often located in older, fully developed areas of the service districts, where projects are more expensive to execute due to challenges such as the need for traffic control/road closures, coordination to avoid or relocate underground utilities, disruption to public services (water, gas, electric, etc.), and site restoration (streets, sidewalks, landscaping, etc.). Service providers must balance investment needs required to increase the capacity of existing systems (pipes, treatment plants, pump stations, etc.) to support population growth and new development with upgrades required to meet increasingly stringent permit requirements and address high-risk assets with elevated probabilities and/or consequences of failure.

ROOT INTRUSION IS A SIGNIFICANT CONTRIBUTOR TO I&I IN SEWER PIPES

A related issue facing wastewater service providers in Oregon is inflow and infiltration (I&I) of groundwater and stormwater into the conveyance system through deficiencies such as cracks, separated pipe joints, and roots that have pushed their way into the sewers. During the Oregon wet season (November-March), it is not uncommon for communities to experience loadings five to seven times their normal dry-season flows due to I&I, but flows 20 times normal dry weather flows are not unheard of. If not addressed, these deficiencies leave the conveyance system vulnerable to I&I that can lead to excessive loading on downstream treatment processes, reducing the facility's ability to completely treat the wastewater received before it is discharged.

According to the Oregon Department of Environmental Quality (DEQ), there are 198 Publicly Owned Treatment Works (POTWs) regulated through the National Pollutant Discharge Elimination System (NPDES) permit program to treat domestic sewage, meaning that they discharge from a point source to state waters. There are nearly 50 additional public facilities that operate under Water Pollution Control Facility (WPCF) permits to discharge wastewater effluent to land. Roughly, 30 percent of Oregon households do not have access to public sewer services and must rely on on-site treatment (septic) systems to manage their domestic wastewater. There are no strong regulatory drivers for diligent tracking of septic system conditions, and issues often go unnoticed until failure occurs. It is estimated that as many as 10 percent of on-site septic systems (~45,000 systems) fail each year. Ineffective treatment or capture in any percentage of these systems poses a significant environmental and public health threat to Oregon.

Oregon has a significant need for wastewater system improvements to address both capacity and condition deficiencies. The most pressing needs for wastewater infrastructure in Oregon include those for rehabilitation or replacement of existing conveyance assets beyond their useful service life, treatment plant expansions to accommodate increased system loads, and treatment plant upgrades to replace failing mechanical systems or meet new permit conditions. The correlation between capacity and condition cannot be separated and should be considered in every future planning effort concerning repairs and upgrades.

The importance of addressing these wastewater infrastructure deficiencies cannot be overstated. Failure of wastewater infrastructure (public or septic systems) can have serious, wide-reaching impacts on humans, wildlife, and our environment. Failures can lead to contamination of groundwater, surface water, or marine water sources, making them unsafe for drinking, recreational use, shellfish harvesting, and agricultural uses. They can also pose risks to human health and create life-threatening conditions for aquatic species.

O&M

Especially for smaller communities, a lack of existing system knowledge makes it very challenging to plan ahead for system operation and maintenance needs, and the resulting reactive (versus proactive) approach inevitably leads to increased spending on emergency maintenance and repairs.

As discussed in the *Condition and Capacity* section of this report, I&I entering the system dramatically increases the volume of wastewater that conveyance systems must accommodate and treatment plants are required to treat during periods of wet weather. As a result, treatment plants must be grossly oversized to accommodate seasonal flow volumes, and service providers must have two separate operating strategies: one for wet weather season and one for dry weather season. System work required during the wet season quickly becomes more expensive, as staff must account for high system flows and increased consequences of failure. While sometimes emergency repairs are inevitable, a more proactive approach to identifying and addressing defects would help minimize risks and reduce costs of repairs by allowing them be completed, whenever possible, during months with lower system loadings when pipelines and treatment components are more easily taken offline. Improved asset management and replacement planning for conveyance and treatment systems is critical to reducing the need for reactive (and more expensive) maintenance approaches.

AERATION BASIN AT CLEAN WATER SERVICES DURHAM WWTF

FUNDING & FUTURE NEED

The population of Oregon has grown by just over 11 percent in the last nine years, from 3.83 million in the 2010 census to an estimated 4.2 million in 2019. Approximately 1.40 million of the total state population (32.8 percent) is concentrated in Multnomah, Clackamas, and Washington Counties, with the largest City being Portland, which is home to nearly 15 percent of the state population. Based on a 2015 survey, ratepayers were, on average, paying $43.84 per 5,000 gallons, which works out to be about $0.01/gallon of wastewater discharged into the system. Other means of funding comes from connection charges and development charges, but service providers are still facing massive gaps between available revenue and funds required to meet minimum conditions of their permits.

Especially in smaller communities, there are inadequate rate-payer bases to support what larger service providers often view as basic program needs (e.g. development of digitized asset databases, regular asset condition assessments, etc.). Some rural communities are also limited by the demographic of their service population. For example, affordability of service is imperative in communities with a large retirement population with fixed incomes. Additional sources of funding are critical to bridging the gap between available revenues and funds needed to address the full gambit of infrastructure needs.

The League of Oregon Cities completed a survey in 2016 to determine estimated infrastructure investment needs. Based on responses from 120 cities representing 85 percent of the state population living in cities, an estimated $4.4 billion investment is needed for repair, replacement, or capacity expansions for water quality capital projects (e.g. wastewater treatment, stormwater facilities, water reuse, etc.) in the next 20 years. The total estimated investment need for Oregon's wastewater infrastructure is likely more than $5 billion when needs for cities that did not respond to the survey are accounted for.

System extensions are often driven by and paid for by new developments. However, responsibility for upsizing older portions of the system that are not designed to handle increased loads resulting from new developments falls on the wastewater service provider. A majority of wastewater service providers rely heavily on loans and grants to subsidize system improvements and treatment plant expansions. Costs for new extensions driven by development are typically covered by the development companies and in the case of housing developments, are passed off to benefitting property owners upon purchase of the property

One of the most well-known sources for financing is the Oregon Clean Water State Revolving Fund (OCWSRF), which provides technical assistance and below-market rate loans for planning, design and construction projects related to stormwater and wastewater. In 2018, the OCWSRF issued a total of $75,306,681 in loans to 11 communities (six small communities, four large communities, and one irrigation district). The state also operates a Circuit Rider Program through the OCWSRF to provide up to 10 hours of on-site technical services (per issue) for community water systems that service populations under 10,000 people. Wastewater service providers often have to sell bonds to acquire funds for larger projects or secure other funding sources from resources such as the Oregon Business Development Department (OBDD), Oregon Association of Water Utilities (OAWU), Oregon Water Resources Department (OWRD), United States Department of Agriculture (USDA), the Rural Community Assistance Corporation, U.S. Department of Commerce Economic Development Administration (EDA), and the Oregon Health Authority (OHA). All of these programs are highly competitive, and in some cases, it can be a challenge for service providers to find resources necessary to collect required data and get through the application processes.

RESILIENCE & INNOVATION

The concentration of Oregon's wastewater infrastructure is west of the Cascade Mountains and founded upon alluvial soils with varying degrees of susceptibility to failure in an earthquake. Without complete replacement of all pipes designed without seismic considerations, there is no way to achieve actual resiliency in the worst-case scenario. The best opportunities for improving resiliency come from investment in planning and construction that focuses on providing redundancy for critical infrastructure. Oregon has only recently increased its consciousness on this front, leaving most infrastructure outdated. However, there are now construction codes and emergency preparedness planning efforts in the works to improve seismic resiliency.

PROJECTS IN DEVELOPED AREAS REQUIRE ADDITIONAL PLANNING AND EXPENSE TO MINIMIZE DISTURBANCE TO BUSINESSES AND RESIDENTS.

Wastewater managers are tasked with the responsibility to provide adequate system functionality to allow residents to survive the months following a natural disaster. Master plans must include the identification of critical conveyance paths and facilities so that all projects within that system can attempt to improve the robustness of those paths, if possible. There are many examples of WW master plans in Oregon that do incorporate seismic response, but it has yet to be confirmed to what degree the practice is being implemented.

A majority of the smaller wastewater service providers do not have the resources to focus on innovation in their systems. Instead, they rely on programmatic approaches and technologies that have been proven over time to be reliable. However, the service providers for mid to large size communities have made investments in innovative technologies and concepts. For example, through investments in energy recovery and production, the City of Gresham now generates enough energy on-site to sustain operations of their wastewater treatment plant, saving them an estimated $500,000 annually in electricity costs. The City of The Dalles also invested in energy recovery technology, with funding support from the OCWSFR.

Another area of focus for innovation in Oregon is direct potable reuse, which is the recycling of treated wastewater derived from domestic and industrial sources for beneficial purposes. This initiative is largely driven by the threat of water shortages from increasingly common drought conditions in the pacific northwest. One of the largest barriers is public perception of using wastewater effluent for potable applications. Clean Water Services, a water resources management utility in Hillsboro, OR, has launched a public awareness campaign called Clean Water Brew which puts wastewater effluent through additional ultra-purification processes and provides it to local brewers to make beer for the Pure Water Brew Challenge. The purpose is to "demonstrate an innovative solution to preserve clean water, now and in the future" and highlight the capabilities of modern technologies that allow safe direct potable reuse to be a reality for the future.

CO-GENERATORS AT THE CITY OF GRESHAM WASTEWATER TREATMENT PLANT CONVERT BIOGAS INTO HEAT AND ELECTRICITY - ENOUGH TO HEAT THE PLANT AND PRODUCE 5.2 MILLION KWH OF ELECTRICITY A YEAR, SAVING THE PLANT $500,000 A YEAR ON ELECTRICITY.

RECOMMENDATIONS TO RAISE THE GRADE

- Raise awareness of the true cost of wastewater conveyance and treatment, as well as for the implications of inadequate investment in wastewater conveyance and treatment systems. Utility rates should cover the full cost of service including operation, maintenance and capital costs.
- Provide assistance to smaller communities to help them identify and apply for available loan and grant programs
- Preserve tax exempt municipal bond financing. Low-cost access to capital helps keep lending for wastewater upgrades strong and accessible for communities large and small.
- Utilities should improve asset management programs and replacement planning strategies to ensure efficient use of rate-payer dollars and promote a proactive approach to system maintenance and repairs.
- Service providers should perform comprehensive rate studies to increase rates and development charges to a level that closes the funding gap over time.

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